12th international conference

celda 2015

cognition and exploratory learning in digital age

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language
memory
expertise
observation
technology
focus
knowledge
creativity
emotion

24 to 26 October 2015
Maynooth, Greater Dublin, Ireland

Proceedings

Edited by:
Demetrios G. Sampson,
J. Michael Spector,
Dirk Ifenthaler and
Pedro Isaias

iadis
international association for development of the information society

12^{th} INTERNATIONAL CONFERENCE
on

COGNITION AND EXPLORATORY LEARNING IN THE DIGITAL AGE (CELDA 2015)

PROCEEDINGS OF THE
12th INTERNATIONAL CONFERENCE
on
COGNITION AND EXPLORATORY LEARNING IN THE DIGITAL AGE (CELDA 2015)

MAYNOOTH, GREATER DUBLIN, IRELAND

OCTOBER 24-26, 2015

Organised by

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International Association for Development of the Information Society

Co-Organised by

Maynooth University
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Edited by Demetrios G. Sampson, J. Michael Spector,
Dirk Ifenthaler and Pedro Isaías

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FOREWORD

These proceedings contain the papers of the 12th International Conference on Cognition and Exploratory Learning in the Digital Age (CELDA 2015), 24-26 October 2015, which has been organized by the International Association for Development of the Information Society (IADIS), co-organized by Maynooth University, Ireland, and endorsed by the Japanese Society for Information and Systems in Education (JSISE).

The CELDA 2015 conference aims to address the main issues concerned with evolving learning processes and supporting pedagogies and applications in the digital age. There have been advances in both cognitive psychology and computing that have affected the educational arena. The convergence of these two disciplines is increasing at a fast pace and affecting academia and professional practice in many ways.

Paradigms such as just-in-time learning, constructivism, student-centered learning and collaborative approaches have emerged and are being supported by technological advancements such as simulations, virtual reality and multi-agents systems. These developments have created both opportunities and areas of serious concerns. This conference aims to cover both technological as well as pedagogical issues related to these developments. Main tracks have been identified. However innovative contributions that do not easily fit into these areas will also be considered as long as they are directly related to the overall theme of the conference – cognition and exploratory learning in the digital age.

The following areas are represented in the submissions for CELDA 2015:

- Acquisition of expertise
- Assessing progress of learning in complex domains
- Assessment of exploratory learning approaches
- Assessment of exploratory technologies
- Cognition in education
- Collaborative learning
- Educational psychology
- Exploratory technologies (simulations, VR, i-TV, etc.)
- Just-in-time and Learning-on-Demand
- Learner communities and peer-support
- Learning communities & Web service technologies Pedagogical issues related with learning objects
- Learning paradigms in academia
- Learning paradigms in the corporate sector
- Life-long learning
- Student-centered learning
- Technology and mental models
- Technology
- Learning and expertise
- Virtual university

The CELDA 2015 Conference received 92 submissions from more than 23 countries. Each submission was reviewed in a double-blind review process by at least two independent reviewers to ensure quality and maintain high standards. Out of the papers submitted, 31 were accepted as full papers for an acceptance rate of 34%; 28 were accepted as short papers and 6 were accepted as reflection papers. Authors of the best published papers in the CELDA 2015 proceedings will be invited to publish extended versions of their papers in a book from Springer.

In addition to the presentation of full papers, short papers and reflection papers, the conference also includes a keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Professor Mary J. Bishop, Director, Center for Academic Innovation, University System of Maryland, USA, as the CELDA 2015 keynote speaker.

A successful conference requires the effort of many individuals. We would like to thank the members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We are especially grateful to the authors who submitted their papers to this conference and to the presenters who provided the substance of the meeting. We wish to thank all members of our organizing committee.

Last but not least, we hope that participants enjoy Maynooth and their time with colleagues from all over the world.

Pedro Isaías, Universidade Aberta (Portuguese Open University), Portugal
Conference Chair

Demetrios G Sampson, Curtin University, Australia
J. Michael Spector, University of North Texas, USA
Dirk Ifenthaler, University of Mannheim, Germany and Deakin University, Australia
Program Co-Chairs

Rose Dolan, Maynooth University, Ireland
Local Organizing Chair

Maynooth, Greater Dublin, Ireland
October 2015

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KEYNOTE LECTURE

INSTRUCTIONAL MESSAGE DESIGN: PAST, PRESENT, AND FUTURE RELEVANCE

Professor Mary J Bishop,
Director, Center for Academic Innovation,
University System of Maryland, USA

Abstract

Instructional message design explores how various media and delivery systems might be used more effectively to help optimize instructional communications within context-specific instructional situations and learner needs. But use of the term appears to have fallen out of favor over the years since the mid-1990s. A review of the historical and theoretical foundations of instructional message design reveals that, while instructional design generally has shifted from objectivist to more constructivist perspectives on learning theory, the instructional message design field remains firmly rooted in early "transmission oriented" communications models. It appears that instructional message design has also suffered from definitional problems as well, with more recent narrow views of the field focused on media attributes supplanting earlier broad views of the field as an applied "linking science" between theory and practice. And, finally, while findings from studies on media attributes provide designers with some guidance for generally what will not work in terms of cognitive processing, the guidelines seldom shed light on what one should actually do within a particular learning context. Re-establishing instructional message design as a valid area of inquiry within the field of instructional design will require catching up with recent philosophical shifts in communication theory while adjusting our definitions and research foci accordingly.

In this presentation I will briefly revisit instructional message design's objectivist learning theory and transmission-oriented communication theory foundations, discuss current trends and issues being raised in the literature, and explore ways the field might continue to serve as a "linking science" between learning theory and instructional practice. I will conclude with recommendations for a revised guiding theoretical framework based in conversation theory, a broader definitional focus that looks at more than just optimizing cognitive processing, and a new systems view of our approach to research in this area.

Full Papers

TOWARDS A METADATA SCHEMA FOR CHARACTERIZING LESSON PLANS SUPPORTED BY VIRTUAL AND REMOTE LABS IN SCHOOL SCIENCE EDUCATION

Panagiotis Zervas[1], Eleftheria Tsourlidaki[2], Sofoklis Sotiriou[2] and Demetrios G. Sampson[1,3]
[1]*Information Technologies Institute (ITI), Centre for Research and Technology Hellas (CERTH)*
6th km Charilaou-Thermi Rd,, GR 57001, Thessaloniki, Greece
[2]*Ellinogermaniki Agogi, Dimitriou Panagea Str. GR 153 51 Pallini Attikis, Athens, Greece*
[3]*School of Education, Curtin University, Kent Street, Bentley WA 6102, Australia*

ABSTRACT

Technological advancements in the field of World Wide Web have led to a plethora of remote and virtual labs (RVLs) that are currently available online and they are offered with or without cost. However, using a RVL to teach a specific science subject might not be a straightforward task for a science teacher. As a result, science teachers need to be able to find existing lesson plans supported by RVLs (designed by other science teachers), so as to (a) be informed on how specific RVLs can be used in the context of a science education lesson and (b) be inspired and possibly adapt existing lesson plans supported by RVLs to cover their specific teaching needs. The most common way to facilitate this process using web technologies is to (a) characterize lesson plans with appropriately selected educational metadata and (b) to build a web repository that collects the metadata descriptions of lesson plans following a common metadata schema and offers search and retrieval facilities. Within this context, the scope of this paper is twofold: (a) to propose a metadata schema that can be used for characterizing school science education lesson plans supported by RVLs and (b) to validate this metadata schema with 82 European school science teachers that was performed in the framework of a major European Initiative namely, the Go-Lab project, so as to identify which metadata elements are considered important when science teachers are searching in web-based repositories.

KEYWORDS

School education, science education, inquiry-based learning, remote lab, virtual lab, web-based repository, metadata schema, lesson plan, validation study

1. INTRODUCTION

Remote and Virtual Labs (RVLs) constitute significant educational tools for supporting science teachers in their daily teaching practice, especially when adopting the inquiry-based teaching model (de Jong et al., 2013). In particular, remote labs provide teachers with the opportunity to engage their students in the process of data collection data from a real physical laboratory, including real equipment from remote locations (Gomes & Bogosyan, 2009), whereas virtual labs constitute interactive environments for designing and conducting simulated experiments (Balamuralithara, & Woods, 2009). However, using a RVL to teach a specific science subject might not be a straightforward task for a science teacher, especially a novice one (Govaerts et al., 2013). As a result, science teachers could benefit from having access to existing lesson plans supported by RVLs (developed by other science teachers), so as to (a) be informed on how specific RVLs can be used in the context of a science inquiry-based education lesson and (b) be inspired and possibly adapt existing lesson plans supported by RVLs to cover their specific teaching needs. A lesson plan describes how a lesson should take place, which planned activities will be executed by students (individually or at groups) and teachers/tutors, the order in which the activities are planned to be executed, the required contextual conditions within which the activities will be executed, how learners will be grouped (if appropriate) and which educational resources and/or tools will be used for each activity (Van Es & Koper, 2005).

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A key problem then emerges on how to support school science teachers to select and find lesson plans supported by RVLs in an efficient (that is, easily via simple web-based searches) and effective (that is, according to their teaching needs and conditions) way. The most common way to address this need by using web technologies is to:

- Characterize lesson plans with appropriately selected educational metadata (Dagienė & Kubilinskienė, 2010; Battigelli & Sugliano, 2009)
- Build a web application that facilitate lesson plans' search and retrieval according to a specific user (that is, science teacher) defined requests, i.e. searching with specific elements of lessons plans such as subject domain, educational objectives or age range addressed. Such applications are typically build in the form of a web repository that collects the metadata descriptions of lesson plans following a common metadata schema and offers search and retrieval facilities (Dong et al., 2009)

Within this context, the scope of this paper is twofold: (a) to propose a metadata schema that can be used for characterizing lesson plans supported by RVLs and (b) to validate this metadata schema with 82 European school science teachers that was performed in the framework of a major European Initiative namely, the Go-Lab project[1], so as to identify which metadata elements are considered important when science teachers are searching for lesson plans supported by RVLs in web-based repositories.

The remainder of the paper is structured as follows. Following this introduction, section 2 reviews existing repositories of school education science lesson plans supported by RVLs and performs an analysis of the metadata elements used by these repositories towards identifying common metadata elements. Section 3 presents the proposed metadata schema for characterizing RVL-supported school science education lesson plans, which consists of the synthesis of the metadata elements identified in section 2. Section 4, presents the methodology that was followed for validating the proposed metadata schema. Section 5 presents and discusses the validation results. Finally, we discuss our main conclusions and our future work in this agenda

2. REVIEW OF REPOSITORIES OF LESSON PLANS SUPPORTED BY RVLS

The aim of this section is to review existing repositories of school science education lesson plans supported by RVLs and identify common metadata elements used for characterizing these lesson plans. A set of ten (10) repositories is reviewed. These repositories have been selected because their purpose is twofold: (a) they store and provide searching facilities for RVLs and (b) they store and provide searching facilities for lesson plans supported by these RVLs. As a result, we consider them as the most appropriate for review towards defining our proposed metadata schema. Table 1 presents the existing repositories that were reviewed, the number of lesson plans that they store (at the time of our study), as well as the number of metadata elements used by each repository for characterizing its lesson plans.

Table 1. Overview of Existing Repositories of Lesson Plans supported by RVLs

No	Name	Repository URL	# Lesson Plans[2]	# Metadata Elements used
1	PhET	http://phet.colorado.edu	552	13
2	Labshare	http://www.labshare.edu.au/	12	13
3	Explore Learning	http://www.explorelearning.com	478	13
4	Open Sources Physics	http://www.compadre.org/osp	355	12
5	Lab2Go	http://www.lab2go.net	**N/A**	11
6	ChemCollective	http://www.chemcollective.org/	55	10
7	Intel Education Resources - STEM	http://inteleducationresources.intel.co.uk/index.aspx	264	10
8	iLabCentral	http://ilabcentral.org	21	10
9	Molecular Workbench	http://mw.concord.org/	75	3
10	Remotely Controlled Laboratories (RCL)	http://rcl-munich.informatik.unibw-muenchen.de	17	3

[1] http://www.go-lab-project.eu/

[2] Data retrieved on 22/5/2015

As Table 1 depicts, the number of metadata elements used by the different repositories to characterize the RVL-supported school science education lesson plans that they store, varies from a small number of elements (namely, 3 elements) to a larger number of elements (namely, 13 elements). This is due to the fact that each repository uses its own customized metadata schema for characterizing the RVL-supported school science education lesson plans that it stores without following a specific metadata standard (such as IEEE LOM (IEEE LTSC, 2005)). As a result, some of the metadata schemas adopted by the examined repositories are richer than others. Moreover, in some cases a metadata element used by the metadata schema adopted by one repository might not be used by others. To this end, in order to come up with an initial proposal about a metadata schema of lesson plans supported by RVLs, we harmonized the lesson plan's metadata elements used by the repositories presented in Table 1 and we produced a master list (comprising a synthesis of the different metadata elements used by the examined repositories), which is presented in the next section.

3. PROPOSED METADATA SCHEMA OF LESSON PLANS SUPPORTED BY RVLS

As already mentioned, the starting point for developing our proposed initial metadata schema was the outcomes of the study of the metadata schemas of existing repositories of RVL-supported science education lesson plans presented in section 2. Table 2 presents our proposed initial metadata schema which consists of the synthesis of metadata elements identified from the review presented in section 2. Moreover, Table 2 presents for each metadata element the frequency of use at the repositories that were reviewed in section 2.

Table 2. Proposed Metadata Schema of Lesson Plans supported by RVLs

No	Element Name	Description	Taxonomy Available?	Usage Frequency
1	Title	This metadata element refers to the title of the lesson plan	No	10 (100%)
2	URL	This metadata element provides a URL for accessing the lesson plan	No	10 (100%)
3	Description	This metadata element provides a textual description of the lesson plan	No	8 (80%)
4	Subject Domain	This metadata element refers to the lesson plan's subject domain	Yes	8 (80%)
5	Lab(s) Used	This metadata element denotes the online labs used in the lesson plan	Yes	8 (80%)
6	Owner(s) and Contributor(s)	This metadata element provides information about the owner, as well as entities that have contributed to the authoring of the lesson plan	No	8 (80%)
7	Additional Materials included	This metadata element describes additional supportive material that can facilitate teachers to deliver the lesson (based on the lesson plan) and students to execute the lesson	No	8 (80%)
8	Language(s)	This metadata element refers to the languages that the lesson plan is available in.	Yes	7 (70%)
9	Age Range	This metadata element refers to the age range for which the lesson plan can be used.	Yes	7 (70%)
10	Keyword(s)	This metadata element refers to a set of terms that characterize the content of the lesson plan	No	5 (50%)
11	Status	This metadata element provides information about the current status of the lesson plan.	Yes	4 (40%)
12	Educational Objectives	This metadata element refers to the educational objectives that the lesson plan addresses	Yes	3 (30%)
13	Organizational Requirements	This metadata element refers to the requirements that are needed in order to carry out the lesson plan without troubleshooting.	No	3 (30%)
14	Level of Difficulty	This metadata element refers to the level of difficulty of the lesson plan.	Yes	2 (20%)
15	Average Learning Time	This metadata element refers to the amount of time that the lesson plan requires in order to be completed	Yes	2 (20%)
16	Group Learning Method used	This metadata element indicates whether the lesson plan follows a specific group learning method (such as jigsaw, changing hats etc)	Yes	2 (20%)
18	Access Rights	This metadata element refers to the lesson plan's access permissions	Yes	1 (10%)
18	Level of Interaction	This metadata element refers to the level of interaction the lesson plan offers in terms of (a) variables manipulation during experimentation and (b) interaction and collaboration with peers	Yes	1 (10%)
19	Students' prior Knowledge	This metadata element refers to students' prior knowledge in order to execute the lesson	Yes	1 (10%)

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As we can notice from Table 2, our proposed initial metadata schema includes 19 metadata elements. 10 out of 19 metadata elements are used in more than fifty percent (50%) of the repositories that were reviewed in section 2, whereas 9 out of 19 metadata elements are used in less than fifty percent (50%) of the reviewed repositories. The proposed metadata schema has been used for storing and classifying lesson plans in a web-based repository, namely the Go-Lab Repository (http://www.golabz.eu/) developed in the framework of the Go-Lab Project and presented in (Dikke et al., 2014). The Go-Lab project (http://www.go-lab-project.eu/) aims to establish an online portal, namely the Go-Lab Portal that will facilitate the federation of existing virtual and remote labs (de Jong et al., 2014; Govaerts et al., 2013). In the context of the Go-Lab project, a lesson plan comprises (a) a set of technology-supported activities structured in inquiry phases that follow parts of the full inquiry-based teaching model and they are executed individually by the students with the support of the Go-Lab Portal and the RVLs that includes (this set of activities is referred to as an inquiry learning space-ILS) and (b) a set of supplemental activities to the aforementioned technology-supported activities, which are not supported by technology and they are executed by the teacher or the students (individually or at groups) (de Jong et al., 2014). The Go-Lab Repository is part of the Go-Lab portal, it has been populated with 137[3] RVL-supported science education lesson plans, and provides functionalities for facilitating search and retrieval of these lesson plans by school science teachers.

4. VALIDATING THE PROPOSED METADATA SCHEMA OF LESSON PLANS SUPPORTED BY RVLS

4.1 Related Studies

In order to develop our methodology for validating our proposed metadata schema, we reviewed existing works on validating metadata schemas with real users Since there are not related works that focus on validating metadata schemas for lesson plans supported by RVLs, the review is performed on related works for validating metadata schemas for educational resources in general. Table 3, presents briefly these studies along with their basic parameters.

Table 3. Studies on Validating Metadata Schemas of Educational Resources

Study	Application Domain	Validation Instrument	Users
Palavitsinis et al. (2009)	Agriculture and Agroecology	Questionnaire	Subject Domain Experts
Krull et al. (2006)	Interdisciplinary	Questionnaire	Teachers/Trainers
Howarth (2003)	Interdisciplinary	Questionnaire	Subject Domain Experts and Teachers/Trainers
Carey et al. (2002)	Interdisciplinary	Questionnaire & Interview	Subject Domain Experts

As we can notice from Table 3, commonly used validation instruments are questionnaires through which end-users (teachers/trainers or subject domain experts) are asked to validate one by one the various metadata elements of the proposed metadata schema. As a result, a similar methodology has been followed in our case and it is described in details in the next section.

4.2 Study Methodology

4.2.1 Sample

The study was conducted with N=82 European School science teachers who were invited to be part of the Go-Lab Project pilot activities. Our sample included school science teachers from thirteen (13) European member states. Moreover, in our sample there was a gender balance between the participants (52% female, 48% male). The majority of the participants were experienced science teachers (69% of the participants had more than 6 years of teaching experience). Furthermore, almost all science education school teachers in our

[3] Data retrieved on 13/7/2015

sample were experienced in using ICT for their daily teaching activities and the majority of them had previous experience in working with RVLs (66% using virtual labs and 23% using remote labs). Finally, 61% of them have at least a master's degree. Thus, overall we consider that our sample is well selected for the purpose of our study.

4.2.2 Procedure

In order to validate the proposed metadata schema, we provided to the participated science teachers a questionnaire. The aim of the questionnaire was to collect participants' opinions on the importance of certain metadata elements from our proposed metadata schema. More precisely, the teachers were asked to rate each metadata element with a five-point like scale, where 1 denotes "low importance" and 5 denotes "high importance" for the following there different contexts of use: (a) importance of metadata elements within the context of "*making a general search for lesson plans*" in the Go-Lab repository, (b) importance of metadata elements within the context of "*filtering search results for lesson plans*" in the Go-Lab repository and (c) importance of metadata elements within the context of "*viewing the preview page of a Go-Lab lesson plan*" in the Go-Lab repository

It should be noted that out of the 19 elements that are part of the metadata model, 17 were included in the questionnaire. Elements such as "Location URL" and "Description" were not included in the questionnaire, because we consider them essential for our proposed metadata model and thus no further investigation was needed on validating their importance. In order to receive feedback from the participants based on the questionnaire that was designed, appropriate workshops were organized that had the following structure:

- **During the workshops:** all participants attended a demonstration of the Go-Lab repository. More specifically, the main functionalities of the repository, as well as the search and retrieval facilities were presented, along with the lesson plans that were stored in the repository. Moreover, all participants could navigate within the Go-Lab repository during the workshop, through their personal devices (laptops or tablets) and use it themselves directly. Thus, they had a concrete idea of how lesson plan's metadata elements have been deployed within the Go-Lab repository.
- **After the workshops:** all participants were asked to rate the lesson plan's metadata elements by completing the designed questionnaire.

5. RESULTS

This section presents quantitative data analysis results for participants' feedback regarding the importance of lesson plan's metadata elements (see Table 4) for the different contexts of use (as described in section 4.2.1).

Table 4. Ranking of the Importance of Metadata Elements

Ranking	Making a General Search			Filtering Search Results			Viewing the Preview Page		
	Metadata Element	**Mean**	**SD**	**Metadata Element**	**Mean**	**SD**	**Metadata Element**	**Mean**	**SD**
1	Title	4,39	0,84	Title	4,40	0,68	Lab(s) used	4,45	0,69
2	Subject Domain	4,28	0,91	Keyword(s)	4,38	0,75	Title	4,39	0,86
3	Keyword(s)	4,18	1,06	Language(s)	4,30	0,87	Subject Domain	4,22	0,95
4	Lab(s) used	4,17	0,91	Lab(s) used	4,29	0,79	Language(s)	4,20	0,99
5	Language(s)	4,17	0,83	Subject Domain	4,21	0,77	Keyword(s)	4,16	0,90
6	Age Range	4,15	0,93	Age Range	4,12	0,75	Organizational Requirements	4,09	1,05
7	Educational objectives	3,87	1,05	Organizational Requirements	3,98	0,97	Age Range	4,07	1,00
8	Students' prior knowledge	3,76	1,00	Average learning time	3,96	1,02	Educational objectives	4,01	1,00
9	Average learning time	3,70	1,01	Students' prior knowledge	3,92	1,03	Status	4,01	1,20

10	Organizational Requirements	3,70	0,98	Additional materials included	3,90	1,03	Additional materials	4,00	1,04
11	Status	3,65	1,17	Educational objectives	3,89	0,89	Students' prior knowledge	3,94	1,11
12	Collaborative learning method used	3,63	1,11	Status	3,89	1,14	Average learning time	3,93	1,13
13	Additional materials	3,63	1,04	Level of interaction	3,86	0,97	Level of interaction	3,88	1,07
14	Level of interaction	3,58	0,99	Level of difficulty	3,86	1,05	Collaborative learning method used	3,84	1,12
15	Level of difficulty	3,57	0,99	Collaborative learning method used	3,68	0,95	Level of difficulty	3,77	1,16
16	Access rights	3,43	1,17	Access rights	3,43	1,17	Access rights	3,65	1,27
17	Owner and Contributor(s)	3,10	1,24	Owner and Contributor(s)	3,23	1,24	Owner and Contributor(s)	3,31	1,37

It is worth noticing that no elements received very low score, in fact, the lowest score in average was 3.10 - corresponding to element "Owner and Contributor(s)" (for the context of use related to general search for lesson plans in the Go-Lab repository), which is still on the positive side of the likert scale. Thus, an overall indication could be that none of the metadata elements can be regarded as non-important and our proposed metadata schema can be considered as valid and useful for the science teachers participated in our study. Nevertheless, besides this general indication, it is worth further analyzing the ranking of the metadata elements based on their average score for each context of use. More specifically, as we can notice from Table 4, there are some elements which are highly ranked across all three contexts of use. These elements are (as presented in Table 5): (a) "Title" (1-2-1: ranked 1st for the context of use related to making a general search for lesson plans in the Go-Lab Repository, 1st for the context of use that was related to filtering search results of lesson plans in the Go-Lab Repository and 2nd for the context of use that was related to viewing the preview page of a lesson plan in the Go-Lab Repository), (b) "Lab(s) used" (4-4-1), (c) "Subject Domain" (2-5-3), (d) "Keywords" (3-2-5), (e) "Language(s)" (5-3-4) and (f) "Age Range" (6-6-7).

Table 5. Highly Ranked Lesson Plan Metadata Elements across all three Contexts of Use

No	Metadata Element	General Search (Average Value - Rank)	Filtering (Average Value - Rank)	Preview Page (Average Value - Rank)
1	Title	4,39 (1)	4,40 (1)	4,39 (2)
2	Labs used	4,17 (4)	4,29 (4)	4,45 (1)
3	Subject Domain	4,28 (2)	4,21 (5)	4,22 (3)
4	Keyword(s)	4,18 (3)	4,38 (2)	4,16 (5)
5	Language(s)	4,17 (5)	4,30 (3)	4,20 (4)
6	Age Range	4,15 (6)	4,12 (6)	4,07 (7)

Based on these results presented in Table 5, we can identify that:

- Science teachers are interested in searching lesson plans using the title and the languages used in the lesson plans. This was an expected finding since these elements are very general and they are very important in any type of search performed on web based repositories of educational resources as highlighted by other studies (Tsourlidaki et al., 2015; Palavitsinis et al. 2009; Krull et al. 2006)
- Science teachers are interested in searching lesson plans that are developed around specific online labs that they are probably competent in using.
- Science teachers are interested in searching lesson plans with metadata elements that are mapped to the science curriculum. These elements are 3 out of the 6 most highly ranked elements (namely, subject domain, keywords and age range).

On the other hand, the elements that were ranked low across all three contexts were the following (as presented in Table 6): (a) "Lesson Plan Owner and Contributors" (18-18-18), (b) "Lesson Plan Access Rights" (17-17-17), (c) "Level of Difficulty" (16-14-16) and (d) "Level of Interaction" (15-13-13).

Table 6. Lowest Ranked Lesson Plan Metadata Elements across all three Contexts of Use

No	Metadata Element	General Search (Average Value - Rank)	Filtering (Average Value - Rank)	Preview Page (Average Value - Rank)
1	Owner and Contributor(s)	3,10 (18)	3,23 (18)	3,31 (18)
2	Access Rights	3,43 (17)	3,43 (17)	3,65 (17)
3	Level of Difficulty	3,57 (16)	3,86 (14)	3,77 (16)
4	Level of Interaction	3,58 (15)	3,86 (13)	3,88 (13)

Nevertheless, the average scores (as presented in Table 6) of these metadata did not call for an automatic elimination from the list of metadata elements of our proposed metadata schema. Moreover, we can identify that it makes sense that "Lesson Plan Owner and Contributors" and "Lesson Plan Access Rights" metadata elements are at the bottom of the ranking list since they do not offer rich information in order to facilitate the selection of a certain Lesson Plan, but they are essential in order to give credits to the owner of the offered Lesson Plan and to clarify the access rights in order to avoid legal issues.

6. CONCLUSIONS AND FUTURE WORK

Building on an identified need of science teachers to be able to find and select lesson plans supported by RVLs, in an efficient and effective way, the main contribution of the paper is the proposal for a metadata schema that can be used for characterizing lesson plans supported by RVLs. Moreover, the validation of this metadata schema with 82 European school science teachers demonstrated (a) the added value of the proposed metadata schema and (b) important elements are those that describe the RVLs utilized by a lesson plan, as well as those metadata elements that provide a concrete mapping to the science curriculum (namely, subject domain, keywords and age range).

Future work will focus on two main strands. First, we aim to collect teachers' search logs through the Go-Lab repository and analyze them for validating further the significance of the metadata elements of our proposed metadata schema. Secondly, we aim to combine the proposed metadata schema for lesson plans supported by RVLs with our previous work on describing RVLs with appropriate metadata (Zervas et al., 2014) towards developing decision support systems that will facilitate science teachers to select appropriate RVLs during the lesson planning process. An initial work towards this direction was reported in Zervas et al. (2015) and it could be significantly enhanced by incorporating the results of this study.

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DIVULGING PERSONAL INFORMATION WITHIN LEARNING ANALYTICS SYSTEMS

Dirk Ifenthaler[1] and Clara Schumacher[2]
[1]*University of Mannheim and Deakin University, L4, 1, 68131 Mannheim, Germany*
[2]*University of Mannheim, L4, 1, 68131 Mannheim, Germany*

ABSTRACT

The purpose of this study was to investigate if students are prepared to release any personal data in order to inform learning analytics systems. Besides the well-documented benefits of learning analytics, serious concerns and challenges are associated with the application of these data driven systems. Most notably, empirical evidence regarding privacy issues for learning analytics is next to nothing. A total of 330 university students participated in an exploratory study confronting them with learning analytics systems and associated issues of control of data and sharing of information. Findings indicate that sharing of data for educational purposes is correlated to study related constructs, usage of Internet, awareness of control over data, and expected benefits from a learning analytics system. Based on the relationship between the willingness to release personal data for learning analytics systems and various constructs closely related to individual characteristics of students it is concluded that students need to be equally involved when implementing learning analytics systems at higher education institutions.

KEYWORDS

Learning analytics; higher education; control over data; transparency

1. INTRODUCTION

Massive administrative, systems, academic, and personal data within educational settings and higher education institutions are becoming more and more available. These vast amounts of educational information provide new opportunities to improve administrative decision-making as well as to facilitate learning and instruction. Learning analytics uses dynamic information about learners and learning environments, assessing, eliciting and analyzing it, for real-time modeling, prediction, and optimization of learning processes, learning environments, and educational decision-making (Ifenthaler, 2015).

Serious concerns and challenges are associated with the application of learning analytics (Pardo & Siemens, 2014). For instance, not all educational data is relevant and equivalent. Therefore, the validity of data and its analyses is critical for generating useful summative, real-time, and predictive insights (Macfadyen & Dawson, 2012). Furthermore, limited access to educational data may generate disadvantages for involved stakeholders. For example, invalid forecasts may lead to inefficient decisions and unforeseen problems (Ifenthaler & Widanapathirana, 2014). Moreover, ethical and privacy issues are associated with the use of educational data for learning analytics. That implies how personal data are collected and stored as well as how they are analyzed and presented to different stakeholders (Slade & Prinsloo, 2013).

Currently, most research towards privacy issues in learning analytics refers to guidelines from other disciplines such as Internet security or medical environments (Pardo & Siemens, 2014). However, due to the contextual characteristics of privacy an adoption from other contexts is not recommendable (Nissenbaum, 2004). More importantly, empirical evidence regarding privacy issues for learning analytics is scarce. Therefore, the purpose of this exploratory study was to investigate if students are willing to release any personal data for informing learning analytics systems.

2. RELEASE OF PERSONAL DATA

2.1 Privacy in the Digital World

The most general definition of privacy is freedom from interference or intrusion (Warren & Brandeis, 1890). A legal definition of the concept of privacy is a person's right to control access to his or her personal information (Gonzalez, 2015). More precisely, privacy is a combination of control and limitations, which implies the possibility of individuals to influence the flow of their personal information and to hamper others to access their information (Heath, 2014).

Within the digital world, this view on privacy seems to be no longer valid. Many individuals are willing to share personal information without being aware of who has access to the provided data and how the data will be used as well as how to control ownership of the provided data (Solove, 2004). Accordingly, data are generated and provided automatically through online systems which limits the control and ownership of personal information in the digital world (Slade & Prinsloo, 2013). Only recently, this phenomenon has been adopted by higher education institutions through the implementation of learning analytics.

2.2 Privacy Principles for Learning Analytics

Higher education institutions have always used a variety of data about students, such as socio-demographic information, higher education entrance qualification grades, or pass and fail rates, for academic decision-making as well as resource allocation (Long & Siemens, 2011; Prinsloo & Slade, 2014). Such data can help to successfully predict dropout rates of first-year students and implement strategies to support learning and instruction as well as to retain students (Tinto, 2005).

Accordingly, advanced digital technologies and learning analytics systems enable higher education institutions to collect dynamic real-time data from all student activity within the higher education institutions' systems which offers huge potential for personalized and adaptive learning experiences and support (Berland, Baker, & Bilkstein, 2014). Consequently, higher education institutions are required to address privacy issues linked to learning analytics: They need to define who gets access to which data, where and how long will the data be stored, and which procedures and algorithms are implemented to further use the available data.

Slade and Prinsloo (2013) as well as Pardo and Siemens (2014) established several principles for privacy and ethics in learning analytics. They highlight the active role of students in their learning process, the temporary character of data, the incompleteness of data on which learning analytics are executed, transparency regarding data use, as well as purpose, analyzes, access, control, and ownership of the data. However, empirical evidence toward student perceptions of privacy principles related to learning analytics is lacking.

2.3 Purpose of the Study

Empirical research is currently addressing the validity and effectiveness of learning analytics systems for learning, instruction, and educational decision-making (Ali, Hatala, Gašević, & Jovanović, 2012; Gašević, Dawson, & Siemens, 2015; Ifenthaler & Widanapathirana, 2014). In contrast, ethics and privacy issues in learning analytics are in an early stage of research (Pardo & Siemens, 2014).

In this regard, the purpose of this exploratory study was to investigate if students are willing to release any personal data for informing learning analytics systems and if other constructs such as study interest and use of Internet are related.

It is argued that first year students have to adjust to different learning and teaching requirements, manage workloads and course loads, as well as matching the universities' expectations and personal interest (Bowles, Fisher, McPhail, Rosenstreich, & Dobson, 2014). Learning analytics may provide scaffolds to overcome the before mentioned hurdles especially in the first year of university studies. Specifically, we assume that divulging personal information within learning analytics systems is related to study related constructs such as year of study (Hypothesis 1a), course load (Hypothesis 1b), and study interest (Hypothesis 1c).

Another factor which may influence the use and acceptance of learning analytics are the students' technology competencies (Kennedy, Judd, Churchward, Gray, & Krause, 2008). It is increasingly recognized that a majority of students possess a core set of technology-based competencies, however, no empirical evidence exists how these competencies influence the use and acceptance of learning analytics systems. For example, Trepte, Dienlin, and Reinecke (2013) report that students who frequently use social media tools are more open to disclose personal information in online environments. Therefore, we assume that releasing any personal data for learning analytics systems is related to the students' percentage of use of the Internet for learning (Hypothesis 2a) and social media (Hypothesis 2b).

Students' trust and control with regard to online systems in general and learning analytics systems in particular may be another factor guiding the use and acceptance of learning analytics (Ennen, Stark, & Lassiter, 2015; Nam, 2014). We also assume that student's willingness to provide personal data is related to their anticipated control over data (Hypothesis 3).

Last, students may disclose personal data for learning analytics systems if the overall benefits for learning are greater than the assessed risk of releasing personal data (Culnan & Bies, 2003). We assume that releasing personal data for learning analytics systems is related to the anticipated benefits from a specific learning management system (Hypothesis 4).

3. METHOD

3.1 Participants and Design

The study was designed as an online laboratory study implemented on the university's server and conducted in June 2015. Participants received one credit hour for participating in the study.

The initial dataset consisted of 333 responses. After removing incomplete responses, the final dataset included $N = 330$ valid responses (223 female, 107 male). The average age of the participants was 22.75 years ($SD = 3.77$). The majority of the participants studied in the Bachelors program (80%), with 20% of the participants studying in the Masters program. The average course load in the current semester was 5 courses ($SD = 1.70$). Participants reported that 33% of their Internet use was for learning, 33% was for social networking, 26% for entertainment, and 8% for work.

3.2 Instruments

3.2.1 Study Interest Questionnaire

The study interest questionnaire (FSI; Schiefele, Krapp, Wild, & Winteler, 1993) includes 18 items (Schiefele, Krapp, Wild & Winteler, 1993) which focus on study-related interest such as feeling- and value-related valences as well as intrinsic orientation (Cronbach's $\alpha = .90$). All items were answered on a five-point Likert scale (1 = not at all important; 2 = not important; 3 = neither important nor unimportant; 4 = important; 5 = very important).

3.2.2 Technology Affinity Scale

The technology affinity scale (TAS) focuses on information behavior to indicate educationally relevant activity, such as information seeking and sharing (Mills, Knezek, & Wakefield, 2013). TAS consists of 22 items which were answered on a five-point Likert scale (1 = not at all important; 2 = not important; 3 = neither important nor unimportant; 4 = important; 5 = very important) (Cronbach's $\alpha = .645$).

3.2.3 Control over Data Scale

The control over data scale (COD) focuses on access, control, and use of data in learning analytics systems, including four subscales: 1. Privacy of data (PLA; 5 items; Cronbach's $\alpha = .78$), 2. Transparency of data (TAD; 8 items; Cronbach's $\alpha = .72$), 3. Access of data (AOD; 11 items; Cronbach's $\alpha = .83$), and 4. Terms of agreement (TOA; 6 items; Cronbach's $\alpha = .73$). All items were answered on a five-point Likert scale

(1 = not at all important; 2 = not important; 3 = neither important nor unimportant; 4 = important; 5 = very important).

3.2.4 Sharing of Data Questionnaire

The sharing of data questionnaire (SOD) focuses on specific personal information participants are willing to share in learning analytics systems, such as date of birth, educational history (self and parents), online behavior, academic performance, library usage, etc. The 28 items are answered on a Thurstone scale (1 = agree, 0 = do not agree; Cronbach's α = .74).

3.2.5 Demographic Information

Demographic information included age, gender, Internet usage for learning and social media, years of study, study major, course load, etc.

3.3 Learning Analytics Systems

Three different examples of learning analytics systems were presented to the participants. The first example was based on the Course Signals project including simple visual aids such as completion of assignments, participation in discussion (Pistilli & Arnold, 2010). The second example included a dashboard showing general information about the student, average activities over time (e.g. submissions, learning time, logins, interactivity), and average performance comparison across study major and university. The third example provided detailed insights into learning and performance including personalized content and activity recommendation (e.g. reading materials), self-assessments, predictive course mastery, suggestions for social interaction, and performance comparisons. Participants rated each of the examples regarding acceptance of the learning analytics system and expected benefits for learning (ALA; 10 items; Cronbach's α = .89).

3.4 Procedure

Over a period of two weeks in June 2015, students were invited to participate in the laboratory study which included three parts. In the first part, participants received a general introduction regarding learning analytics and use of personal data in digital university systems. Then they completed the study interest questionnaire (FSI; 18 items; 8 minutes) and the technology affinity scale (TAS; 22 items; 10 minutes). In the second part, participants were confronted with three different learning analytics systems. After a short time to familiarize with each of the learning analytics system, they were asked to rate acceptance and expected use for learning of the learning analytics systems as well as to compare the three different systems (30 minutes). In the third part, participants completed the control over data scale (COD; 30 items; 20 minutes) and the sharing of data questionnaire (SOD; 28 items; 20 minutes). Finally, participants reported their demographic information (14 items; 7 minutes).

4. RESULTS

Table 1 shows the zero-order correlations among the variables with regard to the first set of hypotheses. Students' *study year* was negatively related to their *course load*, as was their percentage of *Internet use for social media*. Students' *study year* was positively related to their percentage of *Internet use for learning*, as was their anticipated *control over data*. Their *study interest* was related to their anticipated *control over data*. Additionally, their percentage of *Internet use for learning* was positively related to their anticipated *control over data* as well as their expected *benefits of the learning analytics system*. Finally, students' anticipated *control over data* was positively related to their expected *benefits of the learning analytics system*.

A hierarchical regression analysis was used to determine whether study related variables (SY, CL, FSI), Internet usage (IUL, IUS), control over data (COD), and expected benefits of learning analytics systems (BLA) were significant predictors of *sharing of data for a specific learning analytics system* (SOD; dependent variable). Table 2 shows the four steps of entering data into the equation. The final regression model explained a statistically significant amount of variance in *sharing of data* (SOD), $\Delta R^2 = .370$, $F(7, 329) = 28.58$, $p < .001$.

Table 1. Descriptives and zero-order correlations for study related variables, Internet usage variables, and data as well as learning analytics related variables ($N = 330$)

Variable	1	2	3	4	5	6	7
1. Study year (SY)	-						
2. Course load (CL)	-.378***	-					
3. Study interest (FSI)	-.008	.071	-				
4. Internet use for learning (IUL)	.123*	-.076	.014	-			
5. Internet use for social media (IUS)	-.156**	.023	-.066	-.032	-		
6. Control over data (COD)	.141**	-.038	.111*	.290***	.007	-	
7. Benefits of learning analytics system (BLA)	.076	-.017	-.009	.630***	-.006	.362***	-
M	3.58	5.36	2.99	35.00	32.95	2.71	3.13
SD	2.30	1.70	.28	21.21	20.43	.39	.97

Note. * $p < .05$, ** $p < .01$, *** p < .001

Table 2. Regression analysis predicting sharing of data on study related variables, Internet usage, control over data, and expected benefits of learning analytics systems ($N = 330$)

	R^2	ΔR^2	*B*	*SE B*	*β*
Step 1	.038	.029			
Study year (SY)			.538	.170	.186**
Course load (CL)			-.081	.231	.726
Study interest (FSI)			-.094	1.295	.942
Step 2	.322	.311			
Study year (SY)			.432	.145	.149**
Course load (CL)			.010	.195	.002
Study interest (FSI)			-.127	1.093	-.005
Internet use for learning (IUL)			.165	.014	.525***
Internet use for social media (IUS)			.040	.015	.122**
Step 3	.352	.340			
Study year (SY)			.366	.143	.127*
Course load (CL)			-.005	.191	-.001
Study interest (FSI)			-.609	1.077	-.026
Internet use for learning (IUL)			.149	.015	.474***
Internet use for social media (IUS)			.037	.015	.114*
Control over data (COD)			3.144	.806	.185***
Step 4	.383	.370			
Study year (SY)			.373	.140	.129**
Course load (CL)			-.035	.186	-.009
Study interest (FSI)			-.376	1.054	-.016
Internet use for learning (IUL)			.106	.018	.339***
Internet use for social media (IUS)			.037	.014	.113*
Control over data (COD)			2.339	.813	.138**
Benefits of learning analytics system (BLA)			1.606	.400	.234***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Specifically, students' study year (SY) positively predicted their willingness to share personal data for a specific learning analytics system (SOD), indicating that the higher the study year (SY), the higher the students' liberality to provide personal data for educational purposes. Accordingly, Hypothesis 1a is accepted.

The percentage of Internet usage for learning (IUL) and social media (IUS) positively predicted the students' release of personal data for learning analytics purposes (SOD), indicating the higher the usage of the Internet for learning and social media, the higher their disposition to share personal data for learning analytics systems. Hence, Hypotheses 2a and 2b are accepted.

The student' awareness about control of data (COD) positively predicted their preparedness to share personal data for a specific learning analytics system (SOD), indicating that the higher the awareness about the control of personal data, the higher their disposition to share personal data for learning analytics systems. Thus, Hypothesis 3 is accepted.

The expected benefits of a learning analytics system (BLA) positively predicted the students' release of personal data for learning analytics purposes (SOD), indicating the higher the expected benefit of the learning analytics system, the higher the readiness to provide personal data for learning analytics purposes. Consequently, Hypothesis 4 is accepted. As shown in Table 2, no significant correlations were found for course load (CL) and study interest (FSI). So, Hypotheses 1b and 1c are rejected.

5. DISCUSSION

At a time of growing interest in learning analytics systems of higher education institutions, it is important to understand the implications of privacy principles to ensure that implemented systems are able to facilitate learning, instruction, and academic decision-making and do not impair students perceptions of privacy. To a large extend, students are the producers of data used in learning analytics systems, however, passive recipients of information provided in dashboards (Prinsloo & Slade, 2014).

The findings of this exploratory study highlight an overall interest of students in learning analytics systems. As students mature in their higher education studies they seem to be more aware of the context of sharing educational data (Bailey, Ifenthaler, Gosper, Kretzschmar, & Ware, 2015). To make the benefits of learning analytics and emphasize the need of sharing data within the learning analytics system to first year students, tutoring systems and/or training sessions need to be implemented accordingly.

Students spend a large amount of time for using the Internet for learning and social media activities. Not surprisingly, spending time on the Internet is associated with the openness of sharing data for learning analytics systems. This effect may be explained by trust students generate with regard to online systems in general and learning analytics systems in particular (Ennen et al., 2015). The relationships between perceived control over personal data and expected benefits as well as sharing personal data is closely related to the phenomenon of trust (Nam, 2014). These findings indicate that a high computer literacy is prerequisite for the acceptance of learning analytics as well as the willingness to share data and should be systematically trained.

From a holistic point of view, learning analytics may provide multiple benefits for higher education institutions and for involved stakeholders and different data analytics strategies can be applied to produce summative, real-time and predictive insights (Ifenthaler, 2015). For example, students may use *summative learning analytics* implemented as an interactive dashboard to analyze learning outcomes of individual courses after completing a semester of study or track their progress towards self-defined goals (e.g., credit points). Students may also be able to compare their own learning paths and outcomes between individual units or courses. This may enable students to understand their learning habits and to adjust their learning strategies as well as private habits in order to be successful in their studies. On the same dashboard or within a learning management system, students may receive *real-time learning analytics information* based on their currently available data. Automated interventions may point them to learning materials and tips for progressing further in a particular study unit. Students may take self-assessment on a specific topic and receive just-in-time feedback or get recommendations to participate in online discussions or connect to peers using preferred social media. *Predictive learning analytics* for students may help to optimize the learning path in a specific study unit by providing them probabilities of success when choosing a particular pathway. Such predictions are expected to increase the overall engagement and success rates of students (Ifenthaler, 2015).

However, reliable and valid learning analytics systems require rich and current information of students including personal characteristics and preferences, academic performance, educational pathways and logfiles of various online learning systems. If the underlying learning analytics algorithms do not have access to the required information, the above-described benefits cannot be produced. While higher education institutions implement learning analytics systems, students may find themselves in a dilemma situation concerning the divulgence of personal information for learning analytic systems. In order to overcome such a dilemma situation, it is necessary to provide students transparency of the implemented learning analytics system and its underlying algorithms, as well as clear guidelines towards access, analysis, control, ownership and use of relevant data.

6. CONCLUSION

Remaining questions such as who should get access to which data, where and how long will the data be stored, which analyzes and deductions are conducted and are the students aware of the data collected from them need to be discussed in prospective research. From an instructional design point of view, research may focus on usability, personalization, and adaptivity of learning analytics systems. Understanding these factors may be crucial for implementing learning analytics systems at higher education institutions. Student's computer literacy is expected to be a prerequisite for using learning analytics systems. Professional development for learning analytics including transparency of underlying algorithms and involving all relevant stakeholders in the development and implementation phases may help to increase trust and acceptance in the systems.

Students are more than shattered bits of information given and produced while interacting with learning analytics systems implemented by higher education institutions (Solove, 2004). Learning analytics may reveal personal information and insights into an individual learning history, however, they are not accredited and far from being unbiased, comprehensive, and valid.

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TAGALONG: INFORMAL LEARNING FROM A REMOTE COMPANION WITH MOBILE PERSPECTIVE SHARING

Scott W. Greenwald, Mina Khan*, Christian D. Vazquez* and Pattie Maes
MIT Media Lab, Cambridge, MA 02139, USA

ABSTRACT

Questions often arise spontaneously in a curious mind, due to an observation about a new or unknown environment. When an expert is right there, prepared to engage in dialog, this curiosity can be harnessed and converted into highly effective, intrinsically motivated learning. This paper investigates how this kind of situated informal learning can be realized in real-world settings with wearable technologies and the support of a remote learning companion. In particular, we seek to understand how the use of different multimedia communication mediums impacts the quality of the interaction with a remote teacher, and how these remote interactions compare with face-to-face, co-present learning. A prototype system called TagAlong was developed with attention to features that facilitate dialog based on the visual environment. It was developed to work robustly in the wild, depending only on widely-available components and infrastructure. A pilot study was performed to learn about what characteristics are most important for successful interactions, as a basis for further system development and a future full-scale study. We conclude that it is critical for system design to be informed by (i) an analysis of the attentional burdens imposed by the system on both wearer and companion and (ii) a knowledge of the strengths and weaknesses of co-present learning.

KEYWORDS

Informal learning, situated learning, remote learning, contextual memory, wearable technology

1. INTRODUCTION

Much of the practical and tacit everyday knowledge employed in workplaces is acquired on the job, through learning-by-doing. One reason why this type of learning is highly effective is that knowledgeable coworkers can be found nearby to not only assist in completing tasks at hand, but also to subsequently engage in broader discourse, in which ideas from specific tasks are generalized and abstracted. That is, they use these task examples as props to explain ideas that generalize to other tasks, explain the reasons behind procedures, and so on. The physical elements at hand provide a point of reference for the learner to become curious and ask follow-up questions, based not only on what the expert has chosen to highlight, but also on her independent observations of the environment and apparatus. With a shared physical environment as a precondition, this type of learning episode requires three attributes: the immediate need for assistance as impetus to start the conversation, an expert available to assist, and the opportunity to seamlessly transition from an assistance-focused dialog to a broader discussion through which deep knowledge exchange can happen.

We seek to broaden the applicability of this powerful episodic learning model in two ways. Firstly, we seek to make it possible to learn in this way from an expert who is remote instead of co-present. This would dramatically increase the reach of such interactions, so they could happen at any time in any physical or geographic location. Secondly, we aim to apply this model not just to assistance and learning in workplaces or communities of practice, but also to the myriad other contexts where curiosity may arise, not only out of necessity. In general, this means engaging in dialog to answer and expound on questions that arise due to the immediate physical surroundings. By supporting informal and exploratory learning in this way, we can move towards a world where deep (human) learning can happen anywhere and everywhere, driven by the intrinsic motivation of curiosity.

* These authors contributed equally to this work.

In this paper, we seek to investigate specifically what kind of system is necessary to facilitate a fluid dialog between learner and remote expert, allowing each to make reference to specific physical objects in the learner's environment? Can such a system be made effective without being cumbersome or requiring distracting device interactions? Can this be achieved today, building only on readily available devices and infrastructure? This represents an exploratory phase of research, the goal of which is to inform the design of future systems, as well as identify specific questions for future research, including full-scale studies that employ such systems.

We designed a prototype system called TagAlong and performed a qualitative pilot study in which the same task (discussing fine artwork) was performed with three different communication mediums: (i) co-present (oral and gestural) communication, (ii) mobile phone-based video chat, and (iii) using the TagAlong prototype system, utilizing synchronous audio in combination with still image capture and annotation.

This paper is structured as follows: Section 2 discusses prior work and positions TagAlong within this framework. This allows us to build on what is already known, as well as highlight the challenges that are particular to our use case. Then, Section 3 presents the design goals for the TagAlong prototype system, initial design, and enhancements based on the results of preliminary testing. Section 4 describes a pilot study based on a learning scenario in an art museum. Section 5 talks about implications for future work, and finally, Section 6 presents concluding remarks.

2. RELATED WORK

This work is situated at the intersection of learning, communication technology and wearable technology. From a learning perspective, the theoretical underpinnings are based on the concepts of informal learning, situated learning and contextual memory. Informal learning happens through curiosity or necessity within a social or experiential context, and is unintentional from the perspective of the learner. Situated learning refers to the acquisition of knowledge relevant to needs or actions at hand. In the field of language learning it has been shown that students are more receptive to learning relevant vocabulary and phrases in such circumstances (Brown 1987). Closely related is the theory of contextual memory, which holds that a person is more likely to recall information when situated in a context analogous to the one where they were originally exposed to it. This is explained by the presence of similar memory cues both at the time of exposure and the time of retrieval (Tulving and Thomson 1973; Davies and Thomson 1988).

On the communication technology side some research has focused on use cases for collaboration with shared subject matter, evaluating the usefulness of different communication capabilities and mediums. For instance, Chastine et al. (Chastine et al. 2007) have looked at different configurations of physical and virtual object representations in a collaborative 3D task, and investigated the impact of these representations in a virtual environment. They found that a fundamental requirement is the ability for users to effectively refer to artifacts within the shared environment. Ochsman et al. (Ochsman and Chapanis 1974) have investigated the comparative value of audio, video, and text channels to support cooperative problem solving, concluding that the audio channel is the most critical medium.

Other research has focused on audio/video conferencing use cases where the communication medium primarily carries voice and video of the participants themselves. Isaacs et al. (Isaacs and Tang 1994) evaluated video conferencing as compared to audio calling and concluded that there is significant social value to seeing those you interact with, especially when the purpose is professional team-building. It facilitates interpreting non-verbal information, noticing peripheral cues and expressing attitudes.

Even though video offers a rich communication medium and provides several advantages for interpreting non-verbal information between collaborators when using desktop or personal computers, in the case of task assistance or situated learning via a wearable devices, this might not be the case. For example, video of the face of the user using a wearable device would be both difficult to capture and not add much value when the purpose is to communicate about the environment. Careful attention must be given to what behaviors are supported through the choice of medium and other affordances of the system.

Next we consider related work in wearable device interaction including assistance systems and telepresence. The development of wearable computing was just burgeoning when a seminal work carried out by Starner et al. (Starner et al. 1997) put forth the concept of computing that proactively assists a user. Early work such as that carried out by Feiner et al. (Feiner et al. 1997) looked specifically at how information could be presented to users with wearable computers – highlighting the fact that the type of interactions required by such systems are completely different from the ones required by desktops or mainframe computers.

Thereafter, researchers began to investigate how wearable systems could be used to facilitate remote collaboration since, by their nature, they were able to track and convey information about the wearer's surrounding environment. For example, early work carried out by Mann (S. Mann 2000) shows that a mobile system that gives very simple feedback in the wearer's environment (a laser dot) can effectively be used to experience visual collaborative telepresence. Among the disadvantages of this system are that (i) it is limited to very simple feedback about the environment, (ii) this feedback is highly ephemeral, since any movement by either wearer or companion results in moving the laser dot off target, and (iii) it is quite obtrusive, if not dangerous, to those individuals in the immediate surroundings of the system due its utilization of a laser pointer. Building on the TelePointer concept, Gurevich et al. (Gurevich et al. 2012) developed a system for more sophisticated feedback called TeleAdvisor. TeleAdvisor is a stationary system that gives visual feedback using a projector mounted on a robotic arm. It enables a remote helper to view and interact with the workers' workspace, while controlling the point of view.

3. TAGALONG SYSTEM

The TagAlong system is a mobile context-sharing system that runs on Google Glass and a mobile phone or tablet. The system wearer can send still images on-demand to a remote companion or teacher, who can then reply by annotating the source material and sending it back. Synchronous interaction is optionally supported through the use of a real-time audio channel. In this section we describe the design goals, interaction design, and architectural decisions that make the system work robustly in the wild.

3.1 Design Goals

As outlined above, the TagAlong prototype system is intended to be both well-adapted to facilitating dialog about the wearer's physical surroundings and usable in everyday settings. The latter requirement goes well beyond what is necessary just to perform our experiment. Designing and building the system to be usable in everyday settings makes our experimental results significant when considering (i) what kinds of systems can be built into an everyday usage flow, without assuming mass adoption, and (ii) what device technology and infrastructure are already here *today*. This way we can comment on how this will change in the immediate term, as well as where it is most important to invest effort in both of these areas. Accordingly, our design goals are as follows:

- Create a system that can be worn continuously and with minimal burden by the wearer, and can allow both users (the wearer and the companion) interact with the system in a mobile setting.
- On the wearer side, the system should operate in the background requiring little of her attention. Giving input to the system should incur little startup cost, and when information from companion wearer arrives, it should be noticeable but not disruptive.
- Support synchronous interaction, so as to reap maximum benefit from high-engagement interactions with the companion.
- Additionally, support asynchronous interactions. There is a spectrum from low-engagement, low-bandwidth communication to high-engagement, high-bandwidth communication that needs to be supported for in-the-wild usage.
- Allowing anyone with a smartphone to play the role of the companion, and accordingly develop a flow for initiating interactions that is natural and requires a minimal amount of effort. This dramatically increases the reach of real-world usage of the prototype system.

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3.2 Interaction Design

There are two user roles in the TagAlong system: (1) the wearer, who uses a Google Glass connected via Bluetooth to an Android mobile device, (2) the companion, who is any person with a smartphone web browser that the wearer connects with, as shown in Figure 1.

When the wearer wishes to interact with a remote companion, he uses the app to send a text message to the desired companion to ask her to “connect”, or “opt-in” to a TagAlong session. As such, the session through which the exchange of visual information happens is asynchronous and can last indefinitely (hours, days, or weeks). The text message contains a link which, when clicked, opens a page that describes what the companion is opting in to, and then allows her to confirm. Figure 2 shows the registration and connection process for the TagAlong users. For interactions with synchronous audio, the wearer can call the companion using the carrier network.

When the wearer wishes to take action by sending an image, she must press a button once to enter a view-finder mode that opens a camera preview so that the wearer may take a picture using Google Glass. The wearer presses a button to take a picture, and the companion receives a text message containing a url. Clicking on the url causes opens up the image in a browser window and allows the companion to annotate and edit the image. The companion can then send back the annotated image, which is displayed on the wearer’s device and accompanied by an audio chime.

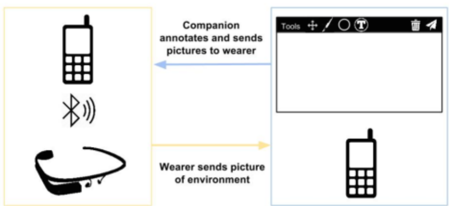

Figure 1. Basic Information Flow in TagAlong System

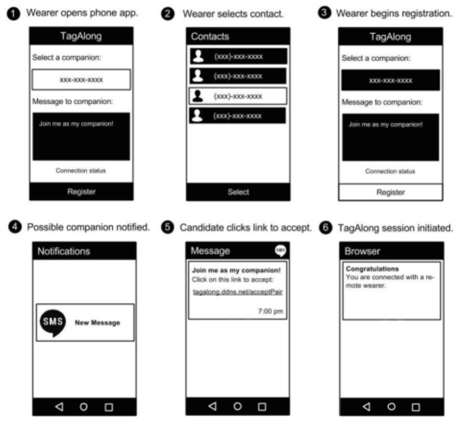

Figure 2. Interaction Initiation Flow

3.3 TagAlong Wearer UI Enhancements

Exploratory usage of the initial implementation of TagAlong exposed a number of usability problems in the wearer interface. We describe these problems and the features we introduced to address them.

3.3.1 Four-button Input

We found the native Glass touchpad to be both unreliable at detecting input events, as well as awkward to operate in public settings (this awkwardness was heightened by the unreliability of event detection, when repeated attempts needed to be made). For this reason we used a wireless slide changer remote as an input device. This device is unobtrusive, can be easily stowed in a pocket or purse, and offers tactile feedback to support eyes-free operation.

3.3.2 Status Notifications

In early trials of our system, a lack of feedback for the wearer left them uncertain of the state of the system. We had used audio chimes to notify the user of progress – such as an image being captured aor successfully uploaded to the server. In moderately noisy environments or with moderate attentional loads, it was easy to miss these updates. Our enhanced design uses visual status indicators to indicating whether a message has been sent and seen by the receiver. In exploratory trials, users reported better usability when status messages were used.

3.3.3 Viewfinder

Another important user interface choice was to use a viewfinder. The canonical use of the Google Glass camera takes a picture without showing a live camera preview. In our exploratory trials, users complained that they could not frame the picture sent to the remote companion, and this limited the effectiveness of these pictures at communicating the object of their attention. Introducing a viewfinder allows the user to know immediately both that the device is attempting to take a picture, and that the field of view is scoped and aligned as desired.

4. PILOT STUDY: LEARNING FROM AN EXPERT

The goal of this study was to understand how the fully-mobile TagAlong system compares with video streaming and face-to-face communication in terms of effectiveness at communicating about the visual environment for learning purposes. The basic activity in the study is an informal learning dialog about a work of art between an art expert and a novice.

4.1 Setup

A remote art expert interacts informally with a non-expert to convey knowledge about a specific work of art, which the non-expert is in the presence of. No guidance is given to either party about how to initiate the dialog. They interact using one of three conditions (i) TagAlong with live audio, (ii) video streaming on a mobile phone with live audio, and (iii) co-present, face-to-face interaction. In the dialog that they have, either party can determine the subject, questions can be asked, and clarifications requested.

Figure 3. Wearer in Pilot Study

Figure 4. Companion in Pilot Study

In the TagAlong system condition, participants are connected with a live audio stream, and can use the system to exchange images and annotations of the subject matter in the wearer’s environment as shown in Figure 3 and Figure 4. The wearer’s interaction is hands-optional, since she only needs to use her hands when she wants to send an image. No physical posture change is required for her to shift focus between the system’s visual feedback and the world, and the input device can be operated eyes-free.

In the second condition, the “wearer” streams video from a hand-held mobile phone. The wearer and companion are once again connected with a live audio stream. The video stream of the wearer’s rear-facing phone camera is previewed on-screen and streamed real-time to the companion’s mobile phone. There is no affordance for spatial annotation in the interface, but the wearer can physically point with his free hand to indicate an object of interest.

In the third condition, learner and expert are co-present and communicate face-to-face. The two stand next to each other in front of the painting and discuss.

4.2 Procedure

We tested a total of four wearers, each with one of two art expert companions. The wearers were each involved in two trials, and in each trial, the wearer and companion would discuss two works of art for five minutes each. For each wearer, one of the two trials was TagAlong, and for the other trial, two participants tried video streaming, while the other two tried face-to-face explanation. For each expert, the four art pieces stayed the same across trials, but the order of the trial conditions was switched in subsequent trials with respect to the TagAlong trial.

After both trials were completed, an in-depth interview lasting between 5 and 15 minutes was conducted with both wearer and companion present. In addition, after each expert's second trial, a solo follow-up interview was performed, where she was asked to contrast the experience of explaining the same work of art in the two different conditions, considering each work of art individually.

4.3 Results

First we compare results from the TagAlong system with video streaming, and then with the co-present learning condition.

4.3.1 Still Images vs. Streaming Video

Still images and streaming video each presented their own advantages and disadvantages. Still images from TagAlong provided a clear advantage over streaming video as a vehicle for detailed and persistent annotations by the companion. The companion could circle, underline, outline, and label with text specific visual elements. In the video streaming condition, companions needed to use verbal cues and gestures to draw the wearer's attention to particular subject matter in order to explicate it. Once a subject was identified, a verbal description was needed to make detailed comments. As a corollary, the ability to freeze a subject matter allowed the dialog to be more focused. With moving images, the companion felt she had to follow the dynamic whim of the wearer, whereas with still images, her highlighting specific details also caused the wearer to stay still long enough to focus on those details.

A disadvantage of still images in our implementation was that the companion was limited to annotating only the most recent image taken by the wearer. When this was a close-up, she no longer had an effective way of suggesting the next subject of focus. One way of addressing this limitation would be to allow the companion to refer back to previous (less close-up) images to suggest the next focal point (e.g. as shown by Greenwald, et al (Greenwald, Khan, and Maes 2015)).

Video streaming was clearly advantageous over still image exchange in terms of responsiveness. One wearer commented about using video-streaming when discussing the sculpture:

> *I could show her what I was talking about it real-time. It was a smoother process than taking pictures all the time.*

That is, when the subject was a sculpture, the wearer needed to move around to find interesting viewpoints, and having a live stream was advantageous.

Even so, there was agreement among participants that which system was better depended on subject matter. As one art expert participant expressed:

> *For Matta [painting] I prefer cards [still images]. I could actually point out the things that I thought were interesting ... [for the sculpture] I liked video actually, I think that has a lot to do with the subject matter.*

That is, when the subject was a painting with different objects and details to be highlighted, the ability to circle and point at them was more important.

We propose that the interfaces we experimented with are best understood as performing two separate but overlapping functions – first, giving the companion some level of situational awareness about the physical surroundings and focus of attention of the wearer, and second, creating a locus of attention that is shared and can be modified by one party or the other. A video feed is constantly being moved by the wearer and gives the companion no control over the shared locus of attention other than to intervene verbally to highlight visual landmarks. In the case of TagAlong, the wearer selects the frame, and the companion can select a subregion and annotate by sketching.

4.3.2 Co-Present vs Remote Learning

One assumption we made going into this study was that “being there”, i.e., co-present learning, is always the best. Perhaps the most unexpected insight we gained was that this is not necessarily the case. Indeed participants in the face-to-face condition noted the comparatively more natural and intuitive way that gestures could be used for both pointing and expression. However, they highlighted that using mobile devices to interact remotely allowed them to focus more exclusively on the work of art. It seems that this is related to the social burden of face-to-face interaction, or the need to “entertain” as one participant described it.

> *I felt a little more like I was watching TV, with the Glass on, drowning into this painting while she’s talking. But there [in person] it felt more like I was trying to entertain, hold a conversation, smile, get a laugh out of you [addressing companion].*

Face-to-face interaction carries with it the burden of proxemics– the ensemble of body and facial gestures and eye contact that must be constantly maintained during co-present social interaction. Eliminating that burden liberates the learner’s attention to focus only on the subject matter. Participants, including experts and wearers alike, consistently echoed the sentiment that they were highly focused during the TagAlong system interaction in comparison to the feeling of having many distractions while the face-to-face discussion was taking place. This seems to support the claim that the maximum amount of attention was available for the artwork itself in the hands-free, remote condition (TagAlong).

These results show that co-presence is an important point of reference which we can use to understand and predict what will work well. We can frame future work in terms of imitating co-presence in a targeted way. For example, we do wish to emulate the ability of either party to draw attention to a point in the environment. We do not wish to emulate the attentional burden of face-to-face social interaction. The generalization is that co-presence provides a wonderful set of affordances for two people to communicate in high-bandwidth. What it does not do is allow us to selectively switch off some of those affordances in order to achieve greater focus for specific tasks. In essence, future work in this area concerns identifying ways of learning that are better than co-present, face-to-face interactions within certain contexts or with certain specific purposes in mind.

5. FUTURE WORK

The above results point towards some specific improvements to TagAlong-like systems in the immediate term, as well as some challenging ones for the longer term.

There is a straightforward concept for designing a system that imparts the powerful feeling of synchronous visual presence that we saw with video streaming, but also affords the important ability to annotate specific objects which we saw when using still images. In a hybrid system, this would be to have both live streaming and annotation at the same time. A split screen, or swappable picture-in-picture interface could be used to maintain both real-time awareness, and the ability for the companion to suggest or define a locus of attention.

Although the wearer is able to “point” by framing a still image and speaking over it, the ability to engage more directly in a dialog of annotation with the companion is something that would be sure to add expressive power for the wearer and hence make dialogues richer. The challenge would be to maintain the same low level of attention required for operating the system. Some candidate input methods would be Live Trace (Colaço et al. 2013), which uses a depth sensor to allow the wearer to lasso environmental objects using a gesture at arms length in front of the face; the Nod ring, which uses a ring-mounted IMU to create 2D or 3D input signals from free hand movements, and the Thalmic Labs Myo, which interprets a small discrete set of hand gestures, in addition to including an IMU that could be used similarly to the Nod.

Our results also pointed to the need for the companion to maintain the broadest possible representation of the environment, so that he can highlight subjects that are not currently being attended to by the wearer. This may be done by compiling all the data explicitly sent by the wearer device, but could also in general include reference information that could be externally retrieved. For example, in the case of the art museum, the companion could be provided with a map of the museum, as well as high-resolution representations of all the art within it. With additional information, the expert companion would not be limited to just the comparatively low-quality images provided by the wearer. The latter would only be used to create situation awareness for the companion about what the wearer is currently attending to. In another use case, like navigating streets, maps archives like Google Maps may be used to invoke to points of reference that haven't yet been visited by the wearer.

The overarching challenge in all of this future work is to avoid confusion or attentional burden when making systems with these hybrid assemblages of content which is streaming and frozen, past or present, overlaid or peripheral, from internal and external sources, and so on.

6. CONCLUSION

In the present work we have demonstrated that individual mediums for learning-focused discourse have advantages and disadvantages based on what the subject matter is, and who is taking part in the dialog. Still images are good for making detailed reference to static elements of the environment, as we saw with the example of paintings. Video streaming, on the other hand, appears better when physical movement is important to the exploratory activity – in our example, viewing sculptures from different angles. Considering co-present versus remote teaching, in some cases face-to-face behaviors of like gesturing and making eye contact are helpful, but in other cases they can distract from the subject matter. In summary, our results support the claim that, in order to maximize the effectiveness of remote interactions, a carefully assembled melange of mediums should be selected for particular use cases.

Moving forward along this path, we envision a world where seeking input from a remote expert will be as easy as tapping an office colleague on the shoulder. Tomorrow's TagAlong-like systems will utilize numerous technologies to create ever more vivid glimpses into remote environments and the state of the those who occupy them. High-resolution 3D capture and display will make the environments seem real. Real-time computer vision applied to these data streams will make it possible for the companion to identify and annotate environmental objects in a way that is fast and persistent. Labels and annotations can adapt to changes in the environment. Input and output may take many non-visual forms. For instance, remote sports instruction might use EMG data to inform the companion how the wearer is moving, and muscle stimulation allows her intervene with correct motions. In the present work we haven't even scratched the surface of more exotic forms of input and output, such as those just mentioned, and the challenges we encountered will be compounded when these are brought into the mix. On one hand this means fruitful grounds for future research, and on the other it calls for a principled approach, since we will otherwise be overwhelmed by the combinatorial complexity of the design space, and corresponding difficulty of finding good designs.

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ACCOUNTING PROFESSOR QUALIFICATION IN DIGITAL AGE: A PERCEPTION STUDY ON BRAZILIAN PROFESSORS

Maria Ivanice Vendruscolo[1] and Patrícia Alejandra Behar[2]
Universidade Federal do Rio Grande do Sul (UFRGS)
[1]Av. João Pessoa, 52- Porto Alegre, RS, Brazil
[2]Av. Paulo Gama, 110 Prédio 12105, sala 332- Porto Alegre, RS, Brazil

ABSTRACT

This papers aims at analyzing the perception of Accounting professors about the necessary qualifications in Accounting undergraduate courses. The contribution of this study is to theoretically discuss the education of Accounting professors, with empirical data, because Accounting teaching requires specific competencies in the digital area. The research is applied in the Accounting Higher Education, descriptive in relation to the objectives, a qualitative approach to the problem with quantitative elements for descriptive data analysis. The technical procedure was the survey by online questionnaire via Google Forms. The research population are professors of the Accounting professional education in undergraduate courses in Brazil. The sample consisted of 378 professors, selected by the representativeness and typicality criteria. The results evidenced the perception of professors about the complexity of Accounting teaching, by applying a set of professional, academic and pedagogical competencies as well as practical knowledge about the accounting practice and teaching. However, they indicated the prevalence attributed by professors to the technical competency and professional practice knowledge over the other educational competencies. The professors showed feeling of deficiency in relation to the academic education received and they worried about the need for continuous training. They also prove, with empirical data, that mastering contents by Accounting professors is not enough to the teaching practice in Accounting courses. The results obtained in this paper may support institutional policies regarding continuous education of professors in Accounting undergraduate courses as well as the proposition of initiatives to develop them systematically by the education institutions.

KEYWORDS

Accounting Professor. Accounting Education. Professor education. Teaching Competencies.

1. INTRODUCTION

The education of professors in contemporary societies is based on a complex combination of scientific, pedagogical and technical contributions, generally built from within the profession (Nóvoa, 2009). The teaching practice in Accounting involves the relationship between theory and practice, as well as the constant changes that affect the academy. It also involves the preparation for a variety of functions to be developed by their future professionals (Nossa, 1999; International Federation of Accountants, 2001). Such fact represents an important challenge to these professors (Miller and Becker, 2010). Therefore, they require a debate and actions regarding the education of professors involved in the Accounting Education process (Miller and Becker, 2010; Miranda *et al*., 2012), by the Higher Education Institutions of all countries.

The Accounting professor must have technical and accounting knowledge, as well as some knowledge of related areas, teaching methodology, general culture and social aptitudes, in addition to the ability of constant integration of the various social, political, economic and legal phenomena in their pedagogical practice (Nossa, 1999). Such education is expected to mainly emphasize the professor's reflection on his/her own practice (Kraemer, 2005; Ramalho *et al*., 2013). Laffin (2002) points out that didactic-pedagogical issues have not been considered as fundamental in the education of Accounting professors, by the post-graduation programs in Brazil. The pedagogical theoretical basis would help teachers to reflect on their daily practice.

Hernandes *et al.*, (2006) reinforce the need of an education based on the reflection on the theory, so that accounting professors may encourage their students with critical thinking. Thus, according to Silva (2000) the Accounting professor needs to care for his/her teaching competency through updates and *stricto sensu* education (master's degree and/or PhD), in order to develop the assimilation conditions of new management forms within the growing expansion of the professional practice. As a support, the recommendations for academic training of professors in the accounting area "requires a combination of original academic preparation (*stricto sensu* education) in addition to follow-up activities that maintain or establish preparation for current teaching responsibilities " (Association to Advance Collegiate Schools of Business, 2010, p. 43). However, a weak academic education at *stricto sensu* post-graduation level of professionals in the area is observed in the Brazilian labor market (*Conselho Federal de Contabilidade*, 2013), and such fact may cause an effect on the qualification of the contingent professors of Accounting undergraduate courses in Brazil.

In this sense, what are the necessary qualifications for the teaching practice in Accounting undergraduate courses? The objective of this study is to investigate the perception of professors of the professional education area about the necessary qualifications for the teaching practice in Accounting undergraduate courses in Brazil.

Swain and Stout (2001) surveyed graduates from 73 accounting doctoral programs in the United States. The researchers evaluated the individual development needs regarding the teaching process. The respondents pointed out having received minor pedagogical training during the doctoral program and that they had developed them mainly through self-training (Swain and Stout, 2000).

Another studies (Slomski, 2008; Miranda *et al.*, 2012; Vendruscolo and Behar, 2014; Vendruscolo and Bercht, 2015) surveyed the pedagogical practice of professors in Accounting undergraduate courses offered by Brazilian Higher Education Institutions. The results revealed in the study indicate they arise from the "initial and continuous education of professors, curriculum and school socialization, knowledge of the courses to be taught, professional experience, personal and professional culture, peer learning etc." (Slomski, 2008, p. 3). "Teaching requires professional education for its practice: specific knowledge to appropriately practice it or, at least, the acquisition of knowledge and skills related to the teaching activity in order to improve its quality " (Slomski, 2008, p. 3). Thus, the teaching knowledge have a temporal and social character and leads to acquired and perfected processes within the practice and teaching career in the Accounting area (Slomski, 2008).

Miranda *et al*. (2012) observed the qualifications of Accounting professors in three teaching education cores: academic qualification, professional qualification and pedagogical qualification. The professional qualification is related to the current accounting practices in the professional and pedagogical practice, to the systemic preparation for the teaching practice, whose knowledge arising from such qualifications pointed out in the study were: mastering the content, experience knowledge and didactic knowledge, respectively. The qualification component factors ascertained by the author are described in Table 1.

Table 1. Accounting teaching qualification component factors

Professor's Qualification	Component Factors
Academic qualification	The PhD degree (preparation for research), master's degree, specialist, acting as referees or reviewers of scientific journals, exclusively acting at Higher Education Institutions, having papers published in scientific journals, participating in research associations or bodies. Thus, it was considered that the academic qualification should concern the teaching preparation for the practice of research on the issues he/she teaches.
Professional qualification	The accounting professional practice; as a consultant, advisor or referee; participation in professional associations or regulatory agencies; development of applied research involving the academy and the community; and the participation in projects of university extension programs with the involvement of the community.
Pedagogical qualification	Offer of teaching training programs; support to the teaching participation in research projects and scientific events; support to the teaching participation in *stricto sensu* courses offered by other Higher Education Institutions; promotion of scientific events contemplating teaching; have a *stricto sensu, lato sensu* and extension pedagogical education courses; teaching-related research projects; and teaching experience.

Source: Miranda *et al*. (2012).

Vendruscolo and Behar (2014) investigated the professors' competencies elements (knowledge, skills and attitudes) in Accounting undergraduate course. The authors have not identified a consensus on the literature about the pedagogical competencies of professors. The studies about the education of Accounting professors are recent and were tangent to the teaching competencies issue. They have not mapped them or identified their elements, not even approached how to develop them. However, in general, the presence of the three constitutive elements of competencies is observed: knowledge, skills and attitudes (Vendruscolo and Behar, 2014).

Vendruscolo and Bercht (2015) have analyzed the perception of affective aspects in their pedagogical practices, with 96 accounting undergraduate professors in Southern and Southeastern Brazil. The study data evidenced that Accounting professors do not adopt pedagogical practices through Accounting Information Technology, compatible with the distance education, revealing the training need in information technology.

Thus, the contribution of this study is to theoretically discuss the education of Accounting professors, with empirical data, in order to produce more concrete answers, contributing to the mediation between the new base of the social reality and the requirements of specialized professionals to act in the organizations, in order to meet the evolutive challenges of society.

2. METHODOLOGICAL PROCEDURES

The research is applied to the higher education in Accounting. Based on the approach, the research may be classified as qualitative, since it represents an interpretative analysis of the collected empirical data and with quantitative elements for the descriptive analysis of data (Gil, 2007; Creswell, 2010). In relation to the objectives, it is descriptive. The technical procedure adopted was the survey through the online questionnaire via Google Forms, characterized by the direct questioning of the subjects whose behavior was expected to know and determine the characteristics and opinions of the study population (Gil, 2007).

The respondents were 378 Brazilian professors, selected using non-probabilistic sampling through the typicality criterion: being professor in Accounting undergraduate courses and teaching professional education courses within the course's program. The collection instrument contemplated the objectives of the research, the voluntary participation statement and the authorization for disclosure of the research anonymous data. In order to guarantee anonymity along the research, no name or identifying data of the respondents were disclosed. The denomination P*n* was adopted, where "P" refers to the respondent professor and "*n*" corresponds to the sample order number in the data base.

The data collecting instrument was organized in multiple choice questions, from the Likert scale (Likert, 1975; Günther, 2003), in order to capture the perception of the research respondents in relation to the qualifications of a professor regarding the accounting teaching function for professors in Accounting undergraduate courses. The scales were: Essential, Very Important, Important, Of little Importance and Irrelevant.

3. RESULTS AND DISCUSSION

The analysis processes and data interpretation obtained by the survey technical procedure are shown.

3.1 Profile of the Research Respondents

In all Brazilian regions, most professors are male (64% of the participants). In the Northeastern and Northern regions this participation was even more expressive, with 67.4% and 76.5%, respectively. Out of the total of respondents, 74.6% are under 50 years old and 25.4% are older than 50 years. The age group with the largest concentration in all regions is between 41 and 50 years. Approximately, 53% of the professors act at private Higher Education Institutions, compared to 44.7% of public Higher Education Institutions, while 2.1% act in both. The regions with the highest presence of professors acting at private Higher Education Institutions are the Southern (63.3%) and Southeastern (67.3%) regions. This situation is inverted in the Center-Western

(64,1%), Northeastern (83,7%) and Northern (58.8%) regions, where the public institutions are more representative in the sample.

The predominant academic education (78.8%) of the professors who responded the survey was Bachelor of Accountancy Science, in all regions. The Northern region stands out (94.1%), followed by the Center-Western (90,5%) and Northern (88,4%) regions. Professors from related areas represent 17.2% of participants and Other Knowledge Areas, represent around 4%. This participation is more influenced by the Southern (16.9%) and Southeastern (24.5%) regions. It has also been observed that 4% of the participants have double education, generally in accounting-related areas.

In relation to the qualification of the sampled professors, 24.3% have a PhD (8.2% with post-doctorate) and 51.9% are concentrated in the Master's Degree – of these, 18% are currently enrolled in PhD programs. Thus, 76.2% of participants have the minimum title required by the Brazilian Ministry of Education for professional activity in undergraduate courses. This characteristic was similar in all regions, with emphasis placed on the Center-Western region, with a higher participation (85.7%), and the Northeastern region, with a lower participation (69.8%). Among professors with the minimum qualification of PhD, 71% are from public Higher Education Institutions, 61% of them are men and 39% women.

The teaching experience resulted more uniform among the intervals analyzed. Most professors (65.3%) in the sample had up to 15 years of teaching experience. The largest contingent was in the interval between 5 and 10 years, with 23.8% of the total. The interval between 15 and 30 years contemplates 29.9% of the professors. The sample also contains professors (4.8%) with more than 30 years of teaching experience. Confirming the theoretical references, 78.6% of professors have professional experience, in addition to the teaching practice. However, 21.4% only work as professors, mainly represented by professors who work at public Higher Education Institutions (61.7%). The research of *Conselho Federal do Rio Grande do Sul* pointed that 4.8% of Accountants also work as professors (*Conselho Federal do Rio Grande do Sul*, 2013).

3.2 Data Analysis

Professors were consulted about the importance of qualifications and practical knowledge, necessary for the teaching function in Accountancy. The result obtained is indicated in Table 1, by scales.

Table 2. Perception of respondents about the Qualifications of Accounting professors

Qualification and Knowledge	Essential		Very Important		Important		Of Little Importance		Irrelevant		Total
	fr	%	*fr*	%	*fr*	%	*fr*	%	*fr*	%	*Fr*
Technical Qualification	245	65,3	91	24,3	41	10,9	1	0,3	0	0,0	378
Pedagogical Qualification	136	36,3	153	40,8	83	22,1	5	1,3	1	0,3	378
Academic Qualification - Masters	106	28,3	161	42,9	89	23,7	17	4,5	5	1,3	378
Academic Qualification - Doctorate	53	14,1	138	36,8	142	37,9	33	8,8	12	3,2	378
Practical knowledge of Professors	159	42,4	158	42,1	57	15,2	3	0,8	1	0,3	378
Practical knowledge of Accountants	164	43,7	144	38,4	64	17,1	6	1,6	0	0,0	378

Technical Qualification was indicated as Essential (65.3%) and Very Important (24.3%) in the perception of 336 professors, representing 88.9% of participants. Practical knowledge as professors was considered by 83.8%, as Essential (43.7%) and Very Important (38.4%) and as Accountants by 81.4%. The empirical data show that the sample teachers attach greater importance to the technical qualification and professional experience if compared to the others. Such importance can carry a greater weight in their continuing education, instead of the pedagogical and technological skills required in the teaching profession in the digital age. The market has required increasingly technically qualified professionals, but also shows a diversification of skills developed in their academic studies. In this regard, extensive training, covering the development of teaching skills result in a more significant contribution.

The consideration of one of the respondents to the research illustrates the point of view of professors in relation to the importance of technical qualification and knowledge of the specific area:

P52 "For the good teaching of the accounting practice, the technical disciplines must be taught by professionals who work in the area. As we no longer have technical accounting courses, the Higher Education Institutions must prioritize the technical education (Accounting, Fiscal, Asset and HR bookkeeping) until the 5th period and professional disciplines should be taught from the 6th period on. The disciplines of accounting practice should be taught in computing laboratory with specific software".

On the other hand, Pedagogical Qualification was considered Essential (36.3%) and Very Important (40.8%), by 289 respondents (76.5%) and Important by another 22.1%, totalizing 98.4% of participants. Data evidence that professors also consider pedagogical qualification relevant to the teaching practice in Accounting Science. It is observed with even greater significance given the technical knowledge that the consulted teachers also recognize the importance of Pedagogical Qualification. This involves knowledge, skills and specific attitudes, related to each other that enable teachers in conducting the process of teaching and learning accounting and enable a reflection on their practice.

As stated in the literature review, the professor of Accounting courses did not receive academic training envisaging the needs for the teaching practice. Professors have been developing them in their own practice, which this study ratifies with empirical data. Professors have verbally expressed the comments indicated in Table 3.

Table 3. Comments of respondents on the received academic training

Professor	Comment
P186	The undergraduate professor must share practice and teaching in order to develop competencies.
P258	The classroom is always a challenge, since in some classrooms a methodology works and in others the same methodology doesn’t, so professors should find these competencies and feel which methodologies should be applied in each classroom, discipline and each content.
P363	The professor, in his/her deepest essence, should be bound to the complex cognitive-pedagogical process of their students, searching to constantly improve his/her methods, in order to obtain a different, unique, process from his/her creativity, adapted to his/her personal dimensions. In other words, he/she should develop his/her own creative methodology, by applying a set of knowledge and experiences which expand as his/her teaching experiences accumulate. Experience improves it when he/she uses time as an extension process of the experiences he/she practiced.

The comments of Accounting professors evidence the construction and development of their teaching competencies are attributed to the practice, trial and error, sharing of experiences with colleagues. Change in their methodologies through experience. They attribute to their teaching experience the constant improvement of their methods, without necessarily being aware of the process.

By analyzing the comments, in the light of the Genetic Epistemology Theory (Piaget, 1975), they demonstrate the occurrence of a cognitive imbalance resulted by the “classroom” assimilation process. A beginning of awareness occurs by observing the need for change in action schemes (methodologies), as cited by P258 "in some a methodology works while in others the same methodology doesn’t". So, in an attempt to assimilate the object, the professor needs to modify their action (accommodation process): P258 "find these competencies and feel which methodologies should be applied in each classroom, discipline and each content". By doing this, professors develop cognitive structures in order to assimilate the object, developing their teaching competencies, even if they are not completely aware of the process.

In relation to the Academic Qualification for the function of Accounting professor, the Master’s degree received a higher weight (70.6%; 267 respondents) if compared to the Doctorate degree (50.5%; 191 respondents), considering the Essential (28.3%) and Very Important (42.9%) scales. This result may be related to the qualification of the respondents, which indicated that 51.9% (196) have a maximum qualification of Master and 24.3% of PhD, or even to the parameters required by the Brazilian Ministry of Education. In this aspect, the voluntary comments of participant professors give an idea of the meaning attributed to the professor education, as shown in Table 4.

Table 4. Comments of respondents about academic qualification

Professor	Comment
P148	I believe higher education teaching lacks training of teaching techniques. We leave the Master's and Doctorate degrees as researchers and have little or no teaching practice. Therefore, during the first teaching years we tend to reproduce the old board/marker system to pass on knowledge. I notice that even being aware of such change in the teaching techniques, only a few professors adopt or have autonomy to apply them. I think there is a lack of training, courses and sharing of experiences among professors.
P94	The institution where I work ignores the need for training professors for a better performance in their classroom. I need training and I see my colleagues need it too. But I believe this training should be partly optional, and partly obligatory and periodical.
P220	The Accounting Higher Education Institutions need to improve a lot with new Technologies and professionals with a good qualification in order to train competent professionals for the labor market.

The feeling of deficiency in relation to the academic education received and the need for continuous training is expressed through the comments of professors in digital area. The concern of professors about the systematization of periodical training may also be observed, which could be provided by the Higher Education Institutions where they work. Professor P148 indicated that the academic qualification prepares the professor for research and not for the teaching practice and that professors adopt the modelling process for the conduction of their pedagogical practices.

The results indicated the prevalence attributed by professors to the technical qualification and professional practical knowledges about the other teaching qualifications. However, they have attributed relevant weight to all of them, once almost all respondents scored up to the Important scale. This denotes a perception by professors of the complexity of the teaching practice in Accountancy. They also prove, with empirical data, what had been noted in previous studies, that is, that mastering contents by Accounting professors is not enough to the professional training in the accounting area.

4. CONCLUSION

The analysis results of empirical data contributed to reinforce the need for an academic education that envisages the practice requirements of professors and emphasize the need for a continuous education. Similarly, considering the social context of Accounting undergraduate professors' practice, they revealed the feeling of deficiency in relation to the academic education received and the concern of professors about the systematization of periodical training which could be provided by the Higher Education Institutions where they work. Therefore, the Higher Education Institutions need to reflect on the pedagogical models adopted by *stricto sensu* Accounting courses in Brazil.

The study indicated, also, that the professors adopt the modelling process for the conduction of their pedagogical practices. The academic qualification prepares the professor for research and not for the teaching. Mastering the contents is not enough for the teaching practice in Accounting courses. This denotes a perception by professors of the complexity of the teaching activity in Accountancy in digital area.

Considering the respondents to the research are related to classroom courses and teach most disciplines only in this modality, we understand that further studies should be carried out with Accounting professors who teach in distance education. Specific research with respondents from distance education courses is recommended. As pointed out by Minayo (1994), in Social Sciences research, the social context must be considered due to the nature of this knowledge field, whose social education and configuration are specific.

The results obtained in this paper may support institutional policies related to the continuous education of Accountancy undergraduate professors and the proposition of initiatives to develop them systematically.

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SUPERVISORY AND DIGITAL LITERACY PRACTICES IN POSTGRADUATE SUPERVISION: A CASE STUDY

Sarjit Kaur[1], Gurnam Kaur Sidhu[2], Lee Lai Fong[2] and Leele Suzana Jamian[2]
[1]*English Language Studies Section, School of Humanities, Universiti Sains Malaysia, Malaysia*
[2]*Faculty of Education, Universiti Teknologi MARA, Selangor, Malaysia*

ABSTRACT

The twin forces of globalisation and internationalisation witnessed the global democratisation of higher education leading to the mushrooming of institutions of higher learning alongside with the rapid increase in student enrolments at all levels including postgraduate study. Despite the rapid developments in higher education, postgraduate study has been plagued with high attrition and low completion rates. Consequently, there is a need to look into delivery systems to ensure postgraduate supervisors use effective delivery systems in providing quality supervision. This paper investigated the supervisory and digital literacy practices among 40 supervisors in two public universities in Malaysia in the following four aspects: ethics, personal commitment, climate and use of digital tools. This mixed methods study collected data using questionnaires and semi-structured interviews. The findings revealed that the supervisors provided academic support, created a positive climate and guided their students about ethics in research to a great extent. The findings also revealed that supervisors should equip themselves with a diversity of supervisory practices, including making use of digital tools in managing their supervision practices more effectively. While a majority of the supervisors made use of digital tools in their supervision process, the interview sessions with six supervisors revealed that some of them reported being reluctant to make use of digital tools to check their students' draft chapters. These findings have implications for the need of quality delivery systems especially institutional and academic support for postgraduate study.

KEYWORDS

Postgraduate supervision, digital literacy practices, supervisory practices, digital tools, academic support

1. INTRODUCTION

In the 21st century, global experts acknowledge the rapid economic growth and development as well as impressive achievements made by higher education institutions in Asia. The cultural, educational and demographic depth of Asian civilisations is immense (Marginson, Kaur & Sawir, 2011). In line with such developments, empowering human capital through high levels of education is increasingly seen as being vital towards achieving better economic growth through the impact of research in driving innovation and competitiveness for any country in today's competitive world, including Malaysia. Realizing the need of knowledge and innovation of becoming a developed country with higher income, the Malaysian government through the Ministry of Higher Education (MOE) launched the National Higher Education Strategic Plan (NHESP) 2007-2020 on 27 August 2007. Under this plan, a special emphasis has been placed on providing better access to higher education, particularly in postgraduate programmes in the plan's Phase 2: Strengthening and Enhancing (2011-2015) pillar. In this phase, a programme for financing postgraduate studies labelled 'MyBrain15' has been included by the MOE and it aims to produce more doctoral graduates (PhD). MyBrain15 was specifically established to develop a talent pool of high-level intellectuals to spur the growth of research and innovation in the country. Through MyBrain15, the Malaysian government aims to produce a total of 60,000 Malaysian PhD holders by 2023. Up to June 2009, a total of 10,248 doctoral graduates have graduated from public universities, followed by 2116 graduates from private universities (Ministry of Higher Education Malaysia, 2011).

Nevertheless, Sidhu (2010) stated that the number of doctoral graduates produced by each institution has been substantially low because close to 60% of them drop out at a global level. Various researches cited that one of the main reasons that contribute to the attrition rate is postgraduate supervision (e.g. Moses, 1994; Wright and Lodwick, 1989). It takes an average 6-8 years to complete a PhD in most universities as a result of inadequate facilities and resources as well as inadequate guidance from supervisors (Manyika & Szanton 2001). For this reason, best supervisory practices were found to have a great impact on students' success in completing their study and the supervisor became an important mechanism that ensures the students make good progress towards completion (Melissa Ng Abdullah & Evans, 2012). This calls for a need to re-examine the quality of postgraduate supervision in Malaysia. Though there are numerous studies that have looked into postgraduate supervision in the West there is little or scant empirical research on postgraduate supervision in Malaysia. Among the researchers that have explored this issue in Malaysia include Sidhu (2010) who conducted a comparative study that explored the perspectives of Malaysian and the UK supervisees on postgraduate supervision. Another study on postgraduate supervision was conducted by Norhasni Zainal Abidin (2006). However, there is limited research that has explored this issue from the perspectives of supervisors in Malaysia. Therefore, this study aimed to investigate supervisors' perspectives of postgraduate supervision. To be specific, it aimed to look into the supervisors' perspectives on the supervisory and digital literacy practices in postgraduate supervision.

2. LITERATURE REVIEW

In today's interconnected world, other than academic issues postgraduate supervisors are confronted with pertinent issues such as the criteria involved in being considered 'literate' in today's digital age and the requirements involved in cultivating digital literacy for themselves as well as their supervisees. To a great extent, educators need to be aware that the use of digital literacies involves the shift from traditional print-based media to the current information and communication technologies that can be used in learning and teaching contexts (Lankshear & Knobel, 2008). In promoting learner-centred education, supervisors around the globe acknowledge that the focus of instruction has shifted to the learner and they need to make their learners cultivate cognitive and critical thinking abilities as well as research skills in their search for information and play more active and participatory roles in their postgraduate journey. There is a vast array of digital resources integrated as part of our social and work related practices that can cause inability of managing the choice of materials. Digital literacy involves the technical skills which will enable the effective usage of digital gadgets and it comprises executing tasks in digital environments such as constructing knowledge during surfing the web, deciphering user interfaces, searching in databases, creating and sharing content on the web, chatting in chat rooms and communicating in social networks. Kress (2010) demonstrated how even the traditional textbook has undergone significant changes in both appearance and content, becoming increasingly image-centred and moving away from the linear toward a more modular design framework. Similarly, Lotherington and Jenson (2011) advocate the use of digitally mediated communication in today's postmodern world and call upon educators to put in place appropriate assessment practices that respect the varying academic competencies of all members of a learning context. For postgraduate students, living a literate life increasing means they have to learn how to navigate these spaces while managing one's identify and online data and considering complex issues of privacy and representation (Buck, 2012).

High quality supervision has been proven as an important element that facilitates students in fulfilling their academic potential (Cryer, 2000; Li & Seale, 2007). In view of that, Norhasni Zainal Abidin (2006) emphasized that best practices in supervision is a combination of factors which include the following: (1) the skill and commitment of supervisors (2) the ability and commitment of the students and (3) the existence of a policy or clear guidelines from institution. Thus, supervisors need to be clear about their roles and responsibilities in order to provide themselves with the necessary requirements and perform at their best during their supervision process. Since the quality of supervisory practices has a significant effect on postgraduate outcomes (Delany, 2009), it has become the interest of universities as well as governments to reliably improve the efficacy of postgraduate supervision. Van de Noort (2010) highlighted that supervisors should give guidance in terms of the planning of the research framework, helping to select relevant literature review and sources, conceptualizing research design and research methods as well as instrumental techniques, research data management and others. For example, some advice which should be given to students includes asking them to read books and journal articles, either in print or online form, that are related to the area of their investigation (Holdway et al., 1995). Additionally, during the period of writing-up of the thesis, supervisors are expected to keep in contact with students and respond to reasonable requests for assistance (Abdulfattah Yaghi, 2006) and at the same time provide guidance on the writing and preparation of the thesis. This also includes commenting on at least one draft of the student's thesis. Besides that, supervisors also need to respond through the drafts of students writing by giving constructive criticism of the draft chapter by chapter until the completion of the study.

In addition, an effective supervisor must be competent, possess a solid research background and must be able to lead their students. Zhao (2003) highlighted that the main criteria in effective supervision is supervisory competence and emphasized that supervisors must be experts and be familiar with the students' area of investigation. Spear (2000) claimed that postgraduate students should be able to be responsible for their studies as taking responsibility helps students to take charge of their postgraduate study. Hence, supervisors should treat the students as independent researchers who take initiative in proposing and executing research. McQueeney (1996) asserts that supervisors do not need to exercise too much control on their students' progress as this can threaten the originality of the PhD and the autonomy of the novice researcher while too little control can delay and even lead to total failure. Thus, most of these researchers advocate the view that supervisors need to change their supervisory practices appropriately every time students move to another stage of academic writing.

3. METHOD

This study employed a descriptive research design with a mixed methods approach which involved both quantitative and qualitative data collection. The quantitative data were gathered from questionnaires while the qualitative data were obtained from interviews with the supervisors. A total of 40 postgraduate supervisors from two public universities in Malaysia (from three selected faculties comprising Education, Social Sciences and Science) responded to the questionnaires. These supervisors are referred to as Sample group A of the population. To maintain the respondents' confidentiality, these respondents were coded as R1 to R40. Sample group B of the study comprised six respondents (three from each university) who volunteered to take part in the interview sessions. Convenient sampling was used for the interview sessions. The supervisors were encouraged to give their honest views, opinions, comments, suggestions and recommendations on postgraduate supervision based on their experience as postgraduate supervisors. Keeping in line with research ethics, these supervisors were given pseudonyms such as S1-S6.The questionnaire used in this study was adapted from a study conducted by Sidhu, Chan and Farhana Wan Yunus (2012). Apart from that, the researchers also adapted some items from the questionnaire developed by the AKEPT Centre for Teaching and Learning in Selangor, Malaysia. The questionnaire developed in this study was referred to as the Postgraduate Supervision Questionnaire (PGSQ hereafter). The PGSQ was divided into two sections. Part A examined the demographic profile of the respondents while Part B comprised 19 items regarding the supervisory and digital literacy practices of the supervisors. The ratings that were used ranged from 1 to 5 on a Likert scale (with the starting point of "1- To a very little extent" and the end point of "5- To a very great extent"). Table 1 below shows the four aspects in supervisory practices that were explored in this study. The reliability of respondents' responses to the questionnaire was tested using the Cronbach's coefficient alpha which was .895 (α=.895) indicating it was reliable (Cohen, Manion & Morrison, 2011).

Table 1. Distribution of survey items in Part B

Aspects	Number of Items
Ethics	5
Personal commitments	6
Positive climate	2
Use of digital tools	6
Total	19

4. RESULTS

A total of 40 supervisors responded to the questionnaire in this study. Most of the respondents were female supervisors (62.5%) and the remaining were males (37.5%). In terms of their academic qualifications, a majority of them were PhD holders (67.5%) while the others possessed a Master Degree (32.5%).

4.1 Supervisory and Digital Literacy Practices

This study investigated supervisors' perceptions of their supervisory and digital literacy practices in postgraduate supervision. The scope of practices encompassed the following four aspects: (1) ethics, (2) personal commitments, (3) climate and (4) use of digital tools.

4.1.1 Supervisory Practices Based on Ethics

Table 2 shows the findings of supervisors' perceptions of their supervisory practices with regards to ethics. In general, it can be deduced that a majority of the supervisors demonstrated 'to a great extent' their supervisory practices during the supervision process (M=4.18, SD=.594).

Table 2. Supervisors' Perceptions with regards to Ethics (n=40)

Ethics	Mean	SD
Make students aware of issues in plagiarism	4.30	.687
Ensure students adhere to ethical data collection and data analysis procedures	4.30	.608
Clear about your roles and responsibilities as a supervisor in supervision	4.25	.670
Ensure students are aware of the ethical codes for postgraduate study	3.92	.764
Read the institution's Supervisory Guidelines /Code of Practices for Supervision	3.70	.823
Overall	4.18	.594

Scale: 1= To a very little extent, 2= To a little extent, 3= To some extent, 4= To a great extent, 5= To a very great extent
SD : Standard Deviation

From the results shown in Table 2, it was found that a majority of the supervisors demonstrated that they went to a great length to make their students aware of issues in plagiarism (M=4.30, SD = .687). Besides that, they also demonstrated (to a great extent) that they made sure their students adhered to ethical data collection and data analysis procedures (M=4.30, SD = .608) and it can be deduced that they were clear about their roles and responsibilities as a supervisor during the supervision process (M=4.25, SD=.670). On the other hand, supervisors 'almost agree' that they ensure their students are made aware of the ethical codes for postgraduate study (M=3.92, SD=.823) and assist their students to read the institution's Supervisory Guidelines /Code of Practices for supervision (M=3.70, SD =.823).

Based on the interview findings, all six supervisors claimed that they demonstrated 'to a great extent' that they made sure their students adhered to research ethics. Female supervisor S2 pointed out that she warned her students from the first meetings with regards to the issue of ethics in research:

> *"During my first meeting with my students I will make sure that he or she reads the institution's Supervisory Guidelines /Code of Practices for Supervision*"
>
> Likewise, male supervisor S1 also further stated that
>
> *"I always ask for their soft copy to be checked for originality before checking students work further; in this way, I feel that my students will follow ethical procedures when doing their study"*

4.1.2 Supervisory Practices Based on Personal Commitments

Table 3 presents the findings of supervisors' perceptions of their supervisory practices with regards to personal commitments. The results show that a majority of the supervisors demonstrated 'to a great extent' that their supervisory practices greatly assisted their students during the supervision process (M=4.30, SD=.648).

Table 3. Supervisors' Perceptions with regards to Personal Commitments (n= 40)

Personal Commitments	Mean	SD
Ensure students produce high quality work	4.50	.555
Read and edit given drafts before consultations	4.35	.770
Ensure students possess adequate research skills	4.35	.622
Ensure students' plans are divided into clear steps which lead towards completion	4.27	.716
Provide prompt high quality constructive feedback	4.13	.723
Ensure students know how to publish and where to publish	3.80	1.067
Overall	4.30	.648

Scale: 1= To a very little extent, 2= To a little extent, 3= To some extent, 4= To a great extent, 5= To a very great extent
SD : Standard Deviation

As seen from Table 3, a majority of the supervisors demonstrated 'to a very great extent' the need to ensure that their students produce high quality of work (M=4.50, SD=.555). Besides that, they also demonstrated 'to a great extent' the need to read and edit students' drafts before consultations (M=4.35, SD=.770) as well as ensure their students possess adequate research skills (M=4.35, SD=.622). Furthermore, the supervisors also agreed that they have to ensure their students' plans are divided into clear steps which lead towards completion of their study (M=4.27, SD=.716) and they also provided prompt high quality constructive feedback during the supervision process (M=4.25, SD=.670). On the other hand, the supervisors chose the option 'to some extent' in relation to the need to make sure their students know how to publish and where to publish (M=3.80, SD =1.067).

From the quantitative data, it can be deduced that 90% of the supervisors highlighted the importance of providing constructive feedback (both verbal and written feedback and on-the-spot feedback) in order to enhance the quality of their supervision. These findings were collaborated with data from the interview sessions in which the female supervisor S3 stressed,

> "*In order to make sure my students produce a good study I usually help them select what kind of journal they need to find or help them in googling the article. I read the same article too so that I can help my students better. Then I will assist them pick up the main point and link the point with another relevant article. I will do it first and show it to my student so that they will have the right idea. Later, I will let them do the critical reading and try to connect the contents of several articles. I also give them feedback and tell them what they need to improve*."

4.1.3 Supervisory Practices Based on Positive Climate

With regards to positive climate, Table 4 displays the findings of supervisors' perceptions of their supervisory practices. In general, most of the supervisors demonstrated 'to some extent' that their supervisory practices helped to create positive climate (M=3.85, SD=.700).

Table 4. Supervisors' Perceptions with regards to Positive Climate (n= 40)

Positive Climate	Mean	SD
Possess good communication skills	4.12	.791
Ensure students engage with academic research communities	3.38	.979
Overall:	3.85	.700

Scale: 1= To a very little extent, 2= To a little extent, 3= To some extent, 4= To a great extent, 5= To a very great extent
SD : Standard Deviation

The findings indicate that a majority of the supervisors possessed good communication skills (M=4.12, SD=.791) in creating a positive climate with their students. On the other hand, the supervisors demonstrated 'to some extent' the need to ensure that their students engage with academic research communities (M=3.38, SD=.979).

4.1.4 Supervisory Practices Based on the Use of Digital Tools

The following section presents the supervisors' perceptions of their supervisory practices based on the use of digital tools. The level of the supervisors' perceptions of their use of digital tools looked into aspects such as their access to digital tools, use of search engines and use of data analysis tools. The study also explored supervisors' use of digital tools to communicate with students with regards to checking and providing feedback to student drafts online and engaging with students for online discussions/supervision. From the quantitative findings presented in Table 5 below, it can be seen that supervisors reported that they had good access to online services (M=4.28, SD=.887) and frequently used emails (M=4.45, SD=.632) to communicate with their supervisees. The findings show that many supervisors also frequently make use of search engines (M=4.26, SD=.808) to look for information related to their students' research areas. However, the use of data analysis tools in the supervisory process is a less common practice among supervisors (M=3.97, SD=.067). In addition, the supervisors engaged less frequently in checking and providing feedback to student drafts online (M=3.23, SD=.597) and engaged to a lesser extent with their supervisees for online discussions (M=2.98, SD=.876).

Table 5. Supervisors' Perceptions Based on the Use of Digital Tools (n=40)

Ethics	Mean	SD
Access to online services	4.28	.887
Use of search engines	4.26	.808
Use of data analysis tools	3.97	.067
Email communication with students	4.45	.632
Checking & providing feedback to student drafts online	3.23	.597
Engaging with students for online discussions / supervision	2.98	.876
Overall	4.18	.594

Scale: 1= To a very little extent, 2= To a little extent, 3= To some extent, 4= To a great extent, 5= To a very great extent
SD : Standard Deviation

The extent of the use of digital tools in supervising postgraduate students was further investigated in the interviews with the six postgraduate supervisors. The supervisors stated that they used their institution's available online reporting system to record and track their supervisees' performance each semester. Only two of the supervisors expressed the view that they made use of digital tools to provide feedback to their supervisees on a regular basis. According to male supervisor S1,

> *"I use technology for functional purposes, that is to access networked sources, media and digital gadgets for my own purposes and I encourage my supervisees to do the same. Similarly I ensure that my students are at ease with using a range of search engines, online services and data analysis tools as well as powerpoint and other types of digital tools. This is important for all of us in the academic community. I admit I don't engage much in online forum discussions with my supervisees, mainly due to time constraints"*

One female supervisor (S5) had this to say,

> *"I acknowledge that using technology can help me supervise better. But I feel more at ease with working on hard copies of my students' draft chapters instead of working on their softcopy version. I can proofread and correct their work faster in print form. Generally, I don't make use of digital tools in my supervision process; I email my students mainly for setting appointments but prefer to provide feedback orally or on their hardcopies"*

Female supervisor S2 expressed the following view:

> *"As a supervisor, I believe I possess functional knowledge of digital tools. To be honest, I'm still learning how to use the 'Review' tool in Microsoft Word….because I'm over 50, it's taking me longer to get used to editing students' work digitally. But I am familiar with using search engines to look for new information and I read a lot of articles online and I encourage my supervisees to do that as well…also to locate Phd theses index etc."*

5. DISCUSSION AND CONCLUSION

The findings of this study indicate clearly that supervisors should equip themselves with a diversity of supervisory practices, including making use of digital tools in managing their supervision practices. The results of the study indicate that some supervisors are reluctant to make use of digital tools to check their students' draft chapters. The supervisors demonstrated their supervisory and digital literacy practices to a great extent and provided good support to their students. This implies that supervisors were clear about providing guidance to their students during the different stages of supervision. There were four aspects explored in supervisory practices namely ethics, personal commitment, positive climate and use of digital tools. In the aspect of ethics, supervisors reported that they tried to make their students aware about plagiarism and they took steps to ensure that their students adhered to ethical data collection and data analysis. Supervisors also took measures to ensure that their students are aware of relevant regulations and legal issues, not only limited to plagiarism but also in terms of copyright, data protection, health and safety and any other ethical issues that might arise in research. McQueeney (1996) supports the claim that supervisors also have to make sure that their students understand university policies in preparing academic project reports.

With regards to personal commitments, supervisors always ensure that their students produce high quality work by giving feedback and discussing plan of study with their students as well as giving academic advice during the supervision process. Supervisors also act as evaluators, monitors and gatekeepers (Holdaway et al., 1995). Supervisors have legal responsibility and ethics to monitor the quality of care that is being delivered to their students. In order to assure quality of care and enhance the professional functioning of the students, the supervisor constantly monitors and provides feedback regarding their students' performance (Spear, 2000). In addition, supervisors also reported that they maintained good communication skills with their students with regards to building a positive climate. Moses (1994) and Zhao (2003) emphasized that good supervisors necessarily led to trust and respect based on academic standards by possessing counseling skills. Based on gender, male and female supervisors have significant differences regarding their supervisory practices in the personal commitment aspect.

In terms of the supervisors' digital literacy practices, the quantitative findings indicated that there was no significant difference between male and female supervisors, indicating that the supervisors were comfortable in utilizing technology to enhance their supervisory practices. The interview data further indicated that male supervisors appear to encourage their supervisees to make use of a range of digital tools in searching for relevant information for their research topics in comparison to female supervisors. While there are hurdles in using digital tools in postgraduate supervision, the findings of the study indicate that supervisors do make use of such tools 'to a great extent' and acknowledge that institutional infrastructure can be further improved to support the use of such technologies on a wider scale.

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POSTGRADUATE STUDENTS' LEVEL OF DEPENDENCE ON SUPERVISORS IN COPING WITH ACADEMIC MATTERS AND USING DIGITAL TOOLS

Gurnam Kaur Sidhu[1], Sarjit Kaur[2], Lim Peck Choo[3] and Chan Yuen Fook[1]
[1]*Faculty of Education, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia*
[2]*English Language Studies Section, School of Humanities, Universiti Sains Malaysia, Penang, Malaysia*
[3]*Academy of Language Studies, Universiti Teknologi MARA, Shah Alam, 40450 Shah Alam, Malaysia*

ABSTRACT

The empowerment of human capital through higher education is a key element that contributes to the growth of national income. In line with this, Malaysia under the MyBrain15 initiative aims to produce a total of 60,000 doctoral degree holders by 2023. However, high attrition and low completion rates among postgraduate students to date have hindered the noble aspiration. Among the factors that have contributed to this are postgraduate supervisory practices and student limitations in terms of knowledge, and 21st century skills such as critical thinking, autonomy and lifelong learning. Therefore, this paper aims to investigate students' perceptions of their level of dependence on supervisors in postgraduate study in relation to digital literacy and academic matters in terms of providing motivational support, writing a proposal, collecting and analysing data and writing the final report. This exploratory descriptive case study involved 132 postgraduate students from the largest public university in Malaysia. Data were collected using a mixed-methods research design through the use of a questionnaire and semi-structured interviews. The findings show that students' level of dependence on supervisors for academic matters such as the need for was much higher compared to dependence in using digital tools. In terms of digital literacy, students articulated dependence on supervisors in aspects such as data analysis, data visualization and data management tools. With regard to academic study, students' dependence on supervisors was highest at the proposal stage but reduced at the data collection and data analysis stages. Nevertheless, their dependence again increased at the final writing stages. The findings of the study suggest that postgraduate students lack autonomy for lifelong learning and hence appropriate steps need to be taken to improve the quality of postgraduate supervision in the university.

KEYWORDS

Postgraduate students, digital learning, lifelong learning, dependence, autonomy, postgraduate supervision, student-supervisor relationship

1. INTRODUCTION

In today's competitive global markets, the development of a critical mass of human capital through higher education has become a key element that can contribute to the growth of national income. For this reason, the Malaysian government initiated a special programme referred to as MyBrain 15 which hopes to produce a critical mass of 60,000 graduates with doctoral degrees by 2023. Though this move has contributed to the increasing number of postgraduate students in institutions of higher learning in Malaysia, graduation rates have been low due to high attrition and low completion rates. Researchers such as Sidhu et al., (2014) have attributed this to student limitations in terms of knowledge, skills, student autonomy, inappropriate supervision and research learning environments.

Sidhu et al. (2013) in their comparative study between Malaysia and the UK found the supervisees in Malaysia looked for a 'people' oriented supervisor who was a motivator and confidence booster. These students were also more dependent on their supervisors and had higher expectations of their supervisors compared to postgraduate students in the UK. Cryer (2006) further highlighted that though new postgraduate students usually are more dependent on their supervisors, they need to learn how to wean off their dependence as they progress along their postgraduate journey. Developments in research by researchers such as Stefano et al, (2004) has indicated that learner autonomy can be fostered via organizational support (providing students with decision making roles), procedural autonomy support (offering students choices in use of different media) and cognitive autonomy support (opportunities for students to self-evaluate work).

Consequently, there is a critical need for postgraduate students to become independent and autonomous lifelong learners. Knowles (1990) noted that the ultimate aim of all education should be lifelong learning if we are 'to avoid the catastrophe of human obsolescence' (p.135). The concept of autonomy, self-direction and lifelong learning which were rather contentious and hotly debated issues in the 1990s have gradually become accepted ideas in education. Today, almost all universities and educational organisations, including the Ministry of Higher Education in Malaysia, have lifelong learning as an important attribute for graduates. Hence, students in today's technology driven environments need to be responsive to change, inquiring and reflective in practice, through information literacy and autonomous, self-managed learning so that they leave tertiary institutions as lifelong learners.

Autonomy, on the other hand, refers to the "capacity for making informed decisions about one's own learning" and this can be developed through 'introspection, reflection and experimentation through learner training' (Sinclair, 2009, p. 1). To this discourse, Sidhu (2009) adds that for students to become autonomous lifelong learners in today's ever changing digital learning environments, they must first be equipped with the right tools and strategies so that they are capable and willing to plan, organise, monitor and evaluate their own learning. Researchers (Sinclair, 2009; Sidhu, 2009) note that for students to be autonomous learners, they must be active learners who are capable and willing to engage themselves in academically stimulating and challenging learning environments. Besides that, students must be willing to take responsibility for their own learning. Taking charge of one's learning is of utmost importance in postgraduate study if students want to leave academia as lifelong learners.

Keeping in line with the noble aspirations of becoming a developed nation by 2020, Malaysia launched the Malaysian Education Blueprint 2015-2025 (Higher Education) in 2015. This Blueprint outlines 10 shifts to spur continued excellence in the higher education where shift number nine (9) pushes for the need for globalized online digital learning and shift four (4) focuses on developing a nation of lifelong learners in a bid to develop holistic, entrepreneurial and balanced graduates to fulfil the needs of a high-income economy (Ministry of Education Malaysia, 2015). If the postgraduate students are to become the nation's critical mass of knowledgeable lifelong learners, it is only pertinent that supervisors empower students and move away from patriarchy, control and dependence.

For success in completing an academic research study at the postgraduate level, students must be well equipped with current 21st century skills which include digital literacy. In today's cyber 21st century, students need to be digitally literate to access opportunities to learn, live and work effectively. The ability to utilize digital tools has also been identified as one of eight key competences for lifelong learning, as it ensures active participation in society and economy (European Parliament and the Council, 2006). Consequently, in today's world of learning, both academics and students alike need to be digitally literate and be aware of the vast array of digital tools available for teaching and learning. The digital natives of today's learning environments need to be well equipped with technical skills for the use of digital gadgets and software to manage and construct knowledge whilst surfing the web and deciphering user interfaces (Hall, Nix & Baker, 2013). Today, both students and supervisors can even share content on the web, chat in chat rooms and communicate via social networks during on-line supervisory sessions. As such digital literacy involves a range of abilities from basic computing skills to the creation of multimodal texts and tools that can help postgraduate students in managing information, organizing the literature review and analyzing and visualizing data collected for the preparation of their final research report.

Beside having to cope with the use of digital tools, these students also need to gain independence in online academic matters such registering for courses, settling fees and communicating online with supervsiors and other administrative personnel. Cryer (2006) notes that even though new postgraduate students are usually more dependent on supervisors for support in both academic study and digital literacy, supervisors must learn to strike a balance between control and autonomy. They need to slowly dissuade their students off their dependence and guide them towards pathways of autonomy and independence. This is important because at the end of the day, students need to emerge as confident researchers in their field of expertise so that they can contribute to the critical mass of knowledge workers required by the country. Even though postgraduate supervision is growing steadily to be an explored field of interest, there still exists scant empirical evidence on postgraduate supervision from the perspectives of postgraduate students, particularly in terms of their level of autonomy. Therefore, this study hopes to examine students' level of dependence on their supervisor in coping with academic matters and using digital tools effectively in their postgraduate study.

2. THE STUDY

This study was conducted in one of the largest public university in Malaysia and employed a descriptive research design with a mixed-methods approach. Data were collected through a questionnaire and semi-structured interviews. The questionnaire was aimed to investigate students' perceived level of support / dependence on their supervisors in terms of coping with academic matters and using digital tools. A total of 132 postgraduate students responded to the questionnaire whilst eight respondents agreed to be interviewed. These 8 respondents were coded based on gender (4 males and 4 females – coded as M or F) and academic study (PhD and Masters coded as P and M). In this study, these eight respondents were referred to as follows R1-FP (R=Respondent 1, a Female PhD student), R2-MP, R3-FP, R4-FP, R5-MP, R6-FM, R7-FM and R8-MM

The questionnaire used in this exploratory study was adapted from Sidhu et al. (2014) Postgraduate Supervision Questionnaire to suit the objective of this study. It consisted of two sections: Section A explored the demographic variables of the students (e.g. gender, mode of study and academic qualification) whilst Section B consisted of 18 bipolar constructs that explored students' need for support / level of dependence on their supervisor in coping with academic matters and using digital tools. The bipolar constructs in the student-supervisor relationship for academic matters examined students' perceptions of the support they needed based on three stages in their postgraduate study which would indirectly reflect postgraduate students' level of readiness for autonomy and lifelong learning. The three stages of study explored in this study for academic matters were: 1) the proposal stage, 2) data collection and data analysis stages and 3) the final writing stage. The scale used is shown in Figure 1. Appropriate support on the left of the scale reflects the level of students' dependence on their supervisors. Meanwhile the autonomy generation (on the right side of the scale) indicates students' level of independence.

Appropriate Support <-------1------2--------3-------4-------5 ------>Autonomy Generation
(indicating students' dependence) (leading to students' independence)

Figure 1. Scale for Student-Supervisor Dependency

The reliability of respondents' responses to the questionnaire was tested using the Cronbach's coefficient alpha in a pilot study which involved approximately 52 students from another public university in Malaysia. The Cronbach's alpha reliability indexes for different dimensions in the instrument namely overall support required by students in postgraduate study (.96), dependence on supervisors for using digital tools (.94), academic support required by students at different stages (.94), and dependence on supervisors at various stages of study (.95) were identified at high level. Overall, the average Cronbach's alpha reliability for the questionnaire was identified at .95 (α=.95) indicating it was highly reliable (Cohen, Manion & Morrison, 2007).

3. RESULTS AND DISCUSSION

A total of 132 postgraduate students from a public university in Malaysia responded to the questionnaire. The demographic profile revealed that a majority of the respondents were females (65.9%) and 34.1% of them were males. As for the mode of study, 81.8% were full-time students while 18.2% were part timers. Out of these 132 respondents 85.6% were currently pursuing their masters whilst the remaining 14.4% were pursuing their PhD.

3.1 Overall Support Required By Students in Postgraduate Study

Table 1 below shows the amount of academic support students needed in their postgraduate study. Based on the findings in this pilot study, it can be seen that a majority of the respondents (79.5%) reported that they needed moderate academic support from their supervisors, indicating a moderate dependence on supervisors. This reflects a moderate readiness towards autonomy and lifelong learning. Another 10.6% of respondents claimed that they needed little support indicating that approximately 14 students were rather independent and were moving towards the path of autonomy. Another 13 students (9.8%) indicated that they were highly dependent and required much support from their supervisors.

Table 1. Level of academic support required by students (n=132)

Level of Support	Frequency	Percentage (%)
Low (1 – 1.99)	14	10.6%
Moderate (2 – 3.99)	105	79.5%
High (4 -5)	13	9.8%
Total	132	100.0%

3.2 Students' Level of Dependence: Using Digital Tools

The following section presents the students' perceptions of their dependence on supervisors in terms of using digital tools in their study. From the quantitative findings presented in Table 2, it can be seen that students articulated independence on a variety of aspects. The highest level of independence was recorded for the use of referencing software (M=4.58, SD=.715) followed by the use of online academic matters (M=4.56, SD=.864) and use of search engines for research purposes (M=4.23, SD=.762). On the other hand, the highest dependence on supervisors was for the use of data visualisation tools (M=2.03, SD=.740) followed by use of data analysis tools (M=2.43, SD=.659) and use of plagiarism software (M=3.05, SD=.766). In addition, students expressed moderate dependence in terms of using social media in research, managing literature review online tools and use of technology for online supervision.

The extent of support required by students was further investigated in the interviews with eight postgraduate students. Findings indicated rather similar findings obtained from the questionnaire. Almost all students highlighted that they were not dependent on their supervisors when it came to online academic matters. For example, Respondent R3-FP stressed that "I *do not need any help from my supervisor on online academic matters because everything is on the postgraduate website. I can register for a semester, take a semester off and even apply for a change of supervisor*." Similarly Respondent R7-FM expressed that the "*university website was very user- friendly"* and she experienced no problems accessing it even though she was not as techno-savvy as her younger course mates. Likewise, a majority of them also voiced agreement that they encounter few problems when using available digital tools for referencing and manthey had little problems with the use of available digital tools for referencing and managing information obtained from the web. Respondent R1-FP pointed out that during the orientation programme they were taught how to use various search engines and referencing software to locate information. She added, "*We were also introduced us to some data management tools and the university library staff were very helpful . . . some of them taught us how to reference materials and where we could go for further help . . .but I think I need help and expertise in managing and writing my literature review*."

Table 2. Student dependence on supervisors for using digital tools (n=132)

Items	Mean	SD
Online academic matters	4.56	.864
Using Online search engines – research	4.23	.762
Managing lit review online tools	3.23	.643
Data Analysis & Analytics tools	2.43	.659
Using referencing software	4.58	.715
Understanding data visualisation tools	2.03	.740
Use of plagiarism check tools	3.05	.766
Use of social media in research	3.79	.462
Use of latest tools e.g. mobile apps, etc.	4.05	.783
Use of technology /media for online supervision /chat	3.65	.875

Scale: Appropriate Support 1—2—3—4—5 Autonomy Generation
(indicating dependence) (leading to independence)

To this Respondent R6-FM highlighted that . . .

> "*my supervisor has exposed me to a number of software available for managing the writing of literature review such as Mendeley. In fact my supervisor is very techno savy as she is into computing software and has even created her own software called LIRAS to help us manage our literature review.*"

A majority of these respondents stressed that their main limitation lay in analytics and how to use data analysis software to analyse data. Respondent R2-MP stressed that …

> "*I am rather weak in numbers and I really learnt a lot from my supervisor. He is good in statistics and I think I need his support in helping me use analysis software such as SPSS to help me use SEM and Rasch modeling".*

Respondent R1-FP further added that,

> "*I collected and presented a lot of tables in my thesis but I was not able to present it in an attractive manner. My supervisor, he exposed me to a number of 2D and 3D visualization tools like charts, matrix, scatter plot diagrams and multidimensional pie-charts and histograms. Now I can say I am happy that my research study now looks like a PhD study. I really appreciate his help in helping me visualize my data effectively."*

Interview sessions also investigated challenges students faced with regard to digital literacy. A majority expressed their limitation again in terms of keeping up-to-date with available and supportive software tools to help them manage and analyse data collected. A few other called for the need for more effective plagiarism checking tools and need to up-skill their knowledge in data analysis tools such as NVIVO and latest computing software such advance Microsoft word software for thesis writing and formatting.

3.3 Students' Level of Dependence: Academic Matters

The students' level of dependence on their respective supervisors was also examined in terms of academic matters such as communication, feedback and supervisory meetings at three main stages of study namely proposal, data collection and data analysis as well as writing stages. The details of the overall results were computed and reported in Table 3 which presents the students' level of dependence in seven (7) academic matters at different stages in their postgraduate study. At the proposal stage, they felt they needed to have effective communication (M=2.80, SD=.232) with their supervisors and hence they were rather dependent on highly experienced supervisors (M=2.54, SD=.162) who were able to provide them with proper guidance (M=2.68, SD=.155). More importantly, they also articulated a need for having a close relationship with supervisors as they needed them to provide strong motivational support. Students also indicated their dependence on quality feedback (M=2.77, SD=.163), regular meetings (M=2.54, SD=.140) and appreciated the need for a highly structured programme at this stage of postgraduate study.

Table 3. Students' level of dependence on supervisors at various stages of study (n=132)

STAGE OF STUDY	Proposal Stage		Data Collection & Analysis Stage		Final Writing Stage	
Items	Mean	SD	Mean	SD	Mean	SD
Close relationship	2.84	.165	3.05	.018	2.97	.145
Efficient communication	2.80	.232	3.00	.152	2.92	.205
Quality feedback	2.77	.163	2.98	.068	2.87	.201
Motivational support	2.40	.159	2.92	1.032	2.87	.162
Proper guidance	2.68	.155	2.92	.024	2.84	.111
Regular meetings	2.54	.140	3.05	.018	2.79	.260
Highly structured programme	2.58	.166	2.88	.070	2.73	.165
Highly experienced supervision	2.54	.162	2.82	.032	2.63	.128
Overall mean	2.72		2.95		2.85	

Scale: Appropriate Support 1—2—3—4—5 Autonomy Generation
(indicating dependence) (leading to independence)

This high support and dependence at the proposal stage was also recorded during the interview sessions. This indicated a low level of readiness for autonomy and lifelong learning on their own. They admitted that they were most dependent on supervisors as ‘postgraduate study was a new chapter’ in their lives and they ‘looked forward to developing a close relationship’ with their supervisors (R7-FM). Furthermore, Respondent R1-FP stated that she needed the most support during the proposal stage and therefore, she made it a point to having regular meetings with her supervisor. She further stated that through the frequent meetings, she was able to experience good communication with her supervisor.

“I really needed a lot of help from my supervisor when I was at my proposal stage. We had meetings almost three times a week for two months. The feedback I received on my proposal from her was also good and easy for me to understand. I can say that we had good communication during that time and I was really dependent on my supervisor.” (R3-FP).

Likewise Respondent R2-MP articulated that he ‘lacked confidence’ at this stage and was hence ‘very dependent ‘on his supervisor for ‘identifying readings, providing regular feedback on the writing’, and giving him ‘support, motivation and even guidance on how to survive postgraduate study’.

The findings in Table 4 further illustrate that there was a slight shift in the students’ level of dependence at the data collection and data analysis stages (M=2.95) when compared to the proposal stage (M=2.72). Hence, respondents indicated there was little need for regular meetings with the supervisors (M=3.05, SD=.018) and they felt they could work independently and there was a little need of a close relationship with their supervisors during this stages (M=3.05, SD=.018). They however, indicated a need for quality feedback (M=2.89, SD=.068) and strong motivational support (M=2.92, SD=1.032). The results also show that they were most dependent on their supervisors in receiving highly experienced supervision at the data collection and data analysis stages (M=2.82, SD=.032).

This sentiment was also reflected in the interview sessions. Thus, the meetings with their supervisors decreased. They however pointed out that they still looked forward to support and motivation from their supervisors, particularly on finishing their study on time. For example, Respondent R4-FP stated that she did not meet her supervisor as frequently as when she was in the proposal stage and their relationship became rather distant. Nevertheless, her supervisor still provided support to her.

“Right now I am at my data collection and data analysis stages. As I spent more time collecting data from respondents so I have less meetings with my supervisor compared to previous stage of writing the research proposal. I think that is why we are quite distant but I still receive support from her each time we meet up.” (PPR2)

During the final stage of writing, the results reveal that respondents shifted back to dependence on their supervisors (M=2.85, SD=.861). Consequently, they articulated a need for a highly structured programme and looked forward to more regular meetings (M=2.79, SD=.260) as they were at the tail end of their study. They were still dependent on their supervisors for guidance, motivational support and quality feedback. They also appreciated efficient communication and looked forward to having a close relationship with their supervisors. During the interview sessions, they stressed that since they were at the final stages of their study they were more dependent and looked forward to a close relationship with their supervisors compared to the other stages of their postgraduate study. Respondent, R2-MP, pointed out that he actually had more effective communication with his supervisor as he had more frequent meetings at the writing stage.

“I am in my writing stage now. I can say that my relationship with my supervisor is better compared to the other stages. We also have more efficient and effective communication as we have regular meetings…I think I am still rather dependent on my supervisor” (PMC1)

In addition, Respondent R3-FP further highlighted that she was rather dependent on her supervisor’s feedback and felt that even though she had reached the end of her study she was ‘not able to wean off successfully’. This is what she had to add:

“*I am at towards the end of my study and I know I should be a confident and independent researcher but the truth is I am still rather dependent as I think I still need my supervisor’s approval. I still like her to check my work . . . I do not think I have been able to wean off my supervisor successfully and perhaps that is why I have not been able to achieve the independence required of a PhD student. . .but I am trying slowly.”*

4. DISCUSSION AND CONCLUSION

The findings of this study showed that in general, a majority of the respondents were rather independent of supervisor support in terms of using digital tools but were rather dependent on supervisors in academic matters. Students expressed little need for supervisor support in aspects such as online academic matters and use of search engines for research purposes but called for support in the use of data analysis, data visualisation and data management tools. This calls for a need to further enhance digital literacy among postgraduates so that they do not lag behind the ever-changing demands of work and life. According to Shopova (2014), digital competence is crucial for effective learning and the need for students to adapt to adapt to the dynamically changing labour market.

With regard to academic study, student dependence on supervisors was rather high at all three stages of academic study, indicating a lack of autonomy among postgraduate students. These students were most dependent at the proposal stage as they needed guidance, motivation and quality feedback. This is congruent with findings from a study by Grant (2003) who highlighted that it is crucial for the level of relationship to be high at the beginning of the supervisory process where the production of a thesis is the key component of a supervisory practice. Goldberg, Dixon and Wolf (2012) further reiterated that good communication at the beginning of the relationship helps to build strong bonds. Moreover, good communication between students and their supervisor is necessary for effective supervision. The findings also revealed that students' dependence weaned off a little at the data collection and data analysis stages because at this stage students have to carry out data collection by themselves. This was also supported by Yin (2014) who states that students should learn to be more independent when collecting data. This slight independence however, swung back to dependence at the final stages of writing. Findings from the interview sessions indicated that students again fell back because their supervisors were still viewed as experts and a majority had not successfully learnt to wean off from their supervisors to grow as successful researchers in their own fields of interest.

These findings have implications for postgraduate supervision. There is a need for a more holistic approach to postgraduate supervision that takes into consideration the tenets laid down by educationists such as Maslow and Vygotsky alongside the development of learner autonomy among postgraduate students (Sidhu et al., 2015). More importantly, both supervisors and students need to understand the delicate balance between control and autonomy. Effective supervision requires supervisors to employ a more student-centred approach in today's age of technological advances as educators who see themselves as know-all content experts are redundant in today's learning spaces. Supervisors need to listen to their students' voices, get them engaged in dialogue with their own learning environments and help provide the necessary 'scaffolding' to reach their respective zone of proximal development. Researchers like Delamont, Parry and Atkinson (1998) assert that too much control can not only limit the development of autonomy of the novice researcher but more importantly threaten the originality of research study. Therefore, supervisors need to create a healthy supervisory culture that can help their students towards the path of increasing independence and lifelong learning. On the other hand, students too need to attend training seminars where they can be helped to grow as independent and critical thinkers. Students need to be empowered with lifelong learning skills so that they can be emancipated and encouraged to question and work towards developing as independent researchers and confident members of the disciplinary community.

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TOWARDS GATHERING INITIAL REQUIREMENTS OF DEVELOPING A MOBILE SERVICE TO SUPPORT INFORMAL LEARNING AT CULTURAL HERITAGE SITES

Alaa Alkhafaji, Sanaz Fallahkhair and Mihaela Cocea
School of Computing, University of Portsmouth, Buckingham Building, Portsmouth, PO1 3HE, UK

ABSTRACT

Informal learning allows learners to be in charge of their own learning process instead of being a content consumer. Harnessing mobile technology in informal learning field could help learners in taking a learning opportunity whenever they need either individually or in a group. This paper presents a small-scale study to investigate how people may use mobile technology for learning purposes in cultural heritage contexts. A focus group approach was used to capture preliminary results of user requirements. Based on these results, a scenario-based method was used to reflect a tangible picture regarding how people interact with mobile services. This study serves as an initial step of the series of gathering user requirements in developing a mobile location-based learning service.

KEYWORDS

Mobile Technology. Cultural heritage. Informal learning.

1. INTRODUCTION

Harnessing mobile technology in informal learning (mobile learning or m-learning) provides opportunities for people to learn regardless of their location either individually or in a group (Sharples, 2000). M-learning helps encourage people to undertake new experiences in life as well as promoting lifelong learning (Fallahkhair et al., 2004, Vavoula, 2003). In addition, m-learning offers people the opportunity to learn within different contexts thus enabling people to learn while they are doing their daily activities (Brown et al., 2010, Kukulska-Hulme and Traxler, 2005) which takes place throughout people's experiences (Cohen, 1993). Learning from experiences could be considered as informal learning in which enables learners to be in charge of their own learning process instead of being a content consumer.

Engaging in aspects of cultural heritage may form a significant facet of the informal learning process. Since cultural heritage reflects the identity of societies (Vidal González, 2008), it could be important for people to learn more about the historical information that relates to heritage sites. This may help people to appreciate their history, which could further promote a sense of loyalty and engagement (UNESCO, 2013).

Additionally, visiting historical sites reinforces the revival of the glorious past that the communities have had during a particular age. This would help people to derive a power from that history and to be proud of belonging to that community, and also maintain a link between the present and the past, which would stimulate the perpetuation of culture (Du Cros, 2001, Caton and Santos, 2007).

Learning about historical stories and events that have taken place in a certain space not only attaches people to their roots (Poria et al., 2006), but also evokes their emotion and identity towards societies that they belong to (Poria et al., 2004). In turn this may inspire them to give more to serve their communities and, contribute to community advancement.

Since people learn by interacting with each other (Tseng and Chen, 2014), and mobile learning facilitate the interaction between people in different contexts (Lam et al., 2010), effective mobile services should be introduced to enhance this interaction. This aspect could successively support informal learning in cultural heritage contexts. This paper presents an empirical study of how people use mobile devices for learning purposes with respect to culture heritage sites. A focus group approach was used to capture initial user requirements. A Scenario-based method was used to envisage the interaction process between users and mobile services based on the results of this study.

2. FOCUS GROUP

The present section describes the focus group approach that was used in this study including: the overall methodology, the methods that used to collect and analyse data, and finally, reporting the results.

2.1 Methodology

A focus group discussion was used in this study. Six participants took part in this discussion; their age ranged from 28-50, three male and three female. All of them are familiar with mobile technology. Participants were recruited among the PhD student community. A Doodle notification was sent to them by email asking to state day/time that is suitable for them in order to organize the discussion meeting. A thematic analysis method was used to analyze the data (Braun and Clarke, 2006). The data was coded manually and also electronically using QSR Nvivo 10.

2.2 Data Analysis

The data was analysed by using a thematic analysis method which consists of six phases that were set out by Braun and Clarke (2006) :1) Getting familiar with the data. 2) Generating initial codes. 3) Searching for themes. 4) Reviewing themes. 5) Defining and naming themes 6) Producing the report.

As noted by Braun and Clarke (2006), themes could be 'data-driven' which is emerged from data without any prior ideas about it, or theory-driven', which means that data has been coded around some initial ideas from the literature. Whilst both sources were used in this study, the obtained themes are more 'theory-driven' as the researchers have had some initial ideas regarding this research from the literature. However, a few themes have also emerged from the data.

The data were coded manually and electronically. First, manually: paper, highlighter, coloured paper and pencil. Second, electronically, using computer software: (QSR Nvivo 10) (Bazeley and Jackson, 2013, Bazeley, 2009). The electronic version was used to increase the reliability of coding data by looking at the data from a different angle. Using Nvivo helped to take in-depth insight to the dataset. Its value is that it is more accurate than do it manually in terms of avoiding missing some potential themes that might be important, due to the easy-checking by using software rather than go through the transcription manually every time to check (Basit, 2003). Two lists of themes have been obtained from using manual and electronics versions of coding. A list of final themes emerged by reviewing and combining these two lists. The coding process was conducted in three cycles: 'generating initial codes', 'searching for themes', and 'reviewing themes'.

It is necessary to clarify that throughout this paper we intend to use 'code' for the extracting information in the first level, 'category' for descriptive level of coding, and 'theme' for a more abstract level (Bazeley, 2009). The details of how each phase of the thematic method was carried out are as follows:

1) Getting familiar with the data

This phase involved transcribing the verbal data, reading and re-reading through the entire dataset and also noting down some initial ideas. An initial list of potential themes was obtained through this phase.

2) Generating initial codes

This stage included deconstructing information from its original dataset into initial codes. These codes were assigned clear labels to act as rules for inclusion. The details of coding data in both versions (manually and electronically) as follows:

Manually: The interesting patterns that are repeated across the dataset was highlighted (patterns related: problems, services, motivation) and also new patterns have emerged such as 'a learning concept'. Afterward initial codes were generated as illustrated in Table 1.

Table 1. An example of coding data manually

"…if I go there I want to take picture and keep memory, I want to see memories, I wanna write down. Take picture and save them (manage pictures), I want to take direction as well, and some times I've been lost anyway, I want to find the history of things not just brief, I wanna go in depth like Charles Dickens, so, so. Probably I wanna to have a coffee in place like Charles Dickens lounge, I want when I go back have a look at what I've …"	1- Talking about features and services. 2- Talking about information and facilities

Electronically: the Open Coding stage was carried out using Nvivo. This stage included extracting information from the original dataset into initial 'non-hierarchical codes'. Information was extracted for each participant to define a node or nodes based on the answer. For example, if the participants wrote down online ticketing and online booking for using mobile devices in cultural heritage sites, the node could be 'online services'. As we went through the dataset any similar patterns were assigned to the nodes already defined for those patterns. When a new piece of information emerged, a new node was defined to assign this new information to. For instance, 'learners and visitors' are different than 'usage of mobile devices', so, a new node was defined to assign it.

3) Searching for themes

This phase included re-ordering initial codes, re-labelling and merging similar codes in order to ensure that labels for inclusion accurately reflect the contents.

The initial codes identified from the previous phase were grouped together in meaningful categories. The related codes were assigned to a certain category in order to identify themes. A mind map was used in the manual version of coding (see fig 1). Furthermore, in the electronic version; re-ordering and re-labeling of nodes was carried out to identify categories.

4) Reviewing themes

This stage included breaking down the categories that were obtained from the previous phase into sub-categories to offer a clear insight to the meaning of categories.

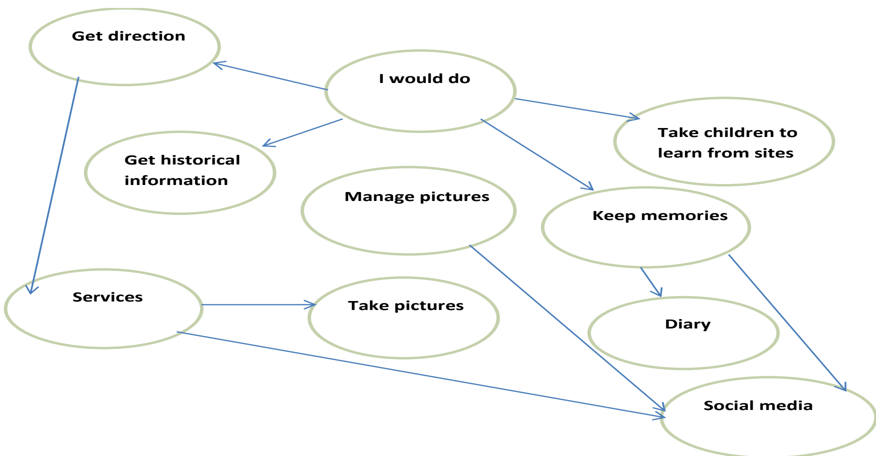

Figure 1. Illustration of grouping patterns using mind map

Furthermore, it is offer an opportunity to reviewing potential themes that might emerge from the defined categories in the previous phase.

This phase was carried out in the manual version using pieces of coloured papers. The pieces were stacked onto an A2 paper to form more specific categories (sub-categories).

Similarly, in the Electronic version: nodes were re-constructed into sub-categories.

5) Defining and naming themes

This phase included consolidation of codes from the three cycles of coding data.

Themes were defined and named according to the meaning of each group that emerged from the previous phase.

At the end of the Defining and Naming Themes phase, the results from electronic and manual versions of coding were reviewed. A list of themes has been produced based on combining the results from these two versions (detailed description in the next section).

6) Producing the report

Based on the analysis of the data, a report was produced to summarise the analysis phases as well as the results.

2.3 Results

This study revealed a set of broad themes, which serve as initial requirements of developing a mobile learning service. These themes include:

Learners and Devices: Learners could be categorized as groups and individuals, and also could be categorized as adults (elderly and young people), and children with their parents, grandparents, and teachers in a school trip. Learners interact with the cultural heritage sites using mobile devices which include: mobile phones, tablets and wearable devices (e.g. google glasses). In terms of kinds of mobile applications (apps), participants reported that is important to consider all types of operating systems to meet the multi-variation interest of people regarding types of mobile devices, "*…different people has different preference"…, "…is it a cross platform app?,…what kind of apps that people comfortable with?*".

A common view amongst participants was regarding considering user profile. Participants stressed that it is important to consider user preferences, "*…personalize your app to suit your convenience…*", which means designing a user model that includes all user's preferences based on user's interests (Cocea, 2011).

The Learning Notion: The discussion has revealed different opinions about what the notion of 'learning' means. One of them considers learning as the process of getting information through courses, so, mobile learning is the ability to access online courses through a mobile device such as MOOCs (Massive Open Online Courses). The rest were divided between considering learning as; firstly, the process of retrieving information and retaining it for using when needed, secondly, as any type of information that people obtain during their daily life (e.g. looking at trains or buses time).

Motivation and Attitude: The participants had diverse reasons for visiting cultural heritage sites and also for using a mobile device whilst there. The main reasons that motivate people to visit cultural heritage sites are: 1) learning, 2) entertaining, 3) discovering other countries cultures. Some of participants stressed that visiting historical sites could play a significant role in terms of helping people to learn about the history; either for themselves or their children, "*I would like to take my children to historical site to help them learn from them…".*

Moreover, some of participants pointed out that the nature of people, who are interested in those sites and they enjoy history, would drive them to visit those sites. Entertainment could be a reason for visiting cultural heritage sites. Curiosity in discovering cultures, either their own cultures or other society's cultures, might influence people to visit heritage and historical sites, "*…I might go to visit cultural heritage or historical sites if I am on holiday in another country*" , *" I would discover society's cultures, so the best way is to visit cultural heritage and historical sites… ".*

Additionally, there was a sense amongst participants that a mobile app that provides almost all services that visitors/learners could need in cultural heritage sites, would encourage people to use it would have all their needs providing in one app.

Services and Features: The main debate in the focus group discussion was about some existing services that are being used by people that could be utilised for cultural heritage contexts; such as the 'Google Now' app that notifies people about aspects based on their interests (Google). Some features that they are hoping to find in a mobile app; such as connecting the app with the social media to share information, photos, etc., keep memories and manage pictures and diaries, "*…I go there, ..,I want see memories, I wanna write down, take picture and save them…".*

Furthermore, provision of interesting services may motivate them to visit cultural heritage sites. For instance, providing some useful information about some interesting aspects or facilities that could bring people attention, "*… I like Charles Dickens; probably I wanna to have coffee in place like Charles Dickens' lounge…"*

In addition, participants claimed that it is important to personalize the app to meet user preferences, which could in turn, motivate people to use it, "*…personalize your app to suit your convenience…*", also, it would be advantageous if the service can provide a story narrator, that might attract children which in turn encourages parents or grandparents to use it when taking children for a day out, *"…they can listen to a story while they are visiting the site…"* or utilize a quiz, "*...quizzes for example…", "… you can make [quizzes] in different level…*" Finally, participants suggested providing a unique and international code to be recognized everywhere which will help the app to be for a global use.

Information: Information plays a significant role of developing mobile learning services for cultural heritage contexts. The reliability and usefulness of the information could encourage people to use this app. The debate in the discussion was about how people can obtain right information in a right time. Participants stressed that the quality of the information and the way that could be obtained is very important in terms of: 1) generating reliable information, in which should be generated immediately at a real time. Managing and maintain data in an efficient manner,"…*how many places you gonna generate this information for, is just England!?*…". 2) pulling information from the cloud, which is easier in terms of it doesn't need to be generated immediately, however, it needs to be checked in terms of authenticity, "…*if you are using information from the cloud, you have to think about the authenticity*…" .

Moreover, participants suggested providing some useful information for instance, how many visitors are visiting the site in a particular day or time, or some information about transportation. Those type of information could be helpful in terms of avoiding a crowdie day or to know about the type of transportation that is available,"…*it can give you information like taxis, buses, it could be helpful or how far from the bus station*…". Participants mentioned that enabling user to review comments that was generated by other visitors might help people to have an initial idea regarding a historical site before visiting it.

Usability, Acceptance and Usefulness: Participants highlighted some factors that may affect people's acceptance of using a new technology such as ease of use as well as provision of useful features and information. Participants stressed that asking a lot of questions and providing many choices could make the app complicated and not easy to use, which may dissuade people from using the software,"…[*if the app is] more complicated, more interaction and more question you will lose number of users…* ".

Additionally, participants suggested giving the users a choice to disable or enable some services (e.g. switch off the notification service). This could give them an opportunity to choose what they prefer to acquire in a certain time. That may motivate them to use the app in which they do not feel restricted by such an annoying app (e.g. annoying notification), *"… make it easy when you can switch things off or not…"* this would provide users with multilevel of interaction and thus, cater for the diversity of interests leads to increased adoption.

Challenges and interventions: Participants underlined some challenges regarding using a mobile device in cultural heritage sites such as; a poor network quality in some remote places.

The small screen size of some devices, such as mobile phones, might be not comfortable for elderly people who have got sight problems so they might prefer to use a tablet, "…*that is an implication for elder people who may be would find it difficult to look at a small screen*…".

The scalability might cause a problem in terms of the amount of retrieval data. For instance videos and images got tend to take a large amount of space in a mobile device memory (Alkhafaji et al., 2014). Nevertheless, using cloud computing as storage for the historical information might be considered as a solution for this issue.

Furthermore, participants pointed out that to enable people to become engaged with the app, a level of trust must be established,"… *[people] may not feel comfortable with something knows where they are…*". Confidentiality is an important aspect in such an app; people might not like apps that ask for personal information. This might lead to issues about why the app asks all these questions or how it knows about a particular aspect, "…*when google suddenly give you an advert about some stuff you've been looking at, you are thinking how it knows that, and you thinking am not sure I like this…".*

In addition, participants, emphasized that there are some people, probably the old generation, do not feel comfortable with the new technologies and may find it not easy to use, which may affect their attitude towards using a mobile device, "…*is just I personally wouldn't, because I don't have that sort of easy to use a mobile phone*…", "…*there is a generation of people who like to have a physical book rather than an app…*". However, it would be more useful to provide some interesting services such as personalizing the app that could bring their interest and encourage them to use it at cultural heritage sites, "…*is like a trigger that makes somebody who never use that kind of things go and use it…", "...I can remember saying I wouldn't never have touch screen phone…then few years later you get you can't imagine life without it…".*

Finally, another interesting issue has been mentioned by some participants who reported that the weather could be considered as a problem in the UK, which may prevent people to use their mobile devices in outdoor settings. However, some participants stated that using a Bluetooth headphone set might solve this problem.

3. DISCUSSION

The result of the focus group discussion acts as an introductory stage of the gathering user requirements process. It gives an elementary idea about how people would use mobile technology in cultural heritage contexts. In the other words, it shows how people would like to interact with mobile services. In turn, it helps in shaping the interaction process between users and systems. The results, while preliminary, suggest some interesting aspects in terms of interaction design.

One important aspect is considering user's profile; people would like to personalize their mobile app based on their profile (Cocea, 2011). In addition, even though people prefer the easiest and quickest ways for doing activities and interact with systems, they also like obtaining them in reliable and effective ways. With respect to using a mobile device to learn from cultural heritage sites, people prefer a mobile app that is easy to use and at the same time can provide rich and reliable information.

Although, some people are not keen to visit cultural heritage sites, they like to do it for their children's sake or for getting extra services while visiting those sites (e.g. visiting Christmas shops in the Dockyard). Hence, despite the diversity of participants' points of view, all of these opinions were revealed that learning about history and cultures would leads them to visit cultural heritage sites.

Another important aspect that was highlighted in this discussion is collaborative learning. The result illuminates that most of people like to share knowledge and gain information via interacting with others. In other word, they like to do activities in a group which enables them to communicate with each other, and at the same time to share information, which may enhance their learning experiences (McLoughlin and Lee, 2008, Laurillard, 2009).

One more interesting aspect has emerged from data, which is the learning perception and how people understand learning. Interestingly, the result shows that people might learn incidentally and informally. Nevertheless, most of the time is happening unconsciously in which they do not perceive that they are learning. Given that, learning could be defined as acquiring information throughout a lifetime either through educational systems, formal learning, or life experiences, informal and incidental learning (Marsick and Watkins, 2001, Ainsworth and Eaton, 2010).

The results revealed that some considerations should be taken into account when designing a mobile app in terms of interaction design. Main considerations include: user profile, ease of use, and sharing information. The next section will illustrate some results of the focus group study that has been used to embody user's characteristics and preferences using a scenario-based design method(Carroll, 1999, Fallahkhair et al., 2004).

4. SCENARIO-BASED DESIGN

A scenario-based design method has been widely used in the field of HCI (Carroll, 2000), this is due to its ability to envision the interaction between users and services (Rosson and Carroll, 2002). Furthermore, scenario-based method helps to identify the suitable context of use and the main actors which consider the key elements for gathering requirements (Carroll et al., 1998). We have developed a novel scenario that responds to some results of the focus group study presented as follows:

Scenario: Dana and Sam are parents of three children; Sarah is 6, Jannah is 8 and Tom is 10. They are keen to get their children to learn about culture and history. They do believe that the best way to do it is taking them to visit cultural heritage sites. However, they concerned about how to get them enjoy the trip and learn at the same time, especially that the kids are different in their preferences and how they like to learn. Sarah and Jannah like to listen to a story whereas Tom likes quizzes. Sam's noticed that some of his colleagues use a mobile app when visiting cultural heritage sites. This app enables them to personalise it based on their preferences and also give them an opportunity to choose how they prefer information to be presented (learning preferences). Sam downloaded this app in his mobile phone as well as to his wife's mobile phone and also to the kids' tablets. During a summer holiday, they took the kids to visit the Southsea Castle in Portsmouth. Sarah and Jannah chose listening to the historic information about this castle in a story form. Sarah chose to listen to the story as an audio cartoon film, while Jannah chose to listen to a story that was told by a narrator. Tom chose to get information by taking a quiz that asks him to find the tunnel for instance and tick the right choice about why this castle was built? At the same time the family created a network between them, which enabled the parents to keep their kids tracks, share information, and also to enjoy their trip together as a group.

5. CONCLUSION AND FURTHER WORK

A Small-Scale study has been presented in this paper. The study was conducted to capture an initial requirement for developing a mobile location-based learning service with respect to cultural heritage contexts. A focus group approach was used in this study. This study serves as a bedrock in the process of collecting user requirement in the user-centred design approach.

Although the current study is based on a small sample of participants, the results suggested a set of interesting themes, which will be useful to be considered in designing interactions of mobile learning services. These themes include: learners and devices; the notion of learning, motivation and attitude; services and features; information, usability, acceptance and usefulness and, challenges and interventions. A scenario-based method was used in this paper to illuminate some of the results regarding the interaction design between users and mobile services.

The study that has been presented in this paper forms the first stage of a research project. This research is intending to develop a mobile location-based learning service with respect to cultural heritage contexts. There are a number of areas that we envision to carry out further work: Firstly, to conduct further steps to fulfil the eliciting of users requirements which includes: a) distributing a questionnaire form to obtain a wide-scale of data. b) Conducting additional interviews to gain in-depth details regarding using mobile devices for learning purposes. We are also planning to develop a task model based on the results of our questionnaire and interview studies using the socio-cognitive engineering methodology (Sharples et al., 2002). Finally, a prototype mobile app will be developed as a proof of concept based on the task model.

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THE DEVELOPMENT AND EMPOWERMENT OF MATHEMATICAL ABILITIES: THE IMPACT OF PENCIL AND PAPER AND COMPUTERISED INTERVENTIONS FOR PRESCHOOL CHILDREN

Maria Lidia Mascia[1], Mirian Agus[1], Maria Chiara Fastame[1], Maria Pietronilla Penna[1], Eliana Sale[1] and Eliano Pessa[2]
[1]*Department of Pedagogy, Psychology, Philosophy, University of Cagliari, Italy*
[2]*Department of Brain and Behavioural Sciences, University of Pavia, Italy*

ABSTRACT

The development of numerical abilities was examined in three groups of 5 year-olds: one including 13 children accomplishing a numerical training in pencil-and-paper format (EG1); another group including 21 children accomplished a homologous training in computerized format; the remaining 24 children were assigned to the control group (CG). The participants were assessed at three successive times (t0, t1 and t2) with a battery of validated tests assessing numerical abilities and fluid intelligence. At times t1 and t2 we found differences between experimental groups and CG, while the children's abilities in the two experimental groups were similar. We underline the crucial role of pre-syntactical and counting dimensions, accounting for a distinction between the experimental groups and control. Results are discussed with reference to the relevance for training activities of the presentation format (pencil-and-paper versus computer-assisted). Pragmatical and practical implications are also considered.

KEYWORDS

Early numeracy learning; Psychoeducational Training; Preschool; Cognitive Empowerment; Educational technology

1. INTRODUCTION

Many researchers are looking for exploring the basic structures that contribute to mathematical success in order to understand mathematical abilities development and to implement effective teaching strategies (e.g., Torbeyns, Gilmore, & Verschaffel, 2015; De Smedt, Noël, Gilmore, & Ansari, 2013). These studies evidenced the full complexity of mathematical acquisition processes starting from the preschool years. In this regard a growing body of studies has reported that early numeracy is developed during childhood even before the onset of formal education and it is progressively enriched at school (e.g., Jordan et al., 2009). Indeed, numerical processing is based on the development of two non-verbal mechanisms, such as the pre-verbal capacity to visually encode and enumerate a limited number of information (i.e., maximum 3-4 items), the so called Object Tracking System (Mandler & Shebo, 1982), and the capacity to discriminate two sets of items as a function of the number of elements expressing the quantity of each set (Approximate Number System; Dehaene, 2011). The latter capacity implies that when more than four items are presented and serial counting cannot be carried out, the capacity to visually enumerate the objects fails and counting responses become more fallacious. Overall, from a typically developmental perspective this impasse can be overcome only when young mathematics achievers learn a symbolic enumeration system and some counting skills, which allow those children to process the numerousness of unlimited sets of elements (e.g., Jordan et al., 2009).

However, further research shows that the development of mathematical skills predicts the successive mathematical achievements at school (e.g., Morgan, Farkas, & Wu, 2009) and the development of the related emotions, such as math anxiety, that is, the feeling of fear and tension interfering with mathematics performance (e.g., Jansen et al., 2013). For instance, early numeracy learning is slower in children attending primary school that successively are identified as students with dyscalculia (e.g., Passolunghi, Vercelloni, & Schadee, 2007). For this reason, during recent years the possibility of empowering early numeracy learning by structured early psycho-educational interventions received much attention. Indeed, researchers (e.g., Fuchs, 2009; Siegler & Ramani, 2009) argue that early psychoeducational programs promoting mathematics-related learning can be very useful both for typically developing children and those being unproficient mathematics achievers. The principle underpinning the early interventions for the empowerment of numeracy-related learning is that, from the one hand, they can strength the mathematics knowledge and skills of typically developed children and, from the other hand, they can provide an opportunity to improve mathematics skills of at-risk children, in order to reduce even the negative emotional impact of scholastic failure on them (e.g., Jansen et al., 2013; Siegler & Ramani, 2009). Some literature shows that trainings based on technology supports have a great importance in the development of many different kinds of learning abilities (Meneses et al., 2012). Most literature focuses the attention on the number line trainings, starting from the beneficial effect of paper–pencil tools on children's numerical development and their mathematics achievement (Moeller, Fischer, Nuerk, & Cress, 2015). This study underlines how computer-supported methods may considerably increase both the motivational aspect but also training efficiency in a great number of ways, for example implementing numerical trainings in general, ensuring adaptivity, accessibility and interactivity of training approaches. Some literature asserts that computer-assisted instruction is more effective and beneficial than traditional instruction for educating students (Gunbas, 2015).

Other studies state that the pencil-and-paper and psychoeducational programs have the same efficacy in the enhancement of cognitive functions in childhood (Penna, Stara, & Bonfiglio, 2002; Penna & Stara, 2010; Ramani, Siegler, & Hitti, 2012; Passolunghi & Costa, 2014). For instance, a series of follow-up studies reports that specific metacognitive and cognitive (e.g., visuo-spatial attention and working memory) psychoeducational trainings can be successfully used in formal education in order to promote the empowerment of specific cognitive processes underpinning learning in the classroom (e.g., Fastame & Callai, 2015). Previous research shows a correlation between individual differences in people's school math abilities and the accuracy with which they rapidly and nonverbally approximate how many items are in a scene (Libertus et al., 2011). A longitudinal study explores the importance of kindergarten measures of phonological awareness, working memory, and quantity-number competencies as predictors of mathematical school achievement in third graders (mean age 8,8 years) (Krajewski & Schneider, 2009). Moreover, a further body of studies shows the efficacy of pre-literacy psychoeducational interventions in improving early numeracy skills (e.g., classification, seriation, counting) of pre-schoolers (e.g., Agus et al., 2015; Cirino, 2011; Clements & Sarama, 2007). For instance, Clements and Sarama (2007) showed the effectiveness of an early numeracy learning intervention for young children lasted 26 weeks and based on a number of tasks such as counting, doing number comparison, and number recognition.

For what concerns the Italian scenario, during the last decade different psychoeducational trainings have been developed in order to empower numeracy knowledge and related skills. In this regard, very recently Agus et al. (2015) conducted a preliminary study combining two pencil-and-paper and computer-assisted psychoeducational interventions aimed at enriching numerical knowledge and visuo-spatial abilities in second graders. The authors found that the combination of both the pencil-and-paper and computer-assisted versions of visuo-spatial and mathematical interventions was more effective on the empowerment of numerical skills than the execution of single treatments.

The aim of this study was to verify the impact of two pencil-and-paper and computerized-assisted trainings on numerical intelligence of five years old children attending the last year of kindergarten. Specifically, we were interested in evaluating the effects of the presentation modality of the interventions in relation to the different aspects of numerical abilities (related to lexical, semantic, counting and pre-syntactical areas) and fluid intelligence empowerment.

Therefore, in agreement with the literature, we hypothesised that: 1) the children that carried out a computerized training display a greater enhancement in mathematical learning (Praet & Desoete, 2014) with respect to children lacking any form of specific psychoeducational training; 2) the participants that performed the training in both modalities could have an analogous improvement compared to that of the children carrying out only the computer-assisted tasks, because the effectiveness of both modalities might be related to the novelty of the resources/tasks used (Swanson & Hoskyn, 1998).

2. METHOD

2.1 Participants

Fifty-eight children, enrolled in the last year of kindergarten in several Italian schools, took part in the study after their parents had provided written informed consent for participation. This study is only a part of larger researches involving more than 300 children. The sample comprised typically developing children, showing no signs of cognitive or perceptual deficits. Four pupils were excluded from the starting sample because they presented some learning difficulties disabilities. The children assessed belonged to the middle socioeconomic status. The research was conducted on the base of the ethical requests defined by the Italian Association for Psychology. Table 1 summarizes the socio-demographic characteristics of participants; there were no differences in relation to the sex variable ($\chi^2 = .557$, df = 2, p = .757).

Table 1. Descriptive statistics in each group

		Control group (C)	Experimental groups	
			Training in pencil-and-paper format EG1	Training in computerised form EG2
PRE-TEST	N	24	13	21
	Percentage of women	41.7	53.8	42.9
	Age Mean in months at pre-test	64.33	64.23	64.62
	Age Standard deviation	3.30	3.29	3.81
	Lowest age	58	59	59
	Highest age	70	70	71

2.2 Materials

Pupils were presented a standardized battery, constituted by the Raven's Colored Progressive Matrices (CPM, Raven, 1958) and by the BIN (Numerical Intelligence Scale; Molin, Poli, & Lucangeli, 2007), in order to have respectively a measure of fluid intelligence and of their numerical knowledge.

The CPM (Raven, 1958) are used also for children in kindergarten (Italian adaptation, Belacchi et al. 2008).

The BIN (Molin, Poli, & Lucangeli 2007) evaluates four areas of numerical skills: the lexical subscale (i.e., assessing the ability to read and write Arabic numbers, moreover the skill to join the number-word to the exact digit); the semantic subscale (i.e., evaluating the ability to associate numerical sizes, dots and Arabic digits); the pre-syntactical subscale (i.e., appraising the capability to link numbers to their number representation and to order several quantities); the counting subscale (i.e., assessing the ability to recite the number–words sequence forward and backward, as well as the knowledge of the order of Arabic digits from 1 to 5).

After the pre-test phase (t0), children in the first experimental group (EG1) underwent the training program "L'intelligenza numerica I" (Lucangeli, Poli, & Molin 2003) and 'Sviluppare l'intelligenza numerica I" (Lucangeli, Poli, & Molin 2010) in pencil-and-paper format. The remaining children were assigned to the second experimental group (EG2) that followed the homologous activities in computerized format ("Sviluppare l'intelligenza numerica I" by Lucangeli, Poli, & Molin 2010). The children in the control group (CG) carried out the regular curricular activities proposed by their teachers. The psychoeducational interventions employed in the current study consist of activities following the same conceptual and theoretical structure, developed to enhance numerical abilities in pre-schoolers pupils. The tasks were settled to empower and to favour a gradual and playful approach to the numerical knowledge in children, preparing them for primary school. The training enhances multiple processes: it favours the use of the Arabian code until 10, the learning of number names, the automation of the number sequence, the estimation of the weight of numbers, the evaluation of space, size and objects and the introduction of ordinality. Specifically, the software is composed of a series of tasks which are presented along the North Pole by an interactive tutor; he explains the instructions, gives feedbacks about the correctness of the performance and encourages the user in case of failure. The level of difficulty of those tasks might be adjusted in order to adapt them to the efficiency of the user.

Similarly, the pencil-and-paper program was aimed at enriching numerical knowledge, following the same principles. The program includes different units and learning situations, characterised by new elements and increasing complexity, organised in a series of printable worksheets for the activities. The pencil-and-paper activities were conducted by trained researchers. Both the computer-assisted and pencil-and-paper programs include several exercises promoting the metacognitive awareness and control of the cognitive processes involved in the activities.

2.3 Procedure

At pre-test (t0), post-test (t1) and follow up (t2), children were tested individually in two sessions, lasting approximately each twenty minutes. Each test was presented following the instructions contained in the original manuals (Belacchi et al., 2008; Molin, Poli, & Lucangeli, 2007). After the pre-test phase, 13 children (6 males and 7 females; M age =64.23, SD =3.2 months) were randomly extracted from the original sample and were presented the training activities in pencil-and-paper format (EG1), selected from "L'intelligenza numerica I" (Lucangeli, Poli, & Molin 2003) and 'Sviluppare l'intelligenza numerica I" (Lucangeli, Poli, & Molin 2010). At the same time, 21 children (12 males and 9 females, M age = 64.62, SD = 3.81 months) were assigned to the second experimental group (EG2) that accomplished the homologous training in computerized format (Lucangeli, Poli, & Molin 2010). The remaining 24 children (14 males and 10 females M age = 64.33, SD = 3.3 months) were assigned to the control group (CG) that carried out the regular curricular activities proposed by their teachers. The groups were matched for chronological age. At the present, it should be stressed that the children in the experimental groups attended different schools from those in the control group. However, their socio-cultural context was similar, because the schools were located in neighboring villages.

In the first experimental group (EG1) the pupils engaged in the pencil-and-paper activities that were carried out collectively during 10 weekly sessions that lasted approximately one hour each. On the other hand, each child in the second experimental group (EG2) was individually trained by the homologous computer-assisted intervention, for 10 weekly sessions, lasting 30 minutes each. When the trainings were concluded (i.e., t1 - post-test after 3 months of the same scholastic year) and also after 6 months from the post-test phase (i.e., t2 - follow-up at the June of the same scholastic year), two further abilities assessments of the sample were carried out. Specifically the post-test was applied in all groups that were presented the same battery of tests originally administered at the pre-test – t0; the follow-up valuation was realized in two experimental groups (EG1 and EG2).

2.4 Data Analysis

In order to verify the hypotheses of research, the potential differences between groups at pre-test in each dimension were assessed. For this purpose, a series of univariate Analyses of Variance (ANOVAs) were carried out on the scores calculated at pre-test, using the training group as factor (CG, EG1, EG2). All variables achieved the rules of the ANOVA application. These analyses did not revealed any significant statistical difference between the experimental groups and the control one in the CPM test [F=. 914; df=2;55; p= .407], BIN Lexical [F=. 217; df=2;55; p= .806], BIN Semantic [F=. 137; df=2;55; p= .872], BIN Counting [F=2.308; df=2;55; p= .109] and BIN Pre-Syntactical [F=. 544; df=2;55; p= .583].

On the bases of these outcomes, it was settled to investigate the information related to the effect of trainings in the groups at post-test and follow up (Keppel, 1991). Then the specific parametric statistical analyses were applied in order to verify the hypotheses, controlling the effect of age. Firstly the linear correlations were evaluated between all pairs of variables (at t0, t1 and t2) by the application of Pearson's r Coefficient. Formerly, to assess the specific role of trainings in the change of performance from pre-test to post test (in each dimension evaluated), a Multivariate Mixed design Analysis of Covariance was computed, where the repeated measures were constituted by the performances in two times (t0 pre-test - t1 post-test), the between factor was the "training group" (control group, experimental pencil-and-paper, experimental computerized) and the covariate was the age at pre-test. The application of this statistics was suitable in order to compare the performances in all scales for all groups in two moments, controlling the effects of influencing factors. Consequently, another Multivariate Mixed design Analysis of Covariance was performed in order to evaluate if there was a retaining of achievements from the post-test (t1) until the follow up assessment (t2); then this analysis focused on the specific performances of experimental groups. Subsequently, a Discriminant Function Analysis was applied in order to identify the variables more useful in making the distinction among children in CG, EG1 and EG2. This analysis allowed to select the dimensions that better predict the probability of a child to belong to one specific group, useful to interpret group differences.

3. RESULTS

The first Multivariate Mixed design Analysis of Covariance was applied on all dimensions taken in account (CPM and BIN scales); the repeated measures were the pre-test and post-test assessments (t0 and t1), the between factor was the training group (CG, EG1, EG2) and the covariate was the age at pre-test (Table 2). A significant effect of the repeated measures was found [$F= 5.521$, $df= 1;54$, $p=.022$, $\eta^2= .093$] at t0 and t1, highlighting that in post-test condition there are generally scores higher than at the pre-test. Moreover, it was also observed a significant interaction effect between the repeated measures (i.e., t0 vs. t1) and training groups (i.e., CG vs., EG1 and EG2) [$F= 4.787$, $df= 2;54$, $p=.012$, $\eta^2= .151$], that is, at post-test the scores of EG1 and EG2 are significantly higher than those of CG (Table 2).

Table 2. Results of Multivariate Mixed Design Ancova comparing pre-test and post-test in groups CG, EG1, EG2

Source	Wilks' Lambda	df	F	p	Eta^2	Bonferroni's Adjusted Group comparisons
t0-t1	.907*	1	5.521	.022ǂ	.093	t0 <t1
t0-t1 * age	.938	1	3.570	.064	.062	ns
t0-t1 * training	.849*	2	4.787	.012ǂ	.151	at t1 CG < EG1 and CG < EG2
scale	.977	4	.260	.903	.005	ns
scale*age	.965	4	.317	.803	.006	ns
t0-t1 * scale	.933	4	.715	.583	.013	ns
t0-t1 * scale * age	.945	4	.584	.674	.011	ns
t0-t1 * scale * training	.865	8	.844	.565	.030	ns

Note: ǂ ǂ p < .01 ǂ p<.05 ns= not significant

In order to focus on the effects of trainings, another Multivariate Mixed Design Ancova was applied, using the scores at post-test and follow up (t1 and t2) as repeated measures. The training groups (EG1 and EG2) as between factor and the age at pre-test as covariate. This analysis did not show any significant effect, emphasizing the preservation of cognitive achievement reached by the trainings, six months after the end of programs in paper-and-pencil and computerised formats (Table 3).

Then, a Discriminant Function Analysis was performed in order to identify the variables discriminating the participants across the groups. We evaluated the issues related to the sample size, multivariate normality and multicollinearity (Huberty, 2005). In particular we met the criterion requiring that the size of the minutest group must be above the number of variables used as predictors. The discriminant function analysis was applied (Stepwise method) using CPM score and BIN subscales. The Box's M statistic was not significant ($p =.719$), guaranteeing that the homogeneity of variance assumption was satisfied. At the last analysis step, the scales comprised in the unique significant function were the post-test BIN Pre-syntactical and post-test BIN Counting (Wilks' $\lambda = .849$, $p<.0001$), indicating that these two dimensions are discriminating the groups. Moreover, the discriminant function analysis had a reliable association with the training groups [$\chi^2 =20.731$, $df=4$, $p < .001$]. The function with the scales mentioned above was able to appropriately classify into groups totally 58.6% of participants [specifically the 70.8% of the CG (i.e. 17/24), the 38.5% of EG1 (i.e. 5/13) and the 57.1% of EG2 (12/21)].

Table 3. Results of Multivariate Mixed Design Ancova comparing post-test and follow up in the groups EG1, EG2

Source	Wilks' Lambda	df	F	p	Eta^2	Bonferroni's Adjusted Group comparisons
t1-t2	.913	1	2.557	.121	.087	ns
t1-t2 * age	.908	1	2.720	.111	.092	ns
t1-t2 * training	.965	1	.971	.333	.035	ns
scale	.872	4	.976	.424	.035	ns
scale*age	.851	4	1.123	.343	.040	ns
t1-t2 * scale	.835	4	1.105	.355	.039	ns
t1-t2 * scale * age	.837	4	.987	.410	.035	ns
t1-t2 * scale * training	.849	4	1.450	.229	.051	ns

Note: ns= not significant

4. DISCUSSION AND CONCLUSIONS

A wide literature states that psychoeducational trainings have some advantages and the same specific training can be settled and presented in two formats: computerized or pencil-and-paper (Penna, Stara, & Bonfiglio 2002). In the pencil-and-paper format, for example, an important aspect can be the novelty, which could be identified in the presence of a new teacher, specialized in the promotion of training activities (Slavin, 2013; Agus et al., 2015). Educational technology is defined as a set of electronic tools and applications that help deliver learning materials and support learning processes to improve learning goals (Afshari et al., 2009, Meneses et al., 2012). Then technology can play a role in promoting an especially propulsive greater adaptability of the education system and in opening it to a range of values and attitudes as diversification of preparations, self-learning ability, aptitude confrontation and cooperation, ability to exploration and research (Vanderlinde, Aesaert, & Van Braak, 2014).

This study shows the efficacy of both computer-assisted and pencil-and-paper trainings in enriching fluid and numerical intelligences. Indeed, differences between the experimental groups that use different training formats were not found. If there aren't significative differences, the training with jcomputer technology opens up new directions for the successful training of numerical competencies that should be pursued as they may be particularly beneficial for those with special needs in numerical/mathematical learning.

Overall, these outcomes, highlighted also by the discriminant analysis, underline the importance of the contents but not of the presentation modality in empowering early numeracy learning (Leh, 2011). Toll and Van Luit (2012) documented the validity of a psychoeducational intervention empowering reasoning, measuring, calculation, use of abstract symbols and number line skills that was developed for kindergarteners with mathematical problems. From an applied perspective, this is very crucial, because the benefits of early numeracy learning interventions in preschoolers at risk of developing mathematical learning difficulties can be already evident when those children attend the first grade of primary school (Dowker & Sigley, 2010). Since there is a high variability in pre-schoolers' mathematics skills, during the last decades a series of trainings has been developed in order to enhance numerical knowledge in early childhood, that is, to promote early numeracy learning especially in low-performing learners (Riccomini & Smith, 2011). Indeed, according to Clarke et at. (2006) the implementation of specific computer-assisted and/or pencil-and-paper interventions, mainly based on the use of explicit and simple instructions, on the employment of visual materials (e.g., cubes, number lines) and demonstrations about how to solve a problem, on breaking complex tasks in simpler units, seem to favour the empowerment of numeracy skills in early childhood, especially in kindergarten children at risk for severe mathematics problems.

Another element of interest is given by the results of the discriminant analysis. This evaluation highlighted that the values of pre-syntactical and counting scales are discriminant (Molin, Polin, & Lucangeli, 2007), distinguishing among experimental and control groups. Indeed, applying this function, the correct classification of group membership appears high in relation to CG, that is, in a condition in which children showed lower scores compared to those of the participants of the experimental groups. Also this fact confirmed the opportunity of differentiating between CG and experimental groups, but not in terms of the modality (i.e., computer-assisted vs. pencil-and-paper) in which the psychoeducational intervention was proposed (Penna & Stara, 2010). In agreement with previous authors (Swanson & Hoskyn, 1998), the effectiveness of the training in both modalities might be related to the novelty of resources used and to the overall educational approach applied to elicit the empowerment of numeracy learning (Swanson & Hoskyn, 1998). Furthermore, the efficacy of our psychoeducational intervention can be also related to the fact that it is aimed at empowering the metacognitive knowledge in numeracy learning. This is very relevant, because as In agreement with our results we can suppose that, as stated in the literature, what is important in order to assess the efficacy of an intervention is not the modality used, but the positive or negative effects on the child intelligence and learning (Penna & Stara, 2010).

Concerning the limits of this work and the future developments, we think that it would be useful to deepen the analysis of the amount of achieved learning by using additional assessment tools. These tools should be appropriate to the recognition of the potential specificities linked to the two different training modalities (i.e., paper-and-pencil and computerized).

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THE RELATIONSHIP AMONG SELF-REGULATED LEARNING, PROCRASTINATION, AND LEARNING BEHAVIORS IN BLENDED LEARNING ENVIRONMENT

Masanori Yamada[1], Yoshiko Goda[2], Takeshi Matsuda[3], Hiroshi Kato[4] and Hiroyuki Miyagawa[5]
[1]*Kyushu University, 744, Motooka, Nishiku, Fukuoka, 8190395 Japan*
[2]*Kumamoto University, 2-39-1, Kurokami, Chuo-ku, Kumamoto, 8600862 Japan*
[3]*Tokyo Metropolitan University, 1-1, Minamiosawa, Hachiouji, Tokyo, 1920397, Japan*
[4]*The Open University of Japan, 2-11, Wakaba, Mihama-ku, Chiba, 2618586 Japan*
[5]*Aoyama Gakuin University, 5-10-1, Fuchinobe, Chuo-ku, Sagamihara, Kanagawa, 2525258 Japan*

ABSTRACT

This research aims to investigate the relationship among the awareness of self-regulated learning (SRL), procrastination, and learning behaviors in blended learning environment. One hundred seventy nine freshmen participated in this research, conducted in the blended learning style class using learning management system. Data collection was conducted in two ways; questionnaires for SRL scale "Motivated Strategies for Learning Questionnaire" (Pintrich and DeGroot, 1990), and procrastination, and data log for learning behavior (report submission time). Students were asked to take the questionnaires in both pre and post class. As for learning behaviors, report submission time and one-minute paper submission time were collected using learning management system. The results revealed that internal value, self-regulation, and procrastination were fundamental elements that enhance the awareness of time management for learning plan, and positive time management awareness promoted to submit one-minute paper report within deadline, and regular report early.

KEYWORDS

Blended learning, Self-regulated learning, Procrastination

1. INTRODUCTION

Over 70 of the students in higher education postpone learning behaviors, until when they feel the necessary to do (Schouwenburg, Lay, Pychyl, & Ferrari, 2004). This learning behavior is known as Procrastination. Procrastination was traditionally regarded as unsuitable learning behavior, in order to perform high learning outcomes. However, planned procrastination seems to be positive learning behaviors for high learning performance. In the case that learner who postpones learning acts for high learning performance, procrastination seems to be positive action, which can be regarded as high-level self-regulated learner. This research aims to investigate the relationship among the awareness of self-regulated learning, procrastination, and learning behavior in blended learning environment.

2. PREVIOUS RESEARCH

2.1 Self-Regulated Learning

In order to foster autonomous learners, self-regulated learning is one of the important concepts for the design of learning environment. Many researchers conducted the research of self-regulated learning in experimental and practical educational settings. SRL is related to motivation, cognition, and self-control, as it is directed toward the accomplishment of learning purposes (Pintrich, 1999; Zimmerman, 1995). SRL learners are able to apply self-control and self-evaluation (Deci et al., 1996). SRL is strongly concerned with metacognition, which leads to enhance the responsibility for learning on learner's learning goal(Schunk and Zimmerman, 1998; Zimmerman, 1986). Thus, the enhancement of the awareness of SRL can improve learning outcomes.

Schunk and Zimmerman (1998) developed a three-phase model for SRL: forethought, performance/volitional, and self-reflection (see Fig. 1). Schunk and Zimmerman (1998) further compared the learning behaviors of novice and expert SRL learners in each SRL phase (see Table 1). In the forethought phase, skillful learners were able to articulate their final goal, and the necessary steps for its accomplishment. The features of both the goal and the steps toward it were constructive and clear. Skillful learners also tended to have internal motivation and high self-efficacy. In the performance/volitional phase, skillful learners try to maximize the effects of learning by monitoring the learning process; in the self-reflection phase, they sought to evaluate their learning performance independently and tended to attribute its quality to learning strategies and practice. Wolters et al (2003) also suggest the SRL framework, which contains the similar concepts concerned with controlling myself with cognitively in learning context.

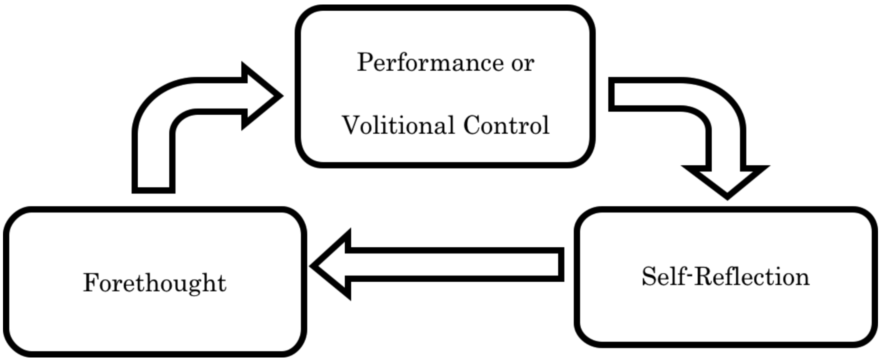

Figure 1. Three phase model of SRL (Schunk and Zimmerman, 1998)

In e-learning context, high performer has time-management skills. Goda et al (2009) investigated the relationship between learning performance and learning habit. The results of their research show that high performer tends to make a regular life with time-management skills. Goda et al (2009) pointed out the importance of time-management skills in e-learning environments and time-management is concerned with all SRL phases, which Schunk and Zimmerman (1998) also indicated the similar points in face-to-face learning environments.

Time management skill plays important roles in fruitful learning outcomes in both e-learning and face-to-face learning environments. Considering daily file, accomplishment of learning tasks following learning plan which learners made by them-selves indicates high SRL skill. In this sense, procrastination is not always harmful learning behavior for high learning performance.

Table 1. Differences between naïve and skillful self-regulated learners (Schunk and Zimmerman, 1998)

	Classes of self-regulated learners	
Self-regulatory phases	Naïve self-regulators	Skillful self-regulators
Forethought	Nonspecific, distal goals	Specific, hierarchical goals
	Performance goal orientation	Learning goal orientation
	Low self-efficacy	High self-efficacy
	Disinterested	Intrinsically interested
Performance/volitional control	Unfocused plan	Focused on performance
	Self-handicapping strategies	Self-instruction/imagery
	Outcome self-monitoring	Process self-monitoring
Self-reflection	Avoid self-evaluation	Seeking self-evaluation
	Ability attributions	Strategy/practice attributions
	Negative self-reactions	Positive self-reactions
	Nonadaptive	Adaptive

2.2 Procrastination

Skillful learners seem to use SRL skills appropriately, that is, SRL learners set appropriate learning goals including small steps, use the effective learning strategies such as monitoring strategy in performance phase, which leads to effective reflection for their learning. In this sense, procrastination can be one of effective learning strategies, in the case that learners can set appropriate learning time schedule, in order to accomplish the learning goals. Most research has found that procrastination has a negative effect on learning performance and can lead to physical and psychological problems (Hussain & Sultan, 2010). However, Chu and Choi (2005) suggested that some procrastinators performed high-quality learning outcomes with monitoring their learning behaviors, that is, procrastination is not always harmful for learning. Chu and Choi (2005) called them ‘active procrastinator’. Active procrastinator has several features to accomplish learning goal effectively and efficiently. Chu and Choi (2005) indicated four features of active procrastinator; outcome satisfaction, preference of time pressure, intentional decision to procrastination, and ability to meet deadline. Strunk, Cho, Steele, and Bridges (2013) proposed a 2 x 2 model of procrastination with two dimensions of time-related academic behavior and motivational orientation.

Several research indicated that relationship between perceived sense of procrastination and procrastination behaviors. Most of the previous research indicated that negative correlation between procrastination behaviors and perceived sense of procrastination in traditional class(e.g., Tuckman, 1991; Howell et al, 2006). In e-learning, Goda et al (2014) reported that about 70 percent of learners were procrastinators, and the learning outcome (English test score) of procrastinator group was significantly lower than learning habit group. However, the relationship among SRL, procrastination, and learning behaviors is not clear.

2.3 Research Purpose

Reviewing sections 2.1 and 2.2, time management skill plays important roles in performing high quality learning outcomes, and procrastination under the learner’s control can be effective on the SRL, however, the overall relationship among SRL, procrastination, and learning behaviors is not clear. This study aims to investigate their relationship in blended learning environment.

3. METHODS

3.1 Subjects and Course

One hundred eighty-three university students participated in this research. They all were the first-grade students, and took education introductory class. This course consists of fifteen classes. Main learning object is to understand the way to design the class with ICT. The students learned educational theories, principles, and history in the former eight classes. There were three criteria for grade; submission of one-minute paper after every class, regular reports (two times), and last report. Students should submit one-minute paper within a day for normal grade, but teacher accepted the submission one day delay (half a normal score was cut). One-minute paper must contain the class abstract and discussion. As for regular and last reports, teacher explained the report themes three weeks before the submission deadline. Students were required to submit one-minute paper and reports on LMS.

3.2 Data Collection

Students were asked to answer two questionnaires; Motivational Strategies for Learning Questionnaire(MSLQ) (Pintrich and DeGroot, 1990) and 2 x 2 time-related academic behavior scale (Strunk et al, 2013). The MSLQ, which consists of five factors (Self-Efficacy: SE, Internal Value: IV, Cognitive Strategies: CS, Self-Regulation: SR, Test Anxiety: TA; 44 items in sum, rated on a seven-point Likert scale; see Appendix A) was used for the subjective evaluation of learners’ SRL skill, but the factor ‘test anxiety’ (four items) was eliminated, because this class did not use test for assessment. 2 x 2 model of time-related academic behavior scale consists of 22 items; seven items for Procrastination-approach, four items for Procrastination-avoidance, six items for Timely engagement-approach, and five items for Timely engagement-avoidance. Students were asked to rate each item in seven-point Likert scale (see Appendix B). The students were asked to complete the MSLQ and 2 x 2 model of time-related academic behaviors scale at the first class. The second method of data collection was a log that record the submission time of three reports, in order to collect the data for learning behaviors. Submission time was converted for analysis; earlier students submitted assignment, submission time increases, for example, when student submitted one-minute paper one hour before the deadline, submission time is one, in another case, when student submitted the regular report 100 hours before deadline, submission time is 100. About one-minute paper, we counted the late submission time through fifteen classes.

4. RESULTS

One hundred seventy-nine first grade students answered two questionnaires in a class. We conducted the path analysis, in order to investigate the relationship between SRL, procrastination, and learning behaviors. In section 4.1, we showed the descriptive data, the results of path analysis were shown in the section 4.2.

4.1 Descriptive Data

Table.1 shows the average of each item. The score of each factor was calculated by the sum of each item in each factor. Average score of each factor and average time of submission are displayed in Tables 2, 3, and 4.

Table 2. Average sum score of each factor in MSLQ

Item	Average score	SD
Self efficacy (min: 9 – max: 63)	28.32	8.23
Internal value (min: 9 – max: 63)	45.28	8.08
Cognitive strategy use (min: 13 – max 91)	59.69	8.73
Self-regulation (min: 9 – max: 63)	36.97	4.61

Table 3. Average sum score of each factor in 2x2 model of time-related academic behavior scale

Items	Average score	SD
Procrastination - Approach (min: 7 - max: 49)	20.13	6.93
Procrastination - Avoidance (min: 4 - max: 28)	14.07	5.61
Timely engagement - Approach (min: 6 - max: 42)	24.72	6.31
Timely engagement - Avoidance (min: 5 - max: 35)	21.32	5.56

Table 4. Average submission time (hour) and the late submission time of one-minute paper

Items	Average	SD
The late submission time of one-minute paper	0.53	0.81
Submission time (hour) of regular report 1	21.31	32.18
Submission time (hour) of regular report 2	32.39	43.70
Submission time (hour) of last report	39.55	67.80

These results revealed that there were big differences between individual students in items Self-efficacy in MSLQ, Procrastination-Approach, and all learning behaviors, due to big standard deviation.

4.2 Path Analysis

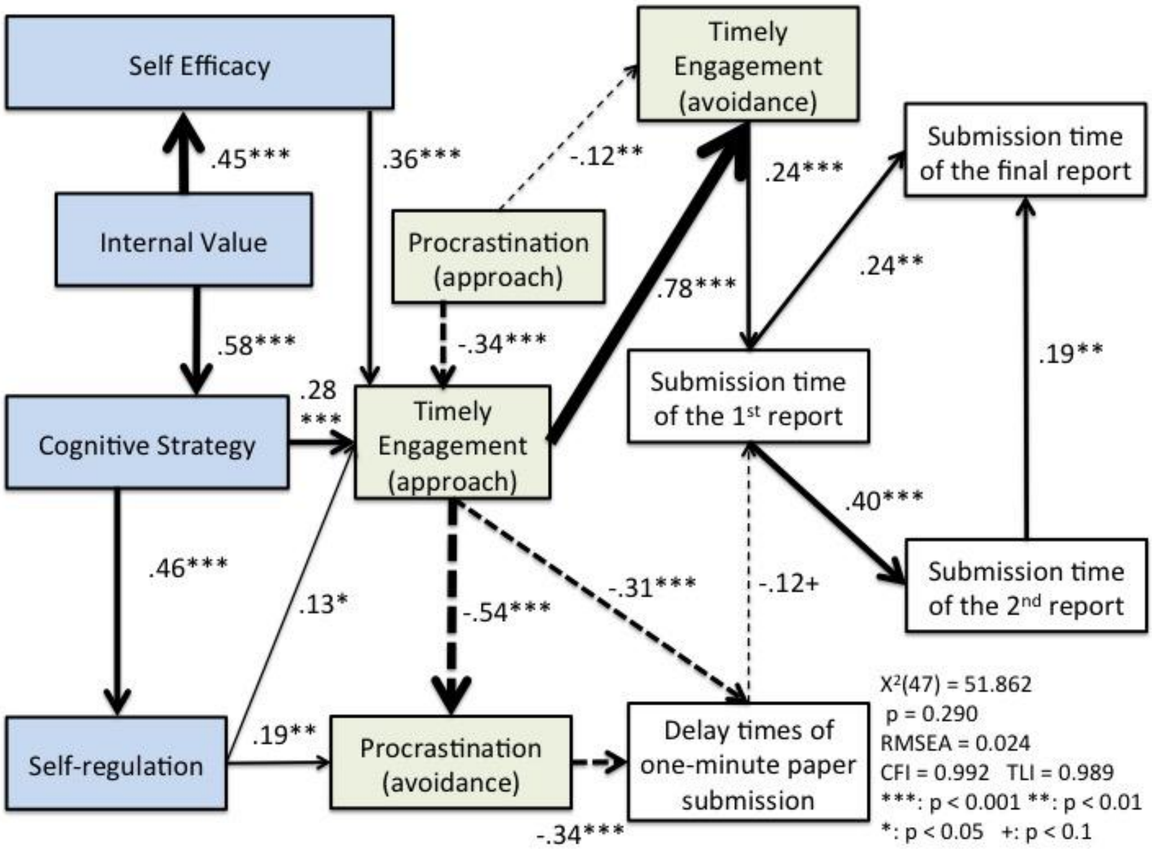

Figure 2. Results of path analysis (Dotted line means negative relationship)

Path analysis was employed using the average sum score and average submission time of three reports, and average late submission time of one-minute paper, in order to investigate the relationship among them. Figure.1 shows the relationship among them using path analysis. Considering the statistic criteria of model fitness, this model is acceptable (chi2 = 51.862, df = 47, p = 0.290, RMSEA = 0.024, CFI = 0.992, TLI = 0.989)

The results indicated that internal value in MSLQ, and Procrastination – approach in 2 x 2 model were fundamental factors in order to raise the awareness of other MSLQ and time-related learning behaviors. In this overall model, negative and positive flow can be confirmed. In positive relationship, procrastination – avoidance affects on the late submission of one-minute paper negatively, and the late submission of one-minute paper also has negative relationship with the submission time of the first report. The submission time of the first report affects on both the submission times of the second and final report positively. In this relationship, learners who have high SRL awareness and active procrastination, keep the time for learning outcome submission. On the other hand, there seemed the learners who took negative time-related learning behaviors. Though learners had high SRL awareness, several learners have negative awareness of time-related learning behavior. Less procrastination - approach learners also have negative awareness of time-related learning behavior. However, the difference between positive and negative relationships is whether the late submission time of one-minute paper is mediated in the relationship. The learners who have high SRL awareness and time-related learning behavior seem to be aware of the engagement of weekly-task in every class.

5. CONCLUSION AND FUTURE WORKS

This study aims to investigate the relationship between the awareness of SRL, procrastination, and learning behavior, in particular, the submission time of learning outcome, which is one of time-related learning behavior. The results revealed that SRL and procrastination positively affects on the learning behavior. Both positive and negative viewpoints of procrastination play important roles in the learning behavior; both the awareness of time-related learning behavior kept the deadline of the submission. Time management is one of important skills in SRL (e.g., Wolters et al, 2003; Barnard et al, 2009). The results of this study also indicated the awareness of that high SRL has positive relationship with the awareness of time engagement – approach, which is one of active procrastination elements. This results supports the findings of the previous research. However, not only active procrastination, but also passive procrastination keep the submission deadline, that is, even if learners regard time-related learning behavior as negative action, learners can do suitable learning behaviors. Wäschle, Allgaier, Lanchner, Fink, and Nuckles (2014) show feedback loop between low self-efficacy and perception of goal achievement in procrastination in the investigation of the relationship between SRL and procrastination. But, in case that learners have high SRL awareness, learners can do appropriate learning behavior, even if learners have negative awareness of time-related learning behavior. Self-efficacy seems to play an important role in bridging learning behaviors and learning performance (Yamada et al, 2015).

Future research should to clarify the relationship between SRL and learning performance. Schunk and Zimmerman (1998) indicated the differences between skillful and naïve self-regulated learners. There seems to be differences between high and low learning performers in the relationship among SRL, procrastination, and learning behaviors. Attitude of ICT use in education should be considered in the future re-search. Usta (2011) indicated that negative attitude of ICT use has positive relation-ship with goal setting, time management, help-seeking, self-regulation, in particular, help-seeking behavior in e-learning setting can affect on learning performance (Goda et al, 2013). In this study, ICT was used in blended learning settings. Therefore, the effects of ICT use may affects on the results of this study.

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Appendix A Motivational Strategies for Learning Questionnaire (Pintrich and DeGroot, 1990)

Factor	Item
Self-Efficacy	Compared with other students in this class, I expect to do well.
	I'm certain I can understand the ideas taught in this course.
	I expect to do very well in this class.
	Compared with others in this class, I think I'm a good student.
	I am sure I can do an excellent job on the problems and tasks assigned for this class.
	I think I will receive a good grade in this class.
	My study skills are excellent compared with those of other students in this class.
	Compared with other students in this class, I think I know a great deal about the subject.
	I know that I will be able to learn the material for this class.
Intrinsic Value	I prefer class work that is challenging so I can learn new things.
	It is important for me to learn what is being taught in this class.
	I like what I am learning in this class.
	I think I will be able to use what I learn in this class in other classes.
	I often choose paper topics I will learn something from even if they require more work.
	Even when I do poorly on a test, I try to learn from my mistakes.
	I think that what I am learning in this class is useful for me to know.
	I think that what we are learning in this class is interesting.
	Understanding this subject is important to me.
Test Anxiety	I am so nervous during a test that I cannot remember facts I have learned.
	I have an uneasy, upset feeling when I take a test.
	I worry a great deal about tests.
	When I take a test, I think about how poorly I am doing.
Cognitive Strategy Use	When I study for a test, I try to put together the information from class and from the book.
	When I do homework, I try to remember what the teacher said in class so I can answer the questions correctly.
	It is hard for me to decide what the main ideas are in what I read. (R)
	When I study, I put important ideas into my own words.
	I always try to understand what the teacher is saying even if it doesn't make sense.
	When I study for a test, I try to remember as many facts as I can.
	When studying, I copy my notes to help me remember material.

Self-Regulation	When I study for a test, I practice saying the important facts over and over to myself. I use what I have learned from old homework assignments and the textbook to do new assignments. When I am studying a topic, I try to make everything fit together. When I read material for this class, I say the words over and over to myself to help me remember. I outline the chapters in my book to help me study. When reading, I try to connect the things I am reading about with what I already know. I ask myself questions to make sure I know the material I have been studying. When work is hard, I either give up or study only the easy parts. (R) I work on practice exercises and answer end of chapter questions even when I don't have to. Even when the study materials are dull and uninteresting, I keep working until I finish. Before I begin studying, I think about the things I will need to do to learn. I often find that I have been reading for class but don't know what it is all about. (R) I find that when the teacher is talking, I think of other things and don't really listen to what is being said. (R) When I'm reading, I stop once in a while and go over what I have read. I work hard to get a good grade even when I don't like a class.

Appendix B: 2 x 2 measure of time-related academic behavior scale (Strunk et al, 2013)

Factor	Item
Procrastination - Approach	I more effectively utilize my time by postponing tasks I delay completing tasks to increase the quality of my work I put off starting tasks to increase my motivation I feel a stronger state of flow in my tasks when working closer to a deadline I intentionally wait until closer to the deadline to begin work to enhance my performance I delay tasks because I perform better when under more time pressure I rarely have difficulty completing quality work when starting a task close to the deadline
Procrastination - Avoidance	I put off tasks for later because they are too difficult to complete I avoid starting and completing tasks I often delay starting tasks because I am afraid of failure I delay starting tasks because they are overwhelming
Timely engagement - Approach	I work further ahead of the deadline at a shower pace, because it helps me perform better I believe I can successfully complete most tasks because I start work immediately after being assigned a task I do my best work well ahead of the deadline I start working right away on a new task so that I can perform better on the task I complete my tasks prior to their deadline to help me be successful I begin working on difficult tasks early to achieve positive results
Time engagement - Avoidance	I start my work early because my performance suffers when I have to rush through a task I do not start things at the last minute because I find it difficult to complete them on time I begin working on a newly assigned task right away to avoid failing behind When I receive a new assignment, I try to complete it ahead of the deadline to avoid feeling overwhelmed On extremely difficult tasks, I begin work even earlier so I can avoid the consequences of putting it off for later

SOUND AS AFFECTIVE DESIGN FEATURE IN MULTIMEDIA LEARNING – BENEFITS AND DRAWBACKS FROM A COGNITIVE LOAD THEORY PERSPECTIVE

Anke Königschulte
University of Applied Sciences Bremerhaven, Germany

ABSTRACT

The study presented in this paper investigates the potential effects of including non-speech audio such as sound effects into multimedia-based instruction taking into account Sweller's cognitive load theory (Sweller, 2005) and applied frameworks such as the cognitive theory of multimedia learning (Mayer, 2005) and the cognitive affective theory of learning with media (Moreno, 2006). Proceeding from the assumption that sound is an incisive means to affect people's emotional state it is argued that sound may also be well suited to stimulate involvement and motivation in learning situations, thereby bringing the learner to invest more mental effort into learning, which finally leads to better learning performance.

This paper refers to an experimental case study, which was carried out within the framework of a Master's Thesis at the University of Applied Sciences Bremerhaven (Germany). In order to investigate the cognitive effects of including sound into multimedia learning, two groups of 1st semester Digital Media students were asked to learn about a historic subject using two different experimental designs: One version of a prototypical learning application consists of a photo slideshow with accompanying audio narration and another version consists of the same material supplemented with environmental sounds that illustrate the content of the lesson.

Comparing both groups, the results don't reveal significant differences in learning performance. However, the subjective mental effort ratings of the participants are identified as a positive predictor for the performance score and are thus hypothetically discussed as being an indicator for learner motivation. The analysis finally confirms that the learner involvement, which is a measure relating the performance score and the mental effort ratings (Paas et al., 2005), during the subsequent achievement test is significantly higher when sounds were presented during instruction. These results suggest that the inclusion of sound may have positive effects on motivation and learning, which is according to a cognitive-motivational theory.

KEYWORDS

Multimedia Learning, Instructional Design, Sound, Cognitive Load, Motivation, Involvement

1. INTRODUCTION

Through the introduction of digital audio in the early 1980s and the evolution of Internet capabilities, appropriate and cheaper software and (portable) audio players, multimedia developers are nowadays able to easily store, manipulate, (re-)use, and thus fully integrate sound in (instructional) software. However, even though there have been significant changes in technology since the heyday of radio in the 1930s, only "little has been done to advance the single notion of audio in instruction", Holmes and LaBoone (2002) argue (p. 57, cited in Schlosser & Burmeister, 2006).

Research within the realm of auditory perception (e.g. McAdams & Bigand, 1993; Van Leeuwen, 1999) as well as common practice in film sound (e.g. Chion, 1994) and computer game sound (e.g. Jørgensen, 2009) suggests that sound offers many promising possibilities in instructional design that remain largely unexplored. Without a doubt, auditory information participates fundamentally in the development of knowledge by facilitating the acquisition, processing, and retrieval of information in many ways (McAdams & Bigand, 1993, p. 1-9; Gaver, 1993). However, the integration of non-speech audio, that is sound and music in its different forms, has been apparently neglected in the current state of research and practice in

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multimedia learning. Although some applications indeed add sound (because it is possible), there are very few research studies that formally evaluate the effects of it, respectively, provide guidelines or a structured way to integrate sound in instructional media (Bishop et al., 2008).

1.1 Objective and Framework

Sound is a very different medium for representing information than visual images. Due to natural factors, such as the absence of some mechanism to shut the ears ("eyelids"), and the omnidirectionality of hearing, listening is much less limited than seeing. Therefore, people encounter sounds and noises every time and everywhere, so that they usually 'fade them out' as long as it is not relevant to (re-)act to them. In everyday listening, people naturally seek to denote sounds to their sources, actions, and events that cause them in order to get important details about the immediate surrounds; it is, like Smalley (1996, p.79) puts it, "a question of living and acting in the world, ultimately of survival". When a person walks along a road at night hearing a car he/she most likely does not focus on the sound itself, e.g. its pitch and loudness, but compares the sound to his/her memories for the known objects that make that sound. With attending to the whole scene, drawing from existing schemas and experiences the person will understand the situation, e.g. it is a car with a strong engine approaching quickly from behind and I should step out of the path (Gaver, 1993, p.1). It may be for these reasons that sound, even not alarming by itself such as an even faraway motor's engine or flat tire's faint thumping, can immediately activate existing schemas and is thus generally more effective than images for gaining attention (Posner et al., 1976; Bernstein & Edelstein, 1971, cited in Bishop & Cates, 2001, p.11). Sounds, which also carry strong affective significance, may add yet another dimension to the audiovisual by making the environment more immersive, tangible and by provoking emotions, such as suspense. That way, even unintrusive sounds, as for example waves hitting the shore or whistling tree leaves, may also effectively hold attention over time and reduce distraction of competing stimuli (Thomas & Johnston, 1984, cited in Bishop & Cates, 2001, p.12). Chion (1994) points out, that it is the sound's physical nature as vibrant phenomenon and its omnipresence that interferes with and affects people's perception more than the image, especially when people do not give conscious attention to it. Therefore, sound can be an insidious means of affective and semantic manipulation (pp.33). Sound facilitate a rather intuitive view of the information it presents than the visual.

The present study draws mainly on the emotive qualities of sound and tries to approach in how far the inclusion of sound (i.e. non-speech audio) to audiovisual learning material can affect the learners' affective state; in particular, if it can stimulate learners' involvement and motivation to learn in a way that learning can be enhanced.

Nevertheless, numerous of experimental media studies reveal that the actual challenge for the instructional multimedia design is for the processing demands to not exceed the limited capacity of the cognitive system, which otherwise easily end up in creating a cognitive overload and decreased learning performance (e.g. Moreno & Mayer, 2000; Mayer et al., 2001). Moreno and Mayer (2000, p.118) accordingly conclude that any additional material "that is not necessary to make the lesson intelligible or that is not integrated with the rest of the materials will reduce effective working memory capacity and thereby interfere with the learning of the core material". It is thus especially a cognitive perspective on learning that raises doubts about the effectiveness of including sound in instruction. Accordingly, Bishop and Cates (2001, p.6) argue that "without a strong theoretical cognitive foundation, the sounds used in instructional software may not only fail to enhance learning, they may actually detract from it". In line with this, this work aims to integrate and design sound with regard to research-based theory of how students learn in order to successfully enhance learning.

1.2 Theory and Predictions

Cognitive theories of multimedia learning, such as Sweller's *cognitive load theory* (Sweller, 1988; Sweller, 2005), and Mayer's *cognitive theory of multimedia learning* (Mayer, 2005), clarify memory processes of learning and problem solving and have thus contributed a solid foundation to guidelines that help practitioners to design multimedia instruction more effectively. According to the *cognitive theory of multimedia learning* (CTML, see Figure 1), different stages of memory process audio/verbal and visual/pictorial information in distinct, independent but cooperative channels. Meaningful learning only occurs through active processing in working memory, that is, selecting, organizing and integrating information with the aim to construct coherent mental representations. These processes are partly guided by prior knowledge stored in long-term memory.

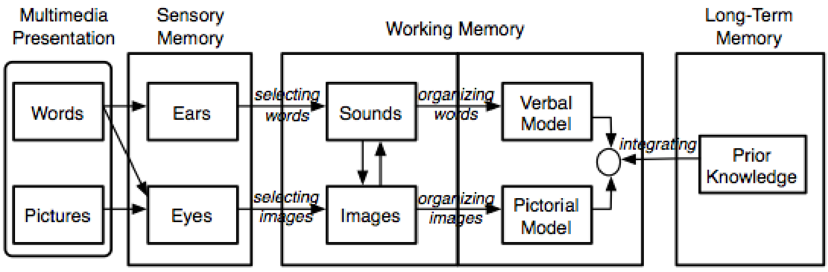

Figure 1. CTML, according to Mayer (2005)

The working memory processes only a very limited amount of information at any one time, which is a major impediment when learners are required to learn new material. Therefore, learning instruction should avoid to provoke processing and storage that is not relevant for learning, which is the primary objective set by Sweller's *cognitive load theory*. Cognitive load represents the load that performing a particular task imposes on the learner's cognitive system and is determined by the interaction of environment, learner, and task characteristics. On this account, three types of cognitive load are distinguished (see Sweller et al., 1998, pp.259): The intrinsic load is the inherent difficulty level of the topic to be learned, extraneous load is considered as unnecessary processing and is determined by the manner in which information is presented, and germane load is devoted to learning, that is, processing, construction, and automation of schemas. Cognitive load theory and CTML focus on instructional methods aimed at reducing extraneous load and that way freeing memory capacity for an increase in germane learning activities (Sweller, 2006, p.168). Several empirically validated methods for eliminating extraneous load via the instructional design have been published yet, such as the modality principle, redundancy principle, coherence principle, signaling, segmentation, and many more (e.g. Mayer, 2005; Mayer & Moreno, 2003).

In Moreno and Mayer's (2000) study investigating the inclusion of seductive details in multimedia instruction, participants perform significantly worse in subsequent retention and transfer tests when they have learned on basis of narrated animations with looped bland background music or with sound effects. With reference to CTML, the authors suggest that sound and music constitutes unnecessary (extraneous) load that might prime the activation of inappropriate prior knowledge as the organizing schema in working memory. Furthermore, additional sounds risk to reduce the learners' capacity for integrating the relevant verbal and visual material to a coherent system, which impedes learning due to memory's capacity limitations.

Cognitive load theory and CTML, however, focus mainly on freeing working memory capacity by reducing extraneous load, which assumes that learners would automatically spend all their available resources in productive ways, that is, in germane learning activities. Accordingly, Paas et al. (2005, p.25) criticizes: "Until now, cognitive load theory (CLT) has focused on the alignment of instruction with cognitive processes, without recognizing the role of motivation in training". It is important to note though, that learners' investment of cognitive resources can be rather affected by relatively instable factors such as general orientation, motivation and state of arousal. The *cognitive affective theory of learning with media* (CATLM) extends CTML to better integrate the role of motivation, that is, affect and motivation that mediate learning by increasing or decreasing the amount of cognitive resources that learner invests on the task (Moreno, 2006; Moreno & Mayer, 2007). On that account, different germane load inducing techniques have been investigated in recent studies. These reveal that, for instance, emotional design features (e.g. Plass et al., 2014), interesting additional material (e.g. Park et al., 2011) and methods such as imagination assignments (e.g. Cooper, et al., 2001) may lead to an increase in mental effort investment and thereby learning performance.

These considerations form the theoretical case for including sound into multimedia instruction presuming that the addition of sound may be a useful tool to direct attention, add emotion and "playfulness" to the lesson and encourage imagination. According to CATLM, it is hypothesized that sound in multimedia lessons can stimulate learner's interest and enjoyment and achieve a greater level of motivation to engage in deeper learning. Sound as affective design feature thus encourages the learner to invest more mental effort into learning, which lead to a better learning performance.

2. EXPERIMENT

The aim of the experiment is to investigate whether the addition of corresponding environmental sounds to a narrated photo slideshow increases the learner's involvement and motivation, thereby encourages to invest more mental effort into learning, which, according to CATLM, leads to better learning performance.

Two groups of students are asked to learn using two different experimental designs, which are with or without sound illustrations. Via subsequent achievement tests and questionnaires the performance score, invested mental effort, motivation, and user experience related data is measured and compared using quantitative methods.

2.1 Learning Material

For the experimental test, a learning application is prototypically implemented that teaches the user about the history and (re-)construction of the medieval cog found in Bremen, which is exhibited in the German Maritime Museum Bremerhaven. The learning application, which is installed on desktop computers in the computer lab of the University, is segmented into five screens, each one presents a slideshow lasting about three minutes including two or three pictures and accompanying audio explanations. The learner can use the standard media control buttons *play/pause, rewind, repeat, volume* and can move to the next or previous screen using the mouse when they want to.

One version of the application includes environmental sounds, which adapt during runtime according to the content of the lesson. As the sounds are included with the aim to attain positive effects on learning efficiency, the requirements is set to minimize the (feared) likelihood of cognitive overload and distraction. Considering the theoretical considerations summarized above, it is important with the sounds to not just add “appealing” extraneous load. As auditory information can be far more attention-grabbing than visual pictures, only relevant, not too intrusive sounds are applied deliberately and rather sparingly in order to not distract from the other material. The sound needs to fit in with the context and is arranged in a one-to-one correspondence with the related spoken text (or “idea unit” of the text) and pictures so that the information can be easily associated with each other. Even spoken text and other sounds can be perceived when presented simultaneously, this work suggests to present verbal and related non-verbal auditory information somewhat successively due to possible interferences. For the sound to be intelligible and meaningful, the application presents them with and shortly after the related text unit and/or picture. That way, text or picture, which are certainly more self-contained and self-explanatory, provide the necessary context to enable a clear attribution of the sound.

In order to verify these assumptions and design decisions, one “control chapter” of the application does not comply with the design principles as made above. Here, rather ambiguous and intrusive sounds are played simultaneously to the spoken text and alongside animated pictures, which is supposed to make cognitive load higher, holding the risk of reducing the learners' capacity for processing relevant information.

Even though sound can take numerous different forms, such as speech, alarm signals and “beep”-sounds, music, and more, considerations in this experiment are limited to the inclusion of environmental sounds with the aim to facilitate imagery and a dual coding of information (Paivio, 1986; Thompson & Paivio, 1994). That means, environmental sounds included are referred to real events related to the content of the lesson and have meaning based on their causal relation to that event. For example, the picture of a cog (replica) at sea and its general information is supported by the sound of sailing, that is mainly wind and waves plus a clear deep wooden creaking and the flapping of a sail, in order to increase the listeners immersion into the content and to make him/her feel the dangers of such journeys. These sounds should mentally refer to and reinforce the sound-producing source, which is the cog as wooden – sailing – ship depicted by the picture. Further sounds illustrate and strongly highlight the circumstance the cog sank. Hammering on wood (it sank when still being under construction), the sound of whistling wind, storm, flood, creaking and breaking wood, and crashing depicts the process of the sinking cog during a storm. These sounds are all source-disconnected (“off camera”), that is, neither ship-building nor the sinking cog is depicted by the pictures, and should thus increase the listener's imagination. The use of the capstan is illustrated by the sounds of using the capstan, quarter turnings, wooden tool, sticks and quarter turnings, panting of men, the latter “off-camera”, which intends to make this procedure rather palpable and reinforce the information that this tool was made of wood, heavy to use – hard work – and needed to be used by multiple man.

2.2 Method

2.2.1 Measures and Instruments

The *prior knowledge* is controlled via a short pre-knowledge questionnaire before instruction. Five open questions assess the participants prior knowledge and understanding of basic concepts concerning the Hanseatic League and cogs in general.

Learning performance is gained from learning objectives achieved by the participants, which is measured by points given for correctness and/or accuracy of answers. An achievement questionnaire that has to be completed directly after instruction tests memory of the material via retention questions (mostly multiple choice) and deeper understanding via open and transfer questions.

Mental effort refers to the cognitive capacity that is allocated to accommodate the demands of the task. Due to practical reasons, data is collected through self-reports of the participants using a 7-point likert-scale, which is a valid and widely-used tool for measuring mental load as supposed to correlate highly with objective measures (e.g. Kalyuga et al. 2000, p.130). Participants are asked to rate the mental effort they needed for the task by translating it into numerical values from 1 (very low) to 7 (very high) directly after instruction and after the achievement-test, so that the values indicate mental effort associated with learning and with the performance test.

Task involvement combines measures of mental effort and performance. Presuming that motivation, mental effort invested on the task, and performance are positively related, Paas et al. (2005) theorizes that the combination of mental effort and performance score is a more accurate measure of motivational effects of instructional conditions then subjective rating scales. High performance associated with high effort is called high involvement instruction, whereas low-task performance with low effort is called low involvement instruction. The computational model of task involvement (respectively learners' motivation on the task) calculates the relative involvement of learners by mapping z-values of mental effort and performance score using a particular formula as derived and depicted in Paas et al. (2005, p. 29).

The "*User Experience Questionnaire*" ("UEQ"[1]), which allows the participants to express feelings, impressions, and attitudes towards the application, is utilized to gain further quantitative data that helps to interpret (as supposed to mediate) the performance results. In particular, the UEQ is supposed to measure the affective and attentional factors the sound might have an influence on. This test uses the scales *Attractiveness,* which assesses general impressions towards the application, and *Stimulation,* which asses if the application is interesting and exciting to use and if the learner feels motivated to further use it.

2.2.2 Participants and Procedure

The participants are 38 Digital Media Bachelor students in their 1st semester recruited from the University of Applied Sciences in Bremerhaven (Germany). The mean age is 22 years ranging from 18 years to 32. 42% of the sample are male students.

Two different versions of the multimedia-based learning module "A Guided Tour of the Hanseatic Cog" are copied onto computers in the computer lab before the experiment. The participants are randomly assigned to one of the two experimental groups:

(1) One group of participants receive a slideshow containing pictures and verbal information in form of audio narration (basic-group).

(2) The same material as in (1) but additionally supported by corresponding environmental sounds that illustrate the content of the lesson (sound-group).

Participants are not informed about the research question and the differences of the two versions of learning material. The test is conducted in three sessions with 11 – 13 participants each lasting around 75 minutes. Each student completed the instruction individually using a personal computer and good quality headphones, which lasts about 20 minutes. Once the instructional program is finished each participant get the first post-test questionnaire, which asks the participants to rate their invested mental effort during instruction, followed by the 13 items retention and transfer questions. This questionnaire concludes again asking for the invested mental effort on the achievement test. After that, the participants are asked to fill out a second form including further two transfer questions and the UEQ.

[1] http://www.ueq-online.org/; (perceived July, 2015)

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2.3 Results

2.3.1 Preliminary Study

Most of the participants have very little prior knowledge about the topic Hanseatic League and cogs as indicated by the pre-test questionnaire. However, four participants are excluded from further calculation because of high scores in the pre-knowledge test. A homogeneous sample of 34 participants remains for this study; having 16 students in the basic-group (group 1), 18 in the sound-group (group 2). Simple t-tests indicate that finally both groups do not differ significantly (with $p < .05$) in basic characteristics, that is, pre-knowledge, gender, mean age, and initial motivation regarding the test and the learning topic.

The reliabilities for the post-test scales are calculated using Cronbach's Alpha, which reveals satisfactory results for the 17 items of the post-achievement test (α=0,78).

2.3.2 Learning Performance

As Figure 2 shows, the sound-group's performance score is higher on the descriptive level in all types of question, i.e. open, retention, and transfer questions. However, separate analyses of covariance (ANCOVA) with the experimental condition as independent variable, the performance scores as dependent variables and the pre-knowledge as covariate (as there is a strong positive correlation between performance and pre-knowledge, with r=.56; p=.00), shows that the sound-group did not perform significantly better then the basic-group on the retention nor on the transfer part of the post-test.

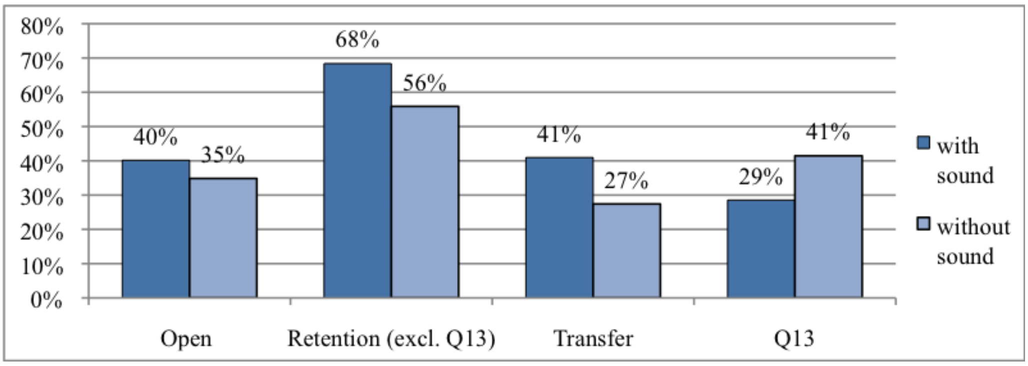

Figure 2. Performance score

In order to verify the design decisions theoretically set in order to prevent cognitive overload, the control chapter, which is covered by question 13, is evaluated separately. An analysis of the score of the nine retention questions show that the results of question 13a and 13b exceptionally differs from the other results in a way that the basic-group considerably outperformed the sound-group (Figure 2).

Overall, there is no evidence that the inclusion of sound within audiovisual learning material improves transfer and retention performance in learning. However, the results suggest that learning performance depends on it's design, such as its intrusiveness and arbitrariness, and it's integration with the rest of the material in a way that sound may impede retention if it is not integrated deliberately.

2.3.3 Mental Effort

For the mental effort ratings separate analyses of variance (ANOVA) were conducted using the experimental condition as independent variable and the mental effort ratings for the instruction and for the test phase as dependent variables. Table 1 shows that the mean of mental effort, which are mapped to a scale from -3 to +3, are higher for the sound-group during the test phase, but do not differ significantly.

Table 1 Mental effort ratings mapped to a scale from -3 to +3

	mental effort ratings test phase					mental effort ratings learning phase				
	N	M	SD	F	p	N	M	SD	F	p
1) without sound	16	,66	1,01	4,03	,12	16	,25	,68	1,14	,43
2) with sound	18	1,11	,63			18	0	1,08		

2.3.4 Learner Involvement

A regression calculation indicate that mental effort during the test phase may be a positive predictor for the performance score (with p=.04), and thus supports the cognitive-motivational viewpoint as depicted by the learner involvement construct. Accordingly, the z-values of mental effort ratings and performance score of the transfer questions – as being an indicator for germane load investment and "deep" learning – are mapped on a Cartesian axis in order to calculate the task involvement of the learner. Figure 3 shows that the sound group is clearly in the high involvement area compared to the basic group.

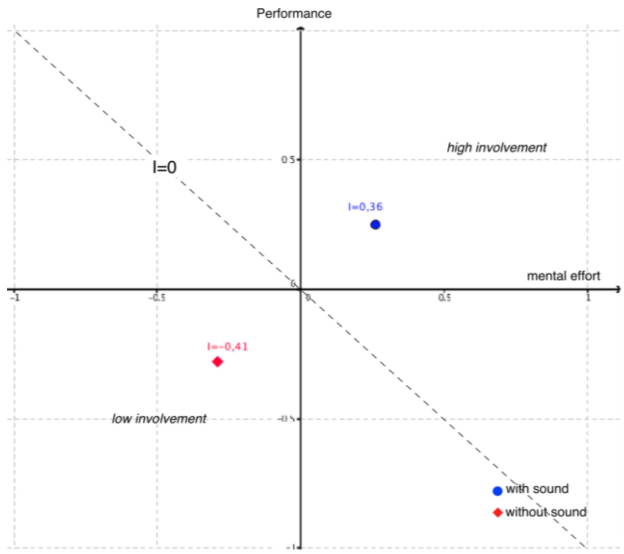

Figure 3. Learner involvement during test phase

An ANOVA reveals that the sound-group (M=0,36; SD=0,92) shows a significant higher learner involvement during the achievement test than the basic-group (M=-0,41; SD=1,25), with p < .05.

2.3.5 User Experience

Even though the sound-group is expected to state higher affective ratings than those of the basic-group, the groups did not differ significantly on their mean ratings of attractiveness or stimulation of the learning material.

3. CONCLUSION

3.1 Summary of Main Findings

The study does not confirm differences in retention and transfer performance nor in subjective mental effort ratings during learning, which suggests that sound, as designed, arranged and coordinated in this work, just do not impose additional cognitive load during learning nor have other effects on cognitive processes, which benefit or hinder learning. Another possible interpretation is that the advantages concerning motivation (as assumed in this study) can be offset by the distraction disadvantages of the environmental sounds, which results in no differences in the learning performance between learners that have learned with audio-enhanced narratives and the basic version without sound.

However, a regression calculation confirms that the invested mental effort in the achievement test is a predictor for the performance score, that is, the more mental effort the participants invested in answering the test questions the better they scored in the test. As a result of the higher performance score and mental effort ratings, the study finally shows a significant higher learner involvement of the sound-group, which supports the notion of sound having a positive influence on the learner's motivation to engage in appropriate learning processes. However, as there is no difference in mental effort investment during learning, the results suggest that motivational effects may exert its influence only during the subsequent performance test.

3.2 Discussion

The study does not identify the mechanisms by which the integration of sound encourage learners to invest more effort in answering the test questions. Against expectation, the results reject that the higher involvement of the sound-group is attributable to the audio-enhanced narratives being more stimulating and appealing, as the UEQ scales reveal. One possible interpretation of the results, even though rather speculative, refers to positive imagination effects induced by the environmental sound. The instructional material may have encouraged imagery and concreteness of the learning topic and to process the concept of the material actively and more deeply, which could have lead to an increase in mental effort investment conducive to learning. This notion is supported by participants' statements that the presentation of sound has made them feel rather immersed into the content of the lesson. However, this could be an interesting topic for further investigations, which should also include appropriate qualitative measures. It has to be noted that the use of subjective rating scales and with it the participants ability to reliably value his/her affective state and invested mental effort has clearly its limits.

It can be concluded that the results do not confirm Moreno and Mayer's (2000) study that reveal detrimental learning effects induced by the incorporation of sound effects into audiovisual learning material. The deliberate design and inclusion of relevant sound as it is done in the application used in this experiment, does not increase extraneous cognitive load nor has negative effects on learning performance. However, practically, the results suggest that sound also risks interfering with the processing of the otherwise essential verbal information depending on its design and integration. Therefore, the study concludes in accordance with Moreno and Mayer (2000, p.124): More studies that examine the design of sounds, its integration and coordination in multimedia lessons seem to be necessary to get solid results.

3.3 Limitations

The study can be seen as a first attempt to investigate the cognitive effects of having sound effects in multimedia instruction. It was carried out within the framework of a Master's Thesis and has thus clearly it's limits – starting from the small sample size of 38 participants.

It can be assumed that only learners with a basic (at least) medium prior knowledge may profit in general from additional environmental sounds. However, the role of prior knowledge (as well as other student characteristics, such as spatial ability, age, gender, etc.) has to be subjected to further investigations as it couldn't be provided by this experiment.

The results and conclusions are also practically very limited as the study only deals with two different instructional formats, that is multimedia explanations with or without sound, and with one kind of learner. It also entirely neglects to look into different instructional methods, which should be closely connected to the choice of media and its format as well as learner characteristics (see e.g. Moreno, 2006). To extend the external validity, more research is needed in order to generalize the results to other learning environments, also more authentic ones, such as a museum or mobile guides in different contexts, also to different instructional methods (e.g. game-based methods), to other learners, as well as to other learning topics.

With the aim to get clear and solid results, the case study has concentrated on the design and evaluation of mainly one aspect of how sound can be utilized in multimedia learning, which is the role of motivation in order to improve memory performance. However, sound promises to have many more possibilities to support multimedia learning in the same way as sound can take numerous other forms than environmental sounds, such as musical sounds or other abstract sounds, which are worth investigating. For example, guiding musical themes, leitmotifs, could be a means to orientation and structuring in lessons, as they can be applied to repeating events. It can furthermore be assumed that auditory features being distinct from the content of the lesson could be also used to elicit and maintain attention and support structuring and selection of the content to be further processed in working memory. More on sound's potential role in instructional software can be found in Bishop and Cates (2001).

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THE WILL, SKILL, TOOL MODEL OF TECHNOLOGY INTEGRATION: ADDING PEDAGOGY AS A NEW MODEL CONSTRUCT

Gerald Knezek[1] and Rhonda Christensen[2]
[1]*University of North Texa , 3940 Elm St. #G-150, Denton TX USA 76207*
[2]*The Institute for the Integration of Technology into Teaching and Learning, 3940 Elm St. #G-150, Denton TX USA 76207*

ABSTRACT

An expansion of the Will, Skill, Tool Model of Technology Integration to include teacher's pedagogical style is proposed by the authors as a means of advancing the predictive power for level of classroom technology integration to beyond 90%. Suggested advantages to this expansion include more precise identification of areas to be targeted for teacher professional development, and the prospect for aligning teaching-with-technology style with student learning styles, in order to better serve educational system goals such as student engagement, learning and achievement. Initial findings are that pedagogical preference or style with old and new technologies accounts for approximately 30% of level of classroom technology integration. The authors contend this is worthy of retaining as a fundamental model improvement.

KEYWORDS

Technology integration, predictors, will, skill, pedagogy, access to technology tools.

1. INTRODUCTION

Since 2005 the authors have surmised that the Will, Skill, Tool Model of Technology Integration (WST) unveiled at the turn of the century (Knezek, Christensen, Hancock, & Shoho, 2000) and shown in Figure 1, might be improved by having pedagogical practice (teaching style) "become a full partner in the model" (Hancock, Knezek, & Christensen, 2007, p. 91). A higher order factor analysis (Dunn-Rankin, Knezek, Wallace & Zhang, 2004) completed in 2014 indicated that one of the original model's measurement scales, Teaching with Technology (TWT), and a newly developed measurement scale, Emerging TWT, clustered together in a higher order domain tentatively labeled Pedagogy (Christensen & Knezek, 2014). This prompted the authors to conduct a preliminary test of the integrity of Pedagogy as a separate model construct. This paper details the procedures employed and reports on the initial outcomes of testing the Will, Skill, Tool, Pedagogy Model of Technology Integration (WSTP).

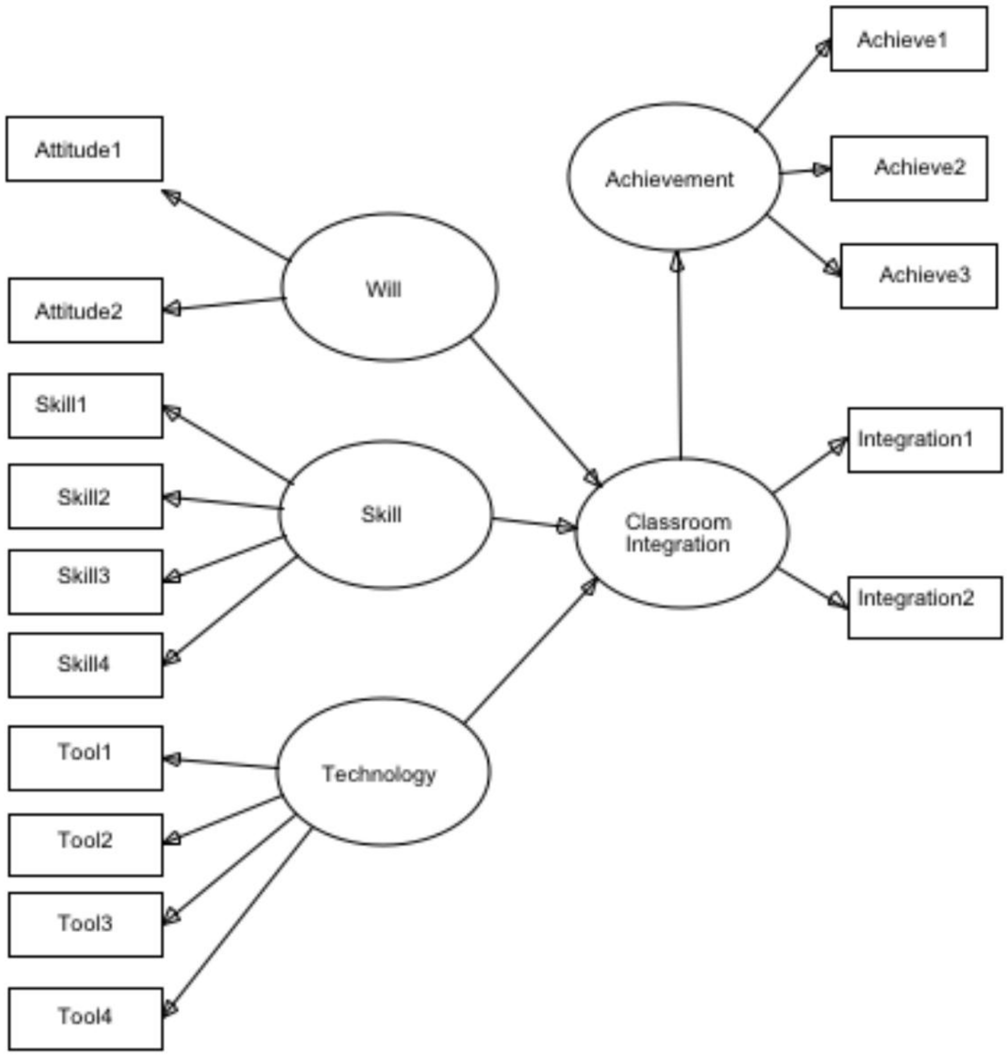

Figure 1. Will, Skill, Tool Model of the impact of technology integration on academic achievement.

2. DEVELOPMENT OF THE WST MODEL

2.1 The School Learning Environment

Learning in school has been recognized as a complex issue for many decades. For example, in 1975, Klausmeier and Goodwin identified 37 variables in nine major categories that affect the school learning environment. Among these were items such as instructional goals and objectives, student intellectual ability, teacher interest and knowledge of subject matter, home-school-community relations, physical space and equipment characteristics, and availability of print and audiovisual instructional materials (Klausmeier & Goodwin, 1975, p 13.). A complete listing of the variables and categorizations developed by Klausmeier and Goodwin are provided in Table 1.

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Table 1.Variables affecting the school learning environment

I. Objectives
1. Outcomes incorporated
2. How formulated
3. How used
II. Subject matter
1. Kind; e.g., language arts, music
2. How organized
3. How sequenced
III. Instructional materials
1. Kind: printed, audiovisual
2. Quality
3. Availability
IV. Characteristics of the learner
1. Level of achievement and intellectual abilities
2. Physical maturity and related psychomotor abilities
3. Affective characteristics: interests, motives, attitudes, values, emotional expressions
4. Health
5. Self-concept
6. Perception of situation
7. Age
8. Sex
V. Characteristics of the teacher
1. Knowledge of subject matter, development, learning, and teaching skills
2. Psychomotor abilities and physical attributes
3. Affective characteristics; interests, motives, attitudes, values, emotional expression
4. Health
5. Self-concept
6. Perception of situation
7. Age
8. Sex
VI. Classroom interactions
1. Student-student
2. Student-teacher
3. Teacher-teacher
4. Teacher-Administrator
VII. Organization for instruction
1. Elementary level: self-contained classroom, team arrangements, departmentalized
2. Secondary level: departmentalized in separate subjects - self-contained, team arrangements; broad fields - self contained, team arrangements
VIII. Physical characteristics
1. Space
2. Supplies
3. Equipment, etc.
IX. Home-school-community relations
1. Teachers of particular children – Parents of children
2. Total school - Total neighborhood
3. Total school district - Total community

Note. Adapted from Klausmeir & Goodwin, 1975, p 13.

2.2 Consolidation of Attributes

Knezek and Christensen (Knezek, Christensen, Hancock, & Shoho, 2000) created a simplified environmental model for student learning in the WST model. In this model the 37 attributes identified by Klausmeir & Goodwin (1975) were consolidated into three categories focused on learning in a classroom environment aided by the integration of technology. The three-construct WST model is shown in left-hand portion of

Figure 1. The authors also developed a second stage of the WST model focused on predicting the impact of classroom technology integration on achievement. This was in response to the U.S. Department of Education's 1999 calls for gauging the impact of the infusion of technology into the nation's classrooms (Preparing Tomorrow's Teachers to Use Technology Program, 1999). Also in 1999, the Milken Exchange on Education Technology identified seven major categories of variables intended to "… help policymakers answer the question, 'What is the return on the public's investment in K-12 learning technology?" (Coughlin & Lemke, 1999, p.3.8). Since the initial model was introduced, other researchers such as DeMars (2001) have identified the need to build effective models to deal with the multiple variables. This second stage of the WST model, which focuses on the impact of classroom technology integration on student achievement, is shown in the right-hand portion of Figure 1.

3. APPLICATIONS OF THE WST MODEL

Knezek, Christensen, and Fluke (2003) found using 1999 – 2001 data that 70% to 84% of teachers level of technology integration could be predicted based on measures of Will, Skill, and Tool, while 8-12% of first and second grade technology intensive reading achievement was attributable to level of classroom technology integration. Morales, Knezek, Christensen, and Avila (2005) examined 10 teacher school district samples spanning 2001 - 2005 and found Will, Skill, and Tool accounted for 64 - 83% of the variance in technology integration proficiency for practicing teachers. Morales (2006) conducted a transnational study of the model using refined measures for seven samples of teachers from Mexico and the USA and concluded 90% to 96 % of classroom technology integration could be attributed to Will, Skill, and Tool measures for these teachers. The total variance explained by the model was more than 90% for all samples, with the trend being that Skill was the strongest predictor of technology integration in the USA, whereas Tool was the strongest predictor in Mexico (Morales & Knezek, 2007). Petko (2012) used the WST model with self-selected measures to determine the impact of constructivist teaching style on the use of digital media in classrooms. Five factors accounted for a total of 60% of the variance in the intensity of use of Information and Communication Technologies. Among these factors were teacher confidence in their competence, access to technology, teacher belief in the power of technology to improve learning and frequency of constructivist forms of teaching and learning (Petko, 2012).

4. UPDATED MODEL SPECIFICATION

The findings by Petco (2012), as described in the previous section, served as an added impetus for the authors of the current work to examine the possible benefits of isolating pedagogical style as a separate construct in an extension of the basic WST model. According to the original model shown in Figure 1, the constructs Will, Skill, and Tool independently influence the Integration of technology in the classroom. Will is conceptually defined as a positive attitude toward the use of technology in instruction; Skill as the self perceived confidence and readiness to use technology; Tool is related to the accessibility and use of technology; and Integration as a self perceived level of technology adoption for educational purposes. Each one of the constructs was operationally defined by several measures:

Will was defined by two measures: Subscales from the TAC and TAT.
Skill was defined by four measures: Email, World Wide Web, Integrated Applications, and Teaching with Technology (TWT) from the TPSA.
Tool was defined by Home access and Classroom access to technology.
Integration was defined by three measures: Stages of adoption, CBAM, and ACOT, as detailed later.

The additional construct of Pedagogy is being added to enhance the model. Watkins and Mortimore (1999, p.17) offered a definition of pedagogy as 'any conscious activity by one person designed to enhance learning in another'. For the purposes of expanding the WST Model, Pedagogy includes teaching style (constructivist, behaviorist, etc.) and in the case of technology integration, the level of confidence teachers feel in their use of technologies to enhance learning for their students.

5. CURRENT CONSTRUCT INDICATORS

5.1 Measures of Will

The Teachers' Attitudes Toward Computers 5.1 Questionnaire (TAC) (Christensen & Knezek, 1998) measures seven indices regarding teachers' attitudes. These scales are: F1 - Enthusiasm/Enjoyment, F2 - Anxiety, F3 - Avoidance/Acceptance, F4 - Email for Classroom Learning, F5 - Negative Impact on Society, F6 - Productivity, and F7 - Semantic perception of computers. The reliabilities for these subscales typically range from .87 to .95 with K-12 teacher data.

The Teachers' Attitudes Toward Information Technology Questionnaire (TAT) (Knezek & Christensen, 1998) is a semantic differential instrument that measures attitudes toward new information technologies including email (variable coded as EMAILT), the World Wide Web (WWWT), multimedia (MMT), technology for teacher productivity (PRODT) and technology for classroom learning (PRODCL). Reliabilities for these scales typically range from .91 to .98 for K-12 teachers.

5.2 Measures of Skill

The Technology Proficiency Self-Assessment (TPSA) (Ropp, 1999) measures technology skills in the following areas: E-mail (TPSA_EMT or TPSA_EMAIL), Integrated Applications (TPSA_IA or TPSA_IAT), use of the World Wide Web (TPSA_WEB) and Emerging Tools. Reliabilities typically range from .81 to .87.

5.3 Measures of Tool

Measures of access to technology Tools include the number of computers available to the teacher in the classroom as well as teacher home access to a computer and teacher home access to the Internet.

5.4 Measures of Pedagogy

The updated version of the Technology Proficiency Self-Assessment (TPSA), TPSA C21, includes two measures of pedagogy, Teaching with Technology (TWT) from the original instrument and, Teaching with Emerging Technologies (Emerging TWT) such as smartphones and social media, from the updated TPSA. Reliabilities typically range from .87 to .93 (Christensen & Knezek, 2014).

6. OUTCOME MEASURES

Three self-reported outcome measures were also included in the battery of instruments administered to teachers. One was the Level of Use Questionnaire (CBAM_LOU) based on the Concerns-Based Adoption Model/Level of Use scale for diffusion of innovation (Hall, Loucks, Rutherford, & Newlove, 1975), while another was the Stage of Adoption of Technology in Education scale (Stages) developed by Christensen (1997), based on the earlier work of Russell (1995). The third instrument was based on work of Dwyer, Ringstaff, and Sandholtz (1990) for the Apple Classrooms of Tomorrow (ACOT) Project, and is called the ACOT Teacher Stages instrument. Each of these is a single-item instrument that cannot be easily checked for internal consistency reliability. However, test-retest reliabilities for several groups of K-12 teachers have shown reliabilities to typically be higher than .8. Research by Hancock, Knezek and Christensen (2007) demonstrated that the three indices used together as a Technology Integration scale produced Cronbach's Alpha = .84. For many research studies using these measures, the authors produce a unidimensional factor score based on extracting the "true" score for each teacher across the three measures, and use this as the technology integration (outcome) measure.

7. RESULTS

Summary results of the 2011-2014 series of analyses are displayed in Table 2. As shown in Table 2, Teaching with Technology (Pedagogy, aka Technological Pedagogical Knowledge) alone can explain 33 percent of classroom technology integration. Not shown in Table 2 is that the old TWT portion of Pedagogy is currently a much stronger indicator of technology integration (beta = .446) than the Emerging TWT (beta = .147) based on smartphones and other newer technologies. However, both are significant contributors ($p < .05$). It is anticipated that the Emerging TWT will become more important in the future.

Other analysis details not shown in Table 2 demonstrated that among the Technology Proficiency Self-Assessment (Skill) measures, Email skills contributed very little to the regression prediction (beta = -.017, p = .793), once the TWT indicators were included (TWT beta = .446, $p < .0005$; Emerging TWT beta = .137, p = .046), and the contribution of WWW skills was also small (beta = .101; p = .216). Interestingly, Integrated Applications (Microsoft Office Tools) turned out to be the strongest predictor (beta = .363, $p < .0005$) on the entire TPSA instrument, but Emerging Tech Skills (beta = .123, p = .049) was also a significant contributor to classroom technology integration.

The Tool measures summarized in Table 2 collectively contributed at least nine percent of level of classroom technology integration for this group of educators. Among these, Student Classroom Use (beta = .145, p = .015) and Home Hours of Use by the teacher (beta = .159, p = .003) were the strongest contributors.

Implications of the initial exploratory analyses were that the Will, Skill, Tool Model of Technology Integration might benefit from placing a fourth predictive construct for the technology integration model, called Pedagogy, into the model. As shown in the first RSQ column of Table 2, the components of Skill, Tool, and Pedagogy were able to account for 28 percent, nine percent, and 30 percent respectively, of the percentage of the construct *Technology Integration* for the 2014 data set in this study. In addition, as shown in the last column of Table 2, a parallel school district data set from 2011 that also included measures of Will (Teachers Attitudes Toward Computers, TAC) (Christensen & Knezek, 2009) in the professional development assessment battery of instruments administered to 1648 teachers, produced comparable regression coefficients to the 2014 study for the three components identified in the data set. Further analysis of the 2011 data set indicated that 29 percent of Technology Integration could be attributed to the scales comprising Will. The expanded WST Model (WSTP) is shown in Figure 2.

Over interpretation regarding the strength of each of these predictors is cautioned because some portion of the variance predicted by one scale set (for example, Skill) would likely also be able to be predicted by another scale set (for example, Pedagogy), and in fact the sum of the RSQs for the four model components in the second column of Table 2 is more than 100 percent. Nevertheless, these exploratory findings provide hope that a formal structural equation modeling (SEM) approach to testing the WSTP model might confirm the predictive power of a four-component model of technology integration to be beyond the previously reported 90 percent (Morales, 2006; Morales & Knezek, 2007; Knezek & Christensen, 2008), and approaching 100 percent. The authors plan to test this conjecture when the volume of teacher data acquired covering all four components of the model, and using the new TPSA, surpasses n = 1500.

Table 2. Prediction ability of Will, Skill, Tool, and Pedagogy indicators

Model Component	Indicator	RSQ Current data set (2014) (n = 466)	RSQ – Prior data set (2011) (n= 1648)
Will	TAC Subscales 2 (Tech Comfort), 6 (Utility), 8 (Absorption) were sig.		.29
Skill	TPSA 1 (Email), 2 (WWW), 3 (IntApp) (Email was NS)	.28	.29
Tool	Home use, student use, access	.09	.15
Pedagogy	TPSA Teaching with Tech	.33	.30

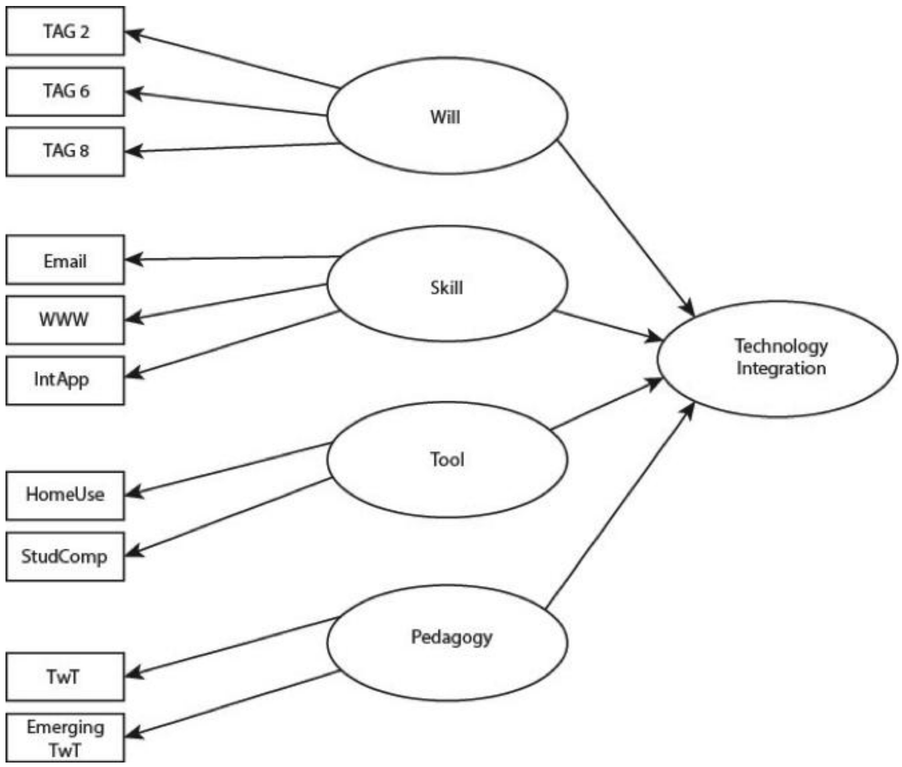

Figure 2. Expanded will, skill, tool model of technology integration, including pedagogy.

8. DISCUSSION

Previous studies (eg. Morales, 2006) found that the strength of the regression-style coefficients for the major model components varied depending upon the local context in which the teachers providing the data resided. For example, for the Morales (2006) study, level of technology-using Skill development was found to be the strongest predicator of technology integration for teachers in the U.S., while for teachers in Mexico, extent of access to technology Tools was the most important predictor. The implication is that the domain in which the local environment has the greatest variability becomes the strongest predictor. The authors of the current paper have found from other studies (Christensen & Knezek, 1999) that for teachers who are near the highest level of technology integration, it is the Will to push forward that becomes the greatest predictor. By following these analogies, we can infer that among the 2014 and 2011 data sets featured in this paper, pedagogical style (Pedagogy) is likely to have the greatest variability among the teachers surveyed, since it accounted for 33% (2014 data) and 30% (2011 data) respectively, of teacher's level of technology integration (see Table 2). The leadership of school districts might wish to provide alternative professional development activities for teachers from different pedagogical schools of thought, in order to better support this diversity.

9. CONCLUSION

Initial testing of the expanded Will, Skill, Tool Model of Technology Integration indicates that Pedagogy as a predictive construct has empirical support from recently-gathered data and promises to bring new perspectives to the realm of initiatives for technology-intensive teacher professional development. In addition to enhancing the ability of the WST model to predict beyond 90% of a teacher's level of technology integration in his or her classroom, it is likely that elucidating the importance of pedagogical style of the teacher will bring more focus on aligning teaching with the preferred learning styles of students. This could enable educational practitioners to push beyond the 8-12% per year of positive impact on student achievement previously identified as attributable to level of classroom technology integration.

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Watkins, C., & Mortimore, P., 1999. Pedagogy: What do we know? In Mortimore, P. (Ed.) Understanding pedagogy and its impact on learning. London, Paul Chapman Publishing.

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CHALLENGES OF BIG DATA IN EDUCATIONAL ASSESSMENT

David C. Gibson[1], Mary Webb[2] and Dirk Ifenthaler[1]
[1]*Curtin University, Kent Street, Bentley WA 6102, Australia*
[2]*King's College London, Strand, London WC2R 2LS, England, United Kingdom*

ABSTRACT

This paper briefly discusses four measurement challenges of data science or 'big data' in educational assessments that are enabled by technology: 1. Dealing with change over time via time-based data. 2. How a digital performance space's relationships interact with learner actions, communications and products. 3. How layers of interpretation are formed from translations of atomistic data into meaningful larger units suitable for making inferences about what someone knows and can do. 4. How to represent the dynamics of interactions between and among learners who are being assessed by their interactions with each other as well as with digital resources and agents in digital performance spaces. Because of the movement from paper-based tests to online learning, and in order to make progress on these challenges, the authors advocate the restructuring of training of the next generation of researchers and psychometricians to specialize in data science in technology enabled assessments. This call to action stemmed from discussions at EDUsummIT 2013, which will be published in depth in a special issue of *Education and Information Technologies*.

KEYWORDS

Learning analytics, big data, data science in educational assessment, educational measurement, new psychometrics

1. INTRODUCTION

Assessment and learning analytics challenges have dramatically increased since new digital performance affordances, user interfaces, and the targets of technology-enabled assessments have become more complex. The increased complexity is due in part to technology's capabilities and roles in presenting interactive learning experiences and collecting rich data (de Freitas, 2014; Quellmalz et al., 2012) which is leading to the infusion of data science methods and techniques into learning and behavioural science research (Gibson & Knezek, 2011; Kozleski, Gibson, & Hynds, 2012). These changes require new quantitative methods as well as a reconceptualization of mixed methods (Tashakkori & Teddlie, 2003) that include domain experts as well as stakeholders in the construction of knowledge of such complex systems.

In technology-enhanced assessments, the emergence of 'big data' - which are defined as data with a large numbers of records, of widely differing data types, that are rapidly collected for immediate action (IBM, 2015; Margetts & Sutcliffe, 2013) – underscores the need to develop assessment literacy (Stiggins, 1995) in teachers, learners and other audiences of assessment. Assessment literacy has become more important than ever for understanding how technology influences and impacts assessment types and processes and especially for developing confidence in creating and analysing arguments from evidence, based on a user's current understanding of validation (Black, Harrison, Hodgen, Marshall, & Serret, 2010).

The paper discusses the main challenges associated with applying data science methods in educational assessment to address a digital media assessment's psychometric properties; time sensitivity; digital performance and the problem space for analysis; the hierarchy of tasks, turns and translations between different levels and the dynamics of interrelationships in assessment systems. The OECD PISA plan for assessing CPS is used as an example to explain these challenges in relation to a complex problem space. The paper then illustrates with a learning analytics case that shows how the identified challenges have been addressed in the development of assessments.

2. BACKGROUND

There is uncertainty as to whether and how four different perspectives on assessment – providing feedback information, supporting improvement decisions, identifying the degree of engagement and understanding, and making value judgments - can co-exist to the benefit of learners (Webb, Gibson, & Forkosh-Baruch, 2013). Even with the increased possibilities that IT provides there is not yet a way to say confidently that the multiple purposes for which some assessments have been used (Mansell, James, & the Assessment Reform Group, 2009) can or should be supported through the same assessment systems. This is because *the impacts of some purposes interact with the validation processes of others* (Messick, 1994). Therefore in considering assessment design for multiple purposes for example for formative as well as summative purposes, users need to examine those impacts carefully in order to minimise negative consequences on learning and learners.

Developing theory for the application of data science methods in educational research is important for two primary reasons. First, assessment of virtual performance presents new challenges for psychometrics (Clarke-Midura & Dede, 2010; Ifenthaler, Eseryel, & Ge, 2012; Quellmalz et al., 2012). Secondly, new tools are needed for discovery of patterns and drivers in complex systems for working with 'big data' in educational research preparation and practice (Gibson, 2012; Patton, 2011). Indicators of progress in theory development would be an increase in research exploring and articulating the use of data science methods in learning analytics to improve learning and achievement; and the expansion of methods beyond traditional statistics and qualitative approaches in educational research, to include data mining, machine learning, and in general, the methods of data science.

3. PSYCHOMETRIC CHALLENGES IN THE ERA OF BIG DATA

Psychometrics is the branch of psychology that deals with the design, administration, and interpretation of quantitative tests for the measurement of psychological variables such as intelligence, aptitude, and personality traits ("Psychometrics," 2014). A good psychometric test is "internally consistent, reliable over time, discriminating and of demonstrated validity in respect of its correlations with other tests, its predictive power and the performance of various criterion groups. It also has good norms" (Kline, 1998, p.92).

Until recently, the field dealt almost exclusively with the construction and validation of measurement instruments such as questionnaires, tests, and personality assessments. However there is now a need to expand to include highly interactive digital learning and adaptive test experiences, such as the OECD PISA assessment of CPS. In brief, PISA is a triennial international survey that aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students in order to determine the extent to which they can apply their knowledge to real-life situations and hence are prepared for full participation in society. To constrain the quite complex variables that would be involved if the collaboration was among a set of real people, the OECD assessment utilizes the computer to play roles as collaborators in a *virtual performance assessment* (Clarke-Midura, Code, Dede, Mayrath, & Zap, 2012). The PISA assessment plan incorporates a complex behaviour space that illustrates some of the new demands on psychometrics.

The challenge with technology enabled assessments is to evolve the procedural foundations of psychometrics, which until recently have been primarily based on population statistics and static snapshots of data. The new foundation outlined here highlights the need to include time sensitivity, digital performance space relationships, multiple layers of aggregations at different scales, and representations of the dynamics of a complex behaviour space (Gibson & Jakl, 2013; Quellmalz et al., 2012).

3.1 Time Sensitivity

In the OECD assessment, time is controlled as a boundary variable of the test and the computer is used to prompt the test taker to 'move on' when the evidence rule system detects that the student needs to be rescued from an unproductive problem-solving path. The decision to redirect appears natural to the situation because the computer is playing the role of one or more collaborators, so the suggestion to move on comes from a simulated peer. This situation illustrates that a technology-enabled assessment might well give the student perceived or actual control over time, compared to an assessment that only displays test item prompts in a

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timed test. In some virtual performance assessments, time is open-ended, and the use of item resources (e.g. in what order, with or without returning to the resources multiple times, time spent with each resource, timing of the appropriate use of a resource, and total time to utilize the appropriate resources to accomplish the task) all may be critical to the classification of the learner's response (Gibson & Jakl, 2013; Stevens & Palacio-Cayetano, 2003).

The OECD assessment solves the time sensitivity problem by parsing time into critical events and then monitoring the event patterns to detect the level of evidence of the competencies in the domain model (see Table 1). This is a form of *time segmentation*, because some events cannot happen until other events have occurred (e.g. establishing and maintaining team organisation must occur after establishing a shared vision, and while maintaining that vision and taking appropriate action to solve the problem). A planned sequence of activities and timed release of testing resources, known in game-based learning as a 'branching storyline' (Aldrich, 2005) is a method for controlling the evolution of a process.

Table 1. Domain model for assessing collaborative problem solving

	(1) Establishing and maintaining shared understanding	**(2) Taking appropriate action to solve the problem**	**(3) Establishing and maintaining team organisation**
(A) Exploring and Understanding	(A1) Discovering perspectives and abilities of team members	(A2) Discovering the type of collaborative interaction to solve the problem, along with goals	(A3) Understanding roles to solve problem
(B) Representing and Formulating	(B1) Building a shared representation and negotiating the meaning of the problem (common ground)	(B2) Identifying and describing tasks to be completed	(B3) Describe roles and team organisation (communication protocol/rules of engagement)
(C) Planning and Executing	(C1) Communicating with team members about the actions to be/ being performed	(C2) Enacting plans	(C3) Following rules of engagement, (*e.g.*, prompting other team members to perform their tasks.)
(D) Monitoring and Reflecting	(D1) Monitoring and repairing the shared understanding	(D2) Monitoring results of actions and evaluating success in solving the problem	(D3) Monitoring, providing feedback and adapting the team organisation and roles

Other problem-solving contexts, such as coordination of group actions needed for scientific inquiry and experimentation, require simultaneous actions mixed with sequences of actions. The classification system of the assessment has to handle *patterns of simultaneous and sequential interactions* in order to make valid links to time-sensitive evidence rules within the conceptual assessment framework (CAF), which is a key component of evidence centred design (Mislevy, Steinberg, & Almond, 1999), an approach that is becoming increasingly prominent in assessment design and on which this analysis is based. The CAF has three core components: the student model, task model and evidence model (Mislevy et al., 1999; Mislevy, Steinberg, & Almond, 2003) within and among which the time sensitive relationships adhere.

3.2 Digital Performance Space Relationships

A learning experience entails a designed structure of knowledge and action (Jonassen, 1997) and when that experience is interactive and digital there are many measurement challenges (Quellmalz et al., 2012). The emerging varieties of network analysis (e.g. social networks, visualization, artificial neural networks, decision trees) have arisen as new analytical tools and methods for understanding the structural relationships in technology-enhanced learning (Choi, Rupp, Gushta, & Sweet, 2010; Shaffer et al., 2009). In addition, the traces of knowledge and action (i.e. the actions, communications and products) created by a learner during the course of interacting with a digital learning application bear a relationship to that person's mental representations of the problem (Newell & Simon, 1972) and the knowledge and capability they acquired, accessed and utilized during the interaction (Pirnay-Dummer, Ifenthaler, & Spector, 2010; Thagard, 2010). This set of ideas are referred to here as '*digital performance space relationships*' which will be shown to be similar to 'items' and 'constructs' in classical test theory.

An interactive digital performance space can support several scenarios, each with one or more classification challenges for inferring what the test taker knows and can do. In the OECD assessment, for example, the scenarios presented to the student are designed to sample the digital performance space construct of 'collaborative problem solving.' Each scenario allows the classification of the test taker into one or more cells of a matrix created by the intersection of three stages of 'collaboration' with four stages of 'problem-solving' (Table 1). In classical test theory, the 'construct' plays a similar role to the digital performance space; several test items are used to make multiple measures of the construct. A review of the historical idea of a valid construct is helpful for making the bridge from classical testing to the digital age.

A valid construct was thought of as an *inductive summary* and as *part of a series* of validity investigations that included concurrent, predictive and content considerations. In addition, the *construct can change* and *become more elaborated over time,* as Cronbach noted (Cronbach & Meehl, 1955):

When a construct is fairly new, there may be few specifiable associations by which to pin down the concept. As research proceeds, the construct sends out roots in many directions, which attach it to more and more facts or other constructs.

Finally, the construct acquired validity through the idea of a *nomological network* which is a collection of overlapping *mappings* from (*a*) observable properties or quantities to one another; (*b*) different theoretical ideas to one another, or (c) theoretical constructs to observables (ibid). A single mapping might include examples of all these relations, as a construct might be a complex set of factors that interact with one another. The idea of a network of ideas and relationships was a fairly abstract philosophical idea in the 1950's but today has a concrete meaning that has become known as network theory in social science (Borgatti & Halgin, 2011) and network analysis in computational sciences, both of which are applied graph theory from mathematics (Brandes & Erlebach, 2005). This history outlines a bridge of ideas that carries forward into today when digital media learning spaces can record a network of traces of the actions of a learner.

Digital media learning presents problems as well as prompts for learner performance (e.g. problem-solving, collaboration) in a space that is characterized by hyperlinked resources that can be represented as nodes and relations in a network (Clarke-Midura et al., 2012; Quellmalz et al., 2012; Stevens, 2006). As a learner uses such a space to learn and perform (e.g. interacting with the resources to solve a problem, adding new information, re-arranging resources into new relationships) a new network can be created that represents the learner's response, a time-specific performance path through the digital performance space (Ifenthaler et al., 2012). The learner's performance network is a constructed knowledge structure that needs to be taken into account in assessment (Gijbels, Dochy, Van den Bossche, & Segers, 2005). The digital performance space and the constructed knowledge structure of the learner hold the same kind of relationship as the nomological network does to a demonstrated construct; the digital performance space holds the learning designer's view of the construct (e.g. what it means to act like a scientist in a given situation) and the constructed knowledge structure (e.g. what the learner did in this instance) holds evidence of the processes and products of knowing and doing.

The terms of the nomological network inference, which underpins a claim of construct validity, bear a similarity to the rules of a chain of a reasoned argument, which can lead to a claim concerning what a learner knows and can do as used in Evidence-Centered Design (ECD). In ECD, an argument has constituent claims, data, warrants and backing and must take account of alternative explanations. In a nomological network by comparison, there are observations, ideas and relationships and a chain of inference must be used in order to establish a claim that a particular test is a measure of the construct.

The relationships and nodes of a network representation of the traces of learner interactions can be compared to the digital performance space resources and relationships to enable inferences about what the learner knows and can do (Al-diban & Ifenthaler, 2011; Quellmalz, Timms, & Schneider, 2009). Network measures such as similarity, centrality, clusters and pattern matching are used in such inferences, where the patterns of the network imply functional and structural connectivity (Sporns, 2011). Digital performance space relationships examined with time sensitive network analysis has increased the ability of research to characterise and make comment on processes, products, knowledge and know-how, and their complex entanglements in authentic performance settings.

3.3 Layers of Aggregations and Translations

In the OECD assessment of CPS, aggregations of events into tasks takes place in a hierarchy that begins at the top with a scenario and ends within each task of the scenario at the level of a 'turn' - a game-based learning concept that updates the state of the scenario based on the learner's input.

Each problem scenario (unit) contains multiple tasks. A task, e.g., consensus building, is a particular phase within the scenario, with a beginning and an end. A task consists of a number of turns (exchanges, chats, actions, etc.) between the participants in the team. A finite number of options leading onto different paths are available to the participants after each turn, some of which constitute a step towards solving the problem. The end of a task forms an appropriate point to start the next task. Whenever the participants fail to reach this point a 'rescue' is programmed to ensure that the next task can be started (PISA, 2013).

With this hierarchy in mind (e.g. scenarios containing tasks that contain turns) the challenge of aggregating with time sensitivity and translating from one level of analysis to another can be addressed with moving averages, sliding time windows, and event recognition. The OECD uses event recognition, in which an action, communication or product of the test taker triggers a reaction by the test engine to update the scenario, which might include rescuing the test taker. In a moving average, some window of time is selected (e.g. every second, or after every three turns) and an average is performed to form an abstracted data layer that preserves some of the shape of the data movement over time. In the sliding time window (Choi et al., 2010; Han, Cheng, Xin, & Yan, 2007), a combination of event recognitions and moving averages, or some configuration of either, might be performed and then used as an abstracted data layer. In the example case summarized below, for example, the time stamps of every action were subtracted from each other to compute duration, which was then applied to each action, to nearby action-pairs and to action-ngrams (motifs) for further analysis.

Within any slice of time, or when comparing two or a few slices of time, standard statistical procedures and aggregations apply (e.g. means testing, correlations, regressions), but when high resolution data is involved (e.g. many data points per record per unit of time) and where there are complex aggregations (e.g. widely varying sources of data and different units of measure) then data mining techniques are more applicable. Of note, regression techniques in data mining are not equivalent to the same methods in statistics, even though the terms sound and look the same. In data mining, regression represents a search within a complex nonlinear space for patterns and representations of structure and causal dynamic relationships, rather than the reduction of error of a linear model (Schmidt & Lipson, 2009). Thus, aggregations in the two approaches are also of different lineage and need to be considered as separate entities with separate representational functions, meaning and purposes (Bates & Watts, 1988).

3.4 Representations of Dynamics

Systems dynamics (Bar-Yam, 1997; Sterman, 1994) involves a mathematical modeling technique for framing, understanding, and discussing the issues of time, digital performance space relationships and aggregation-translation in highly interactive technology-enhanced assessments. Field experiments with systems dynamics methods have for example, focused on mid-level model-based theory building in an assessment context (Kopainsky, Pirnay-dummer, & Alessi, 2010). The process of building a model from snapshots of a dynamic system is called a 'nonlinear state space reconstruction' (Sugihara et al., 2012). In such a state space equivalent to a network all the data falls within a finite band or manifold of behaviour. That is, every state of the system will be in one of the spaces created by the finite possibilities for each variable at some point in time. Such reconstructions of the underlying manifold governing the dynamics of a system can map to and uncover the causal relationships in a complex system (Schmidt & Lipson, 2009) including those that support inferences concerning what a user knows and can do.

Visualizing the current status of a learner's progress on an assessment is an example of representing a state of a dynamic system, as is visualizing the progress of the learner in relation to a domain model driving the assessment's evidence collection processes. The Khan Academy (Khan, 2011) for example, charts progress in learning mathematics or science content against a visualization of the content hierarchy. If the learner has mastered division, a visual tree shows how mastery fits with addition and subtraction and allows access to the next higher level of math skill. More dynamic and fine-grained visualizations are also possible, for example, that would trace the process steps of a solution, or document the details of a constructive process. Visualizations can aide pattern discovery involving both nonverbal and verbal expressions; for example, from bodies of text, from online student discussion forums, and from cognitive and mental model representations (Pirnay-Dummer et al., 2010).

To date the developments in learning analytics that provide visualisations of learning traces for learners and teachers have been represented by learning analytics dashboards. Such dashboards have been developed that keep track of time, social interactions for insights into collaboration, the use of documents and tools, and the artefacts produced by students (Verbert, Duval, Klerkx, Govaerts, & Santos, 2013). While these dashboards currently fall far short of the detailed traces of assessment data that are possible to create, even these more limited opportunities for analysing their learning have been found to support learners' reflection and improve self-assessment as well as increasing course satisfaction (Verbert, et al., 2013).

Examples of the more highly detailed traces are readily found in serious games, as well as casual games that are designed to be immersive and emotionally engaging rather than a simple pastime (Aldrich, 2005). In these game-based examples, the high-resolution feedback is always on, giving the player an up-to-date view of progress, hints about upcoming challenges, and a view to the longer-term goal (Prensky, 2001). Clearly educators and researchers might want to promote to policymakers the importance of researching the methods and impacts of presenting visualisations of data to teachers and learners along with developments in data processing that will better enable judgements of student performances.

Perhaps the biggest unresolved issue of representation of collaborative learning (and perhaps any learning progress during a complex process) is how to represent the moving and evolving quality of change over time. ‘Movies’ of dynamic educational processes have not yet been documented in many cases, and if existing, have not been widely disseminated into common practice. This lack of a practice base and experience hampers theory as well as practice in technology-enhanced assessments, and points to the need illustrated by the case in the next section, for future research and practice to create a shared understanding of the methods of data science in educational research.

4. CASE STORY: VIRTUAL PERFORMANCE ASSESSMENT

A case story illustrates how technology enabled educational assessment can produce a large number of records, how time and process can be an included mediating factor in analysis and how machine learning and data mining methods are needed to support the rapid simultaneous testing of multiple hypotheses.

A game-based assessment of scientific thinking was created at Harvard (Clarke-Midura et al., 2012) and analysed by one of the authors (Gibson & Clarke-Midura, 2013) to ascertain the abilities of middle school students to design a scientific investigation and construct a causal explanation. A summary of the data science findings and issues included the observation of two of the three aspects of big data: volume (~ 821,000 records for 4000 subjects, or 205 records per subject); and variety of data (user actions, decisions and artifacts provided evidence of learning and thought processes). The third element of big data, velocity, was less important in this case; because the flow of data was not used in near-real time to give hints, correct mistakes, or inform the learner during the experience, so the data was streamed off to storage for later analysis.

This case illustrates several of the features of big data in educational assessment. First, the context was captured along with the learner action, decision, and product, but that context needed to be effectively constructed from the smallest items of data into larger clusters of information. For example, a data element named ‘opened door’ by itself was relatively meaningless compared to knowing that it was a particular door, opened after another significant event such as talking to a scientist. Thus, patterns of action were transformed into *n-grams* (Scheffel, Niemann, & Leony, 2012) or *motifs*, which then became the transformed units of analysis. This concept of the unit of analysis containing the semantic, time and space contexts for lower levels of aggregation may be a new methodological requirement of digital assessments, and needs further study.

Second, as a large number of users traverse through the network of possibilities in a digital performance space, key movements of the population within the network can be counted and then used as the basis for *empirical prior probabilities* which assist in creating Bayesian inferences about the scientific problem-solving path-maps of learners (Stevens, Johnson, & Soller, 2005). In particular, each pathway in such a network can be further characterized or specified with a predictive nonlinear mathematical relationship (Gibson & Clarke-Midura, 2013), for example, found through *symbolic regression* an evolutionary machine learning technique (Schmidt & Lipson, 2009). Or, alternatively an *association rule network* can be created that distinguishes user action patterns and motifs according to the prevalence of utilizing one resource compared to another. For example, if 100% of the population goes to resource 3 after resource 1 (skipping over and not utilising resource 2), then with a very high probability, if the sample is a good sample of the greater population, the next user entering the system will follow that path and the inference system can make a highly probable educated guess about what the person now using resource 1 will do next.

The third feature is that the complex set of relationships in various analyses such as those just mentioned, bear a structural relationship to something meaningful about the digital performance space as outlined above. For example, a *cluster analyses* can reveal that some resources are critical to success and others are ignored and not important to the most successful learners (Quellmalz et al., 2012) or a *network visualization* can highlight how people relate to each other or to a task such as quoting and using scientific resources (Bollen et al., 2009).

5. CONCLUSION AND IMPLICATIONS FOR TEACHING AND LEARNING

This paper has introduced four challenges of big data in educational assessments that are enabled by technology: how to deal with change over time and time-based data; how a digital performance space's relationships interact with learner actions, communications and products; how layers of interpretation are formed from translations of atomistic data into meaningful larger units; and how to represent the dynamics of interactions between and among learners who are being assessed by their interactions in digital performance spaces. The article linked the big data challenges to solutions offered in the OECD PISA assessment of collaborative problem solving, and then reviewed some of the same issues by briefly summarizing a particular case.

The challenges and issues discussed in this article reveal the requirements for developments in theory as well as some of the practical challenges that will need to be overcome if educators are to achieve the vision of providing learners and teachers with a 'quiet assessment' system in which the impact can be turned up at the request of learners and teachers as they seek to understand the progress of learning. This joint approach which emphasises assessment AS, FOR and OF learning (Bennett, 2010) is discussed further in (Gibson & Webb, 2015) and (Webb & Gibson, 2015)

In moving forward to embrace the opportunities that could be provided by technology enhanced assessments the challenges that remain to be addressed must not be underestimated before educators can use automated assessments of complex skills and understanding with confidence.

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EVALUATING THE INTERACTIVE LEARNING TOOL SIMREAL+ FOR VISUALIZING AND SIMULATING MATHEMATICAL CONCEPTS

Said Hadjerrouit
University of Agder, Kristiansand, Norway

ABSTRACT

This research study aims at evaluating the suitability of SimReal+ for effective use in teacher education. SimReal+ was originally developed to teach mathematics in universities, but it is has been recently improved to include school mathematics. The basic idea of SimReal+ is that the visualization of mathematical concepts is a powerful technique to enhance the understanding of mathematics. The study uses a set of quality criteria, and a survey questionnaire with open-ended questions to evaluate the suitability of SimReal+ in teacher education. The statements of the survey are categorized in five main groups of criteria that include technical usability, pedagogical usability, mathematical content, assessment issues, and teacher education considerations. Additional issues are programming mathematical visualizations, simulations using templates, and flipped classroom. Conclusions and some recommendations are drawn from the results to improve the design of SimReal+ to better suit the needs of students and teachers in mathematics education.

KEYWORDS

Mathematics, teacher education, SimReal+, simulation, usability, visualization.

1. INTRODUCTION

The Centre for Research, Innovation and Coordination of Mathematics Teaching (MatRIC) has been established in 2014 to create and disseminate knowledge and experience that will guarantee high quality learning opportunities in mathematics for Norwegian students. This work is situated within the simulation and visualization workgroup of MatRIC, which seeks to support a network of mathematics teachers collaborating in the production of digital simulations and visualizations by means of SimReal+ to support learning processes. SimReal+ is a digital tool that was developed to teach a wide range of mathematical topics in higher education. Recently, SimReal+ has been extended to include school mathematics, but the suitability of the tool has not yet been evaluated for use in teacher education. According to the New National Curriculum in Norway, being able to use digital tools in mathematics education involves using the tools for visualization, problem solving, simulation and modeling. However, mastering technical issues of digital tools does not automatically make SimReal+ pedagogical usable for teacher students in terms of motivation, variation, student autonomy, individualization. Moreover, the content provided by SimReal+ must be mathematically sound and correct, and help students gain knowledge that is otherwise difficult to acquire in a school environment. Furthermore, assessment issues in terms of feedback must be considered to support the learning process. Hence, adaptability of digital tools to a teacher education context is a complex issue that needs to be evaluated on the basis of criteria that are pertinent to pedagogical software. Clearly, success in mathematics-related subjects does not automatically guarantee success in teacher education. The paper uses an instrument to assess the suitability of SimReal+ for teaching and learning school mathematics. To achieve this goal, SimReal+ was used in a course on digital tools in mathematics education. The work was carried out in two steps. Firstly, teaching and exercise activities over a period of two weeks were performed. The activities included mathematical issues related to trigonometry, programming issues, and diverse teaching material made online. Secondly, the students were asked to evaluate SimReal+ using a set of criteria, and mixed data collection and analysis methods. The criteria were categorized in five groups that include technical usability, pedagogical usability, mathematical content, assessment issues, teacher education

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considerations, and other issues such as programming and flipped classroom. Open-ended questions allowed the students to express in their own words what they think about different issues of SimReal+. Finally, the article suggests some recommendations that help placing SimReal+ as an integral part in teacher education.

2. SIMREAL+

SimReal+ is an interactive learning tool for teaching and learning mathematics for a range number of subjects related to mathematics such as engineering and physics. The basic idea of SimReal+ is that visualizations are powerful mechanisms for learning mathematics and explaining difficult topics. According to Arcavi (2003), visualization is the ability to use and reflect upon pictures, graphs, animations, images, and diagrams on paper or with digital tools with the purpose of communicating information, thinking about and advancing understandings. There is a huge interest in visualization in mathematics education (McKenzie, & Clements, 2014; Presmeg, 2014). Textbooks are filled with pictures, diagrams, and graphs. Graphing calculators have become integral part of mathematics education in secondary schools. Digital tools based on visualizations, such as GeoGebra and Geometer's Sketchpad, are in use in secondary and university mathematics classrooms. However, there is little empirical support for the use of visualizations in educational settings (Macnab, Phillips, & Norris, 2012). SimReal+ as a visualization tool uses a graphic calculator, video lectures, video streaming, video and interactive simulations to teach mathematics. It also provides exercises and applications in various areas of mathematics and physics at different educational levels (Brekke, & Hogstad, 2011). Figure 1 shows the main components of SimReal+.

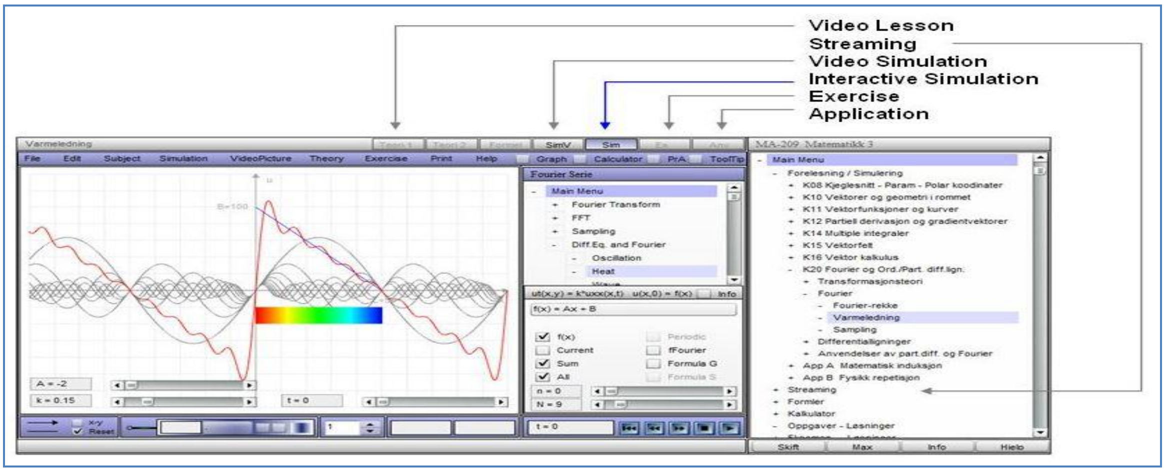

Figure 1. SimReal+ main components

There are three research studies on SimReal+ and its effect on teaching and learning mathematics. Two studies focused on teaching mathematics in higher education (Brekke, & Hogstad, 2010; Hogstad, 2012). These studies report on positive attitudes towards the use of SimReal+ and its suitability and usefulness in difficult and abstract mathematical areas. Students considered SimReal+ as a positive addition and supplement to ordinary teaching. Students encountered few challenges. The third study addresses the use of SimReal+ in teacher education (Cury, 2012). It reports on positive students' attitudes towards the use of the tool in an upper secondary school, but some students did not found visualizations very useful, and that integrating the tool into the educational curriculum was not simple. These studies used quantitative and qualitative methods to assess students' perceptions of SimReal+ such as interviews and surveys.

3. THEORETICAL FRAMEWORK

A wide range of theoretical approaches can be used to address the integration of digital tools in education (Drijvers et al. 2010). No one of these approaches is ready-made for the purpose of this work, but according to Cobb (2007), elements of different theoretical perspectives can be adapted for the concerns of a research study as a source of ideas. Hence, the framework used for evaluating SimReal+ is rooted in four approaches that are particularly pertinent to this study. The first one is the instrumental approach and the distinction between artefact and instrument, and how to transform an artifact to an instrument through the processes of instrumental genesis (Rabardel, 1995; Trouche, 2004). Second, the anthropological approach and the Task-Technique-Theory triad to capture the relationships between tool techniques and conceptual understanding, on the one hand, and tool techniques and paper-and-pencil techniques, on the other hand (Chevallard, 1995). Third, the Theory of Didactical Situations, and the tool's potential for providing feedback, which is an essential condition for supporting learning (Brousseau, 1997). The fourth theoretical background is based on usability issues and related research work on evaluating digital tools in mathematics education (Bokhove, & Drijvers, 2010; Hadjerrouit, & Bronner, 2014). As a result, five groups of evaluation criteria are derived from this theoretical background: Technical usability, pedagogical usability, assessment issues, mathematical content, and teacher education considerations (Hadjerrouit, & Bronner, 2014). Technical usability as defined by Nielsen (1993) is a self-evident requirement for any digital tool in mathematics education. In many cases, however, the impact of technical usability on learning is limited when it comes to pedagogical use of the tool. In addition, the functionality of a particular tool does not always result in pedagogical opportunities, which will only be visible when an explicit pedagogy guides the design and use of the tool in classroom (Burden & Atkinson, 2008). Nokelainen (2006) expanded the concept of technical usability to include pedagogical usability criteria, such as learner control, collaboration, variation, motivation, differentiation, flexibility, and feedback. Hadjerrouit (2010) stated that both aspects of usability are closely related to each other. In addition, the assessment dimension has emerged as one of the most important criteria for evaluating the quality of digital tools. Assessment is associated with the tool's feedback and builds the ground for formative assessment. Another criterion is the inclusion of mathematical content in terms of correctness of mathematical concepts, notations, and symbols (Artigue, et al, 2009; Bokhove, & Drijvers, 2010). Equally important is the congruence between the tool's features and paper-and-pencil techniques to facilitate mathematical reasoning. Finally, it is important to evaluate whether the tool is appropriate in teacher education, takes into account the requirement of adapted education, and enables the teacher to concretize the mathematical subject curriculum. The specificities of the criteria are described as follows:

a) Technical usability

- *Ease-of-use*: SimReal+ should be easy to use, to start, and to exit.
- *Accessibility:* SimReal+ should be accessible anytime and place.
- *Management facilities*: SimReal+ should provide management facilities, e.g., it should be possible to store answers given by students. The tool should also have readily available content that can be modified.

b) Pedagogical usability

- *Motivation*: Motivation measures the extent to which SimReal+ is attractive to use, adapted to the students' age, knowledge level, development, and interest, as well as tied to the students' other activities and tasks. Using SimReal+ should be a motivational factor for learning algebra.
- *Variation*: SimReal+ should be able to present the content in several ways, and facilitate various activities with students. SimReal+ should also be used as an alternative to achieve variation in teaching, and eventually in combination with textbooks and other study material and digital tools.
- *Student autonomy*: SimReal+ should enable a high degree of autonomy so that the students do not necessarily need teacher assistance for help. The knowledge provided by SimReal+ should be potentially powerful to enable students to become less dependent on teacher assistance.
- *Individualization*: SimReal+ should take into account adapted education, and different knowledge levels. The students should be able to work in their own pace, save their work and continue later. Disabled people should be able to work with the tool.
- *Differentiation:* Differentiation means that SimReal+ should provide multiple tasks with different levels of difficulty, and can be tailored to the students. In addition, the tool should provide opportunities for the teacher to make individual adjustments and customize the tool when needed.

c) Mathematical content

- *Quality of content*: Mathematical content (theory, exercises and problems) provided by SimReal+ should be of high quality. The content should be mathematically sound and faithful to the underlying mathematical properties. SimReal+ should provide opportunities to display formulas correctly, and help students to gain knowledge that is otherwise difficult to acquire.

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- *Congruence with SimReal+ techniques*: SimReal+ should enable the student to apply his or her own paper-and-pencil technique reasoning steps and strategies, and express mathematical ideas, as well as facilitate students' mathematical activities.

d) Assessment

- *Formative assessment* is important to measure the extent to which SimReal+ provides several assessment and review modes, appropriate feedback in the process of problem solving, and use of several question types. Providing student profiles is important when it comes to adapt the questions to the student's knowledge level. The quality of interaction and feedback to students' actions are crucial for the learning process. In terms of *summative assessment*, the tool should provide teachers with quantitative data, statistics and results that help to evaluate students' performances. It should give scores and grading.

e) Teacher education

- Adaptability and suitability of SimReal+ in teacher education includes the appropriateness of the tool in teaching school mathematics. This criterion also measures the extent to which SimReal+ provides opportunities to concretize the curriculum as specified by the New National Curriculum, and whether the tool is tied to teaching and adapted to the curriculum.

4. RESEARCH DESIGN

This research study involved 22 teacher students taking the course on digital tools in mathematics education in the fall semester of 2014. The students had very different knowledge background both in mathematics and digital tools. None of the students had any prior experience with SimReal+. The work used a survey questionnaire with open-ended questions to gather empirical data. To explore the use of SimReal+, teaching activities over a period of two weeks were designed and analyzed according to the purpose of this work. The activities were mostly related to the use of SimReal+ to teach trigonometry, but also other mathematical concepts. Table 1 gives an overview of the teaching activities over a period of three weeks.

Table 1. Teaching activities

Teaching activity	Teaching aids	Subject	Date	Duration
Lecture	• Video lecture	• SimReal+ User Interface • 2D calculator	Week 33	45 min
Lecture on mathematical tasks with SimReal+	• Teaching material • SimReal+	• Introduction to SimReal+ • Visualizations and simulations of trigonometric functions and concepts	Week 34	3 hours
Exercises using SimReal+	• SimReal+	• Simulations of trigonometric functions and other similar tasks	Week 34	2 hours
Lecture on SimReal+ and programming	• SimReal+ • ActionScript	• Introduction to programming • programming mathematical functions using ActionScript	Week 35	3 hours
Tasks and exercises using SimReal+	• SimReal+ • ActionScript • Diverse teaching material made online	• Students explore the program *Moving a particle - Drawing a graph* • Students investigate the *Pythagoras theorem, conic section, properties of triangles, cycloid,* and *3D figures*	Week 35	2 hours
Lecture on evaluation issues	• SimReal+ • Survey questionnaire	• Evaluation of SimReal+ using a questionnaire with 73 statements grouped in 5 groups of criteria	Week 36	1-2 hours

The teaching activities included video lectures, simulations of mathematical trigonometric functions, programming visualizations using ActionScript, and diverse teaching material, such as Pythagoras theorem, conic section, properties of triangles, cycloid, 3D figures, and similar mathematical functions. To measure the students' responses, the survey questionnaire used a five-point Likert scale from 1 to 5, where 1 was coded as the highest and 5 as the lowest (1="Strongly Agree"; 2 = "Agree"; 3 = "Neither Agree or Disagree"; 4 = "Disagree"; 5= "Strongly Disagree"). The average score (MEAN) was calculated, and the responses to open-ended questions were analysed qualitatively. The survey included 73 items that were distributed as follows: Technical usability (12 items), pedagogical usability (24 items), mathematical issues (16 items); assessment (12 items), and teacher education (11 items). The students were asked to comment each of the statements in their own words. In addition, the students were required to address 5 open-ended questions to express in their own words what they think on different issues of SimReal+.

5. RESULTS

The students' responses to the survey questionnaire are described for the five broad categories that emerged from the evaluation criteria, and for supplementary issues that were addressed by open-ended questions.

5.1 Global Impression of SimReal+

First, the students were asked to express their opinion on SimReal+, and what they globally liked and disliked about the tool. Basically, most respondents reported both positive and negative aspects of SimReal+: "*It seems like a good program. I like that it is free and easy to use. So you can use it when you want. Sometimes it can be a bit hard to find your way around"*. Some students were more critical as the following comment indicates: *"I think it is confusing. It has too many options that are poorly linked together. It could learn a lot from "Mastering physics", in terms of more linear, logical structure and better feedback assessment. (...) I really like a teachers' opportunity to program (...) and add new graphics."*

5.2 Technical Usability

Most students were globally satisfied with the technical usability in terms of easy-to-start, management facilities, availability of mathematical content and exercises, quality of video streaming and calculator, and accessibility of the tool anytime and anywhere as this students' comment indicates: *"It is not all that difficult for first timer to use SimReal+ due to the information provided to make mathematics easy"*. In contrast, students were not satisfied with the technical usability in terms of ease-of-use or user friendliness, navigability, response time, as this comment clearly reveals: *"Everything does not work for me. I got confused. The long lists of lessons/exercises/ simulations in the rightmost window made it hard to focus attention to a specific task. Pre-made simulations and demonstrations worked well for illustration, but the visualizations that the activity should give, e.g. that Pythagoras' theorem is seen to be true, was not clear to me. The intention was clear, but I don't think the user will readily gain anything."*

5.3 Pedagogical Usability

In terms of pedagogical usability, the students agreed that SimReal+ provides various mathematical activities and multiple representation of mathematical content, and that SimReal+ can be used as a lecture and textbook supplement. Concerning motivational issues, many students think that the tool is motivating to do mathematics with, as this comment shows: *"Especially for mathematics interplay with physics, SimReal+ served as a good motivation and demonstration. However, motivation derives not only from an experience of «..., this is useful/beautiful», but also from one's own development of capabilities to make mathematics useful/beautiful. This latter element of motivation was not offered by SimReal+, so I only felt the brief sense of wonder, not of achievement and skillfulness"*. Furthermore, many students think that SimReal+ contains multiple levels of difficulty and provides opportunities for the teacher to make individual adjustments if necessary. However, the tool does not easily allow students to customize the tool. Nevertheless, the tool enables students to work at their own pace, which is a motivational factor in keeping students engaged in mathematics, as this comment reveals: *"I think this is the greatest advantage of SimReal+ the opportunities for adjustment and individualization. The teacher knowing a little programming (as should all upper secondary teachers in my opinion) can rather easily make small addition and alterations to a pre-programmed lesson, so it fits his needs: add a second particle, hiding/showing the kinematic (...) equations, etc."*. Moreover, most students think that SimReal+ does not fully allow to work independently from teacher assistance or fellow students. Also textbooks are still needed when using SimReal+ in classroom: *"Autonomous learning is not well-supported, only autonomous playing around without goal. And* *for the purpose of playing with mathematics, there were too few options for the student, (….), and mostly teacher-chosen and implemented possibilities/options".* Furthermore, most students agreed that SimReal+ is not fully appropriate to use as an alternative to achieve variation in teaching mathematics as this comment clearly shows: "*The problem as I see it is that there is no clear-cut connection between the variations of a specific topic or notion. For example, changing the parameters in a wave function, (...) and its exact correlation with the graph, (….), but such things are not in any way implemented in SimReal+."*

5.4 Assessment Issues

Most students indicated that SimReal+ does neither provide a diagnosis of student's problem solving nor appropriate feedback that is adapted to the students' knowledge level. In addition, SimReal+ does neither build student profiles nor serve up appropriate questions or several questions to the students. Furthermore, SimReal+ does neither have a review mode showing what the student has done wrong or right, nor allow for the use of several question types. The lack of student profiles may prevent students from engaging in authentic learning activities with SimReal+. Hence, it is obvious that the role of the teacher is still important in assessing the students' learning of mathematics. The following comment summarizes the limitations of SimReal+ in terms of assessment: *"SimReal+ is very weak with respect to feedback. I experience no feedback or assessment of any work or exercises."*

5.5 Mathematical Issues

More than the majority of the students believed that SimReal+ has a good quality of mathematical content in terms of mathematical correctness and representation of mathematical properties and operations, e.g., formulas, functions, graphs, and geometrical figures. A typical comment was: *"SimReal+ is rich in mathematical content. It gives systematic procedure for solving a particular problem in mathematics. It is able to translate algebraic expressions into graphs or geometric figures, etc. The video and audio visual aspect of the software enhances deeper understanding of mathematical concepts".* However, the practical applications and exercises are not fully well-designed as this comment indicates: *"The exercises were too general, not specifically focusing on some mathematical learning object. For example, the most focused exercise was about changing angles into radians and vice versa. The connection was very well visualized on the unit circle, but there weren't added any techniques to do the calculations. (...) The exercises were well-formulated but they were too focused on visualizations done by the program with no connection to paper-pencil work or text book theory".* Furthermore, SimReal+ is useful when it combines video lessons, simulations, live streaming of lessons, and exercises. It helps to acquire new mathematical knowledge, and in a lesser degree, it is congruent with paper-pencil techniques. SimReal+ also provides opportunity to help students gain knowledge that is otherwise difficult to acquire. In addition, the tool's openness enables students to express mathematical ideas. The negative side of SimReal+ is that students do not like programming mathematical visualizations. They prefer focusing on the mathematical part of the program, which is more important than understanding programs written in Action Script as this comment expresses: *"Maybe for the students, but they don't need all the programming stuff, just an interface where mathematical properties can be approached. (...) For the teacher, I think it is essential that he/she understands the programming enough to make non-trivial changes such as adding (...) a button with a new function."*

5.6 Adaptability of SimReal+ to Teacher Education

Most students think that SimReal+ could be an appropriate tool in secondary schools, but not in middle or primary schools. SimReal+ also enables teachers to concretize the curriculum. However, when asked whether they will continue using SimReal+ for teaching mathematics, most of them answered negatively as this comment clearly reveals: *"I will use SimReal+ to further develop an illustration of a phenomenon in my teaching but only for illustration, not interactive student activity."*

5.7 Flipped Classroom

The students were asked whether flipped classroom will be of interest and whether new digital tools can give students new possibilities in teaching mathematics. Most students agreed that flipped classroom is of huge interest, but *"(...) we need to focus and stop believing that just planning around will result in learning. We need strictly directed lessons that allow for continuous interchanging of visual illustrations, theoretical presentations, exercise solving, etc. In short, digital tools could help us in writing the classroom activities that have traditionally been separated in time and space. (...) Flipped classroom also is very interesting but needs highly motivated students.*

5.8 Programming Visualizations

The students were asked in what way do they think programming mathematical visualizations by their own will help them in understanding mathematics if they can use different templates so the concentration can be on mathematics and not on difficult details in the programming process. As mentioned earlier, students prefer focusing on the mathematical part of the program rather than programming. Most students agreed that templates can help to concentrate on the mathematical part, but *"(...), I need very specific templates focusing on illustrating a specific notion, e.g. the kinematic equations of cycloid (....), so I need to know in advance rather precisely which properties I am investigating.(...).* The developer of SimReal+ is planning to design such templates so that students can be able by their own to program mathematics (elementary and advanced visualizations and simulations) directly into their own Web pages without any special tool. They just need to write their own mathematical code. Most students like the idea of using templates, as this comment clearly highlights: *"I think it is great. I think there should be a clear distinction in the programming interface whether you are implementing graphics mathematical properties, exercises and theory (....). Then you can access more readily different settings that a visualization or simulation should offer to a student using it."*

5.9 Suggestions for Improvements

Finally, the students were asked to provide suggestions to make SimReal+ more appropriate for use in teacher education. Perhaps, the most interesting suggestion is expressed by the following comment: *"Focus. It tries to do everything, but really only presents a fragmentary list. Technologically, it needs a more directed structure such that one task leads to the next in a logical way, not just present an array of tasks. (...) Mathematically, it must connect the different settings graphical, algebraic, tabulator, arithmetic, geometric, etc. Assessment-wise, it must offer feedback to the implemented exercises."*

6. CONCLUSION AND RECOMMENDATIONS

The number of participants (*N=22*) may not be sufficient to adequately support the generalization of the results. Hence, new cycles of experimentations and evaluations of SimReal+ are warranted to generalize the findings of the present work to ensure more validity and reliability. However, despite the limitations of the study, it has been possible to make some reasonable interpretations of the results and draw some recommendations for using SimReal+ in teacher education. Firstly, the use of SimReal+ indicates that the tool shows potential for teaching mathematics that is suited to the students' knowledge level, although not all criteria are equally met. Secondly, SimReal+ is technically well designed in terms of accessibility and management facilities. Furthermore, SimReal+ covers a wide range of mathematical content with varied levels of difficulty, including school mathematics. Likewise, the content is mathematically correct and reflects the underlying properties of mathematics at different levels. However, mathematical and technical issues in themselves are not sufficient to make SimReal+ become an integral tool in learning and teaching mathematics in a school environment. SimReal+ is not pedagogically well designed to ensure a smooth integration of the tool in teacher education in terms of variation, student autonomy, differentiation, and individualisation, and assessment issues as well. Hence, SimReal+ in its present form is not fully appropriate for use in teacher education, unless didactical functionalities and pedagogical modalities of using SimReal+ are considered in future versions of the tool. Likewise, the user interface must be simplified to make SimReal+ more intuitive and easy to use in teacher education. Summarizing, the use of SimReal+ in teacher education needs to take into account the pedagogical dimension of teaching and learning mathematics in order to adapt the tool to the modalities of using digital tools in teacher education.

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PREDICTING THE RISK OF ATTRITION FOR UNDERGRADUATE STUDENTS WITH TIME BASED MODELLING

Kevin EK Chai[2] and David Gibson[1,2]
[1]*Curtin Teaching and Learning*
[2]*Curtin Institute for Computation*
Curtin University, Perth, Australia

ABSTRACT

Improving student retention is an important and challenging problem for universities. This paper reports on the development of a student attrition model for predicting which first year students are most at-risk of leaving at various points in time during their first semester of study. The objective of developing such a model is to assist universities by proactively supporting and retaining these students as their situations and risk change over time. The study evaluated different models for predicting student attrition at four different time periods throughout a semester study period: pre-enrolment, enrolment, in-semester and end-of-semester models. A dataset of 23,291 students who enrolled in their first semester between 2011-2013 was extracted from various data sources. Three supervised machine learning techniques were tested to develop the predictive models: logistic regression, decision trees and random forests. The performance of these models were evaluated using the precision and recall metrics. The model achieved the best performance and user utility using logistic regression (67% precision, 29% recall). A web application was developed for users to visualise and interact with the model results to assist in the targeting of student intervention responses and programs.

KEYWORDS

Attrition, retention, student, prediction, machine learning.

1. INTRODUCTION

The student retention rate is a measure of student success used by many universities. Measuring student retention is important because it can reveal how well a university is able to retain students based on the quality of education, research and services provided (Kim 1998). Improving student retention is a highly desirable and challenging goal for universities as a declining student population can significantly affect current and future students, instructors, researchers, professional staff and the university as an institution (Ifenthaler and Widanapathirana 2014, Kovacic 2012, Murtaugh et al. 1999, Olani 2009).

There has been a long history of research into studying and building models concerning student retention and attrition (Braxton 2000, Reason 2009). The most significant benefit of developing such models is to enable student support staff to proactively conduct interventions to assist and retain at-risk students. This can result in other benefits such as improved student graduation rates, better support for students and increased university revenue depending on the quality of the predictive model and student interventions.

There are two primary challenges involved in developing a first year student attrition predictive model. First, predictive models need to be developed under rigorous experimental settings for training, validating and testing the model's prediction performance on historical student data. Second, if the model is used to generate predictions at different points in time during a student's time at university, the model can only be trained with data available at these respective points in time. For example, a model predicting a student's risk of attrition at the beginning of their first semester cannot be trained on data that is only available after they have completed the semester. The risk of attrition is defined for this research study as the likelihood of a student leaving the university in the following year.

This paper reports on several research contributions. First, a taxonomy of common student attrition and retention features is synthesised from the literature. Second, the problem definition describes different ways student attrition can be defined and formally defines the problem of predicting student attrition in this paper. Third, a student attrition model is described that contains features from four different time periods through a university student's first semester of study. Fourth, the settings of the experiment in terms of workflow, machine learning methods and performance metrics used to develop and validate the predictive model are outlined. Last, the results from our experiments are presented and the insights gained from the research are discussed.

2. TAXONOMY

Student attrition and retention research literature was reviewed and a taxonomy of common student attrition features was developed (Table 1). Many of these research papers evaluate features from multiple categories. Demographic (Bogard et al. 2011, Moller-Wong and Eide 1997, Yu et al. 2010) and academic history (Kovacic 2012, Luna 2000, Olani 2009) were the most common studied features, in particular age, gender, ethnicity and high school grades were evaluated by the majority of the papers. Social (Dey and Astin 1993, Kim 1998), psychological (McKenzie and Schweitzer 2001, Olani 2009) and financial (Dey and Astin 1993, Reason 2009) features were less common.

The university category represents features evaluated after the student has enrolled and commenced studying. This category comprises of six subgroups containing enrolment (Bogard et al. 2011, Fike and Fike 2008), course (Lin et al. 2012, Murtaugh et al. 1999), units (Dekker et al. 2009, Kim 1998), resource use (Balakrishnan and Coetzee 2013, Dietz-Uhler and Hurn 2013), engagement (Glogowska et al. 2007, Murtaugh et al. 1999, Xuereb 2014) and during study features (Bogard et al. 2011, Dekker et al. 2009, Kovacic 2012). Measuring the usage of university resources such as the LMS, library and video lectures is less common in the literature but will likely receive more attention due to the popularity of delivering digital education and Massive Open Online Courses (MOOCs) in recent years.

Table 1. Taxonomy of Student Attrition Features

Category	Examples	# Sources
Demographic	Age, gender, ethnicity, living on campus, has children, parents' education, has disability, experience working in study area	11
Social	Hours spent socialising with friends, exercising, engaged in sporting teams, volunteer work, hobbies	2
Psychological	Personality traits, self-esteem, commitment to chosen profession, informal / formal support, GRIT (12 question survey)	4
Financial	Household income, requires financial aid, currently working	6
Academic history	High school grades, high school rank, public vs. private high school, other qualifications (previous diplomas, degrees)	12
University		
- Enrolment	Enrolled in first preference course, enrolled before course start date, language tests taken, reason for attending university	5
- Course	Difficulty (pass rate), student has chosen a major / specialization, attendance mode, load type, field of study	7
- Units	Number of units enrolled, number of contact hours, average pass rate, unit type, quality of lecturer, quality of lecturer feedback	4
- Resource use	Library, learning management system, lectures e-mail	2
- Engagement	Student survey participation, student clubs / groups membership, enrolled in educational support programs	3
- During study	Current course average, number of units the student is currently failing, attended hours, units passed, units failed	5

3. PROBLEM DEFINITION

There are many variations in defining the risk of student attrition at universities determined by stakeholder perspectives and needs and the time period for the desired prediction (Table 2). For example, a predictive model could be developed for a unit coordinator to identify students who are at-risk of withdrawing from their units this year. Alternatively, another model could be developed at the faculty level to identify students at-risk of changing courses outside the faculty in the next semester.

Table 2. Student Attrition Definition Factors

Stakeholder	Enrolment	Desired prediction time period
Unit coordinator	Unit	This semester
School	Course	Next semester
Faculty	University	Next year, 2 years, 3 years etc.
Institution		Student life-time

The problem of predicting student attrition is formally defined as a binary classification problem. The dataset can be described as a set of students $S = \{s_1, s_2, \dots, s_i, \dots, s_n\}$ and an attrition label $Y = \{y_1 = retained, y_2 = attrition\}$ where s_i represents the i-th student in S. Students are represented as a set of student attrition features (factors) x^i in the model as defined for s_i.

$$s_i = x^i = \{x_1^i, x_2^i, \dots, x_j^i, \dots, x_m^i\}$$

$\phi(x^i, y_k)$ is a Boolean function that is used to determine whether s_i belongs to y_k where $k = \{1, 2\}$.

$$\phi(x^i, y_k): X \times Y \rightarrow \{True, False\}$$

This definition can be applied to predict student for different factor mappings (Table 2). The focus of this research is to develop a model for predicting student attrition for the institution stakeholder, at the university enrolment level and the desired prediction time of next year.

4. STUDENT ATTRITION MODEL

A conceptual model for predicting student attrition was developed after reviewing student retention / attrition research papers in the literature, discussions with domain experts and academics, identifying available student data from university data sources in addition to proposing new features based on our knowledge gained through this process. The feature types used in the conceptual model in relation to the proposed taxonomy (Table 1) are demographic, academic history, enrolment, course, resource use, engagement and during study features.

An initial set of 28 features are evaluated in a set of experiments based on the feasibility of extraction and data handling during the time available for the research. The data system of the university is being built for future automated extractions that will utilise these research findings and will allow more features to be included in the model. Due to these considerations, the research scope is restricted to only evaluating student data in their first semester of study.

However, a student's risk of attrition is likely to change over time as more data becomes available on how the student is progressing throughout the semester. Therefore, the study evaluates four models using features that are available at four different time periods in the semester. These models are the pre-enrolment model, enrolment model, in-semester model and end of semester model (Table 3).

The pre-enrolment model includes features that can be used to predict a student's risk of attrition before they commence studying at university. This model contains 17 features based on a student's demographics, academic performance at high school as well as whether a student has participated in the university enabling program or has taken bridging units at the university college as an alternative pathway of entry.

The enrolment model contains an additional 5 features based on data collected from the student enrolment process such as their age at enrolment, the workload of the course (course credit value), whether they are studying on campus or externally (attendance mode), their field of study and whether they are studying full-time or part-time (study load type). This model can be used to predict a student's risk of attrition after a student has completed their enrolment at university.

Table 3. Student Attrition Model Features

#	Pre-enrolment	#	Enrolment
1	Gender	18	Age at enrolment
2	Birth country = Australia	19	Course credit value
3	Birth country region	20	Attendance mode
4	Home language = English	21	Field of study
5	Aboriginal or Torres Strait Islander	22	Study load type
6	Citizenship		
7	Has disability		
8	Western Australia metropolitan status	#	In-Semester
9	Socio economic status	23	LMS logins
10	High school / tertiary entrance score	24	Portal logins
11	Course preference number		
12	High school type		
13	Highest education qualification	#	End-of-Semester
14	Elite athlete	25	Course average
15	University enabling program participant	26	Surveys completed
16	Completed university college program	27	Units completed
17	First in family	28	Units withdrawn

The in-semester model contains an additional 2 features that measure a student's usage (i.e. logins) of the university's Learning Management System (LMS) for accessing course materials and submitting assessments as well as the university's student portal for accessing official communications and other university student Web applications. This model can be used to predict a student's risk of attrition at different points in time during the semester.

The end-of-semester model contains an additional 4 features that measure the student's academic performance at university in terms of their end of semester grade (course average), whether the student participated in teacher and unit feedback surveys in addition to the number of units completed and withdrawn for the semester. This model can be used to predict a student's risk of attrition after they have completed their first semester.

5. EXPERIMENTAL SETTING

The experiment comprises of nine main tasks (Figure 1): feature extraction, feature normalisation, feature encoding, cross validation, feature selection, model training and tuning, prediction, performance evaluation and error analysis. These tasks will now be described in detail.

The dataset is comprised of 23,291 students who commenced their first semester at Curtin University, Australia between 1 Jan 2011 and 31 Dec 2013. This data was extracted from various university systems and data sources such as student administration, business intelligence, LMS, student portal, unit and teacher feedback surveys, university enabling programs and college student records in addition to external sources containing student tertiary entrance scores and preferences as well as Australian census data. After data cleansing and preparation, the dataset consists of 19,222 (83%) retained and 4,068 (17%) attrition students.

Feature extraction acquires the data required for the model features in addition to calculating the student attrition labels (based on definition in Section 3) used for training, validating and testing by the predictive models. Feature normalisation refers to mapping feature values into a new numerical range such that the relative magnitude is preserved. Normalisation is important because it avoids modelling features in larger numeric ranges that can dominate features in smaller ranges. It is also more computationally and memory efficient to perform computations on smaller scaled values than larger data values (Tax and Duin 2002). The features are normalised to a scale of [0, 1] in the experiments.

Data discretisation involves portioning feature values into ranked intervals or bins. Each interval is then treated as a categorical value. Discretisation has been shown to improve classification performance (Dougherty et al. 1995, Fayyad and Irani 1993, Kotsiantis and Kanellopoulos 2006, Liu 2007). The resulting full model comprises of 146 encoded features selected after experimenting with various feature discretisation and encodings to optimise prediction performance.

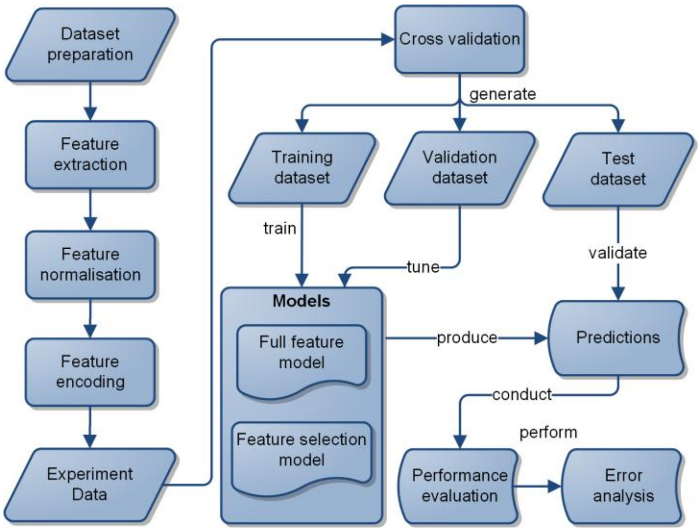

Figure 1. Experimental workflow

A stratified 10-fold repeated random sub-sampling validation cross-validation technique (Liu 2007) is applied for this project. Students are randomly assigned into a training (60%), validation (20%) or test (20%) dataset. This assignment is performed 10 times in a stratified manner to generate 10 different training, validation and test datasets. Stratified means that the class distribution of retained (83%) and attrition (17%) students are preserved in each dataset. Therefore, 10 different predictive models are built for each dataset and their results are averaged to measure overall performance.

Feature selection is the process of selecting a subset of the most important features for use in model construction. Recursive Feature Elimination with Cross-Validated (RFECV) selection is employed to identify the best feature subset in addition to applying L1 regularisation (Lee et al. 2006) for logistic regression. Decision tree and random forest employ embedded feature selection by design as only the most important features are used to construct the tree(s).

With respect to predictions (Kotsiantis and Kanellopoulos 2006) reviewed a number of candidate supervised machine learning techniques and their suitability based on different factors. The aim of the student attrition model is to achieve strong prediction performance, where insights can be understood and assist student support staff in prioritizing the various risks of attrition within their workload of tailoring student interventions. Based on this aim, the model employed three supervised learning techniques: L1 regularised logistic regression (Cox 1958, Lee et al. 2006, Walker and Duncan 1967), decision trees using the CART algorithm (Breiman et al. 1984) with the Gini impurity criterion and random forests (Breiman 2001).

Precision and recall metrics are used to evaluate the performance of the predictive models. Precision measures the percentage of students the model correctly predicted as attrition. Recall calculates the percentage of at-risk of attrition students correctly identified from the test dataset. These metrics are more effective at assessing performance on imbalanced datasets than alternative metrics such as classification accuracy and receiver operating characteristic (Davis and Goadrich 2006).

Error analysis is an iterative process of evaluating the model errors to gain insights in further improving the model. Learning and validation curves are constructed to evaluate the model on the training and validation datasets. These curves allow for the identification of model bias and variance in addition to evaluating the effectiveness of model tuning tasks. A web application was developed to visualise and interact with the model results.

6. RESULTS

The end-of-semester model comprises of 28 features transformed into 148 encoded features. Furthermore, the in-semester model is split into four additional time periods from weeks 1-4, 1-8, 1-12 and 1-17. The purpose

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for experimenting with these time periods is to determine how model performance changes as more student data is collected throughout the semester study period.

The experimental results for the time based model and each machine learning classifier are presented (Figure 2). Random forests achieved the top precision (0.30-0.71) after the in-semester weeks 1 to 4 period and intermediate recall performance (0.08-0.33). Logistic regression achieved the top precision (0.46-0.67) for the pre-enrolment and enrolment time periods and the lowest overall recall performance (0.01-0.29). Decision trees achieved the top overall recall [0.08, 0.37] but lowest precision performance [0.27, 0.60]

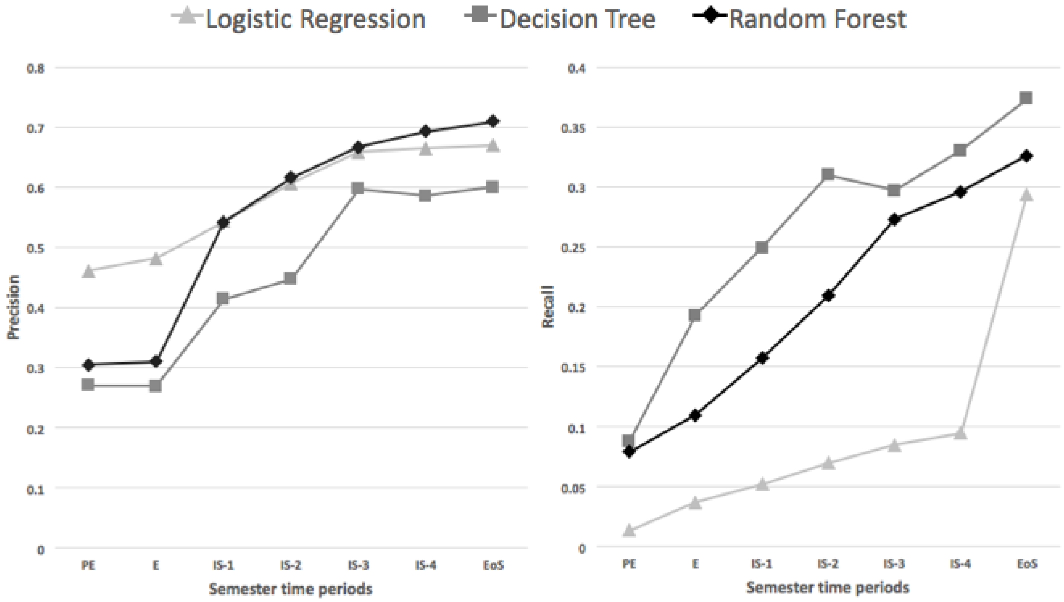

Figure 2. Experimental Results

The experiments show that the end of semester model achieved the best performance, underscoring the expectation that classifiers should achieve better performance as more data is obtained (Figure 2). In terms of overall performance, decision trees achieved the best recall but logistic regression and random forests achieved better precision. Logistic regression outperformed random forests in terms of precision for the pre-enrolment and enrolment models but achieved relatively on-par performance with the in-semester weeks 1 to 4 models, which suggests that that logistic regression might be better suited for predicting student attrition for these semester time periods. Conversely, random forests outperform logistic regression for the remainder of the semester. In practice, one would likely decide upon using one of these models based on other non-performance factors as they have achieved relatively similar precision results.

The model features have different values of importance and strength for each of the time period models and machine learning methods. Overall, the most important features that significantly improved prediction performance are; the course average, LMS logins, portal logins, study load type and course credit value. The other model features make small contributions that are significant when added together. The strength (coefficients) of the encoded features are not presented due to length constraints.

The recursive feature elimination and cross validation feature selection method was used in parallel to training the logistic regression model with the full feature set. In our experiments, the feature selection model often achieved on par and improved performance compared to using the full feature model on the validation datasets. However, this result was not reflected when the models were evaluated on the unseen test datasets as the feature selection models achieved overall lower performance to the full feature model. The training and validation of the full feature model is not computationally intensive so it is used rather than the feature selection model for generating predictions on current Curtin University students.

The two best performing classifiers in terms of precision are logistic regression and random forests. However, it is easier to extract useful insights and examine the logistic regression model than random forests. We can evaluate the coefficients of each feature and identify the top scoring attrition and retention features for individual students with logistic regression. For example, one student may have their low course average score as their highest contributing feature to attrition while another student with a higher course average may have their age at enrolment group (e.g. 40-49) as their highest risk of attrition feature.

Random forests involve building a number of decision trees (10 in our experiments) and averaging the predictions from these trees. Therefore, it is more difficult to explain and visualise how predictions are made from 10 different decision trees. Therefore, logistic regression is recommended over random forests as it achieved similar precision performance but is easier to understand, extract insights and plan student interventions. A web application was developed to visualise the logistic regression model has been made available to university student support staff (Figure 3).

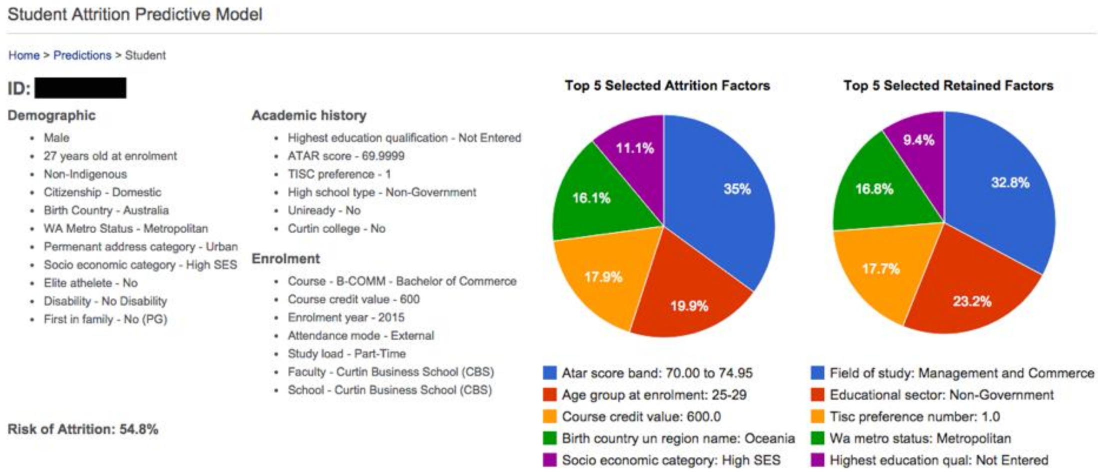

Figure 3. Interactive Model Results Visualisation

7. CONCLUSION

This study developed a student attrition model that predicts a student's risk of attrition at different time periods in their first semester: the pre-enrolment, enrolment, in-semester and end-of-semester periods. The model performance was validated on university students who enrolled in 2011-2013. Three supervised learning methods were evaluated; logistic regression, decision trees and random forests. Logistic regression and random forests achieved the best precision performance on this dataset and based on considerations of ease of use and fitness for purpose, a web-based interface was constructed using the logistic regression model, due to its relative ease in extracting insights to assist university staff in understanding and planning student retention interventions. Future work will involve experimenting with additional features such as student assessment data from the university's LMS to further improve the model and to build a dedicated data exploration environment to make university data more readily available for building, refining and validating predictive models. Next steps also include reviewing and understanding the implications of the predictive methodology on retention policy, practices and technologies in a university span with a wide range of potential changes to business practices, policy concerns and practical implementation issues.

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INSIDE THE DIGITAL WILD WEST: HOW SCHOOL LEADERS BOTH ACCESS AND AVOID SOCIAL MEDIA

Laurie Corrigan and Lorayne Robertson
University of Ontario Institute of Technology, Ontario, Canada

ABSTRACT

This study examines the roles of Canadian school leaders in response to the rising phenomenon of student use of social media which impacts school climate and safety. The use of social media has resulted in more online text and image-based communication to multiple users and less face-to-face communication with single users. Adolescent communication, a previously invigilated phenomenon, has not yet been replaced by an online *social presence* with a *social regulation*. Secondly, there have been changes in national, provincial, and district Safe School policies in response to online misbehaviour that impacts student safety within the school environment. This small study considers the views of nine Canadian secondary school vice-principals about school policies and students' cyber behaviours. Their responses were collected on a NING, a private cyber environment. Findings indicate that when cyber events come to the awareness of the school administration, the school becomes a nexus for investigation and resolution. The study also finds that when Canadian secondary school administrators are compelled to respond to the event, these school leaders can and do access social media, employ cyber skills to identify users, intervene in wrongdoing and, in the process, follow and enact Canadian Safe School legislation. However, these same school leaders express great reluctance to use social media for their personal or professional purposes. The authors hypothesize that this may be due to their exposure to negative experiences with social media in schools.

KEYWORDS

Safe School policy, cyber behaviour, social media

1. INTRODUCTION

Online correspondence occurs at a distance – allowing a sender to be geographically and physically located a distance away from the receiver. With the introduction of handheld devices, users may also be young adults, adolescents, or children sending messages to multiple people without the awareness or consent of a supervising adult. Both social presence and regulation are impacted. Unfortunately, these online activities may involve a range of cyber-misbehaviours which can result in loss of privacy, loss of identity, and cyber-bullying. Cyberbullying is an international phenomenon that is increasing, and teachers are not able to respond or feel they are adequately prepared to deal with these events, particularly since they often occur outside of the school day (McNamara & Moynihan, 2010).

In Canada, Safe School policies which are designed to respond to issues such as bullying and cyberbullying, fall under the purview of each of the thirteen provinces and territories. One of these provinces, Ontario, has recently passed legislation: Bill 13, *the Accepting Schools Act* (Legislative Assembly of Ontario, 2012) which enables administrators to investigate and respond to these online contraventions of Safe School policy. This legislation requires schools and specifically school administrators, to address harassment, bullying, and discrimination in all forms, including online misbehaviour which occurs outside of school hours but impacts student-to-student relationships.

This study uses qualitative methodology to examine secondary school vice-principals' responses to incidents of cyberbullying over a six-week period using a private social media network, examining the roles of social presence and restorative practices in their responses to incidents of cyber aggression and online bullying. Social presence, earlier theorized in the context of building community in online teaching (Aragon, 2003) theorizes the separation or isolation of the online user. Rettie (2003) sees social presence as the judging of the perception of the other online participant. Schools are sites where cyber behaviour is investigated and attempts are made to resolve the conflicts. Little is known about the lack of social presence in cyber-behaviours and its effect on school climate. This study expands our understanding of social presence where its absence may contribute to cyberbullying and its presence may be seen as a means to redress the wrongs.

Findings from this study indicate that school leaders recognize that school is a connection space for students, and they feel a strong sense of obligation to keep students safe, including during events that occur online and out-of-school. One unintended repercussion of the school leaders' online investigations, however, is that they tend to avoid social media for their personal and professional use due to its negative associations.

2. RESEARCH ON SCHOOLS AND CYBERBULLYING

The rise of online communication has implications for schools such as cyberbullying and its impact on school climate. Another area it impacts is policy. There are multiple policy responses to be considered in the Ontario, Canada legislative context. Theory related to social presence and social regulation also contributes to the deliberations and discussion in this paper. Although one research study cannot address every implication of social media use in schools, the authors endeavour to shed a light on the specific insights of a small group of Canadian school leaders who are working with new policies to help students be more aware of the impact of their actions on themselves and others.

2.1 Schools and Cyberbullying

Adolescents have access to new communication technologies all of which can establish instantaneous and anonymous communication, and are increasingly simple to operate. Simultaneously, there has been a rise in bullying and cyberbullying which now impact adolescents and this type of online aggression is perceived to be increasing (Calhoun & Daniels, 2008; McNamara & Moynihan, 2010). The examination of this issue has been identified as a "relatively new and emerging field of research" (Cassidy, Faucher, & Jackson, 2013, p. 576). Research from multiple countries indicates that cyberbullying is an international phenomenon and that schools are seen to bear some responsibility for responding to bullying and online aggression (Boulton & Mirsky, 2006; Calhoun & Daniels, 2008; Grossi & dos Santos, 2012; Hasenstab, 2012; Mark & Ratliffe, 2011; McNamara & Moynihan, 2010).

Education law and policies also recognize that schools have a role in responding to negative cyber phenomena. Ontario, Canada has published a series of policy responses in the past fifteen years toward promoting Safe School environments. Bill 81, (Legislative Assembly of Ontario (LAO), 2000) not only gave teachers the authority to suspend students, it required teachers to do so and gave teachers the right to extend suspensions issued by the principal. This legislation was modified in 2007 with Bill 212 through an amendment to the Education Act with respect to behavior, discipline and safety. Bill 212 required offenses of bullying to be mandatory suspensions of up to 20 days but also allowed school leaders to consider mitigating factors (LAO, 2007, S306 (3)).

Most recently, Bill 13, the *Accepting Schools Act, 2012* (LAO, 2012) amends the Education Act, separating definitions of bullying and cyberbullying and holding schools accountable for dealing with issues surrounding both offenses. This *Act* also requires schools and districts to create and enforce equity and inclusive education policies, and bullying prevention and intervention plans. School leaders must take active measures to ensure a positive school climate. This *Act* also adds more protection for victims' rights and stricter protocols for confidentiality in light of increased occurrences of online conflict (LAO, 2012).

In summary, school administrators have a legislated responsibility to maintain a Safe School environment and respond to incidents of harassment and discrimination if they impact the safe school culture. In both policy and practical terms, school is a *nexus* where the implications of 24/7 cyber events are manifest. School leaders are also ideally situated to access online communications to investigate incidents and to meet with students and their parents in a setting familiar to both. For these multiple reasons, schools are considered to be well-situated to respond to bullying and online aggression.

2.2 Social Presence Theory

Technologies such as the telephone started to change aspects of face-to-face communication. Short, Williams and Christie (1976) defined social presence at that time as the "degree of salience of the other person…and the consequent salience of their interpersonal interactions" (p.1). When Korzenny (1978) observed that face-to-face interactions were being replaced by electronic devices which altered long-established social patterns, he coined the term "electronic propinquity" to describe the changes in proximity when experiences became less direct than in person. Walther (1992) examined early studies on changes in the relational aspects of computer-mediated communication. He found that social connectedness took more time in the computer-mediated settings; the degree of connection was affected by the type of technology in use. Korzenny (1978) and Walther (1992) pioneered theory in *social presence*.

A key consideration in online learning theory is building community for distance learning (Aragon, 2003; Garrison, Anderson & Archer, 2000; Hege; 2011; Korzenny, 1978; Rettie, 2003). Definitions of social presence usually include some reference to the subjective perception of participants to other participants, sometimes in the context of learning communities. However, little research makes connections among social presence, social media, and school-based responses to cyber-behaviours. We hypothesize that, through legislation and predisposition, schools offer spaces where community and social presence can be re-built using restorative practices.

Aragon (2003) theorizes that interpersonal contact is more difficult to establish in the online setting because it affects proximity, eye contact, body language, and interpersonal awareness. Rettie (2003) sees social presence as a judgement of how the other participant perceives the communication or the event, including cognizance of the other person and their intention.

Deng & Tavares (2013) link social presence to student motivation, finding that students report feeling more at ease and casual on Facebook, with more connectedness and belonging. Hege (2011) cautions instructors to have a second Facebook account for professional purposes only. Facebook may increase social presence through immediate feedback and its "likes" function, while Moodle seems more formal, with less regulating instructor influence (Deng & Tavares, 2013). Social presence has also been described as the ability of online users to project their individual (personal) characteristics into the online community "real people" (Garrison et al., 2000, p. 94). Multiple researchers (Walther, & Bazarova 2008; Yamada & Goda, 2012) identify that social presence adds subjective qualities to online environments such as support for co-operative learning (Oyarzun & Morrison, 2013), building enjoyment, and virtual roles (Yeh, Lin & Yu, 2011).

Little attention to date has focused on the impact of the lack of social presence or gap in time to build social presence which may be occurring in cyberbullying and online conflict in schools. More studies are needed to understand how individuals operate within the anonymity of the online world. We theorize that a lack of social presence or time to develop social presence contributes to the negative quality of peer-to-peer digital communications, which can be corrected through person-to-person resolutions.

This research study examines the re-creation of social presence and regulation and the roles that administrators can play to help students understand relational issues created by or impacted by cyberbullying and online conflicts. This particular paper focuses on aspects of the study which reveal how secondary school administrators use social media to investigate and respond to online conflicts and cyberbullying, and how, in this process, they help increase social presence and social regulation. This study also investigates how administrators use social media for professional purposes such as investigating and documenting events of cyber harm.

3. METHODOLOGY

This study employs essentially qualitative methodology, including an online survey for the participants and collection of their perceptions about cyber incidents through a NING, which is a private blogging site. The Limesurvey was chosen as it is considered to be a trustworthy source of the anonymous data collection (Klieve, Beamish, Bryer, Rebollo, Perrett, & Van Den Muyzenberg, 2010). The quantitative questions in the survey included questions based on gender, age, years of experience, understanding of policy legislation, and familiarity with technology.

3.1 NING as Repository

An online private social network (NING) was used to collect the qualitative research. The NING requires a private login and password. The NING acted as a repository of information that captured the story-like experiences of the vice-principals and, it was hoped, would foster online discussion among the vice principals who could access it 24/7. Questions were asked that were intended to elicit their knowledge of and response to online aggression and cyberbullying as well as their understanding of relevant legislation in the context of their roles. Of added research value were the revelations the vice-principals made in relation to their use of social media both in schools and outside of them.

3.2 Access and Permissions

Three district school boards were approached for consent, and only one board chose to participate. Significantly, one school board felt that the research project relied too heavily on the use of an open source, free subscription type application to gather data. This school board cited the protection of the gathered information as a concern as well as information about events that happen at the school and the potential posting of images and video. Given the findings of this study, the decision not to allow participation is of interest as it suggests there may be systemic responses to the use of social media, even with considerable research safeguards in place that respected the anonymity, confidentiality, and ethics. The response of the school boards potentially also reflects a generally negative view of the use of social media by educators.

Despite the lack of consent from the district school boards, school leaders from two other districts heard of the study and participated anonymously. Within the NING, all of the participants used avatars and were instructed on protecting the identity of schools, districts, students, and themselves through the careful reporting of cyber events and responses.

3.3 Data Collection and Analysis

All of the data from the Limesurvey were compiled and are reported next in the Findings. For the responses to the questions in the NING, two levels of analysis were applied. First, the responses to each question in the NING were compiled. Next, the compiled data was analyzed to note reflective passages, key quotations, and patterns and themes in the vice-principals responses (Cresswell, 2012). At that level of analysis key themes and codes were identified, then organized to make sense of the data. For purposes of this paper, some of the key questions from the NING are reported in the Findings section which follows. At the final level of analysis, the findings were reviewed relative to the relevant literature, leading to recommendations presented in the discussion section of this paper.

4. FINDINGS

This study used a mixed-methods approach to data collection with an emphasis on qualitative data collection. Ten respondents completed the Limesurvey questions; however it was believed that one participant completed the survey twice. For the purposes of this study, it was decided to include the data rather than speculating about the respondent's double entry. Three male and 7 females responded. Six participants were between the ages of 35 and 45 and 4 were between the ages of 45 and 60. Seven participants had between zero and three years in their role. Three vice-principals had between four and six years of experience in their role. Most were fairly new at the role of vice-principal. The participants were also asked to indicate their degree of knowledge with the recently legislated Bill 13, the *Accepting Schools Act* (LAO, 2012) which requires schools to respond to any harmful cyber events affecting students and school community which are raised to their attention. Knowledge of the legislation was diverse as five respondents had limited knowledge, two respondents had some knowledge and three respondents had considerable knowledge.

4.1 NING Data

While the online survey was completed by all participants, the number of participants reading and posting online in discussions varied from week to week. For the most part, participation reflected the chronology of the postings; however, some respondents went back to prior postings from previous weeks or contributed to depth probing questions at different times.

NING Question: *"How has Bill 13 affected the work you do in schools? What other policy or legislation has affected your work? In what ways? What policies or rules do you think about when you are resolving safe school issues?"*

The respondents positively viewed the *Accepting Schools* legislation in two ways. To some, the legislation provided helpful and explicit information that could be shared with students and parents. The school leaders used terminology such as "clear direction" and "guidelines." One vice-principal said that "Bill 13 has given school administrators clearer direction and guidance when dealing with students." Another vice-principal said that the policy provided support for what was considered good practice, explaining in this way:

> *[The policy] defines bullying explicitly and it is helpful to have a detailed definition to which I can refer. This legislation compels the administration to notify both the parents of the student harmed as well as the student who has harmed someone…something that is ingrained in our practice.*

*F*or the most part, the vice-principals did not report that other policies were considered in the context of negative online behaviour and cyberbullying. Bill 13 was widely perceived to be a helpful policy both for the reinforcement of current practices as well as for support with future decisions. One participant said the policy provided guidance for "creating a safe school environment and responding to the activities of students despite location and time of day."

NING Question: *"What in your view is cyberbullying? What does this term mean to you in relation to your experience as a VP? How is it distinguished from other negative online communication?"*

One school administrator reported that, "negativity and bullying has gone on since Socrates taught, but cyberbullying adds a new dimension to the role of the vp." Throughout their postings, the vice-principals made distinctions between cyberbullying and online conflict. The respondents provided very clear terms of what they believed constituted *cyberbullying* citing the *repetition of events*, *power imbalances*, and *harassment* as its characteristics (similar to the description in the policy). Cyberbullying, as one respondent explained, "uses online means and applications to harass another person. This can be in the form of direct communication with the victim (emails, chats, posts on their apps) or online communication online about that person." Another administrator indicated that "Cyberbullying is the use of technology to repeatedly intimidate and harass someone."

The vice-principals in the study indicated that cyberbullying included direct and indirect references to another student whether that student was named or not. While *intent* was identified as an aspect of cyberbullying, it was also mentioned that a *lack of intent* did not preclude it. Vice-principals indicated that there were both positive and negative aspects to social media and its use by students. This had complex implications for their role as administrators because they said that they spent "an inordinate amount of time 'sorting and sifting' information on social media." The administrators noted in their comments that social media escalates the harassment by its anonymity and brings shame to the student who receives it. There is a "profound impact if it is not discovered." The potential for public shaming was cited as a great concern as "young people are given so much power in social media to broadcast their unkind thoughts that might have been either whispered or scribbled on a passed note in the past." However, while acknowledging these negative aspects to online communication, the school administrators ironically noted that online communication nevertheless leaves "hard evidence" or a "digital footprint" that they could follow and use in their investigations. In summary, vice-principals could readily distinguish cyberbullying from other kinds of negative online communications, and were able to follow the evidence because online misconduct leaves a digital paper trail.

NING Question: *"How do you perceive your role as an administrator in the context of Safe School legislation like Bill 13?"*

When they reflected on their roles as administrators in the context of the legislation, the vice-principals repeatedly reported feeling a sense of duty or "obligation." They took their responsibilities seriously in the context of the legislation as well as how they saw their roles based on the expectations of parents. They also saw the negative and positive aspects of social media. They spoke of the obligation they felt to create a welcoming climate in their schools and to keep kids safe. One respondent stated,

> *Our role as Administrators is always one of providing all students with the opportunity to come to school and feel safe and successful. With respect to cyberbullying they reported that their role included prevention as well as investigation of cyberbullying, in order to care for kids and help them learn.*

Another articulated that it was reasonable for parents to expect that when students were in school they would be safe. One administrator felt their role "is to continue to support students through the social media landscape, help them understand when they fall outside the lines of what is deemed appropriate, and hope for learning and better choices for the next time." This was echoed by another vice-principal who spoke of the potential of social media and other technology to educate. While this respondent spoke of hearing about the negative actions of students on social media, the observation was made that, "however, other students use social media responsibly." The vice-principal elaborated stating that a "finite group of students that 'overshare'…lack understanding of their actions." Again, this was an indication that some vice-principals perceive that many students do use and understand social media more carefully. In the context of Bill 13, vice-principals see their role as a duty or obligation to keep their school communities safe and to help students learn to communicate appropriately.

NING Question: *"Reflect upon the nature of an online community and its relationship to your school. You may consider your own experience with online communities (this one or another) as well."*

The school leaders spoke of the negative and positive aspects of online communities relating to their work and their personal use. One respondent felt that online communities were helpful in providing an opportunity to "learn from other educators through online discussion, blogs, and connecting with others in similar roles to mine." The vice-principal also saw this kind of communication as an alternative to what was perceived to be a decline in the funding of professional development. However, this respondent did not use the NING for these purposes and posted infrequently. One vice-principal acknowledged the potential for the positive use of social media as a communication link between schools stating, "This poses a timely question. Honestly, I have avoided being part of any social media network that offers the opportunity 'to see' my personal life." Another respondent acknowledged the positive aspects of online communities such as Twitter, Vine, and Instagram for school communication. However, the darker side of social media, including the surreptitious filming of staff and administration, was also commented on, as was the degree of online humiliation that the victim receives, whether that victim is a school staff member or, of even greater concern, a vulnerable student. This participant stated,

Students are connected through their own online communities which are often the new "Wild West" where stray online bullets regularly wound its inhabitants through online insults, 'beefs', etc. As administrators we are asked to try to enforce law and order in these online environments.

In summary, when they reflected on the nature of online communities and their relationship to schools, vice-principals perceived and identified positive and negative aspects to these kinds of communication but they expressed hesitation to participate in them.

5. DISCUSSION

The review of the literature on social presence indicates that electronic media have been changing relationships for four decades (Korzenny, 1978; Short et al., 1976; Walther, 1992) leading to investigations of social presence as a quality that is impacted by the lack of proximity in place and time but can be addressed in online courses (Garrison et al., 2000). While researchers argue that social media interaction can evoke at least the vestiges of community (Köbler et al. 2010) and interaction is both immediate and intimate (Rettie, 2003), the feeling of being in a community is impacted by cyber-misbehaviour. The vice-principals in the study saw is the positive and negative aspects of the social media in their investigations and did not pursue its personal use. Nor did they use the NING as a means of free expression.

Online communication changes relationships and communications in schools, impacting school climate and school safety. The participants in the study spoke of the challenges associated with the anonymous quality of cyberbullying and harassment, a phenomenon thought to be the underlying cause of cyber aggression (Mark & Ratliffe, 2011). Power imbalances appear to be connected to social roles and a lack of social regulated presence (Yeh, Lin and Lu, 2011). The school leaders in this study see that it is of paramount importance to discover incidents of cyberbullying because of its "profound impact" on students. However, they also asserted that an "inordinate" amount of their time was spent investigating what some vice-principals felt was relational conflict and not cyberbullying. Of interest to this study was the breadth of restorative practices outlined, including conversations, questions, and impromptu conferences that were used in an attempt to offset anonymity and aggression.

The findings in this study indicate that vice-principals see that they have an obligation to keep schools safe and to create an inclusive and welcoming climate. There was evidence in the study that this responsibility felt by the vice-principals to maintain safe schools predates the existence of cyberbullying policy (Bill 13) and vice-principals extend its scope to include online conflict as well as a legislated response to cyberbullying. In holding this responsibility, however, the vice-principals do speak of a "new dimension" to their role and the amount of time spent navigating through social media. Vice-principals work to rebuild elements of community and social presence when they investigate and respond to incidents of online misbehaviour. The more positive, regulated aspects of community, achieved through restorative practices, help to respond to a lack of social and regulatory presence reflected in social media communications. Participating vice principals did not articulate the term *social presence* per se, but they did suggest that the anonymous quality of online communication could create the conditions that exacerbated peer-to-peer conflict and bullying.

Vice-principals connect social media to their roles as school administrators, likening their online social presence to the vigilance of the sheriffs in the Wild West, who by their presence "enforce law and order in these online communities." They are reticent to use social media for other purposes, such as for personal use or had stopped using it entirely. Some vice-principals saw the value of Web 2.0 technologies for the purposes of professional development but did not view the NING in this study in this way. As they immerse themselves in technologies for their roles, they maintain a distance and wariness when it comes to their personal use of technologies. In the words of one vice-principal, their school experiences "jaded" them. It is hoped that these findings can be followed up and confirmed or explained further in future studies.

6. CONCLUSIONS AND RECOMMENDATIONS

While small in scope, this study may inform or guide future studies. The vice-principals in this study reported that they enact policy which supports safe schools, and they see their role as maintaining school communities as safe places. While they engaged with and used Web 2.0 technologies to respond to online aggression and cyberbullying, events that had a "nexus" in their schools, they could see the negative and positive aspects of these media. One aspect of their role which may not yet be recognized is that secondary vice-principals also are teaching about appropriate online behaviours. They saw students' missteps in the online world (such as oversharing) as opportunities or teachable moments. The vice-principals used social media for investigations, another area that could be considered in future study as it was not present in the literature reviewed. While they use these technologies in the day-to-day context of their jobs and for the investigation of online incidents, they would appear to use them with great reluctance for their personal use and this may extend to professional use.

There was a time in the not-too-distant past where school administrators focused their discipline-related responses to events and misbehaviour that happened during school time or on school property. This study indicates that the vice-principals in this study are responding to cyber events which occur off school property and outside of class hours in order to maintain student safety. This may help to explain the hesitation of some of the vice-principals in this study to use these same technologies beyond the scope of their school day. The Digital Wild West remains as space worthy of interest and further study.

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MORE THAN A BROKER: A CASE STUDY OF KNOWLEDGE MOBILIZATION IN A DIGITAL ERA

Lorayne Robertson
University of Ontario Institute of Technology, Oshawa, Ontario Canada

ABSTRACT

This research described here examines the role of e-health and medical informatics through the lens of one e-health knowledge broker in Canada. Eating disorders are an important issue in Canadian health and it is difficult to find accurate information online. Theoretical models examined include those which describe the roles of health knowledge brokers, including those who advocate for critical social change. A case study is presented of one Canadian agency which brokers knowledge about eating disorders. This agency has a highly complex role which employs multiple technologies: telephone help lines, a website, and webinars. The help lines and email supports are designed to respond to questions about eating disorders and to refer individuals to service providers. When compared to the oft-cited role of the knowledge broker to disseminate research information, the key roles of this agency move beyond this, providing reliable and consistent information; brokering spaces for capacity-building; promoting crtical health literacy and advocating for health equity.

KEYWORDS

e-Health, Knowledge Brokers, Eating Disorders, Health Equity, Critical Health Literacy

1. INTRODUCTION

The role of the e-health knowledge broker agency has not been fully explored in the literature, leaving gaps with respect to both theoretical considerations and rigorous research studies. This paper presents a case study of one health knowledge brokering institution which maintains both e-health and traditional knowledge brokering practices. A case study is provided which introduces the complexity involved in measuring the impact of health knowledge exchanges in general and e-health knowledge brokering in particular which is designed to support the prevention, intervention, and treatment of eating disorders in Canada. This research is presently in its initial phases.

First, some key questions help increase the focus on the issues. In the present digital era, where do individuals turn to find information when they suspect that their own health or the health of someone who is close to them is in jeopardy? How does this change if there is a culture of silence or shame attached to this ailment? What are society's imperatives if this particular health condition can be fatal? In these circumstances, what are the key roles of the health knowledge broker and how can we measure the impact of the knowledge broker?

In the case of the provision of health information for eating disorders, the role of the e-health knowledge broker takes on a significance and immediacy that may not be experienced by other knowledge brokers or knowledge mobilization intermediaries. The role of the knowledge broker in this case is imbued with a sense of urgency to provide current, helpful, and factual information to support the efforts of the individuals seeking help to connect with health care providers, but also carries a responsibility to educate society.

According to their website, www.nedic.ca, The National Eating Disorder Information Centre (NEDIC) is a Canadian non-profit organization providing resources on eating disorders and weight preoccupation. NEDIC defines clinical eating disorders as medical conditions which require treatment from health professionals and these include anorexia nervosa, bulimia nervosa, binge eating disorder, and eating disorders not otherwise specified. Traffic to the NEDIC website is reported to be very high, and in addition to this, approximately 1,600 individuals annually contact the NEDIC helpline by phone or through email. This paper begins to explore the work of NEDIC in the context of research on the role of knowledge brokers in general, and e-health knowledge brokers in particular, recognizing that they provide a vital health education space.

1.1 Eating Disorders – the Canadian Context

Within the past year, one of the reports of a Canadian parliamentary committee has raised serious, multiple concerns with respect to the rising incidence and lack of treatment for Canadians with eating disorders, especially girls and women (House of Commons, 2014). According to the expert witnesses, eating disorders are described as a serious form of mental illness impacting the health of 600,000 to 990,000 Canadians at any point in time. One expert witness testified that anorexia nervosa and bulimia nervosa are fatal for 1,000 to 1,500 Canadians annually and this rate of incidence may possibly be underreported (House of Commons, 2014).

Eating disorders are also an equity issue; anorexia has the highest rate of mortality of any mental illness but treatment wait times in Canada for eating disorders are not responded to with the same urgency as other life-threatening health crises (House of Commons, 2014). Four out of five persons affected by eating disorders are women, which may reflect that society pressures girls and women in numerous ways to obtain a certain ideal body type. Perceptions of body size and shape are impacted by society's stereotypes, including the marginalization and stigma surrounding weight which can prompt disordered eating. Expert Canadian witnesses identified that fat stigma, which encourages food regulation and dieting, and a national culture of blame for individuals with eating disorders and their families are barriers to treatment (House of Commons, 2014).

According to Jasper (2005) if the generally-accepted and relatively unchallenged messages of a society state that the ideal body *is achievable with effort*, when in fact this body type is generally unattainable for the average population, this contributes to weight preoccupation. Schools are particularly problematic environments for messages about weight and appearance because peers can reproduce societal stigma against obesity, and they can also encourage individuals to pursue diets and persist with them. There is, in addition, an overall focus on *healthism* in schools (Rich, Holroyd and Evans, 2004) which focuses on a person's individual responsibility for their health and size. If this discourse around personal responsibility and health is not interrogated and deconstructed for students, it can help to build anxieties about body size and shape (Rich et al., 2004).

There is, in addition, societal pressure and stigma associated with fat. Schools have been identified as "potentially toxic environments" for weight and appearance messages (House of Commons, 2014; Robertson 1 & Thomson, 2014). Peer messages can reproduce stigma against fat, but they can also encourage those who are dieting to continue to lose weight. If students are perceived to be overweight, they are more likely to experience bullying and teasing (Fox & Farrow, 2009; Puhl, Luedicke & Heuer, 2011) which can, for example, impact their participation in physical education programs (Puhl & Luedicke, 2012). Research has also shown that teachers and in particular, physical education teachers, hold stereotypes around weight; holding lower expectations for students who are overweight in both their cognitive and physical areas of potential (Greenleaf, Martin & Rhea, 2008; O'Brien, Hunter & Banks, 2007).

These kinds of oppressions occur more easily in a society which focuses on individual responsibility and lifestyle change to look a certain way rather than looking at how society is influencing or determining health. Canadian health policy has been criticized for drawing too heavily on lifestyle change or a neo-liberal focus rather than examining societal determinants of health (Mikkonen & Raphael, 2010) and also for pursuing a medical anti-obesity model which promotes consumerism through diet foods, regimes, and self-discipline (Rail & Beausoleil, 2003).

In summary, then, eating disorders in the Canadian context present a very real health risk, but the prevention, intervention and treatment of eating disorders has been compromised by health care systems and education systems that promote efforts to lose weight, and equate health with certain sizes. The key implication for a health knowledge broker in this particular context is that their messages are, essentially counter-cultural. The health knowledge broker needs to convince both the medical practitioner community and society that food and weight preoccupation are harmful and potentially fatal to certain populations.

2. THEORETICAL CONSIDERATIONS

2.1 Knowledge Brokers

The transfer of health research to practice has been described as a slow and complex process (Graham et al., 2006). Knowledge brokers are people or organizations who help to package the knowledge and create connections between the researchers and their audiences (Meyer, 2010). Knowledge brokering is growing in the postmodern era and because new knowledge and brokering spaces are growing, in particular in the healthcare sector, this health research can have immediate implications for patient care and treatment. While earlier descriptions of the role of knowledge brokers include the facilitation of the "creation, sharing and use of knowledge" (e.g., Svarrisson, 2001), Meyer provides other examples of knowledge brokering in healthcare which delineate additional roles for knowledge brokers:

- Identifying knowledge
- Redistributing and disseminating knowledge
- Rescaling knowledge
- Transforming knowledge

According to Meyer, in order for health knowledge to be used, it is not just moved along but it is re-packaged to meet the needs of the users. In order to do this, Meyer theorizes that knowledge brokers need to live and work at the peripheries of both the research world and the world of the knowledge user, working behind the scenes in collective and interactive ways. The end product is "brokered knowledge" (p. 123) which is knowledge "made more robust, more accountable, more usable; knowledge that 'serves locally' at a given time; knowledge that has been de- and reassembled" (Meyer, 2010, p. 123).

The Canadian Health Services Research Foundation (CHSRF) (2003) see knowledge brokers as go-betweens and they emphasize the human aspects of that role. Brokering means bringing people together who share common issues in order to share their experiences and to hear about new evidence. In their words, "Getting the right mix of people and information together to tackle the right issue at the right time is the essence of brokering" (p. 9). Brokering also involves building networks and relationships both to share current research and to stimulate future research (CHSRF, 2003).

CHSRF concludes that health knowledge brokering is not a commonly found role in Canada. Good brokers are curious, flexible, well-informed and able to handle a range of information and ideas. They are also the ones who will resist quick fixes until they have seen that the research-based evidence has been reviewed. CHSRF advocates that the tasks of the broker include the following:

- bringing people together to exchange information and work together;
- helping groups communicate and understand each other's needs and abilities;
- pushing for the use of research in planning and delivering healthcare;
- monitoring and evaluating practices, to identify successes or needed changes;
- transforming management issues into research questions;
- synthesizing and summarizing research and decisions (CHSRF, 2003, p. i)

While the CHSRF report sees multiple roles for knowledge brokers, the report also acknowledges gaps in the research. For example, networking is a key function but much more research is needed on how knowledge brokers set up networks, provide information and train individuals within their organization. Ward, House and Hamer (2009) concur, stating that more needs to be investigated as one challenge to knowledge brokering is a lack of understanding of how it works based on different contexts.

Early research and concept development on the role of the health knowledge broker indicates that more specific research is needed to understand the contexts within which knowledge brokers operate. Early theoretical frameworks focused on knowledge producers and users as two camps, linked by the knowledge brokers. More recent models indicate that knowledge brokers transform the knowledge to specific contexts, and that they work with a presence in both the world of the researcher and the world of the knowledge user. In the section which follows, e-health knowledge brokering is explored, opening up new aspects of the role of the e-health knowledge broker.

2.2 E-Health Knowledge Brokers

The term and concept of e-health has been defined by Eysenbach (2001) as the provision of health information and health services enhanced by utilizing the internet and other technologies. He theorizes that access to multiple sources of information and research can not only inform but empower patients, give them more choices, and encourage more patient-centered medicine. It can also extend health care to persons who may be geographically distant, or who seek information during off hours. E-health provisions are especially important for persons who perceive a stigma associated with their illness. An extensive US study of internet use for e-health concerns indicates that the internet information can be a valuable tool for education about health, particulary when the health concern is a stigmatized illness (Berger, Wagner & Baker, 2005).

Connecting health care practitioners to persons who are potentially at risk is a key role in e-health provision today. An e-health information broker can be a repository for practitioners and provide access to current research. An e-health information broker can also create an interface that encourages people seeking help to connect with health care practitioners. Health care practitioners also have a role in helping their patients identify reliable e-health information websites, or teach them how to critically assess the health information which is on the web.

Adolescents, in particular, can be at risk for health concerns where there is stigma attached (such as mental health) because of their reluctance to reveal their concerns and seek out a health care professional. One Canadian study of how adolescents use the internet for health information reveals that topics of body image and nutrition are very important to adolescents and these are some of the most frequently accessed spaces on the internet. Participants in the Canadian study indicated that adolescents frequently access websites for health information and they value the anonymity provided by a webspace to share their health concerns (Skinner, Biscope, Poland and Goldberg, 2003).

Early research on the internet and its impact on the provision of health care knowledge indicated that even at the turn of the century, literally millions of biomedical research articles were put online annually, creating concerns for information overload and questions surrounding how knowledge users can determine the quality of online information, prompting a call for more formal evaluations of e-health websites (Christensen & Griffiths, 2000). More recently, studies have focused on examining how health users make use of the website information, resulting in new understandings about the factors which contribute to trust in health websites (Sillence, Briggs, Harris & Fishwick, 2007).

One study which evaluated web-based information on eating disorders created a scale of evidence-based clinical practice statements and then analyzed websites based on this scale. They found that in general the quality of information available online about eating disorders left room for improvement, and more research was needed to determine the types of information and quality indicators that health users would find to be the most helpful (Murphy, Frost, Webster & Schmidt, 2003).

2.3 Measuring Health Knowledge Outputs

Very little has been written about how to measure the impact of a health knowledge information on the web (Murphy et al., 2003) and in addition, little is known about how to measure the impact of a health knowledge broker. One output tool which as designed to measure health research (not broker) impact has been proposed by Kuruvilla, Mays, Pleasant and Walt (2006). Its four dimensions are areas of research impact: research, policy, service and society.

- *Research*-related impacts include publications and papers;
- *Policy* impacts include, for example, policy networks, and participation at various policy levels;
- *Service* impacts include quality of care, and evidence-based practice; and
- *Societal* impacts include, for example, health literacy, equity and human rights, social capital and empowerment

Health literacy in this context is described as as a broad range of skills which can help to locate, understand, assess and utilize health information for informed choice, reduced risk, and increased quality of life (Kuruvilla et al., 2006). This impact framework has not yet been applied to outputs of health knowledge brokers or e-health knowledge brokers but it could be potentially helpful in examining and reporting the effectiveness of e-health brokers.

Nutbeam (2000) also argues for health literacy, finding that health education programs which focus on telling people what to do or not to do have not been successful in producing health behaviour change, and transmission has not been an effective way to moderate health outcome gaps between different groups. He describes health literacy as a set of skills that lead to enablement. *Basic or functional* health literacy encompasses knowledge and skills; *communicative* health literacy includes more advanced skills which can be applied in new situations and communicated. The third level, *critical literacy*, involves the critical analysis of information which empowers individuals to take more control over their health and to influence society (Nutbeam, 2000). As Kuruvilla et al. (2006) note, human rights and equity include the rights of individuals to shape health decisions that impact their lives.

In summary, theorizing on the role of the knowledge broker in health knowledge translation indicates that the role is both complex and critically important. At stake is the empowerment and enablement of the users of health research knowledge, the building of community and capacity surrounding health knowledge exchanges, and improvement of the health and life chances of individuals.

3. RESEARCH DESIGN

This paper describes proposed research using the lens of a descriptive case study. Lichtman (2012) describes the case study as a research approach which involves a specific and detailed study of an entity. Qualitative case study research is described by Merriam (2009) as a distinctive form of research design within the critical epistemological perspective which assumes that there are multiple realities, dependent on different individuals' world views and experiences, which involve the privileging of certain realities. For example, within a case study approach in the critical paradigm, there is an examination of those whose interests are protected and preserved at the expense of other perspectives (Merriam, 2009). Similarly, Guba and Lincoln (1994) explain that the reality in a case study which is described to the researcher(s) is shaped by forces such as "social, political, cultural, economic, ethnic, and gender values" (p. 109).

By design, the methodology proposed here is distinctively dialectical and hermeneutical, seeking information and refining it through the interactions which occur between and among participants and investigator and become refined as a result. The voice of the researcher is considered to be both advocate and activist, "transformative and intellectual" (Guba & Lincoln, 1994, p. 112).

Data collection for the case study presented here will employ multiple sources such as online offerings, webinars, interviews, observations, e-documents, and artifacts. These multiple sources allowed for deeper understandings and confirmation of findings. Data will be analyzed through the identification of key themes across the compiled data (Cresswell, 2012). Rather than employ the structure of the entry and closing vignette (Cresswell, 2012, p. 106), this planned research is introduced through a case study which outlines the context, the issues and theoretical conceptions of the role of the e-health knowledge broker. A discussion of selected issues and assertions follows.

3.1 NEDIC: A Descriptive Case Study

NEDIC identifies itself online as, "Canada's leading source of information and support in the field of eating disorders and related issues" (www.nedic.ca). It is a not-for-profit organization that has been working since 1985 to promote health and raise awareness of the complexities surrounding food and weight preoccupation. They provide a first point of contact. Of the individuals who contact NEDIC over the course of a year, approximately 60% will be individuals who have an eating disorder but their parents, friends and teachers will also call for information.

Education, outreach and client support are three of the central roles that NEDIC undertake as an e-health knowledge broker. They maintain a presence through email, phone lines and their website, as well as through webinars and events. NEDIC provides information to school counsellors, teachers, psychologists, psychotherapists, family doctors and researchers, among others, but central to their mission is to give timely information to individuals who need more information about eating disorders and their families. It is important that individuals who contact NEDIC for support are met with consistency, with hope and with an expectation that NEDIC can empower them to navigate to seek answers.

NEDIC connects individuals with information on service providers in their vicinity; they maintain the Service Provider database with just under 800 program providers, including those who are provincially funded, fee-for-service or free. Because the number of institutional beds for individuals with severe eating orders is inadequate in Canada (House of Commons, 2014), many individuals between early identification and tertiary care are not having their needs met. In some of these cases, because individuals have multiple concerns when they have an eating disorder, NEDIC may be able to help them to connect with service providers in order to meet another of their health needs.

A key issue for maintaining the centre is funding – they have limited resources and a huge mandate. Approximately 20% of their funding comes from the Ministry of Health. Other sources of income include fund-raisers, the biennial conference and grants from foundations and sponsors who are carefully selected based on hospital criteria and philosophy.

NEDIC maintains a database of information on eating disorders based on references to peer-reviewed material. While their funding permits access to eating disorder journals, they do not have the funds or personnel to scan journals in other areas such as clinical psychology or school counselling. To broaden their understandings, NEDIC gathers information through listservs, seminars that they attend and many informal conversations with clinicians, teachers and other activists in the field.

NEDIC offers a biennial conference which takes months of planning. Significant time is given to the identification of key researchers and cutting edge research in eating disorders and related areas. NEDIC also provides information through an internal listserv and gives and receives information through the individuals who present webinars for them. Each of these webinars sold out within two days of opening the enrolment. They organize communication efforts by considering different populations – universal populations for prevention, an early intervention group and those who identify as having eating disorders who need to find help.

Two projects undertaken by NEDIC for universal populations have been directed at schools through the Beyond Images curriculum, and at Girl Guides through the Love Yourself badge. Beyond Images is a body-image and self-esteem curriculum designed for students in Grades 4-8 – a time of vulnerability for student populations because their bodies are changing. This curriculum was designed in 2009 and since 2013 is available free of charge through the NEDIC website. NEDIC estimates that, conservatively, more than 10,000 students have undertaken this curriculum. Similarly, the Love Yourself badge, which NEDIC developed with Girl Guides, is the 2nd most popular challenge badge in Guiding with approximately 1,000 guide members undertaking it annually.

At the present time, a key focus for NEDIC as an e-health care provider is to undertake rigorous research to document their role and their impact as an e-health knowledge provider. To that end, an investigation has begun to interview key personnel who access NEDIC as an e-health knowledge broker to better understand the roles that NEDIC provides and examine how researchers, practitioners and the public use the e-spaces and physical spaces for knowledge brokering that NEDIC creates.

4. DISCUSSION

Health knowledge brokering functions can include linkages and partnerships, awareness, capacity-building, support, and policy influence (Cooper, 2012). While NEDIC performs many of the recognized roles of the knowledge broker; this organization also places an emphasis on e-health brokering in non-standard areas. For example, they appear to be more client-centered than research-centered, but maintain deliberate standards for dissemination of research knowledge. They also maintain a focus on collective knowledge without privileging one type of information at the expense of another. Dede (1999) has identified that collective learning is facilitated when knowledge mobilization efforts are supported by digital technologies. NEDIC uses digital technologies through email, webinars and websites for the stated goal of capacity building, but are seeking ways to measure the outcomes of their health knowledge brokering.

This review of the literature and presentation of the initial case study indicate that there is much to be gained from research which examines the role of e-health knowledge brokers in general, but, in particular, in examining the role of an e-health knowledge provider who maintains a deliberate equity stance both by its funding imperatives, but also prompted by the specific needs of Canadians with eating disorders who are experiencing inquities in health care and health outcomes. Much more needs to be understood about the role of an e-health provider which expresses a commitment to building critical health literacy understandings. While hope and empowerment are not often found in the literature as knowledge brokering outcomes, they are indications that findings related to this particular e-health knowledge broker will influence the present field in new ways.

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HOW DO HIGH SCHOOL STUDENTS PREFER TO LEARN?

Leila A. Mills[1] and Putthachat Angnakoon[2]
[1]St Edwards University, Austin, Texas, USA
[2]Thammasat University, Bangkok, Thailand

ABSTRACT

The purpose of this study was to examine learning preference—the match between learners and learning methods—and students' information behaviour in technology-rich information environments. The major question asked was: How will high school students' information behaviour differ by gender and academic interests? A total of 88 students (37 girls, 51 boys) from a predominantly African American high school district in the south of the United States participated in the study. The Integrated Communications Technology Learning (ICTL) survey was used to examine differences in high school students' learning preference for information seeking, information sharing and classroom learning. High school girls and students with Science, Technology, Engineering and Math (STEM) interest were found to be significantly more positive toward learning in the traditional classroom.

KEYWORDS

Information behavior; Learning preference; High school

1. INTRODUCTION

Weiler (2005, pp. 46) posited that "the entire world, is currently in the middle of a massive and wide ranging shift in the way knowledge is disseminated and learned." Information and Communication Technology (ICT) tools now offer previously unavailable options for interaction with information for informal-to-formal learning. Additionally, many students use ICT options for rapid information access, messaging, and online connection in their personal lives and many would welcome opportunities to use these networking tools for formal-to-informal learning (Rennie & Morrison, 2013). Yet, even as there is a trend towards online learning, there is little research on the effect of match or mismatch of learners to their preference of learning methods for learning in traditional and technology-mediated learning environments (Curry 1981). The rapid growth of personal technologies throughout the world and the rapid emergence of mobile technologies and applications (Henríquez & Organista, 2012; Khaddage & Knezek 2012) increases the need for studies that can help clarify how students view the use of technology-mediated communications tools for knowledge construction and how students' views may relate to learning outcomes. Research on the psychology of learning indicates that learner attitudes relate to learning outcomes (Driscoll, 2005). Additionally, learning preference has been linked to academic performance (Koch et al., 2011) and to motivation for learning-related activities (Hong & Milgram, 2000). This study of the learning preference of students in one school district is part of the authors' ongoing research on the role of student learning preference to academic goals. This study also includes an examination of the reliability and consistency of the Integrated Communications Technology Learning (ICTL) survey to gauge high school students' learning preferences for three categories of informal-to-formal learning interaction—classroom learning, ICT information seeking, and ICT information sharing.

2. CONCEPTUAL RATIONALE

2.1 Learning Options

Communication is an integral aspect of learning (Warren & Wakefield, 2012). ICT tools offer previously unavailable options for interaction with information for informal-to-formal learning. As the newest personal technology tools blur the line between informal and formal learning (Cox, 2012; Mills, Knezek & Khaddage, 2014; Henríquez & Organista, 2012; Khaddage & Knezek, 2012), mobile technologies are gradually becoming more geographically dispersed (Castells, 2011) and more readily available to students. The many new ICT tools provide a choice in options for learning. Student choices and preferences are related to learning and they warrant examination of how students prefer to interact with information and the match between learning options and learning methods (Keefe, 1979; Curry, 1981; Owens & Straton, 1980). Interest in ICT tools for learning is shifting from a focus on what channels and resources are used to an emphasis on how students will encounter, interact, and interpret information that can be sought out with ICT tools (Ilgaz, Mazman, & Altun, 2015).

2.2 Learning Preference

Orhun (2013, p. 1159) stated, "Learning can be expressed as gathering information, processing information, the improvement of thinking, and the method of selection for attaining knowledge." Student preference for a mode of learning is an important variable in the effectiveness of learning (Owens & Straton, 1980). Learning preference is a facet of how we learn. It has been defined in relation to learning style and methods, as how a learner perceives, interacts, and responds to learning opportunities (Keefe, 1979). Mayer and Massa (2003) examined learning preference along with aspects of cognitive ability and cognitive style. They describe learning preference as a distinct aptitude and "property of the learner's interaction with a particular learning situation" (Mayer & Massa, 2003, p. 838). While studies on learning styles have not provided conclusive evidence regarding the effect of learning style on academic performance, Orhun's (2013) research revealed that preferred learning style is potentially a tool for improvement of mathematic performance. Learning preference relates most directly to how students prefer to attain knowledge and was found to be a predictor of academic performance in a study of nursing students, for students those who reported a preference for multiple approaches for learning (Koch et al., 2011). Additionally, Hong and Milgram (2000) reported that learning preference is related to motivation for homework and out-of-school learning.

2.3 Research Questions

The research questions addressed were related to how high school students like to learn. Students' information behavior (information seeking and information sharing) in technology-mediated ICT learning environments, as well as students' liking of classroom learning were examined by gender and academic interest in Science, Technology, Engineering and Math (STEM).

The specific research questions examined were:

1) How are male and female students different in their learning behaviors with regard to information?
2) How are students interested in seeking STEM and non-STEM courses of study different in their learning behavior with regard to the information?

3. RESEARCH METHODS

3.1 Participants

Institutional Review Board approval was granted for this study of learning preference among high school students. Data was gathered using paper and pencil surveys. All high school students, with the exception of those who were not eligible for a school field trip, from the district's only high school were invited to participate in the study. Eighty-eight of the 296 students who attended the field trip returned permission forms and surveys and were therefore included in the study. Participants were 58% male and 37% female, attending high school grades 9 to 12. Fifty percent of students, *n*=44, indicated that they are interested in seeking a STEM-related career.

3.2 Measurement and Instruments

The Information and Communications Technology Learning (ICTL) survey was designed and validated to address questions relating to students' preferences in utilizing ICT and to assist in understanding individual differences in information behavior. Instrument development included analysis for internal consistency reliability, principal components exploratory factor analysis, multidimensional scaling, and higher order factor analysis (Mills, Knezek & Wakefield, 2013). The original version of the ICTL survey consisted of 16 items to assess three constructs: two of the three are *information seeking* and *information sharing* (Author, 2014). A new construct, *classroom learning*, emerged in analysis of the ICTL for the participants of this study. These constructs were measured on a five-point *Likert* scale ranging from (1) "strongly disagree" to (5) "strongly agree." Exploratory factor analysis indicated an original model for constructs wherein the *information seeking* construct was developed from six items (ic8, ic10, ic11, ic14, ic2, ic13), the *information sharing* construct was created from six items (ic3, ic6, ic15, ic4, ic1, ic16), and the *classroom learning* construct was created from four items (ic9, ic12, ic5, ic7).

Confirmatory factor analysis was performed to validate the scales from exploratory factor analysis. To modify the model, the observed variables that had produced low factor loading (<0.5) were eliminated. The modification indices were consulted for the model modification. Figure 1 presents the final measuring items for each construct and the factor loadings. The models were considered acceptable if CFI ≥ 0.90, GFI ≥ 0.90, AGFI ≥ 0.90, RMSEA ≤ 0.08, and SRMR ≤ 0.10 (Jöreskog & Sörbom, 1993; Hu & Bentler, 1999). Table 1 presents the model fit indices. Based on the outputs, the model was adequately fit with the given data set and was valid and acceptable for measurement.

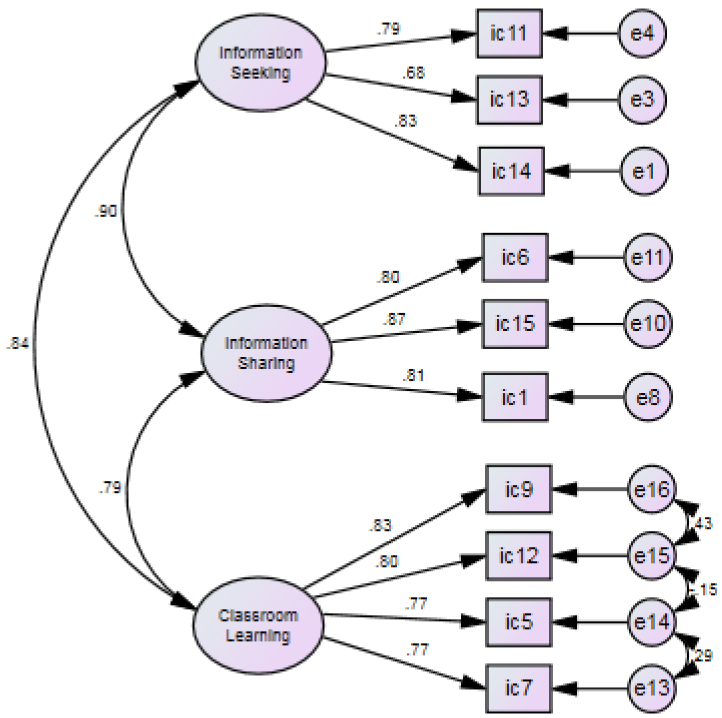

Figure 1. CFA measurement model

Table 1. Goodness-of-fit indices for CFA model model fit indices

	CFI	GFI	AGFI	RMSEA	SRMR
Acceptable if	$\geq .900$	$\geq .900$	$\geq .900$	$< .080$	$\leq .100$
ICTL	.970	.898	.806	.083	.042

Note: (Jöreskog & Sörbom, 1993; Hu & Bentler, 1999)

Table 2. Average variance extract and discriminant validity

	Information Seeking	**Information Sharing**	**Classroom Learning**
Information Seeking	0.596		
Information Sharing	0.814	0.679	
Classroom Learning	0.699	0.618	0.628

Note: In the diagonal-running cells, the average variance extracted (AVE) is in bold; the lower-left half of the table shows the squared inter-construct correlation estimates (SIC).

Table 3. Reliability

Constructs	Cronbach's alpha (reliability coefficient)
Information Seeking	0.82
Information Sharing	0.86
Classroom Learning	0.89

All of the Cronbach's alpha results ranged from 0.82 to 0.89. According to Devellis (1991), these reliability estimates can be considered very good. These Cronbach's alphas suggest that the items in each scale were consistent with each other. Convergent validity was examined from the construct reliability and the Average Variance Extract (AVE) of each construct (See Table 2). All three constructs demonstrated adequate convergent validity with an AVE greater than 0.5. However, the constructs demonstrated poor discriminant validity because the *information sharing* and the *information seeking* constructs are highly correlated.

3.3 Analysis

Among the student respondents, 58% of the respondents are male (n=51) and 42% of the respondents are female (n=37). The majority of the respondents are between 15-17 years old (n=49). When asked about their learning behaviors, students reported an average of 3.53 (SD=1.12) of level of agreement on information sharing, 3.91 (SD=.96) on information seeking, and 4.05 (SD=.86) on classroom learning, respectively. These constructed variables were the combination of multiple items. The *information seeking* construct was developed using three statements: More classroom learning should use technology tools; I learn more when I am free to search for the answers on my own; and I use the Internet to keep current on important topics. The *information sharing* construct was developed using three statements: I learn many things by interacting with other Internet users; I like to share information on the Internet with posts and tweets; and I would like to be a member of an Internet learning online community. The *classroom learning* construct was developed using four statements: I learn best in the classroom setting; the things I need to know are taught in the classroom; I like to take classes to learn new things; and I learn many things in the classroom.

A Pearson's Product Moment Correlation analysis revealed significant positive correlations between these aspects of information behavior (r=0.672-0.754, p<.001). To answer research question 1, multiple analysis of variance (MANOVA) was performed to determine the effects of a categorical independent variable (Gender: Male and Female) on three continuous dependent variables including *information seeking*, *information sharing*, and *classroom learning*. Although the groups for the male and female respondents were unequal (51 male students; 37 female students), the Box's M test (Box's M=13.869; F=2.206, p=0.04) was found to be non-statistically significant based on Huberty and Petoskey's guideline (2000) indicating that the variance-covariance matrices between the groups were equal for the MANOVA purpose.

Generally, female students reported having a higher level of agreement on all three aspects of information behaviors. The one-way MANOVA on learning preference revealed a significant multivariate effect with Wilks' lambda=.87, F(3,84)=4.18, p=.008, η2=.130. Approximately 13% of the multivariate variance of the learning preference construct was associated with student gender. The univariate effects revealed statistically significant differences on classroom learning preference where F(1,86)=10.36, p=0.002. To be specific, female students had significantly higher levels of preference for the classroom learning construct (M=4.38, SD=0.65), indicating that their perceptions on classroom learning are more positive than those of male students (M=3.81, SD=0.91). See Table 4.

Table 4. Learning preference by gender

Learning Preference	*n*	Mean	*SD*	*F*	Sig.	Effect Size (Cohen's *d*)
Information Seeking				2.72	.103	0.36 small
Male	51	3.77	.98			
Female	37	4.11	.91			
Information Sharing				1.05	.309	0.21 small
Male	51	3.43	1.08			
Female	37	3.67	1.18			
Classroom Learning				10.36	.002	0.72 large
Male	51	3.81	.91			
Female	37	4.38	.65			

The one-way MANOVA revealed a non-significant multivariate effect with Wilks' lambda=.924, F(3,84)=2.29, p=.084, η2=.076. However, through the examination of the univariate effects, we found that there was a statistically significant differences on "classroom learning" preference between STEM and non-STEM students, F(1,86)=6.22, p<.05. To be specific, students with STEM major demonstrated higher level of classroom learning preference (M=4.3, SD=.73) than those of students with non-STEM major (M=3.83, SD=.92). See Table 5.

Table 5. Learning preference by STEM major

Learning Preference	*n*	Mean	*SD*	*F*	Sig.	Effect Size (Cohen's *d*)
Information Seeking				1.91	.171	0.25 small
Non-STEM	44	3.77	.99			
STEM	44	4.01	.92			
Information Sharing				3.77	.056	0.45 small
Non-STEM	44	3.30	1.15			
STEM	44	3.80	1.06			
Classroom Learning				6.22	.015	0.53 medium
Non-STEM	44	3.83	.92			
STEM	44	4.27	.73			

Note: Means are based on ratings from 1 to 5 where 1=*strongly disagree* and 5=*strongly agree*.

3.4 Limitations

Confirmatory factor analysis indicated that while the constructs for *information seeking* and *information sharing* have strong reliability, they are related, as might be expected for two aspects of information behavior and therefore low in discriminant validity. Additional research is planned to determine the extent to which additional question items can improve the discriminant validity by reducing the correlation between the *information seeking* and *information sharing* constructs. This research is also limited by the sample of students who are all from one school community, as well as the constraints of self-reported data. Additional research is planned with broader samples of students and observations of actual student information behavior.

4. DISCUSSION AND CONCLUSION

Student attitudes towards learning options, such as information seeking in technology-mediated information environments, provide valuable information to guide in design of instruction and assist in defining useful roles for ICT in informal-to-formal learning. The development of and increased availability of ICT and mobile learning options raise questions about students' tendencies to participate in self-directed learning via ICT and also shed light on students' information behaviors. Students' preferences for use of ICT tools and their information behaviors warrant careful examination because they reveal how students can be expected to interact with information in different learning environments. Additional research is needed to explore the extent to which learning preferences relate to academic outcomes and self-directed learning activities. Validated instrument constructs such as the ICTL i*nformation seeking*, *information sharing*, and *classroom learning* scales can improve teaching and learning by providing an understanding of students' learning preferences for the purpose of supporting instruction and informal-to-formal learning. The scales of the ICTL were found to be acceptable for use in gauging high school students' information behavior preferences for *classroom learning*, *information seeking*, and *information sharing*. The ICTL constructs, as taxonomy built upon empirical data for general, group, and specific factors, may support a theoretical framework for research and experimentation (Cattell, 1987) on information behavior.

Teaching and learning are best facilitated when learning preference can be matched to methods (Keefe, 1979; Curry, 1981; Owens & Straton, 1980). Students' information behavior has been related to critical thinking skills, which are very important to knowledge construction. Weiler (2005, p. 52) pointed out that we assume that students will be effective in seeking information, yet we should be prepared to guide students in developing essential information and critical thinking skills. Findings from this study indicated that regardless of gender and STEM interest, high school students tend to be positive in their perceptions of classroom learning and ICT-mediated information seeking and sharing. As a group, students were most positive toward classroom learning, followed by ICT information seeking, then information sharing. The standout for the students in this study was the classroom learning construct, which when taken into consideration by gender and study major, indicated significant differences of in learning preference between groups. To be specific, female students tend to have a higher preference for classroom learning than male students. Students with STEM interest tend to have a higher preference for classroom learning than non-STEM major students.

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PROCESS MODELS IN E-LEARNING – BOTTOM-UP OR TOP-DOWN?

Sarah Sahl and Prof. Dr.-Ing. Alke Martens
University of Rostock, Faculty of Computer Science and Electrical Engineering, Chair of Practical Informatics
Albert-Einstein-Str. 22, 18059 Rostock

ABSTRACT

In the paper, different approaches of process modelling in e-learning system development are investigated. We provide a look at the DIN PAS 1032-1 and in the process model ROME, which is a derivation of the DIN PAS 1032-1. ROME has been extended by several pattern approaches. However, after several years of using ROME, we found out that ROME has some major flaws, which can be traced back to the so-called top-down approach. In ROME, the decision for a certain type of e-learning system is the first step. After this, the process model is used to structure the development process. In reality, in most cases a bottom-up approach would be better suited: centred around the learner and focused on the learner's needs, a content reduction and development should take place, and later, as second level step in the process, a decision for a certain e-learning type can take place.

KEYWORDS

Process Models, Patterns, Agile Software Engineering

1. INTRODUCTION

Coming from the perspective of Computer Science, the domain of e-learning system development is special with regards to the combination of stakeholders involved. Like in no other domain, the resulting system is depending on how well persons with multidisciplinary backgrounds work together. An optimal team of e-learning system developers consists of the psychologist, providing the learning theory background and the empirical design, the computer scientist, who is responsible for the system implementation and the system architecture, the expert of the application domain, who is responsible for the content development, and who has to work hand in hand with the didactic expert, who helps to structure the content in a way that it is optimized for learning. The designer is responsible for a human computer interface, which is best suited for the target group of learners and for representing the content. And last but not least the learner, who is often ignored in the context of e-learning system development, but who plays an important role as target group and as beta tester of a learning software. This optimal team can be seen in figure 1, but can be called pure fiction, when it comes to e-learning system development. Most of the systems are developed either as research artifacts, which focus on special domains (which can be either computer science domains, when a new technology shall be tested (e.g. (Martens, Himmelspach, 2005)), or in application domains, e.g. psychology (Anderson, 1990)), or as pseudo constructs, when an institution decides that now is the time of e-learning. In both cases, the main stakeholder which is the user of the resulting system, i.e. the learner, is completely ignored in the process. From the perspective of computer science, e-learning system development usually still means to re-invent the wheel, as usually no process models are used (even if they exist since the early 2000s, see e.g. (Harrer, 2003), (Harrer, Martens, 2007), (Martens, 2009), (Pawlowski, 2000)). Things go even worse, if such an e-learning system is evaluated. Most of the time, evaluation methods are used on a very coarse level, chosen investigation periods are too short, no comparable group is given, or the group investigated is much too small.

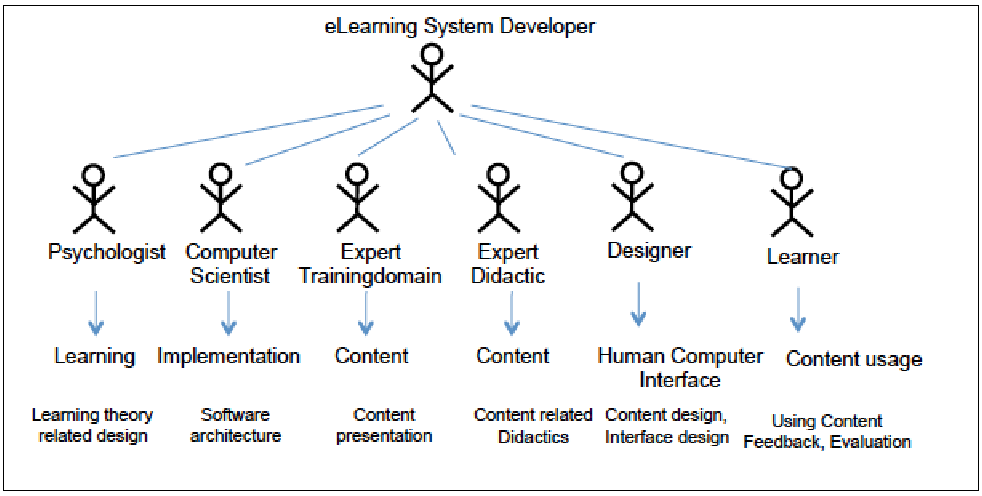

Figure 1. Optimal team of e-learning System developers

With our strong background in instructional sciences, we also have another problem with the state of the art in e-learning system development. In instructional settings, the decision process usually has to start with a focus on the learner (whom shall learn?), shifts to the content (what shall be learned?). The content then is reduced to a level, which meets the learner's needs (in Germany this is called didactical reduction), is then embedded and realized in special purpose methodologies (for education). After all these aspects have been taken into account, the decision regarding the multimedia realizations can take place, e.g. using an e-learning system. We call this the bottom-up approach, due to the fact that the learning itself shall be the basis of all e-learning development, as we perceive e-learning as one of many support technologies to facilitate learning. However, over the last years we have observed in most cases a so called top-down approach, which starts with the e-learning system, then looks for an appropriate content development and, last but not least, looks at the learner. This might be due to the fact that historical e-learning development took exactly this direction (Lelouche, 1999). However, this can no longer be the state of the art.

The reminder of the paper is structured as follows:

In the following section, we give a summary of the existing DIN PAS and ISO/IEC standards in the research area of e-learning, as this is the basis of our development. Several years ago, 2006 to 2009, we have worked with and extended ROME (Rostocker Model for systematic description of e-learning development), which has been developed in the Rostocker Fraunhofer Research Center by Hambach (Hambach, 2008). ROME is an extension of the DIN PAS, and has been brought to another level by integrating software patterns and the idea of boundary objects. This approach has been recently revisited, as we made the experience that even more patterns are usable and that our combined approach has some drawbacks. In the conclusion and outlook, we show some additional point for additional work and we sketch our current field of research, where we are working to bring agile software methods into process model development for e-learning systems.

2. PROCESS MODELS IN E-LEARNING

Process models are used a part of software engineering since several years, at least since the early 1990s (see for example (Gamma, 1995)). In most cases, these process models have been developed as part of knowledge management in multidisciplinary teams, to facilitate communication and to work as boundary objects (see e.g. (Martens, 2009)). The general process management models are independent of the context and they are applicable to all types of software development projects. However, from the perspective of special applications, like for example e-learning, a general process management tool is not easy to use and must be adapted to the special team. For example, the aspects instructional design and the empirical design are special for e-learning systems and cannot be compared to other system types.

As process models for e-learning combine multiple perspectives, which in contrast to the classical software developer – customer scenario require communication on different professional levels, it seems that a new and special purpose process model is required. Several years ago, this led to the development of the system ROME. Since ROME extends the DIN Pas 1032-1 (DIN, 2006), we have taken this as the starting point for our current research.

2.1 DIN PAS and ISO/IEC

To have a foundation to understand the ROME approach, it is necessary to take a look at the different existing standards for a structured development of e-learning proposals. Therefore it is also meaningful to consider the chronology of the German and the international development of the different standards. The German Institute for Standardization (DIN) published in 2004 the DIN PAS 1032-1 "Learning, Education and Training focussing in e-learning" (DIN, 2004). This PAS (Publicly Available Specification) includes a reference model for e-learning proposals for all processes of quality, development, implementation and evaluation. So the DIN PAS 1032-1 gives the team leader a scheme, on which he can rely during the developing, and different use cases. But this reference model is merely focused on the development of e-learning systems and the process structure, coming from a comparably technical perspective. Beyond the decision for an e-learning system is made before the learning objectives and the learners needs were analysed. Thus, the standard cannot be directly transferred to other learning processes and methods, i.e. talks between teacher and learner in the classroom.

After this DIN PAS has been introduced, different other standards were developed. The PAS 1068 (published in 2006) includes a directly description scheme with the motivation, that different e-learning systems could be compared by the components of this scheme (Arnold, 2013). The PAS 1069 (published in 2009) could be understood as a handbook or another reference model for DIN PAS 1032-1 and works, also as the DIN PAS 1032-1, with different examples. As the named standards focus the e-learning system development with a good quality management, the PAS 1037 (it's named in this paper to complete the German standards focussing on e-learning) foregrounds the quality management and introduces therefore a phase model. The PAS 1037 specifies the communication during the process priority.

All in all the different standards show, that they are a support for the planner of e-learning system developments. As the first standard, the DIN PAS 1032-1, describes the structured developing process, the other standards are more or less supplements with examples and concretizations.

Simultaneous to the first DIN standard in Germany, the first international standard for e-learning concepts has been published in 2005. The ISO/IEC 19796:1 describes a process model for the conception of e-learning systems in reference to the DIN PAS 1032-1. The ISO standard has been extended in 2009 by the ISO/IEC 19796:3, which completes the ISO/IEC19796:1 by a process model that includes different methods.

There is also a standard, the so called ISO 9000, which, as does the PAS 1037, focuses the quality management and looks secondary to the development of e-learning proposals. There are also some papers, which describe the adaption of the ISO/IEC 19796:1 for educational organizations (see e.g. (Pawlowski, 2007).

Obviously, all these standards follow the top-down approach, as sketched in the Introduction. This explains the publications, transferring the models on the field of education – like the QAM (Quality adaption model (Pawlowski, 2007) or ROME (Hambach, 2006). The standards are all starting with the e-learning systems and look for a structure or scheme for the development and for an appropriate content development. The learner as main stakeholder in the e-learning system development process and the multimedia decision – whether we need an e-learning system in the educational process or not – are not discussed. This chronological order has to be rearranged. We derived the demand for a model that works bottom-up and will not be obsolete, when the planner decides not to use e-learning units.

2.2 ROME

ROME is based on the DIN PAS 1032-1, but extends the model by a detailed process description and a detailed analysis of phases, tools, roles and artefacts. We will not describe ROME in detail in this paper, but give a short overview. As ROME has the same major drawback (the top-down approach), we sketch our critique in the following section.

As shown in figure 2 on the left hand side, ROME follows the phases: analysis, overall concept development, detailed concept development, production, introduction and teaching/learning. The distinction of overall concept and detailed concept is one difference to the DIN PAS 1032-1. Each of the phases is separated in different steps, which can be seen on the right hand side of figure 2. In the figure, due to graphical readability, we have not noted that the sub-steps of each phase might take place in a different order or even partly in parallel. Moreover, at the end of each phase, the step manage and evaluate allows for a spiral like re-engineering of the sequence of steps. Each of the steps has an associated list of roles, which show the responsibility to plan and execute this step. This is an important tool for the project management leader, who can use this to structure his team. Each of the steps results in artefacts, which can for example be documents, programming parts, data bases or other parts of an e-learning system. In addition to the process and step description in figure 2, ROME contains an elaborate role model, where several roles in the e-learning system design process are sketched, and an extensive resource model, where a list of potential resulting artefacts, their structure and their role in the whole process is given.

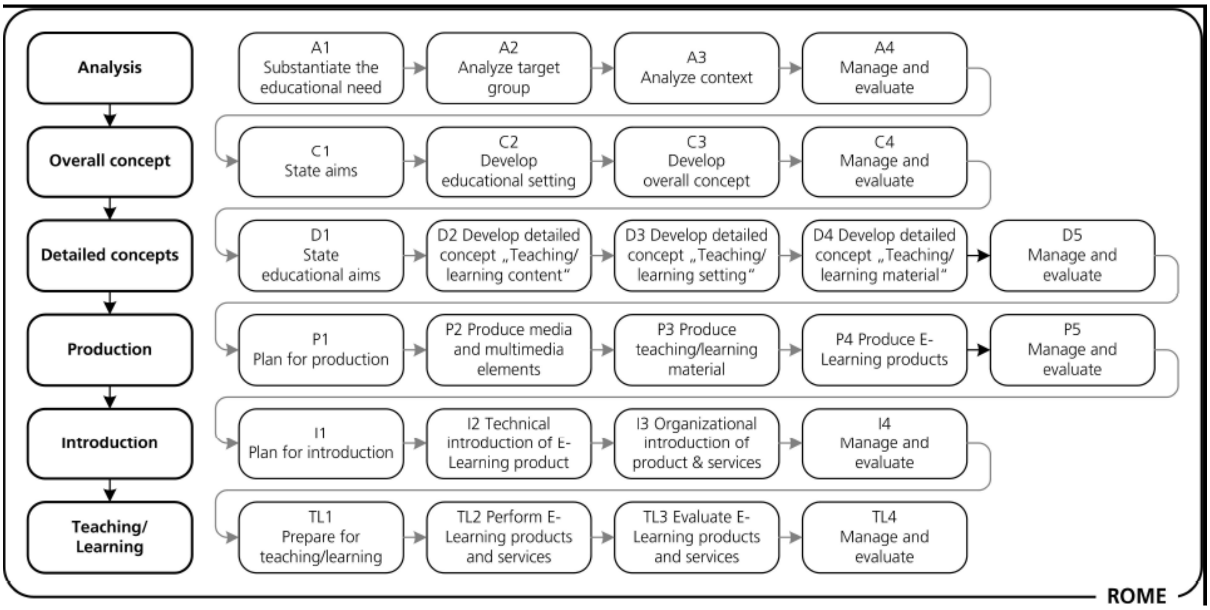

Figure 2. ROME process model for e-learning System development (Hambach, 2008)

In later works, ROME has been extended at different levels. For example, Harrer and Martens have developed a generic pattern language, which has its roots in intelligent tutoring systems and has later been refined and extended towards game-based learning and general e-learning systems (see e.g. (Harrer, 2007), (Maciuszek, 2011)).

From our perspective, ROME as a process model has become mid-level pattern, which is used as intermediate between other patterns, as can be seen in figure 3.

The top level pattern would be given by knowledge management patterns. In the context of multidisciplinary teams, these are usually communication management and time management techniques. One technique, which we like to use as kick off in e-learning project development, is the World Café method, which can be used to structure conversational processes. In addition we want to focus on the participation of all involved during the development process to consider various requirements of the stakeholders.

The related low level patterns are used by the computer scientists and designers in the team, and they are directly related to software development patterns (Gamma, 1995). We have also worked with task models and with content patterns from story design (Maciuszek, 2011), which are low level patterns for non-computer scientists, like for example story authors in role playing games.

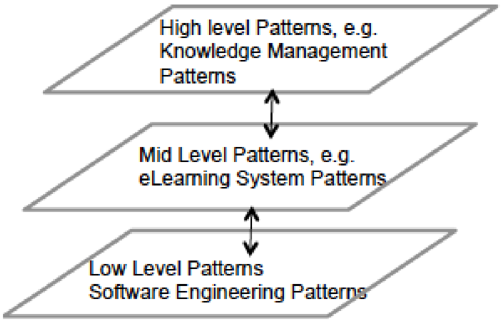

Figure 3. Levels of Patterns in Process Modelling

3. RE-ENGINEERING ROME

After using ROME for several years now, we have experienced the following drawbacks: even if ROME allows interpreting some steps as responsible for the instructional design (e.g. step C2 and D2 have been used for this purpose), an explicit integration of instructional design (or didactical design, as we prefer to call it in Germany) is necessary. Accordingly, after integrating instructional design, the design process as a whole is not any longer correct. If we are thinking in terms of instructional design, the decision for certain content and the reduction of this content to the educational purpose is missing as prior decisions. Thus, the process sequence analysis - concept - production is not valid any more. In ROME, a classical top-down approach is used, where the first step is to decide that an e-learning system shall be developed. The look at the person in the centre, the learner, is taking place comparably late in the process (see figure 2), after the educational setting is analysed.

In our bottom up approach, we use the sequence learner analysis, content analysis, content reduction, instructional concept, technical concept, evaluation concept and production. Moreover, also these phases can be re-visited in a spiral manner. We suggest starting with a specification of the target group (who is the learner and where should he learn?), followed by the analysis of the content (what shall be learned?). A very important step in this context, and flaw of quite a lot teaching and training approaches, is the missing instructional reduction of the content. This means that the content itself is not adapted to the target group, to the prior knowledge of the target group, to the cognitive level (or the assumed level), etc. After the reduction of the content took place, the instructional methods used for re-structuring the content in an instructionally adequate way must be chosen and the design of the content can happen. This, again, has to take the learner into account. Additionally, information about the learning setting must influence this design. After all these analysis and design steps took place, the decision about the e-learning system itself can be performed. A decision here can for example mean to decide for a certain form of e-learning (e.g. intelligent tutoring, game-based learning, simulation, etc). After that, the communicative process about how to bring content and computer system together can take place. However, at this point of development, this is mainly a technical, or software engineering decision.

Interesting in our approach is also the fact, that the usage of e-learning can be completely excluded: the design of an instructional learner centred process can lead to the decision to explicitly not use a computer in the teaching and training of certain content. Naturally, this is quire depressing for e-learning system developers, as we are, but we think that the idea to open up to this direction helps us to develop really useful and usable e-learning systems.

The next aspect, which is completely missing in ROME, is the design of the evaluation of the e-learning systems. In the last years, we found out, that so called empirical evaluation of e-learning is in most cases only on a very bad level: usually, hypotheses are missing; in most cases, the compared groups are not comparable, as instructional design varies between computer based and non-computer based setting; and in most cases, the evaluation is only used as a vehicle for justification of just another e-learning system.

Although another aspect is the knowledge management during the development. Different management techniques that focusses on participation of all involved stakeholders and quality management should not be excluded.

4. CONCLUSION AND OUTLOOK

Most of the e-learning systems, which can be found in research and even in commercial settings, are developed off scratch. This is surprising, as e-learning system development comes with comparably high costs, is very time consuming, and, on the other hand, lends itself for structured approaches. Moreover, diverse structured approaches exist since the early 2000s. As a small overview over the diverse approaches, we have focused in this paper our own work, which has started from the DIN PAS 1032-1, refined this towards the ROME model, which has been used as centre point for multi-level pattern developments. We have sketched these approaches in the section 2. However, after several years of using ROME, we found out, that our approach has some major drawbacks. Thus, we have decided to re-design ROME.

As ROME starts with the idea to develop an e-learning system and then takes into account learners and content (which is called top-down approach in this paper), we have decided to start at the roots: as the learner is the centre of each learning process, we develop a bottom-up approach, which is based on an analysis of the learner, and analysis and reduction of the content and an adaptation of the content to the learner.

Our current revision process of the process model ROME and the related patterns lead us to the idea to combine this with agile software development methods.

In order to adopt the idea and the principals of agile software development for learning processes, we will discuss the fundamentals of agile software development. Based on the "agile manifest" we accentuate the aspects communication, collaboration and flexibility (Beedle, 2001). These notes illustrate a continuity of feedback polish between all included persons and the possibility to adapt the product or the process during the development.

Remembering on the painted experience of actual developing processes, we could repeat the request of the following description: It is necessary to work hand in hand with the person, who is responsible for the content development, the didactic expert, the designer and the learner.

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A MODEL FOR UBIQUITOUS SERIOUS GAMES DEVELOPMENT FOCUSED ON PROBLEM BASED LEARNING

Sandro Oliveira Dorneles, Cristiano André da Costa and Sandro José Rigo
Programa de Pós-Graduação em Computação Aplicada (PIPCA), Universidade do Vale do Rio dos Sinos (UNISINOS)

ABSTRACT

The possibility of using serious games with problem-based learning opens up huge opportunities to connect the experiences of daily life of students with learning. In this context, this article presents a model for serious and ubiquitous games development, focusing on problem based learning methodology. The model allows teachers to create games based on problems. Besides, such games can be adapted to real-world scenarios, using context-aware information to enable interaction with real situations in that environment. The main scientific contribution of this work is related to teachers' autonomy, creating a motivating learning environment and fostering the relationship between theory and practice. To evaluate the model, we developed a use case, detailing the processes of game creation by the teacher, in an adaptive environment, and its use by the student. As a result, we expect greater student engagement in the proposed activities and to promote the development of higher order skills.

KEYWORDS

Problem-based learning, ontologies, serious games, ubiquitous computing.

1. INTRODUCTION

The spread of information and communication technologies is present and influences the social and professional life. Thus, there is no way to separate knowledge regarding Information and Communication Technologies (ICTs) from other areas of human knowledge. According to Carvalho (2011) "society and technology are inseparable phenomena and the changes that occur in one of them changes the other." This implies a new form of language and communication, which is perceptible nowadays in the consolidation of digital mediation, which must be applied to teach and learn. Holland and Holland (2014) reinforces that new technologies offer a great way to invigorate instruction, whether in traditional classrooms, online, or in blended learning environments.

As a result of this need, we observe an increasing use of methods to assist in the learning process, using the most assorted technologies. Thus, theories and learning methods that encourage and motivate students with the use of technologies gain strength, among them stand out the games and educational software (NETO and SOUZA, 2012).

The use of games to encourage motivation and assist in cognitive development is hardly a novelty (RIEBER, 1996), (GARRIS et al., 2002). However, the evolution and the combination of mobile and ubiquitous technologies allow expansion of the game into the real world (SEGATTO et al, 2008), (CHEN and HUANG, 2012), thus allowing space, time, and social relations to be part and interact with the rules of the game, permitting to expand student interaction with the object of study, regarding context aspects.

This article proposes a model for the development of serious games, called UCHALLENGE, fostering motivation in the field of education. This model uses ubiquitous resources as a way of interaction, thus enabling a real environment to be part and an extension for a playful learning. Associated with this technology, a pedagogical proposal is used, supported by the Problem Based Learning (PBL) methodology (BARROWS, 1980). With this, we hope to expand the autonomy of the student, through features and challenges, propose the construction of solutions to real or simulated problems, making them a motivator for learning, thus mobilizing different areas of knowledge.

The possibilities of expanding a game from the virtual to the real world, not only as a fun factor, but also with well-defined educational objectives, present new opportunities for interaction between knowing and doing. However, we are not referring to any game, but those that focus on learning purposes, the so-called serious games (CLARK, 1970; GIESSEN, 2015), whose main purpose is not only fun, but also training, simulation, marketing or education.

The expansion of the game into the real world is based on the possibilities of ubiquitous computing, as defined by Weiser (1991) and reinforced by Satyanarayanan (2001). The latter defines this concept as the "creation of environments saturated with computing and communication capabilities integrating them with users", allowing also the possibility to link and extend learning content with real situations of everyday life.

However, for this to be effective, it is important to create conducive conditions to the student in this autonomy process and search for knowledge. Therefore, we need to use learning methods that assist in the knowledge building, associated with information technology.

In the above-mentioned learning theories, which are presented to us, the question that arises is *how to find a conceptual and general epistemological model that incorporates technology to learning*? Several attempts of using educational games (SANCHES and OLIVARES, 2011), (NETO, 2012), (MORAN, 2012) have been tried as a proposal to assist in this process. However, some games end up emphasizing traditional repetition methods with a technological guise. Therefore, we must find ways to harness the motivation provided by the games to assist students in their knowledge building and autonomy, connecting the virtual and real world.

In this sense, the problem-based learning, hitherto restricted to specific segment of Medicine, has gained strength in schools, colleges and universities in different areas of learning (SAVERY, 2006). When using the problem based learning method, students are encouraged to think critically and they are given responsibility in building their knowledge (ÖZBIÇAKÇI, et al., 2012). Thus, learning is directed by the student in small groups, through problems, which are systematically resolved to achieve the intended educational goals, and seek autonomy, work, and cooperate in team skills.

Barrows (1980) points out that learning from problems is a condition of human existence and that learning occurs in our attempts to solve the many problems we face every day. Therefore, approaching and encouraging students through challenges in solving problems can significantly help in the process of learning autonomy. A serious game, using ubiquitous resources, can motivate and encourage the knowledge building, allowing for even more interaction between the student and the context, thus providing opportunities for more action in this process. According to Piaget (1967) cited by Clark (1974, p.11) "Intelligence is born of action, and anything is understood only to the extent that is reinvented."

Consequently, the goal of this work is to specify and evaluate a model for creating educational serious games that use resources of ubiquitous computing, using a methodology based on PBL. As a result, we expect the model to provide greater motivation for the student, thereby creating new learning opportunities. The main scientific contribution of this work is to enable the teacher to create a real learning environment that fosters the interaction between theory and practice.

This article is organized into five sections. Section two presents related works. Section three discusses the proposed model in details. A case study showing teacher and student role is presented in section four. Finally, we discuss the conclusions and directions for future work.

2. RELATED WORK

Several studies address serious games, using concepts of mobile and ubiquitous computing. As the target of this study, we selected models that jointly dealt with the issues and had, as main point, learning goals.

Huizinga (2008) points out that "every game is able at any time to fully absorb the player" setting for that social, temporal, and spatial aspects. The use of ubiquitous games creates the possibility of expanding these aspects, thus increasing the contractual magic circle of a game (MONTOLA, 2005), creating new social, spatial or temporal relations beyond the virtual world, facilitating the expansion to the real world. The authors also suggest ways and use of technologies for creating ubiquitous games for educational purposes.

Chang et al, (2009) presents an educational game, supported by mobile technologies. In the proposed model, they employ location, geographic information systems (GIS), and sensors such as Radio Frequency Identification (RFID), to develop a ubiquitous learning environment. The aim of the proposal is to improve the students' participation in the planned activities, targeting to study a course whose learning area covers Taiwan culture.

Laine et al., (2010) reports studies performed within a period of three years by the team at the Ubiquelab from Eastern Finland University. The study discusses possible uses of technology in school, through a model for games based on pervasive learning spaces (Pervasive Learning Spaces - PLS). Experiments are laid out based on the development of ubiquitous games using a hipercontextualized design model, that is, "where the game is rooted in the same context in which the player is embedded" (LAINE et al., 2010).

Liu and Chu (2010) present the results of a game and its ubiquitous possibility targeting English learning, and also motivation in that regard. The model, called HELLO, integrates cameras and Quick Response Codes (QRcodes) tags distributed in the learning environment, allowing the student interaction in the available contexts.

Weatherlings (KLOPFER et al. 2012), is a collectible strategy game card, similar to several other games (Trading Card Games - TCG). In this game, the user assembles a custom deck, combining strategic battles, to play against other opponents. The deck is composed of weather creatures and the information available to students is composed of sources of weather data. The activity allows the interaction of students with real data regarding climate and weather. According to Klopfer et al. (2012), the game aims to provide users to "be able to read successfully weather tables to plan appropriate strategies to actual historical weather data."

Chen et al. (2012) presents a model and results of a Ubiquitous system called adventure game (RPG) learning system based on the game. The authors aim to improve the learning experience through ubiquitous games. Thus when students are doing the learning activities, the system will record the path of learning through GPS device, text files and progress. When the game ends, the system shows the learning progress and related content.

All models considered have some ubiquitous characteristics, which can be understood as "the coordination of intelligent devices, mobile and stationary, to provide users immediate, and universal access to information and new services transparently, to increase human capabilities" (SANTAELLA, 2013). Hence, considering these related works, one can consider that some aspects such as the method of learning and motivation from the real world to the virtual intersection can be better exploited.

The models presented do not allow the creation and adaptation of the game by the teacher and there is neither ontology that manages the steps of the proposed challenges, nor adaptation scenarios that can be used in different areas of knowledge.

3. PROPOSED MODEL

The proposed model, called UCHALLENGE, seeks to provide a possibility of creating serious games supported by the PBL methodology. In the proposal, the teacher can manage the game by setting the domain to be used, content, problems, and challenges that will be available at each stage of learning. Other characteristics that the teacher manages include the scenario and the ubiquitous resources that can be integrated in the context in which the game will take place.

UCHALLENGE is based on three aspects: ubiquitous computing (WEISER, 1991), (SATYANARAYANAN, 2001), serious games (CLARK, 1974), and problem-based learning (BARROWS, 1980). Thus, the following aspects take part of the model:

• to be adaptable to different domains, allowing the teacher to organize the game according to the area of interest;

• to allow the insertion and use of information: the teacher has the possibility to manage the database as needed, making use and reuse of existing data;

• to provide the creation of problems and challenges: to enable the teacher to develop problems and sub-problems and the challenges that will be part of each stage of the game;

• to provide environment information: to enable the teacher to generate challenges that can be adapted to the context, defining the points of interaction;

• to manage problems and challenges, so that the student can receive the challenges in each stage of the game and level of learning;

• to use an ontology, based on Bloom taxonomy (Bloom, 1956 apud Chan et al., 2009) and its cognitive objectives, providing challenges, content and problems according to context and development of the student, taking into account an increasing complexity;

• to store game results, including paths followed by the student during the game;

• to manage the game, enabling students to start a game or resume where it left off before;

• to support ubiquitous resources and contexts, including QRcode , RFID sensors and geolocation systems;

• to allow the interaction between users and teachers, providing communication between users to discuss and solve game challenges, as well as interventions and feedbacks;

• to foster social integration, enabling access to social networks for exchange and dissemination of information;

• to be attractive, fun and motivate the student, so that the user want to continue playing.

Figure 1 presents the UCHALLENGE model. Generally, the architecture is divided in two components: teacher and student modules.

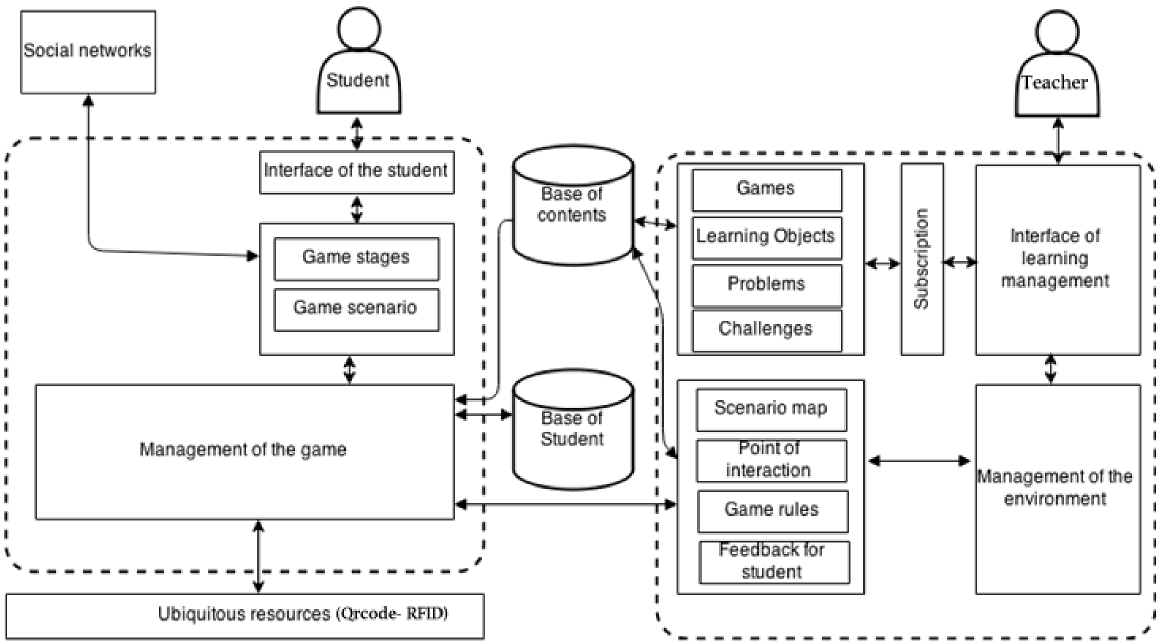

Figure 1. UCHALLENGE Model

The tutor module initially presents a learning management interface, in which teachers can access and manage the game, content, problems and challenges that will be used. Moreover, in the tutor module, the teacher can manage the map of the scene, defining the points of interaction and the rules of the game, as well as the feedback to students. The points of interaction and environmental challenges are defined on the map of the scene and converted to sensors that will be distributed, as defined by the tutor.

The student module displays the home interface, wherein the available games are displayed. When selecting the game, students receive the first step, or, if they had already started, obtain the corresponding step, and the scenario with the possible points of interaction. The management of the game controls the rules, history, access to the base of the student and content, besides enabling the use of ubiquitous resources available, as geographical location in relation to the scenario, communication with the available sensors and points of interaction.

The selection of challenges and problems offered to the student, are defined using an ontology, as in Figure 2. The ontology is based on the educational objectives defined by the teacher, from the cognitive processes established by Bloom (1956) and reinforced by Chan et al., (2009). Thus, levels of increasing difficulty will be presented to the student representing an evolution in their learning processes.

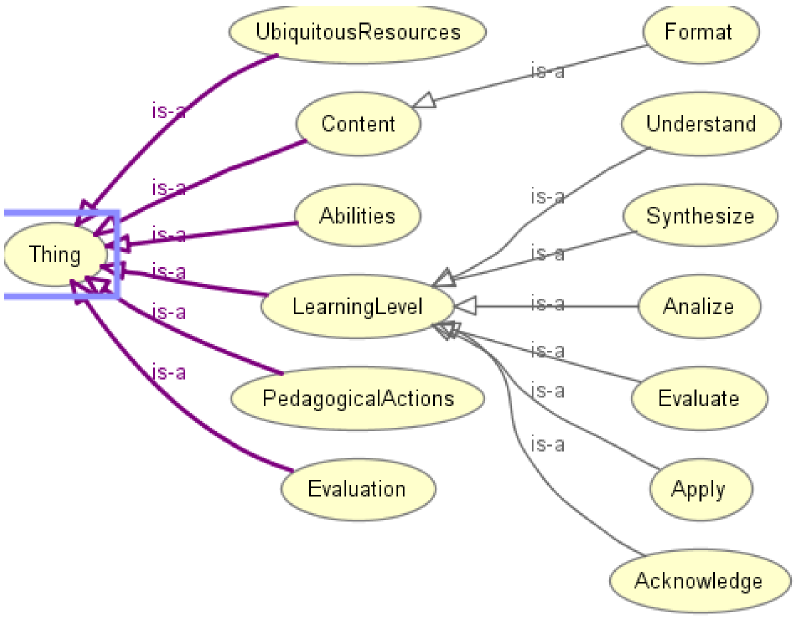

Figure 2. Relationship of the main classes of the ontology

4. CASE STUDY

To evaluate the UCHALLENGE model, we developed a case study to analyze usage scenarios in relation to the teacher and the student interaction. The scientific community has been using scenarios to evaluate mobile and ubiquitous computing projects (DEY, 2001; SATYANARAYANAN, 2001 and SATYANARAYANAN, 2011). Therefore, we proposed a scenario for a lesson in a History course. This scenario was evaluated with a developed prototype. The teacher's web interface has been developed in PHP language and Javascript using MYSQL database. For the student interface, we used the Android platform and developed an application using HTML5.

A History teacher has been teaching Global History, particularly Middle Ages, with the class. Upon bringing the subject on the early 11^{th} Century, comes the need for students to make reflections on what aspects led to the Crusades and how it is possible for them to relate this concept to the present day. In order to encourage students to better learn the historic facts regarding the Crusades, the teacher will make use of UCHALLENGE to build a game set in a park, which simulates medieval forests. With the access to the server through the Web, the teacher logs on into the learning management interface.

In this interface information concerning the game are defined, such as: Area of knowledge: "Human Sciences"; Assessment area: "History"; Theme and the game: “Crusades”. The teacher defines the game scenario, from a map, which obtains the geographic coordinates of the specific park (Figure 3). The student then loads this piece of information. The teacher also registers the main problem to be solved: *Why was the Holy Land the cause of many conflicts between Muslims and Christians? This conflict still exists today?*

In the UCHALLENGE environment, the teacher registers also learning objects that will be available to the student’s research, as well as, problems and challenges. By registering the problems, the teacher needs also to define sub problems to be presented to the students in different stages of the game, as the following example:

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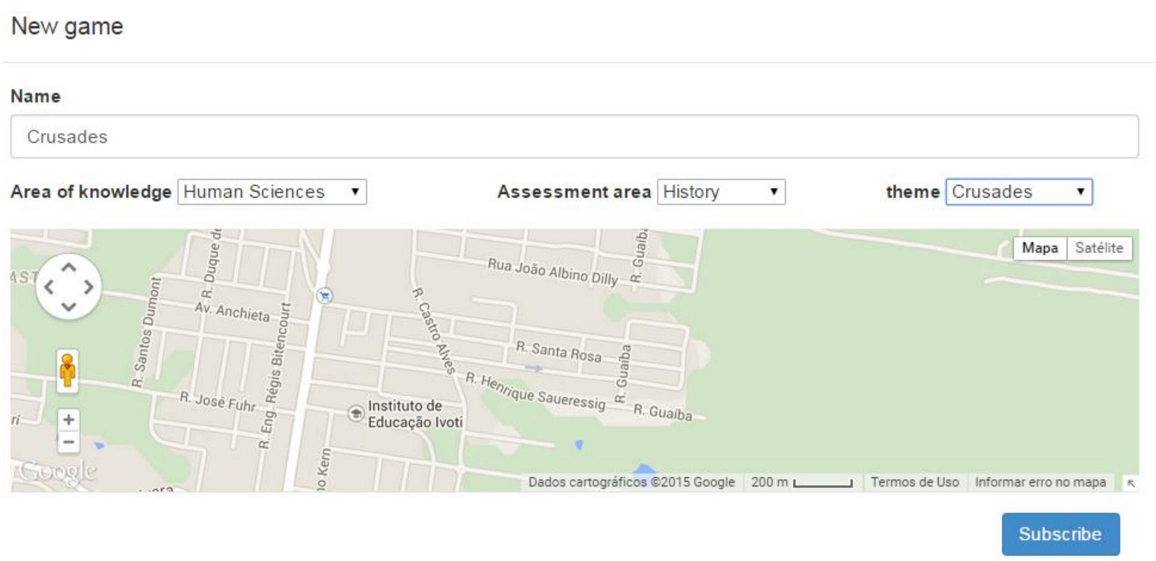

Figure 3. New game development: Selecting the place

- What happened between 11th and 13th Centuries in Europe?
- Do you know what the Crusades were?
- What were the reasons that led to the formation of the First Crusade?
- Which countries were involved in the battles and what were their real objectives?
- Which issues are still reasons for dispute today?

The contents, problems and challenges available are uploaded from the content base, in which they are identified by area of knowledge, assessment area, subject and pedagogical goals, so that they may be inferred by the ontology and presented to the student as the progress of the game.

Teachers prepare the environment of the game, selecting through a specific tool, the map coordinates with the game scenario information. In this defined scenario, the teacher will use QRCode and RFID sensors to create points of interaction with the player. These sensors contain specific clues to solve the problems or challenges during interaction with the context. The created points of interaction are displayed on the map of the environment and loaded later, from the player's position. After finishing the game settings, the teacher physically makes the sensors available in the game scenario, releasing the environment for students.

The student will have to register in advance in the system, after authentication (Figure 4a) the new games or the games in progress will be showed. After the game selection, students can access information about other players who are in the same game and may interact to each other to solve challenges or proposed problems. The interaction may be through messages or contact through social networks, if there is such a possibility.

The student, after registering, connects with the online server via a mobile device, which shows the available games (Figure 4b). Once the game starts, the student receives the main question, as well as a number of small problems on the subject (Figure 4c). The path chosen by the student, within the proposed scenario, will define what challenges and problems will be offered. The game map (Figure 4d) presents its geographical position in the scenario and possible interactions. Upon arriving at the point of interaction, the student drives the marker, thus, the QRcode reader in the mobile App is enabled to capture the information available on the tag. Such information may have practical or theoretical challenges to be solved in the environment. Consequently, the result of the challenge ensures to the student points or important tips for the next steps. At any time of the game, one student can share information with the others, through messages related to the challenges posed.

The teacher defines the rules of access to learning objects. They may be, for example, objects in text or multimedia format accessed freely for consultation. Alternatively, its is possible to specify that some content costs a number of knowledge coins, which are acquired through the solution of a Quiz, challenges, or extra missions that are presented in the game scenario.

(a) (b) (c) (d)

Figure 4. Initial Player Screens

In addition to the knowledge coins, the player also receives a score for each correct answer. Each time the student reaches 100 points, it can answer the problem proposed to that step, enabling the student to move to the next level.

The problems and challenges presented to the student are inferred in the ontology, through pedagogical objectives previously registered by the teacher, based on Bloom taxonomy of increasing complexity. After passing through all steps in the scenario, the student must still solve the main problem. The student may make use of the knowledge and experiences acquired during the game to present a possible solution that will be evaluated by the teacher.

At the end of the game, the student receives feedback from the teacher and share experiences and doubts, enabling new reflections on the working theme and analysis of the results obtained. From these results, the teacher may decide to review a subject or to create new possibilities to work with the class.

5. CONCLUSION

The UCHALLENGE has shown to be a viable option for building serious and ubiquitous games focusing on problem-based learning. The main advantage of the model is the real possibility of motivation of a student for a type of learning able to mobilize a set of cognitive resources and apply different knowledge using Problem Based Learning.

The proposed model presents, as the major scientific contribution, the viability of adapting different scenarios and areas of knowledge in a proposal of reflection on theory and practice by the means of solving problems. Unlike this proposal, the related works considered for this paper focus on specific approaches and with limited use of ubiquitous resources. A case study showed the viability of the model for preparing a class combining the real and virtual world.

As future work, we intend to review the creation of the game in a pedagogical perspective and the usability in different areas of knowledge. Besides the evaluation of the student in a real scenario, we plan to analyze aspects of motivation and engagement in the activities proposed, as well as its reflection in the students learning.

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BLENDED INTERACTION FOR AUGMENTED LEARNING-AN ASSISTIVE TOOL FOR COGNITIVE DISABILITY

Suman Deb[1], Subir Saha[1] and Paritosh Bhattacharya[2]
[1]Computer Science and Engineering Department
[2]Mathematics Department
NIT Agartala, India

ABSTRACT

The fundamental right of education and employment for cognitive disable person is recognized in very recent times. With the advent of technology there have been many interactive way to combat with the challenges of disability and provide supplement training for enabling the challenged person with the skill of employability, so that they can individually lead the normal life without depending on others. In this work we try to identify the problem faced by cognitively week people and find appropriate solution by introducing computer aided interaction. We proposed a platform to blend audio and depth vision for augmented learning. The primary goal of this work is to create a play way teaching environment for individuals with learning disability so that the enhanced method help them for elementary education and provide self-confidence and motivation and encourage for continuous learning. While implementing, the system has shown significant improvement on learning by a range of people including learning challenged and normal kinder garden kids. The augmented method proposed here can be added advantage with the concept of visual teaching, live experience and reactive and pro-active mechanism rather than reading static content from book. This will also involve the physical movement with precise control that can lead to motivated control of limbs by any neuro motor disability effected person.

KEYWORDS

Depth Vision, Hand Joint Recognition, Voice Recognition, Cognitive Map.

1. INTRODUCTION

A cognitive disable child, besides processing a low I.Q, demonstrates impaired or deficient adaptive behaviour originating from conception and continuing into maturity. They fail to learn what average children learn and find difficult to detect an absurdity in a logical statement. They are also limited with respect to imagination. They remain behind their classmates and become bitter and hostile towards them and others. Repeated failures deprive them of confidence and lack the motivation to learn. In a highly technological age, where talent are very much needed, dissipation of human resources is great problem .We can hardly ignore the gravity of the problem and the care education and training of these children are of great importance and significance. Main deficits that people with cognitive disabilities demonstrate are:

A. Memory: Memory refers to the ability to be able to recall what has been learned over time. Meaningful information is typically moved from sensory memory (stored for seconds) to working memory (stored minutes) and then stored in long term memory. People with cognitive disabilities have difficulty with one of these types of memory [1].

B. Problem-solving and attention : People with cognitive disabilities often have difficulty problem solving. One difficult problem arise, such as learning new material in class, they can typically become frustrated and have difficulty expressing their frustration and have difficulty focusing on the task [1].

If we teach the children who faces some kind of learning disability, in more interactively and visualize the teaching content as natural environment rather static content, they can find interest in learning and develop feelings of power to overcome difficulties and accumulate a sense of self satisfaction. So far many interactive systems have been developed but very few interactive systems were developed to educate them based on what has been taught in the class room. Interactive learning provides keen interest in learning and makes learning fun therefore they can remember things more easily. The main focus of this paper is to develop an interactive learning platform for assisting them to learn more quickly through playing and visualization. Microsoft Kinect sensor is used for making the system. It contains one IR sensor and IR emitter to process depth data. It will return depth data of a point with 16 bit gray scale format with a viewable range of 43 degrees vertical and 57 degrees horizontal [2]. The depth data contain the distance between the device and the object in front of the device. For example, if a pixel coordinate is 200 x 300, the depth data for that pixel point contains distance in millimeters from the Kinect device .figure [1] shows the depth data processing of the Kinect device.

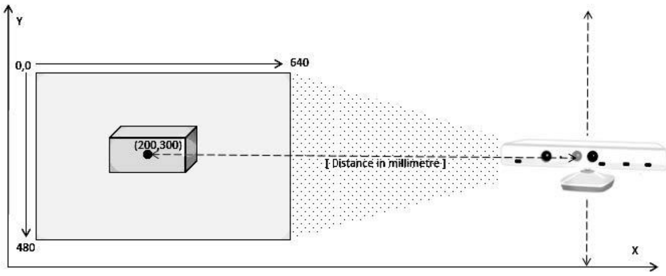

Figure 1. Depth Data Processing [2] of Kinect Sensor

In this proposed prototype Kinect Microphone Array and Kinect speech recognition engine are also used to recognize the speech. Advantages of using Kinect sensor is that it provide us 20 point human skeleton [2] through which gesture can be easily recognized. Moreover the Kinect microphone array have the capability to Identify the source direction of the incoming sound and helps to recognize human speech very clearly by focusing only in a particular direction and cancelling noises in the environment. Figure [2] shows the 20 point skeleton joint of human body return by the kinect sensor.

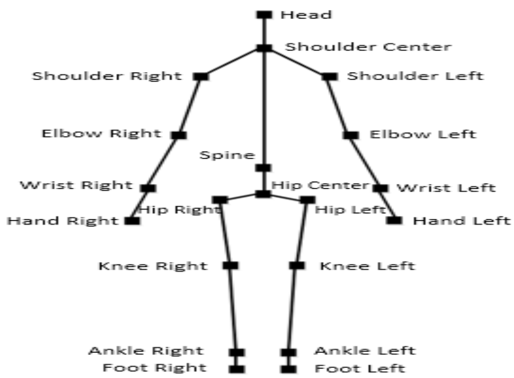

Figure 2. 20 point Skeleton joint [2] of human body

2. EXISTING WORK

Interactive building blocks [5] were developed for the children to learn the concept of geometric structure and shape. First time the system deployed a picture and gives some instruction to build the object. A pattern recognition algorithm is used to compare the children assemble object with the displayed picture .Virtual Laboratory[6] has been developed by using kinect Unity 3D and gesture classification algorithm which is mainly used to assist students to gain interest on particular subject. In paper [7] author developed a useful interactive tool for learning math using blender and Kinect to make learning more visual animated and lively. In paper [8] author developed a e-learning system where a student in remote location effectively interact with the professor by hand gesture. Therefore professor can pay equal attention to both the remote and local student. In paper [9] author proposed an interactive learning platform which combine the full body motion sensing a virtual environment. Therefore student can enter into the virtual environment and have interaction with the object and the virtual character gives some response to this student.

3. SYSTEM ARCHITECTURE

3.1 Hardware and Software System

Kinect was launched on 4 November 2010 by Microsoft and built specifically for the Xbox 360 gaming console. It enables the user to interact directly with the Xbox, allowing the user to perform touch-free operation. The key components of Kinect are (1) Multi-array microphone, (2) IR laser emitter, (3) IR camera, (4) Motorized tilt, (5) USB cable and (6) RGB camera .Below figure [2] shows the key component of the Kinect sensor. Microsoft visual studio 2010, C#, kinect for windows SDK and in back end Microsoft Sql server 2008 is used to develop the system.

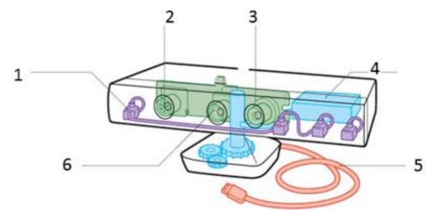

Figure 3. Block diagram of Microsoft Kinect Sensor [3]

3.2 Proposed System

In this work we created a platform where the sensor take the depth information of the object and send it to the process box. This process box performs depth identification ,depth analysis and depth derivation , after analyzing the depth data the computer create their own vocabulary and make a mapping of that vocabulary and store it for future use . Over view of our proposed system are shown in figure [4].

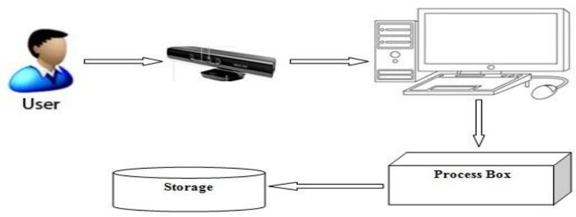

Figure 4. System Architecture of the Proposed System

We divide the system into two phases.

A. Encoding phase

B. Recall phase.

A. Encoding Phase

In this phase when a child comes in front of the Kinect sensor it will first extract the skeleton by processing the depth information and identifies the hand joint. Through this it will recognize the hand portion of the children, after that when the children moves his/her hand in front of the sensor it will map the hand point and draw the object into the computer screen according to the hand movement. After drawing the object he/she assign any pre defined name of this drawing object. The Kinect sensor first recognize the assign name using the Kinect speech recognition engine and mapped the drawing object with given name and store the mapped information into the database. This step was performed repeatedly for acquire accuracy in decision making. Work flow diagram of encoding phase is shown in figure [5].

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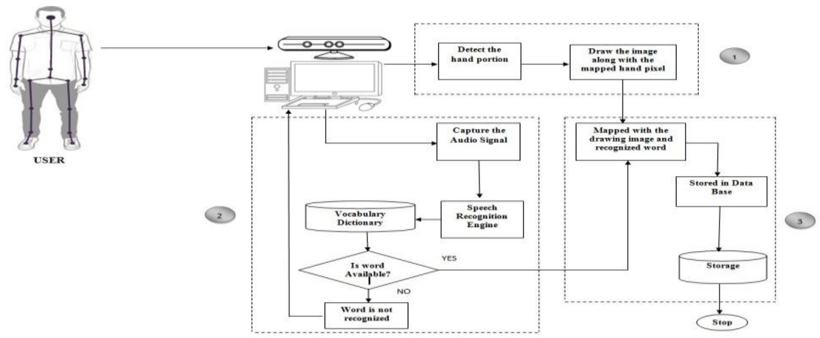


Figure 5. Workflow diagram of encoding phase.

B**.** Recall Phase

In this phase when a child says any word in front of the sensor, it starts its speech recognition engine for recognising the word. If the word is successfully recognised then the system will try to find the mapping between the word and the image from the database. If mapping is found then the image corresponding to the recognized word is displayed in the screen. Below figure [6] shows the workflow diagram of the recall model.

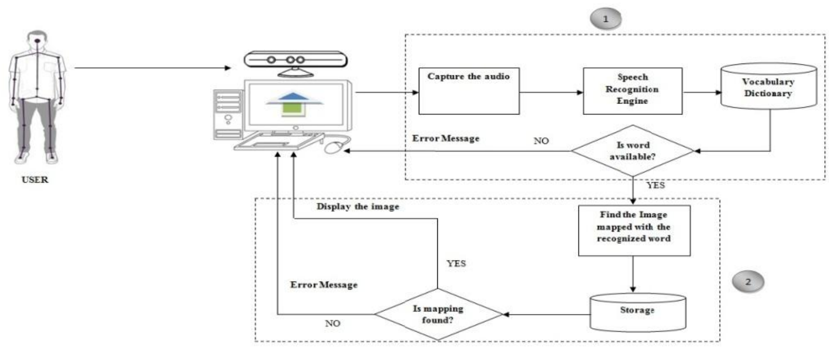


Figure 6. Workflow diagram of recall model

3.3 Algorithm Used

3.3.1 Algorithm for Hand Portion Recognition

Position of both hand for making interactive learning are acquired after skeleton analysis of depth image data return from the Kinect sensor. Following algorithmic step was performed to detecting Hand portion.

Step 1*: Capture the x,y,z coordinate of all 20 skeleton Joint*

Step 2*: Analyse the x,y coordinate of all joint*

Step 3*: Compare the coordinate as*

If(x,y coordinates around hand) {

If(x,y coordinates around Hand_left) {

Left hand is recognized.

}

Else {

Right Hand is recognized.

}

Else {

Hand is not recognized go to Step 2.

}

Step 4*: stop*

3.3.2 Algorithm for Speech Recognition

Recognizing the Speech we are used Kinect Speech recognition Engine. The speech recognition engine consists of the following two major modules [2]:

- Acoustic model
- Language model

Each one of the modules has a sole responsibility for recognizing speech. The following is the list of operations performed for recognizing the speech:

Step 1*: Microphones capture the audio stream convert the analog audio data into a digital wave.*

Step 2*: The audio sound signals are sent to the speech recognition engine to recognize the audio.*

Step 3*: The acoustic model of the speech recognition engine analyzes the audio and converts the sound into a number of basic speech elements; we call them phonemes.*

Step 4*: The language model analyzes the content of the speech and tries to match the word by combining the phonemes within an inbuilt digital dictionary as.*

If (the word exists in the dictionary) {
Recognize the word
} Else {
Word is not recognized.
}

Step 5*: Stop.*

4. MACHINE LEARNING USING COGNITIVE MAP

The word cognitive map refers to a process of mental activities which abstract the information from a real world scenario and encoded into the memory for automatic recall [4]. It represents the cause – effect relationships of event in knowledge. Modelling of cognitive map using fuzzy logic is called fuzzy cognitive map. It has been recently been introduced in the field of machine intelligence coined by Barl kosko [4].It is a graph structure capable of encoding knowledge. In this work we used Pal and Konar’s Fuzzy cognitive model (FCM). In this approach they represent cognitive map as an associative structure consisting of nodes and directed arcs where the nodes carry the fuzzy belief and the arcs or edge carry the connectivity strength [4].Here we represent each recognized word and the image associated to the word as a node and the edge between the nodes represent the connectivity strength. Below figure [7] shows the cognitive map of the proposed system.

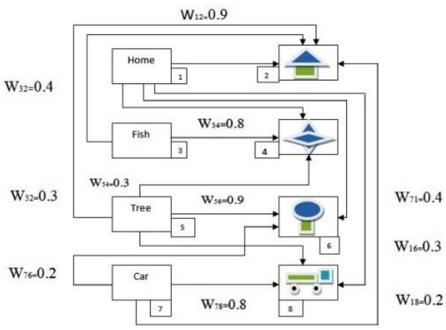


Figure 7. Cognitive map of our proposed system.

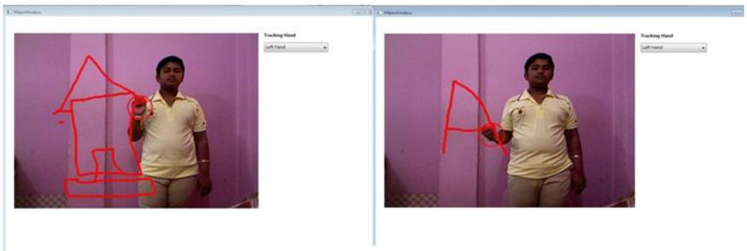
It follows the encoding and recall cycle to build the cognitive map. Process of creating fuzzy cognitive map of our system is as follows.

Let ni, nj be the fuzzy belief of node Ni and Nj.

> ***Step1**: Represent each recognised word and drawing object as node.*
> ***Step 2**: follow the Hebbian learning to find self mortality of Wij as:*
> $\partial W_{ij}(t) = \alpha W_{ij}(t) + S(n_i(t)).S(n_j(t))$. *Where*
> $S(n_k) = 1/[\exp(-n_k)]$ *for* $k = \{i, j\}$. α *represent the mortality rate*
> ***Step 3**: determine the recall model as*
> $n_i(t+1) = \mathrm{Max}\,[n_i(t), \mathrm{Max}_k\{(n_k \,\mathrm{Min}\, w_{ki})\}]$
> ***Step 4**: repeat step 2 and 3 (Encode-Recall Cycle) until steady state condition is reached.*
> ***Step 5**: Stop*

5. EXPERIMENT AND RESULT.

For measuring the accuracy, we test the proposed system several times and found that the performance of encoding and recall cycle is satisfactory. Following figure shows some of screen shot while testing the system.



1 **2**

Figure 8. Screen shot while testing encoding phase of the system

Figure 9. Screen shot while testing recall phase of the system

The results in Tables show that in the majority of the attempts are successfully recognized and the corresponding object are displayed in the screen. This system is tested on different noisy environment and it will produce the accurate result irrespective of any noise. The overall accuracy of the system is about 85%.

Word	Number of attempts	success	failure	Accuracy (%)
Home	50	43	7	86
apple	50	41	9	82
orange	50	42	8	84
car	50	40	10	80
tree	50	38	12	76
fish	50	45	5	90
Sun	50	43	7	86
Moon	50	44	6	88
			Average Accuracy	84

Alphabets	Number of attempts	success	failure	Accuracy (%)
A	50	42	8	84
B	50	41	9	82
C	50	43	7	86
D	50	45	5	90
E	50	46	4	92
			Average Accuracy	86.8

Numbers	Number of attempts	success	failure	Accuracy (%)
1	50	47	3	94
2	50	45	5	90
3	50	41	9	82
4	50	44	6	88
5	50	42	8	84
			Average Accuracy	87.6

Operation	Number of attempts	success	failure	Accuracy (%)
Plus	50	46	4	92
Minus	50	42	8	84
Multiply	50	41	9	82
Divide	50	43	7	86
			Average Accuracy	86

Figure 10. Accuracy matrix of different test case.

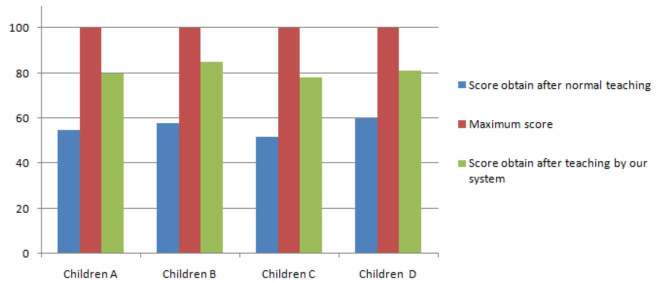
This system is tested on four children who suffer from this disability. First of all we taught them in traditional classroom system based on text book and take a test and the score obtain by each individual are recorded. After few days we taught them the same content using our system and again arrange a test. Significant improvement was found between two score card. All the children secured better score than the previous one and the encouragement of learning among the children is remarkable. They find more interest and motivation to learn and remember things more quickly. Figure [11] shows some experimental result of our proposed system.

Participating Children	Score Secured
Children A	55
Children B	58
Children C	52
Children D	60

[a]

Participating Children	Score Secured
Children A	80
Children B	85
Children C	78
Children D	81

[b]



[c]

Figure 11. [a] Score obtain before after normal teaching [b] Score obtain after teaching by proposed prototype [c]Graphical representation of the experiment result.

6. LIMITATIONS AND FUTURE WORK

In this proposed system some pre-defined word are stored in the vocabulary dictionary and only those word can be recognized by the Kinect sensor and corresponding image are drawn in the screen and mapped information will store in the database. These limitations can be overcome by making the vocabulary dictionary dynamic, therefore any word can be recognized by the system. More over this system can be used as a platform for device and appliance control at any place so that it will work as a assistive tool for aged and physically challenged people.

7. CONCLUSION

The main problem of the children with cognitive disability is the lack of interest and motivation to learn. Therefore a special type of care should be taken so that they can find themselves with higher self-confidence and stimulus environment for learning. The primary motive to achieve a mechanism for continues interest building towards learning has been significantly achieved. In this paper the proposed audio visual augmented interactive learning tool not only enhances the performance of the children effected by cognitive disability, but can also be used as significant support system towards elementary teaching to all level of children. The crucial accuracy of the system is 80-95% in achieving time versus learning outcome, which is a promising result and encourages the children to gain interest in continuous learning and make learning fun. This proposed first prototype is undergoing several real-life calibration like lighting condition, mobility, multilingual support etc. , refinement for individual proficiency and machine guided learning endeavored as a future goal of the work.

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STUDIES RELATING TO COMPUTER USE OF SPELLING AND GRAMMAR CHECKERS AND EDUCATIONAL ACHIEVEMENT

Dr. Odette Bourjaili Radi (PhD)
Faculty of Education , La Trobe University, Victoria, Australia

ABSTRACT

The content of this paper will focus on both language and computer practices and how school age students develop their literacy skills in the two domains of 'language' and 'computers'. The term literacy is a broad concept that has attracted many interpretations over the years. Some of the concepts raised by the literature apply to both language and computer literacy issues. Hence, this paper is intended to review the literature in areas: such as the definitional and conceptual issues of literacy; the development of language literacy (formally assessed in the areas of reading, vocabulary and comprehension) skills, but which also incorporates handwriting practices; computer literacy which applies to the acquisition and development of computer skills, particularly those associated with spelling and grammar checkers; the evolution of computer literacy to include new technological components emerge and interlock in computer usage to encompass Information and Communication Technology (ICT) literacy and its applications; in conjunction with the revelations of studies relating to computer use of spelling and grammar checkers and educational achievement.

KEYWORDS

Reading, Writing, Language and Computer Literacies, Spelling and Grammar Checkers.

1. INTRODUCTION

Today, "technological change happens so rapidly that the changes to literacy are shaped not only by technology but also by our ability to adapt and acquire the new literacies that emerge" (Leu et al 2004: 1591). In addition, Atkin (1998: 12) suggested that our current youth live in the emerging world, a world of transition and with a global and local focus: "life-long learners, learning to learn, contextualised and transformative". The use of electronic medium/computers has influenced the way young people in what Tapscott (1998: 1) referred to as the Net-Generation, perceive and transform the traditional written language into a language of their own, shaped by short conventional text messaging and online-chatting and reading. Children (the Net-Generation) are more perceptive and willing to exploit the electronic devices by engaging in the digital culture to construct self-identity and community (Mountifield: 2006). These changes have made computer literacy skills more available to include interactions and communications through social events and practices (Street 2001: 11). The acquisition of language literacy differs from the acquisition of computer literacy in their achievement and learning development. The school aged children live in the emerging world (Atkin 1998), a world of transition and with a global and local focus. The Net-Generation has the opportunity to use the computer and their tools (spelling and grammar checkers) to present their work in a traditional form rather than in the variety that they invented. Many students trust the spelling and grammar checkers because they are very unsure of their own spelling and grammar (Sinclair 2010).

2. RESEARCH METHODS

I will adopt a triangulation approach including both quantitative and qualitative methods using a mixed methods design for two-phase study. In Phase 1, language literacy tests consists of reading, comprehension and writing, will be administered to 150 year 9 students. Pre-survey was conducted to seek students'

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perceptions of the usefulness of the tools. The quantitative data from the first phase will sequentially be integrated into the second phase where qualitative methodology will be used to obtain a deeper understanding (McMillan and Schumaker 2006, Creswell and Garrett 2008) of the influences of the tools on the students' English writing. To elicit qualitative data, I will observe the students in their classes, analyse their writing and interview them and their teachers.

3. DEFINITIONAL AND CONCEPTUAL ISSUES

Literacy definitions have expanded from an original focus on just reading and writing to include additional types relating to many aspects of contemporary society. Issues relating to literacy definitions have reflected many dimensions and explanations from different perspectives and disciplinary areas. Theorists such as Street (1984) have distinguished between an autonomous model and an ideological model of literacy. In the autonomous model, literacy is defined as a set of value-free skills, like decoding the printed words into sounds (decontextualising text) (Street 1995: 18 – 19). Viewed from this perspective - the acquisition of reading and writing skills is simply a cognitive process. The ideological model is recognized in a multiplicity of literacies and practices to specific cultural contexts. Both models of literacy have been interpreted in different ways by different scholars. For example, Blake and Blake's (2005: 172) interpretation of the autonomous model is "the prevailing Western view of literacy, a single thought". In extending a modified view of literacy into the social domain, Bélisle (2006) included three complementary approaches to literacy that stood out in educational analysis:

> *an autonomous model of literacy is based on the assumption that reading and writing are simply technical skills; a socio-cultural model, based on the recognition of all literacies as socially and ideologically embedded; and a strong claim model based on anthropological statements of the revolutionary power of instrumented thinking processes (p. 52).*

The autonomous model has been criticised many times over the years as a result of questioning its strategies, applications and goal directions, particularly in response to the rapid development of technology and its wide use, by all ages, in contemporary society.

4. DEFINING LANGUAGE AND COMPUTER LITERACIES

Attempts to define language literacy have extended well beyond reading and writing. The varied disciplines defined their respective literacy in accordance with their research and study areas (functional, cultural, political and other literacies). An additional type of literacy is computer literacy. Hence, Street's (1984) autonomous and ideological models of literacy that were subsequently replaced by the notions of literacy events and practices, partially apply to computer literacy. Many technological dimensions have been considered in moving to the current term of ICT and digital literacy (Avila and Moore 2012).

Understandings of computer literacy includes literacy events with many dimensions underpinning literacy practices at the global level such as information, visual, technology and digital literacies (Cohen and Cowen 2008). Taking into consideration the relation to computer literacy, Fehring (2010: 183) stated that there are two "interlocked components of the concept of multiple literacies"; one refers to the multiple forms of literacy now required to operate in the world of education and work; and the other concept of multiple literacies refers to the "multimodal and multidimensional aspects that the learning of literacy skills now encompasses". Hence, Fehring (2010) asserted that the concept of multiple literacies has had a powerful influence on classroom practice: "Multimodal and multidimensional curricular have become the standard for students from the young age to lifelong learners" (p. 180). Ultimately, the young and the old have to become computer literate to effectively use ICT and its components such as the Internet and other digital resources. Despite the need to become computer literate, Blake and Blake (2005: 172) reported that the use of ICT also requires language literacy skills, "[r]eading and writing are [also] used [in order] to transmit information, to interpret, to respond to the expression of human thought." Language literacy skills are fundamental acquisition for the exchange of information required in our society.

5. LANGUAGE LITERACY

The social situations have changed and brought with them changes to the definition of language literacy with the additional emergence of new technologies in educational, domestic and workplace environments. Forster (2009: 12) reported that there is no single internationally accepted definition of ‘literacy’. However, the term has begun to address more complex understandings than when ‘being literate’ was defined by the ability to read and write. The definitions of literacy are of increasing breadth and reflect a growing emphasis on context.

5.1 Reading Vocabulary and Comprehension as Parts of Literacy

The major purpose of reading is the construction of meaning, comprehending and actively responding to what is read (Christie 2005: 1 – 4). Malatesha and Aaron (2010: 317) stated that vocabulary knowledge is a prerequisite and a critical factor in improving reading comprehension. Readers use their knowledge of text structures to build a coherent memory representation, and these structures or relationships are part of their cognitive representation (Luke (2012: 6). Narvaez (2002: 158) outlined the causes of individual differences in the comprehension of texts along two lines: “reading skill” and “reader’s knowledge”.

Chen and Lee (2010: 127) discovered from their study that text rewrites using “social networking applications [such as the Internet using blogs, discussion boards and creating web pages] engage their students more effectively in interacting with the text”. New skills can be derived from using, for example ‘Facebook’ (social networking site), according to Rowsell (2009: 108), “mediating identities through multiple modes and applications. … , shaping written text and visuals around diverse audiences that have shorter and longer timescales”. Moje (2010) acknowledged that these conflicting aspects, together with a probable lack of literacy skills in young people’s language development (due to lack of continued, sustained literacy instruction), create difficulties for many youth in secondary schools to read at even basic levels (p. 50). She stated that reading at the secondary school level is more demanding and complex. Her reason was that “regular and explicit literacy instructions tend to diminish around Grade 6 (p. 49).

Leino et al (2004: 252) included other studies in their article to assert that students who spend a lot of time reading on their own tend to be better readers than those who devote limited amounts of time to reading. From the autonomous view, Mckenna and Simkin (2008: 85 - 87) stated that “reading is a tool, or set of tools, for content acquisition”. Their research into technology applications that foster “reading growth have implications for content learning in digital environments.…The research into technology applications in reading can be divided into two categories: between “higher” and “lower” order processes”. They were described as “word recognition” and “comprehension”.

5.2 Writing

Writing and literacy stand in a complex relationship to one another. As children write in languages such as English, they look closely at how letters are used to form words and construct a system for the spelling (phonic) conventions of written text. As with reading, lots of writing in an alphabetic language improves phonic knowledge. Nevertheless, Boscolo and Mason (2001) concluded that writing can improve students’ learning by promoting active knowledge construction that requires them to be involved in transforming rather than only in a process of reproducing. Through writing, students have the opportunity to manipulate, integrate, and re-structure knowledge by using, and reflecting on their existing conception and beliefs in a continuous process of developing meaningful understanding (p. 85).

5.2.1 Handwriting

Handwriting has been largely forgotten in the literacy and ICT debates, but it is still needed to reinforce learning and language development. The temptations to ignore the development of handwriting skills are due to the advent of alternative modes of composing writing by using word processing and speech synthesis (De Souza and Towndrow 2010: 26). They stressed that handwriting is very important for students who still use pen and paper format in their exams.

6. COMPUTER LITERACY

Computer literacy definitions vary depending not only on the different levels of users from regular users to power users (software developers, programmers and network infrastructure experts), but also on how literacy is perceived and applied by educational and industrial/workplace theorists. Computer literacy involves not only the understanding of what is possible with (and what influences the use of) computers, but also the physical use of combined equipment (peripherals) and software applications (Corbel and Gruba 2004: 23). At a less specialised level and from the autonomous view, computer literacy involves the knowledge of how to turn on a computer, start and stop software applications as well as save and print documents (Corbel and Gruba 2004: 24). In relation to software, Cohen and Cowen (2008: 546) defined computer literacy as "the ability to effectively use [autonomously] computer tools, [and software applications] such as word processors, spreadsheets, databases, [PowerPoint] presentation and graphic software". From a possibly wider perspective, Moursund's (2003: 9) definition of computer literacy, that also reflects an autonomous model, is "a functional level of knowledge and skills in using computers and computer-based multimedia as an aid to communication with oneself and others for the purposes of learning, knowing, and for using one's knowledge". From an ideological view, computer literacy has evolved into a broad term that incorporates the use of the internet, ICT which drives language re-form/transformation and other digital devices.

6.1 The Internet

The Internet is an integral part of computer literacy. It is a "powerful tool and endless source of information, which is easy to find and easy to produce" (Knierzinger and Turcsanyi-Szabo 2001: 926). The effects of the Internet are deep and complex. A study by Leu et al (2007: 46 – 47) suggested that most of the adolescents who read the results page from a search engine [the Internet], … "do not actually read the items on the result page. Instead, the majority use a simplistic 'click and look' strategy". More emphasis has been placed on new literacies as new technological devices appear, but also as their scope elaborates the ideological dimensions of multiple uses that emerge and interlock in expanded computer usage and its applications (Florian 2004: 8). The Internet has become more and more important for young people's lives at school and at home. Ma et al (2008: 197) stated that "the Internet is affecting all subjects in K-12". Ma et al's study included those described by Tapscott's (1998) term the 'Net-generations' who are fluent with digital technology, including all sorts of digital and electronic devices. The Internet use has also meant that "more children at school are practising cheating" (Ma et al (2008: 198). They added that there are "Web sites that provide free essays for students to plagiarize reports and term papers" (p. 199). They reviewed other studies which reported that the majority of their subjects (from different age group) responded that they copied and pasted from the Internet, "the characteristics of the Internet brought more convenience to digital plagiarism, particularly among middle school students" (p. 199). They used an example from one of the studies of a female student who forgot to do her homework. She went online and copied a paper in her handwriting believing the teacher would not find out what she did. Young people are more vulnerable to this kind of data capture since they are inclined to use the internet more interactively and purposefully. It is, therefore, necessary to ensure that ICT (Information and Communication Technology) is understood broadly.

6.2 ICT Literacy

ICT literacy is a broad term that includes multiple communication devices, various services and applications associated with it. ICT literacy is increasingly regarded as a broad set of generalisable and transferable knowledge, skills and understandings that relate to communication tools used to access, manage, integrate, evaluate and create information in order to function in a knowledgeable society (Ainley 2010: 2). ICT literacy covers the new and emergent technological devices combined, introducing new literacies (Internet, iPod and others) as they become available. Harris (2005: 34) stated that ICTs are "social information spaces". They are designed as much for the reciprocal "sharing of information" as they are for "seeking and disseminating information". He elaborates that "sharing" involves exchanging information amongst users and "seeking" implies going to sources outside one's immediate social system. Out-of-school and in-school digital literacies are used by youth interactively and purposefully, in ways that are increasingly hypertextual, connected and communicative (Bussert-Webb and Diaz 2012: 5).

6.3 Language Re-form/Transformation

The re-form of any language in the current era is often attributed to the speech-like characteristics of much electronic communication. For example, printed texts can often become ‘ad-speak’ and therefore unconventionally spelt and punctuated, for example, “btw” replacing by “by the way” (Tapscott 1998: 1 - 2, Christie 2005: 186). Often, people use digital tools to communicate, spell words using only abbreviations or one letter or number or a specific combination of letters, or letters and numbers to mean what the writer suggests. For example, “before” is replaced by “b4”, “later” is replaced by “l8r”, "for" is replaced by "4" and “laughing out loud” is replaced by “lol” and many other re-formed words or expressions (Tapscott (1998: 1 – 2); Christie 2005: 190) noted further opportunities for change and suggested alternative opportunities can be seen in multiple sound-spelling relationships.

In line with Tapscott (1998), Mountifield (2006: 172 – 173) referred to the Net-Generation or Net-Gen. Such people were “born after 1982, [and] are the ‘digital natives’, always connected, highly mobile, able to multitask, format agnostic, comfortable in a visual-rich environment and able to move seamlessly between the physical and the virtual environments”. Despite their reputation as digital natives, according to Harris (2008: 161), young people’s skills in effective navigation of today’s information landscape are actually somewhat limited. He elaborated that “young people are at a developmental disadvantage when it comes to evaluating digital media”. They are more likely to apply their own judgment based on the web sites rating and their choices are based on design and presentation features rather than the content. However, young people’s skills would progressively improve with “cognitive growth, education, and experience”. But Net-chatting and extended text reading in English are expected to have an even greater effect on writing (Nævdal 2007: 1113).

7. COMPUTER TOOLS

The computer software applications consist of many features (font size, text style, colour, WordArt and many others) and tools (spelling checker and grammar checker) for the users to enhance their works and improve their presentations. Galletta et al (2005) reported that the spelling and grammar checkers are common utilities found in many software packages.

7.1 Spelling Checker

The first tool to be described is the spelling checker. The user is prompted by the spelling checker to review individual words with incorrect spelling by instantaneously underlining the words with a squiggly red line (indicator of misspelt words) while they are writing (Hartley and Tynjälä 2001: 165). When the user sees the prompts on the screen, he/she places the mouse pointer on the underlined word and right clicks to access the information. The words are compared to an electronic dictionary included in the software. I pre-surveyed one hundred and fifty Year 9 students on the usefulness of the spelling checker. The students’ responses are shown in Figure 1.

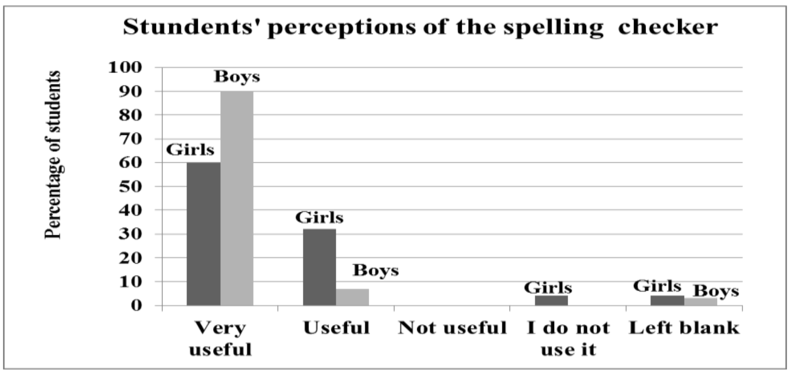

Figure 1. Students’ perceptions on the usefulness of the spelling checkers

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Figure 1 shows that 90% of boys and 60% of girls perceived the spelling checker as very useful. Some students commented that "the electronic spelling checker enhances [their] English writing". However, learning to spell enhances children's English writing. Although, Sinclair (2010: 6) stated that there are at least two types of grammar definition: "one type is [describing] the way the language is used; and the second type emphasises the correct use and following a set of rules". She stressed that when students use the spelling and grammar checkers and do not understand what the checkers are telling them, then they become confused which can affect their literacy skills development (p. 133).

7.2 Grammar Checker

Groups of words with grammatical errors are underlined with a squiggly green line as an indicator of sentence structure issues. A grammar checker is used to check for grammar, writing style, and sentence structure errors, but not all identified groups of words are necessarily 'wrong'. A style feature such as passive voice may be underlined in a decontextualised attempt to make writing 'simpler'. The tool can check documents for excessive use of a word or phrase, identify sentences that are too long, and find words that are used out of context such as 'four example' (Hong Wei and Davies: 2011). I also sought the students' responses on the usefulness of the grammar checker. Their responses are shown in Figure 2.

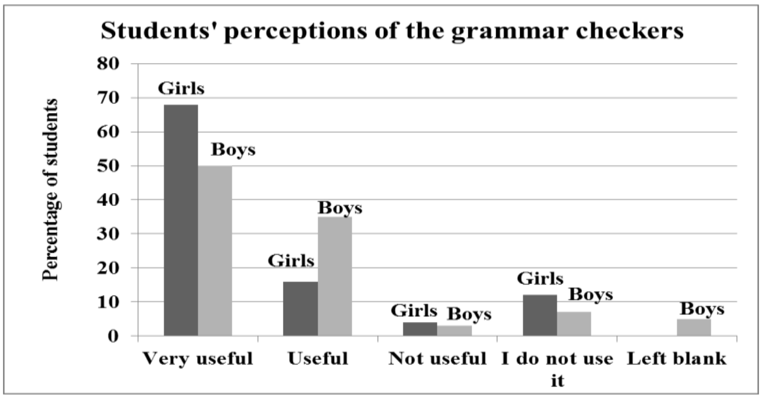

Figure 2. Students' perceptions on the usefulness of the grammar checkers

Figure 2 shows that 85% of the boys and 84% of the girls perceived the grammar checker from useful to very useful. Sinclair (2010: 6) added that many students trust the spelling and grammar checkers because they are very unsure of their own spelling and grammar. Consequently, they assume that the checker must be right. Sinclair (2010) included that the pitfalls are when the checker does not adequately recognise alternatives because the setting is inappropriate, for example, using a US dictionary for work in the UK, resulting in spellings such as 'behavior' rather than 'behaviour'; sometimes the checker can't distinguish between frequently confused words which can often make students change a correct word to a wrong one (p. 140). Since the advent of word processing and spell checkers, according to Moats (2006: 1 – 2), some educators have argued that spelling instruction is unnecessary.

8. STUDIES EVALUATING SPELLING AND GRAMMAR CHECKERS

Several studies have investigated and evaluated the use of the spelling and grammar checkers and their implications for language literacy development for school-age children and their English writing. Facilitated by the electronic medium, according to Lam (2008: 1209) " … the English Language is becoming increasingly tied to the cultural expression of various groups of native and non-native around the world". Conversely, in other language research, Heift and Rimrott's (2008: 196) study revealed that "while the number of correct responses was significantly higher when the system provided a correction list, there was also significantly less learner uptake for the feedback type that did not provide any correction suggestions". Moreover, students were far more successful in submitting the target word if it appeared in the spelling checker suggestion list. In contrast, if the target word was absent from the suggestion list, students picked a wrong replacement word from the list. Heift and Rimrott's (2008) study concluded that the order in which the words appear in the suggestion list seemed to be an influencing factor for students to select one word over another. In other words, their participants picked the word that appeared in first position in the spell checker list more than in any subsequent position.

Figueredo and Varnhagen (2006) conducted their study in Canada titled 'Spelling and grammar checkers: are they intrusive?' Their subjects were twenty-five freshmen, 20 English majors and 20 graduate students revised two essays on a computer, one with the spelling and grammar checkers, and the other with a dictionary (p. 723). For the checker condition, the spelling and grammar checkers were turned on, and the spelling and punctuation errors were flagged in the text by red and green squiggly lines respectively. They modified the correction options offered by the checkers. For the spelling errors, they created a word list of potential suggestions for spelling corrections. If the participant clicked on a flagged error, a pull down menu would appear with three potential choices. The correct choice and two foils were placed in different positions in the pull-down menu. For example, 'retrospect', 'retrespect', 'retrispect' were supplied for the error 'retraspect' (p. 726). They used the same method for punctuation errors. The participants completed two essays. They revised the first essay on a word processor and had access to a dictionary for the second essay. Their findings revealed that content revisions were not significantly different across technology conditions, but all student groups were able to correct more surface errors with the aid of the checkers than they were with the dictionary. They also found a correlation between spelling ability and correction in the dictionary condition but not in the checker condition. They concluded that "the main source of difficulty for students, at that level, in the dictionary condition was in detecting the surface errors without the help of the checkers" (p. 730).

Using a special program, 'Grammatik V', Hong Wei and Davies (2011) sought to assess the effectiveness of a popular grammar and style checker. They conducted their study in Thames Valley University and Richmond College in London. Seventeen students of English as Foreign Language, who came from six different subject disciplines were involved. During the trial, the students were required to produce two versions of each writing sample. One sample was produced prior to using the program. The second contained the changes made during the trial. Both samples were collected in order to provide information on the effects of using the program (p. 2). Their findings revealed both mechanical problems and spelling. The mechanical problems were to do with 'capitalisation', 'punctuation', 'infinitive forms', 'number styles' and others. The spelling errors were separated from the others in order to highlight specific issues and to avoid misleading conclusions (p. 3). They reported that the program proved much less successful in identifying and relating subjects with verbs when they used the modifiers in between or when they appeared in complex sentences. They concluded that the "effectiveness of using the current [Grammatik V] program to check students' writing for academic purposes, on the whole, is not very satisfactory, although the different ratios of correctly and misdetected and questionable problems did suggest that there were variations of performance in the three areas the program focused on: mechanics, grammar and style" (p. 10).

Some researchers have investigated just how much people rely on the little squiggly red and green lines in Microsoft documents. They have found that, while attention to what is identified by the lines improves the quality of poor writers, it makes good writers worse – since they start to rely on the spelling and grammar checkers completely, while ignoring their own instincts (Olsen and Williams 2004: 1020 – 1022). They found that "… spell checkers do little to deal with issues such as the use of homonyms, such as the word 'desert' versus 'dessert'. It will let you eat 'desert' as well as die from thirst in the 'dessert'" (p. 1021). Grammar checkers work from a set of rules about when a plural noun is used with a singular verb in typical cases, for example, "is" versus "are" usage, but they also fail to misdiagnose many cases as well (p. 1022). In line with Olsen and Williams 2005, Galletta et al (2005: 82) investigated different versions of word processors content-related features (spelling and grammar checkers) which they called "language-checking software". They found false positives and negatives: "the false negatives, where the language-checking software fails to detect true errors". The example they used in their study was "[g]o ahead with the complete role-out" where "role" was not flagged to be replaced by "roll"; and false positives, where the software detects problems that are not errors". They illustrated another example for the sentence "Multiple regression was run". The spell checker underlined "regression" and suggested it to be changed to "regressions". If and when the user follows that advice, other difficulties cascade down the errant path. The word "was" was then underlined and the suggestion was made to change the word to "were". Following the suggested advice, distorted the true meaning of the original sentence (p. 3).

Another study conducted by Fandrych (2001: 1 – 12) investigated the spelling and grammar checkers assistance, in two software applications (Microsoft Word and WordPerfect), and the consequences for second language learning and teaching. She selected case studies of English in South Africa. One of the students typed ‘inorder’. It was flagged to be replaced with “one of the following: ‘ignored’, ‘ironed’, ‘ironware’, ‘intruder’, ‘inured’ – all of which would be syntactically inappropriate” (p. 4). More problems were detected that contained misleading advice to restructure the sentence using the grammar checker. She concluded that “word processors cannot solve all the problems many users face when composing texts, especially if English is not their first language” (p. 12). As a consequence, according to Vascellaro (2006: 1 – 3), immersion in new technologies improved student attitudes and behaviours but had little overall impact on student achievement. At a higher academic level, a study was conducted at the University of Pittsburgh, Pennsylvania, United States of America, involving 33 undergraduate students to look at the differences in reader’s ability to correct spelling and grammar errors with and without the assistance of spelling and grammar checking tools. The participants were given a letter to correct. Half of the group utilised spelling and grammar checkers, and the other half did not. Using Skills Assessment Test (SAT) which consists of three sections: critical reading, mathematics and writing. The results were “those with strong verbal skills rely heavily on the grammar and spelling features of word processing software, thereby hurting the accuracy of their documents”. The group that did not use the software performed as expected in relation to each student’s verbal score. She concluded that “[u]nfortunately, a computer is much better at numbers than it is at doing grammar and spell-checks” (Osborne 2003: 1 - 8). From the above studies, it is clear that the spelling and grammar checkers are not helping the digital natives to improve on their traditional literacy development.

9. CONCLUSION

Language literacy acquisition differs from computer literacy, and the two literacies require different skills from each other as shown by their definitions in Sections 3, 4, 5 and 6. Making connections between the two literacies leads to further influences on and implications for the development of traditional language learning as shown in the literature. The literature suggests that being competent in literacy implies that one knows which practices, attitudes and values are appropriate in a given situation. While education is often focused on mastering the autonomous dimensions of a given literacy, the ideological dimensions can present much more compelling and in depth challenges. The prominent messages stemming from the literature are that young children should be developing an enriched vocabulary as an indicator of oral language proficiency which is essential for comprehension of both oral and written language. However, technological changes have happened so rapidly that changes to literacy are shaped not only by technology, but by our ability to adapt and acquire the new literacies that emerge with its applications (Leu et al 2004; Florian 2004). Good examples are shown in Figures 1 and 2, the students perceived the spelling and grammar checkers as very useful in enhancing their English writing.

The conducted studies evaluating relationships between computer use and educational achievement, Olsen and Williams (2005); Hong Wei and Davies (2011), suggested that the mere expanded use of computers is not a guarantee for the acquisition of proficient language literacy. Their conclusions are complex. The students are not developing their language literacy skills sufficiently, or practising their speaking and writing skills, by engaging in direct interactions with the electronic medium. These skills can be developed by reading, expanding their vocabulary and comprehension and by presenting their own written work (Ma et al 2008).

Other studies evaluated the spelling and grammar checkers and just how much school-age children rely on the little squiggly red and green lines in word processing documents. Their findings indicated that while it improves the quality of poor writers, it makes good writers worse by enabling or encouraging them to ignore their own instincts (Olsen and Williams 2004). Word processors cannot solve all the problems many users face when composing texts. There were many issues falsely advised by the tools (Fandrych 2001). In examination of different versions of word processors, Galletta et al (2005) and Fandrych (2001) have shown similar results that the software failed to detect true errors. If and when the user follows the advice suggested by the programs, other difficulties cascade down the errant path.

There are implications in the use of spelling and grammar checkers as the literature revealed. Therefore, teachers should teach students how to use the electronic spelling and grammar checkers and encourage them to use the dictionaries as well. So the students can use the correct spelling rather than guess and select the words and sentences randomly from the provided list by the tools.

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DESIGN THINKING AND METACOGNITIVE REFLECTIVE SCAFFOLDS: A GRAPHIC DESIGN-INDUSTRIAL DESIGN TRANSFER CASE STUDY

Chien-Sing Lee[1] and Kuok-Shoong Daniel Wong[2]
[1]*Faculty of Science and Technology, Sunway University, Malaysia.*
[2]*Faculty of Information Technology, Malaysia University of Science and Technology, Malaysia.*

ABSTRACT

Scaffolding is crucial as transfer of learning does not occur naturally and teaching-learning strategies found to be effective for experts may not be suitably adopted as is for novice learners. Furthermore, opportunities are often "found" or "made." The quality of solutions, however, is mediated by different conceptualizations of contexts. We aim to investigate whether design thinking and metacognitive reflective scaffolds can help graphic design students to design on a different canvas, i.e., for industrial design, in order to increase their job opportunities. Findings indicate that students are able to identify and match patterns, theorize based on their graphic design knowledge (to transform fuzzy association patterns into fuzzy associative rules) and analyse existing designs in the market to create their own designs. The significance of the study are useful to the learning of Science, Technology, Engineering and Mathematics, co-design of designs/uses for smart technologies, industrial design, and embedded cognitive systems, such as robotics and Internet of Things (IoT).

KEYWORDS

Conceptualization; design thinking; metacognitive reflective scaffolding; creative thinking; graphic design-industrial design; acquisition of expertise; transfer of learning

1. INTRODUCTION

Economies are increasingly knowledge-based, i.e., driven by knowledge, information and technology. Hence, the development of skills throughout life becomes critical. A McKinsey report on Education to Employment, highlights two critical issues in the 21st century: high youth unemployment rates and shortage of workforce with critical job skills, due to a mismatch in skills. For example, in 2013, 73.4 million young people are unemployed. In addition, 58% of employers surveyed think that entry-level new hires do not have the necessary skills. Consequently, in a dynamically changing and interconnected world, how can we best equip our students to cope with continuous changes, and to learn continuously?

UNESCO (2015) thus highlights the need for educational innovations, aimed at:

1. developing educational and training contents, pedagogies and knowledge to improve 21st century skills;
2. inculcating significant changes in values, mindsets, practices, behaviours and skills for now and in the future; and
3. promoting and translating principles of lifelong learning in skills development.

These aims focus not only on effective re-skilling and adjustment to skills mismatch (first objective), but also to the development of dispositions which would contribute to productive and sustainable development (second and third objectives). Subsequently, three sets of skills have been identified: (i) foundation skills, (ii) specialized skills and (iii) transversal/transfer skills. UNESCO further points out that these three sets of skills are equally important if we want to enhance the potential of education and the human innovative spirit to address authentic pressing issues facing our world today. These skills are also supported by Outcome-based Education (OBE).

1.1 Objectives

With the above scenario as background to our study, we investigate whether design thinking can help graphic design students to more effectively build knowledge, develop creativity and subsequently, design on a different canvas, i.e., for industrial design. We choose industrial design because of the similarity between the two disciplines. Industrial design mainly focuses on function and form, and is concerned with aesthetics, psychology, market analysis, user interface design and information design, ultimately, leading to interaction design (Pulos, 1988). Given our sample students' knowledge and experience with packaging design, we are interested to investigate whether this knowledge can be transferred to industrial design.

1.2 Hypotheses

Studies by Papert (1980) and many other learning sciences research, attest that computers are construction tools, with great capacity in expanding what people can create and what they can learn in the process. Their constructionist research provide evidential indications that many of our best learning experiences are when we are engaged in designing and creating things, particularly things which are meaningful either to us or to others around us. Bereiter (1995) contends that learning dispositions and beliefs are key in determining learning outcomes.

Subsequently, based on their arguments, we contend that knowledge construction and consequently, learning outcomes (OBE, 1994) and transfer, are built on students' dispositions. We have scaffolded the development of such dispositions through design thinking, framing and metacognitive reflection in our studies (Lee & Wong, 2013, Lee & Wong, 2014a, Lee & Wong, 2014b). Though the first study involves low-fidelity prototyping and the subsequent ones high fidelity prototyping, findings are consistently positive. This leads us to our first hypothesis.

Hypothesis 1: If students fully practice design thinking, and apply our metacognitive reflective scaffolds, they may be able to better link between theory and practice.

This study is different from our prior studies due to the domain concerned, i.e., graphic design. In this study, we incorporate Art and Design theories as methodology. We regard Communication theory as primary in design. Initially perceived as a linear process (Shannon & Weaver, 1949), Schramm's (1971) Communication theory involves sending messages and correspondingly providing and interpreting feedback. User experience is important in determining the quality or success of communication. The emphasis on fields of experience between the sender and receiver implies that life experiences enhance the quality of communication when they overlap. This leads us to our second hypothesis.

Hypothesis 2: If students are able to create user experiences based on Communication theory and related theories, they should be able to design more creative industrial designs.

Our research model is illustrated in Figure 1.

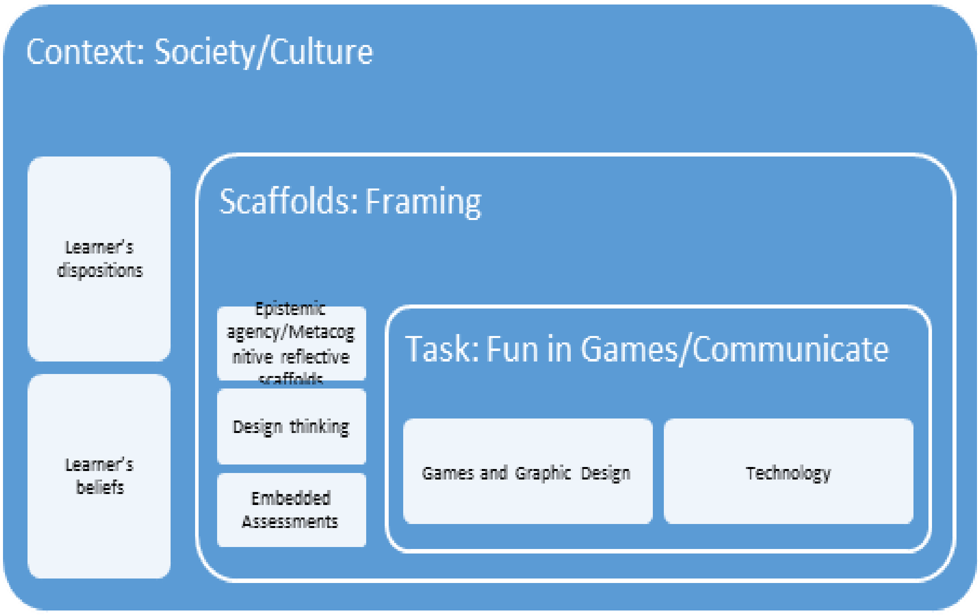

Figure 1. Research model for this study

1.3 Significance of the Study

First, Verganti (2008) argues that innovation is often through increasing the emotional and symbolic value of products. However, the underlying mechanisms are still poorly understood. Second, we hope to increase cognitive access, i.e., equal opportunity to understand and learn, regardless of ability, race, ethnicity, socioeconomic status, and gender as espoused by Outcome-Based Education (OBE, 1994) by developing epistemic agency (Scardamalia & Bereiter, 1995) through our design scaffolds Third, we argue that smart communities encompass not only the use of smart technologies but also the co-design of designs/uses for these smart technologies. In line with natural computation, this implies a symbiotic relationship between the built environment and its ecosystems. A greater awareness of this symbiosis may be useful industries such as industrial design, and embedded cognitive systems, such as robotics and Internet of Things (IoT), due to the translation of epistemic agency to autonomicity in software agents.

2. RELATED WORK

Consistent with the nature of problem-solving in authentic environments, an experimental game-thinking approach which captures the "fuzzy" characteristic of ideation/ innovation contextualized within the ecosystem(s) is adopted throughout our study. The following sections explain why.

2.1 Socio-Cognitive Framework and Framing

One of the approaches directly related to the theory of constructivist learning, experiential learning (Papert, 1980; Bereiter, 1995) espouses that learning is constructed as a response to each individual's experiences and prior knowledge (sense-making); i.e., that learning occurs through active exploration (learning-by-doing) within a social context.

Following from this, we contextualize the design challenge within Engle's (2006) sociological framework. Her framework espouses the constructivist-constructionist views, where technology and learning communities are key mediators which improve sense-making and user experience between interconnected contexts. Given that design is a communicative process, the sociological framework provides a more holistic context within which learning can be framed.

We choose this framework because it provides a situative theory of transfer whereby interconnected contexts create a coherent framework within which students can generatively use what they have learnt. Thus, the ability to frame accurately is crucial to epistemic agency as it provides the reason/ motivation/ epistemology for learning. In other words, if students comprehend and are able to relate to their personal goals, they are more likely to use the content-based supports more effectively. Hence, framing within a socio-cognitive framework will enable instructors and researchers to develop more comprehensive explanations underlying mechanisms of transfer. Transfer is scaffolded/facilitated because as Neumier (2013) points out, the external perspective affords the development of a metaposition and the development of metaheuristics.

2.2 Design Thinking

Design thinking is interdisciplinary and focuses on context, empathy and user experience (Brown & Wyatt, 2010). Grounded on inquiry-based learning, Dunne & Martin (2006) recommend design thinking because problems are framed, questions are asked, ideas are generated, and answers are obtained. These are carried out iteratively, Figure 2 illustrates the design thinking processes. More importantly, being user-centred, outcomes are emergent. As such, the design thinking process allows not only information and ideas to be organized and choices to be made typical of problem-solving, but also insights to be gleaned, situations to be improved, and non-prescriptive/didactic knowledge to be developed.

We choose design thinking because it best captures the game-like experimental spirit and balancing of multiple decision criteria inherent in game design and game-based learning. Furthermore, our prior studies (Lee & Wong, 2013; Lee & Wong, 2014a, Lee & Wong, 2014b) with inquiry learning (first study) and with design thinking (second and third studies) are successful in building knowledge and in developing creativity.

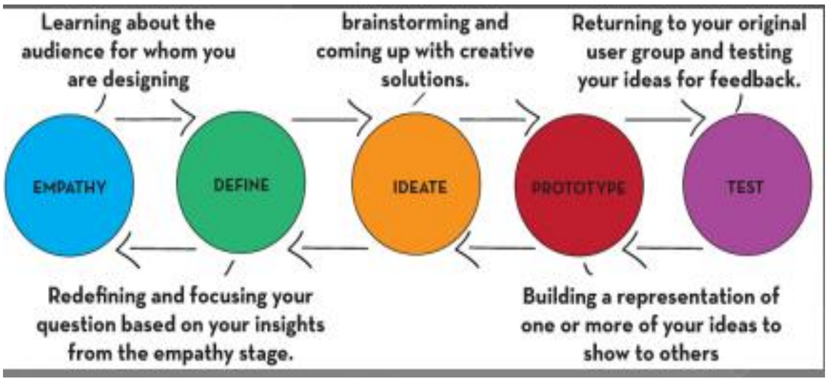

Figure 2. Design thinking phases

3. METHODOLOGY

3.1 Sample

Sampling is purposive. Our sample students are 16 graphic design undergraduate students in a private university in Malaysia undertaking the course Design Reflective Practice, a consequent course after Design Research. All of them are final year students. They are the population for the course. In both courses, design thinking is taught and applied as an addition to the syllabus; serving as the binding thread across course content. The students' backgrounds are mixed, from both Arts and Science (Engineering). Experimental duration is 13 weeks.

3.2 Procedure

Similar to our prior work, we design based on Marini and Genereux's (1995) context, task and assessment.

Context: We frame learning of research skills as increasing the possibilities of job opportunities. First, we ask students what they think industrial training would be like, employers' expectations of them, their designs/products and self-reflection on their own strengths and weaknesses. These form the primary means of framing. A secondary means of framing is through the design of the assessment. Subsequently, students are presented with multiple lectures on various Art and Design movements and theories and have experimented with these ideas as in-class projects.

Task: Thus far, their in-class tasks have been to produce digital media Art to communicate. For the two hour lesson near the end of the course, the objective is to gauge how much they have learnt from the earlier lessons. It functions as one of the embedded assessments in the course. Students are asked to discuss what and how they would design a wallet for their loved ones and why. This is based on an example on design thinking by Stanford University's d.school. Subsequently, they are given the task of designing a wallet for the high-end market (a different target market from the example) where money is not a concern. They are allowed to incorporate technology if they deem suitable. Feasibility is not the primary concern as technology can be developed if the idea is marketable.

Assessment: Their end-of-course final assignment is based on the use of theories. The assessment criteria are similar throughout their reflective practice exercises and assignments. In this study, we regard fun and interactivity as contributing to sustainable user experience. As such, students are evaluated mainly based on fun, interactivity and sustainability. The assessment rubric used was refined from our prior studies (Lee & Wong, 2013; Lee & Wong, 2014a, Lee & Wong, 2014b). It is as shown in Table 1.

Table 1. Refined assessment rubric

	A	B	C	D
Fun	Users are addicted/ intrinsically motivated	Users find it fun and don't mind spending 2-3 hours per day at the Website/ application.	Users find it somewhat fun but wouldn't want to go to the Website or use the application unless they have to.	Users find it boring and dread to go to the Website or use the application.
Interactivity	Users are actively creating and/or co-creating objects and interactions which will result in higher quality objects and more meaningful interaction.	Users are creating and/or co-creating objects and interactions and the outcome are more objects and more interactions which are beautiful to them.	Users are creating and/or co-creating objects and interactions.	Users are not creating and/or co-creating objects and interactions.
Sustainability	Three to four dimensions of application.	Two to three dimensions of application.	One dimension of application.	Failure to sustain.
Problem-solving	Problem and hypotheses properly formulated across 2-3 domains.	Problem and hypotheses properly formulated across 2 domains.	Problem and hypotheses properly formulated across 1 domains.	Problem and hypotheses improperly formulated.
Significance/ contribution	Outcome can actually be used in society directly.	Outcome needs to be adapted slightly before it can be used in society.	Outcome needs major revision but can be adapted before it can be used in society.	Outcome is purely adoption of an existing solution.
Novelty	The outcome is original in relation to the existing work locally and internationally.	The outcome is original in relation to the existing work locally.	The outcome is original in relation to the existing work in the local community.	The outcome is not original.

4. FINDINGS

All students incorporate technology and whatever they perceive as being hot and uptrend in the market in order to optimize user experience and perception of classiness leading towards perception of the brand. All designs indicate top concerns with regards to security followed by customization to individual style. The differences in their designs lie in their emphases on what they perceive as the customers' needs, preferences and desired user experience. In addition, Group 1's design is more inventive and multi-dimensionally functional whereas Group 2's design is functionally adaptive and Group 3's design focuses more on style than functions. Examples of their designs are presented below:

Group 1: Sensor/face detection-unlock function, touch-screen ordering function (the chosen button will eject the card which they want to use so users do not have to rummage through their wallets), charging by shaking (movement detection) so no need to worry about charging anywhere anytime (even while walking), colour change, water proof, light-weight and GPS in case lost.

Group 2: Finger/palm print recognition, the wallet is digitalized totally, functionally similar to a laptop in the sense of both sides of the wallet being able to swivel on different planes in any desired position and the screen being electronic so that all necessary items (assuming that these items are also digital as is possible in the future including ID and cash), magnetic open/close flap, USB port at the bottom left, and a cover which can change based on nanotechnology, GPS in case lost.

Group 3: Thumb print recognition in order to unlock, changeable illustration with black background for day and white background for night.

Each group has targeted only one perceived market. However, considering the beauty and desirability, of each design outcome, we contend that the diversity in design outcomes is able to reach wider and more diverse markets for an organization.

5. CONCLUSION

The discovery of knowledge is usually fuzzy and hence, it makes sense to base knowledge discovery on what is known, i.e., on pattern recognition and subsequently, hypothesize, experiment and consequently, formulate new patterns/ principles/ generalizations (defuzzification).

Fuzziness during knowledge discovery is natural and even encouraged due to the advantages and possibilities of emergent outcomes from such experiments. We hope that based on our design factors (constructionism, design thinking and metacognitive reflective scaffolding as embedded assessment) and findings, cognitive access will improve despite our limited cognitive processing capabilities. Subsequently, with the increase in application of eclectic interdisciplinary student-centred approaches, we hope that students will be able to become better conceptualizers and designers; able to develop and sustain the ability to apply and synthesize knowledge learnt to create practical, useful new knowledge through interactions with the learners' local and international communities and that these designs will become more effective, efficient and most importantly, fun, generative and, meaningful.

The next question is can we accept and find new ways to encourage more meaningful experimentations in the Sciences, where logic is more dominant and knowledge and representations are more well-structured? How can we make learning more fun, interactive and sustainable in the Sciences and increase the number of students taking up Science, Technology, Engineering, and Mathematics (STEM) and its variants in its applications to different domains e.g. e-commerce, social entrepreneurship, healthcare?

Our sample size is small and there may be extraneous variables. At this moment, we can only claim that design thinking and our metacognitive reflective scaffolds help students to be more aware of salient design factors that they need to consider to reach the perceived market and subsequently, to improve lifelong learning, i.e., epistemic agency resulting in meaningful and sustainable knowledge acquisition and knowledge building.

Future work involves broadening our framework to include wider considerations. We intend to include lessons from these two studies as well as studies from the creative industries towards enhancing STEM education and transfer of learning to meet the challenges of the 21st century. We will also include framing from an entrepreneurial perspective and an adapted LBD-based reflection grounded on our findings, to develop deeper understanding of design and design thinking towards more meaningful and sustainable social innovations.

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DEVELOPING A DISPOSITION FOR SOCIAL INNOVATIONS: AN AFFECTIVE-SOCIO-COGNITIVE CO-DESIGN MODEL

Chien-Sing Lee[1] and Kuok-Shoong Daniel Wong[2]
[1]*Faculty of Science and Technology, Sunway University, Malaysia.*
[2]*Faculty of Information Technology, Malaysia University of Science and Technology, Malaysia.*

ABSTRACT

Advancements in technology and liberalization of educational opportunities have transformed the knowledge landscape into an emergent innovation incubator, where sense-making and creativity in and for ill-structured environments are especially relevant. In addition, opportunities are often "found" or "made." The quality of solutions, however, is mediated by different conceptualizations of contexts. As such, we need new teaching-learning models which help students to become more effective and creative knowledge builders and creative innovators. In this paper, we present a summary of our prior work towards this objective, our framework and the refined assessment rubric derived from our various studies. Our design factors/scaffolds are: design thinking as design methodology, metacognitive reflective scaffolds and formative assessment as framing technique. We hope our findings can be applied to the learning of Science, Technology, Engineering and Mathematics (STEM) and its variants. Future work may involve its application to MOOCs or Cloud Computing.

KEYWORDS

Ontological Affective-Socio-Cognitive Design Model, Inquiry/Problem-based learning, Design thinking, metacognitive reflective scaffolds, formative assessment

1. MOTIVATION

Crucial to the discovery, creation and sustainability of competitive advantage, knowledge diversity has resulted in and encouraged interdisciplinary methodologies. These encompass business, technology and human factors. As such, educators are challenged in terms of teaching-learning beliefs and practices with regards to how they should best equip/prepare students for the workplace. This is true especially in Multi Online Open Coursewares (MOOCs), where students are expected to be independent learners and also where dropout rate is sometimes high.

Rentroia-Bonito, Jorge and Ghaoui (2009) point out that in order to address complex and multidisciplinary challenges, development teams need proper design techniques to build effective learning experiences. Thus far, they find that the literature does not indicate solid quantitative approaches which support learning-centered design where student needs and their immediate and broader contexts are considered. Hence, their study explores motivation to e-learn as a variable to designing technology-supported learning experiences. They aim to identify what motivation-related variables are critical for student engagement in learning online as the basis for a specific, bottom-up and quantitative design technique. Their study on the importance of a set of motivation-to-e-learn variables in a real instructional setting has led to an exploratory two-factor structure explaining 96% of motivation to e-learn.

This two-factor structure (presented in Table 1) contributes towards quantitatively understanding and cost-effectively improving the link among learning design process, supporting systems and students in terms of continuous assessment of what students value most systemically. Courseware accounts for 81% of variance whereas organizational communication, accounts for 16% of the common variance. More importantly courseware factors explains four times more variance than organizational communication, indicating that it has a higher influence on motivation to e-learn and thus deserves more focus and priority due to its potential impact. Organizational communication however, influences readiness to e-learn. Among these, the three factors with the highest mean are instructor support, accessibility to contents and easy-to-use-interface. We also note that these salient factors include beliefs (the affective domain), indicating that any systemic solution has to involve not only courseware and organizational communication, but also students' beliefs/dispositions. This finding is consistent with Perkins and Salomon's (1992), Bereiter's (1995) and Engle's (2006) propositions on transfer of learning.

Table 1. Rentroia-Bonito, Jorge and Ghaoui's (2009) two-factor structure and factors/variables which load on them.

Courseware	**Organizational communication.**
Accessibility to contents	Resource availability
Security and data protection	Instructor support
Personalized feedback	Institutional support
Easy-to-use interface	Feeling part of learning group
Flexibility in content presentation	Like studying subject matter
Aesthetic content presentation	Belief: E-learning contributes to my learning objectives
Belief: I can learn this subject online.	Belief: Adequate communication with instructors

We are concerned with the design of embedded formative assessment as personalized feedback (part of instructor support, accessibility to contents) due to the above scenario and because of our concern with cognitive access. Cognitive access extends beyond digital access to include comprehension, and interpretation. Interpretation varies depending on the individual's prior learning and culture. As cognitive access (sense-making) becomes more critical, we need to provide structure and scaffolds to help students to develop their own learning initiative and learning path. We next discuss our suggestions towards this end.

2. LESSONS LEARNT

Based on the learning sciences' literature, we learn that:

a) transfer of learning is important because if students are able to transfer their learning to different contexts, outcomes may be the discovery or creation of opportunities;

b) promotion of transfer of learning based on modelling (e.g. Kolodner's (1995) Learning-by-Design, Engle's (2006) socio-cognitive framework) and visualization (e.g. Bhatta, S. and Goel (1997); Ashok's (2011) study on modelling of the acquarium ecosystem) is encouraged. This is because transfer can occur at different levels from the elemental to contextual;

c) goal-seeking analyses and what-if analyses can lead to drill-down analyses. However, it is the context, which gives meaning to these analyses.

To develop design thinking skills and a disposition for social innovations, we have used metacognitive reflective scaffolds grounded in inquiry-based formative assessment.

2.1 Design Thinking as Design Methodology

Brown and Wyatt (2010) observe that conventional research can point toward incremental improvements. However, these do not usually lead to significant breakthroughs. As such, they point out that conventionally, designers have emphasized on enhancing the look and functionality of products. However, recently, they have begun to utilize design tools in order to address more complex problems. This is because systemic problems require systemic solutions. The change in dynamics necessitates broadening approaches in order to create entire systems to deliver products and services. For example, social challenges require systemic solutions that are grounded not only in the client's or customer's needs, but also form and function, as well as distribution channels. Without considering the whole system, solutions may not be sustainable.

As mentioned earlier, design thinking is inherently optimistic, constructive, and experiential. The beliefs/epistemology underlying design thinking is illustrated in Figure 1.

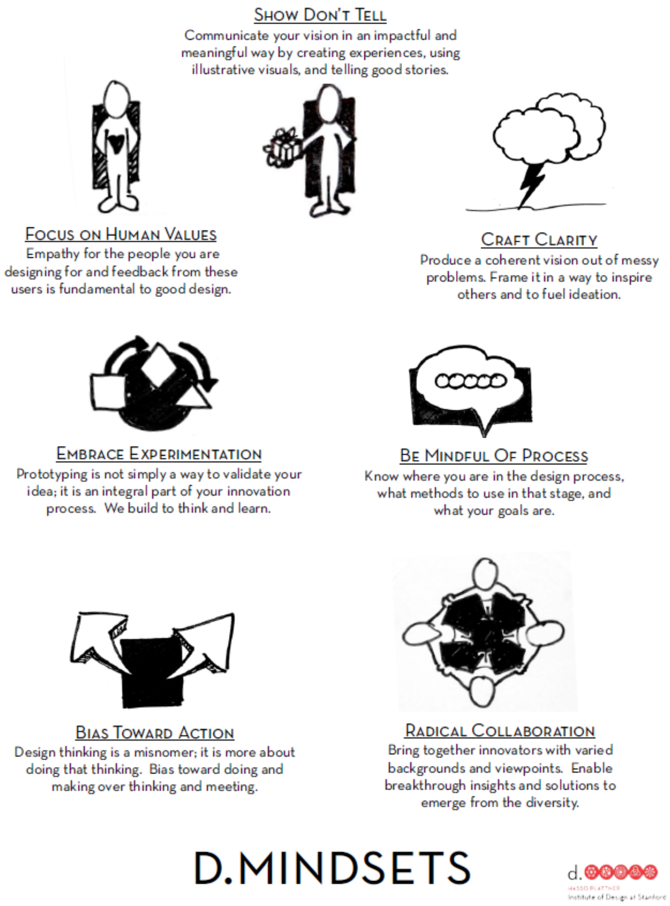

Figure 1. Design thinking mindsets

Source: Stanford's d. school's bootcamp bootleg

Being a Human-Centered Design methodology, design thinking naturally incorporates consumer insights as the first design space. In 2001, IDEO transformed from designing consumer products to designing consumer experiences. With this change, design thinking develops our ability to a)be intuitive; b)recognize patterns; c) construct ideas that have emotional and functional meaning; d) express ourselves in media other than words or symbols. In short, IDEO positions design thinking as the integration of feeling, intuition, and inspiration with the rational and the analytical. The consequent methodology is thus a system of overlapping spaces rather than a sequence of orderly steps. Three main spaces are most well-known: inspiration, ideation, and implementation.

Inspiration emphasizes on empathy through immersive experiences and understanding. These are subsequently validated through in-depth and rapid prototyping. Prototyping (transforming ideas into actual products and services, which are then tested, iterated, and refined) is crucial as it not only validates, but also enables the discovery of unforeseen implementation challenges and unintended consequences; and assesses the feedback and viability of new market approaches critical to more sustainable long-term success.

2.2 Formative Assessment as Framing and Reflective Technique

Mislevy, Steinberg, Almond and Lukas (2006) point out that effective assessments are key in enabling teachers to gather information about students' knowledge and the depth of their understanding of subject matter. In fact, their studies indicate that assessment experts suggest assessments be designed grounded in evidentiary reasoning, i.e., the assessment activity is specifically designed to elicit evidence about the student knowledge that is of interest.

Based on the above literature, in our prior studies (Lee & Wong, 2013, Lee & Wong, 2014a; Lee & Wong, 2014b), we embedded metacognitive reflective scaffolds (Schon, 1996) as formative assessments, integrated with design thinking within progressive inquiry/problem-based learning. Tangible prototypes are produced for the latter two studies consistent with design thinking. Our assessment rubric refined throughout our prior work is presented in Table 2 below.

Table 2. Refined assessment rubric.

	A	B	C	D
Fun	Users are addicted/ intrinsically motivated	Users find it fun and don't mind spending 2-3 hours per day at the Website/ application.	Users find it somewhat fun but wouldn't want to go to the Website or use the application unless they have to.	Users find it boring and dread to go to the Website or use the application.
Interactivity	Users are actively creating and/or co-creating objects and interactions which will result in higher quality objects and more meaningful interaction.	Users are creating and/or co-creating objects and interactions and the outcome are more objects and more interactions which are beautiful to them.	Users are creating and/or co-creating objects and interactions.	Users are not creating and/or co-creating objects and interactions.
Sustainability	Three to four dimensions of application.	Two to three dimensions of application.	One dimension of application.	Failure to sustain.
Problem-solving	Problem and hypotheses properly formulated across 2-3 domains.	Problem and hypotheses properly formulated across 2 domains.	Problem and hypotheses properly formulated across 1 domains.	Problem and hypotheses improperly formulated.
Significance/ contribution	Outcome can actually be used in society directly.	Outcome needs to be adapted slightly before it can be used in society.	Outcome needs major revision but can be adapted before it can be used in society.	Outcome is purely adoption of an existing solution.
Novelty	The outcome is original in relation to the existing work locally and internationally.	The outcome is original in relation to the existing work locally.	The outcome is original in relation to the existing work in the local community.	The outcome is not original.

The first three criteria are part of what we perceive as contributing to meaningful and sustainable user experience. The subsequent three criteria are research-based. Koster's (2014) theory of fun, analogizes people as amazing pattern-matching machines. Once we recognize a pattern, we seek to see it recur. He further observes that "Fun is the process of discovering areas in a possibility space" and that "We talk so much about emergent gameplay, non-linear storytelling, or about player-entered content. They're all ways of increasing the possibility space, making self-refreshing puzzles". Moreover, for games to be art, they need to be puzzles with more than one right answer, open to the interpretation of the target audience. The challenge increases in multiplayer games where there are many instances with variations in player-entered content.

Elaboration on these metrics is explained in an extended version of this paper, which illustrates the evolution of our studies in the creative industries, contributions and implications, and the refined research model. Another paper compares these findings with the findings from the design of assessment for two Science-based courses, Software design and testing (Lee, Wong and Lau, 2015) and Robotics (unpublished technical report), its research model and the integrated Arts-Science model.

2.3 Summary of Findings

From prior studies, we propose an initial conceptual framework to develop generative designs. Our research model (Figure 2) considers the following:

a) learning environments and systems need to focus on theorizing and high-fidelity prototyping;

b) theorizing can be mediated by framing students' role as active participants of and contributors to a larger intellectual and social community to create intrinsic motivation. This is because the situative perspective contextualizes the design of reflective scaffolds to build on prior knowledge triggered by the need to design with authentic future applications in mind;

c) focusing on framing and reframing the context/problem in order to derive more alternatives and better solutions. This is based on the grounds that hypotheses are best formulated and tested within contexts, driven by the formulation and reformulation of goals/objectives;

d) to sustain theorizing, learning needs to be fun and interactive;

e) high-fidelity prototyping is essential during the theorizing, enactment phase;

f) to be creative, technology needs to allow students to view a problem from different perspectives and abstractions to create more novel insights;.

g) to develop multiple perspectives, we need to extend beyond functional designs to designing user experience;

h) design thinking and metacognitive reflective scaffolds as embedded formative assessments need to be integral during lecture and tutorial;

i) instructors must be brave to allow and look forward to emergent outcomes.

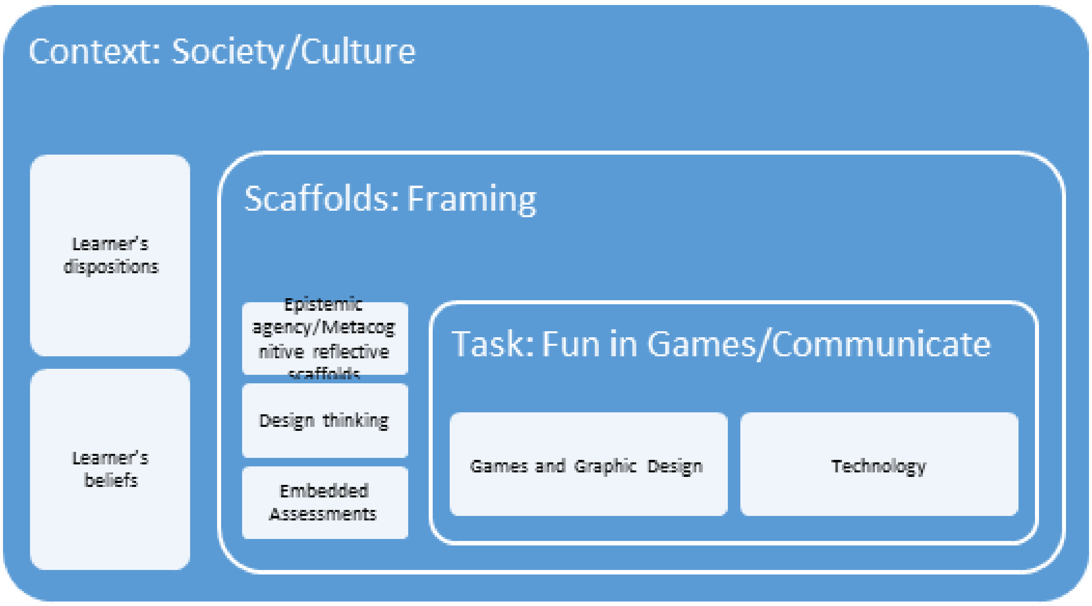

Figure 2. Research model for this study

2.4 Conclusion

According to Brown (2008), thinking like a designer can transform the way we develop products, services and even strategy. In our series of investigations, our objective is to develop a disposition for Social Innovations.

To achieve this, we have aimed to:

1) investigate whether our assessment rubric can be a means to motivate students/designers to learn, to model, to analogize, to theorize and to transfer learning through and to different contexts;

2) develop an ontological affective-socio-cognitive model for context-aware interaction which cares – one which will intrinsically motivate and self-direct them to be more open, critical and creative.

Subsequently, we hypothesize that if we utilize design thinking as our framing methodology, students are more likely to emphasize on user experience above functional requirements. However, our sample size is small. Hence, findings are not generalizable at that stage. As such, we do not make generalizable claims regarding the effectiveness of our scaffolds. At this moment, we can only claim that based on evidential findings, our scaffolds (design thinking, metacognitive reflection as embedded assessments and framing), help students to be more aware of the context and its relation with their prior knowledge, helps them to think broader, make more hypotheses and consider more alternative solutions.

With this paper, we end our research into the creative industries. We hope to test our initial conceptual model in different domains, via different frameworks, interaction platforms and different devices, with diverse interdisciplinary collaborators, especially with regards to Science, Technology, Engineering and Mathematics and its variants.

We are keen to collaborate with others within the gamification entrepreneurial framework, continuing with our investigations into Web modelling and engineering for the Sciences (Software design and testing) and Web modelling and craft for the creative industries while focusing on user experience. UPenn’s eCrafting.org and the Mixed Media Lab are referred to as examples. Possible areas of collaboration are:

a) Enhancing youth's digital lifestyle through social-media-mediated co-creation [Media and engagement]

b) Gamification to improve quality of life to the disabled (visual, learning, auditory). [Assistive tech]

c) eCrafting for fun, convenience, lifestyle [DigiStyle tech] simulating UPenn’s ecrafting.

d) Improving comprehension of programming language concepts through the integration of games, Lego and programming through visual functional gamified co-design [STEM]

e) Technology-assisted affective-socio co-design as driver for e-commerce [Media and engagement]

Ultimately, we hope that our findings in discovering an ontological Affective-Socio-Cognitive Co-Design Model and in developing a disposition for Social Innovations can be used to develop a Symbiotic Context-Aware Recommender suitable for IoT or Cloud Computing.

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TECHNOLOGY GOES BUSH: USING MOBILE TECHNOLOGIES TO SUPPORT LEARNING IN A BUSH KINDER PROGRAM

Jennifer Masters[1] and Leanne Grogan[2]
[1]*University of Tasmania, Launceston, Tasmania, Australia*
[2]*La Trobe University, Bendigo, Victoria, Australia*

ABSTRACT

A 'bush kinder' is the Australian equivalent of a European forest kindergarten. Although it is not usual for technology to be used in the type of program, the authors suggest that mobile technologies can be used creatively and sensitively to support learning in the bush kinder context. This paper describes an ethnographical case study where two early childhood researchers participated in a bush kinder program in "active participant-observer" roles and used a mini-iPad with cellular data access to extend investigations with the children. The advantages of this approach are that information about the natural environment can be accessed 'just in time' and experiences can be captured for future reflection and presentation to a wider audience.

KEYWORDS

Mobile technologies, kindergarten, nature education, bush kinder

1. INTRODUCTION

In his book, 'Last Child in the Woods', Richard Louv (2005) coined the term 'Nature Deficit Disorder' to describe how human beings, particularly children, are losing touch with nature because they spend progressively less time outdoors in natural spaces. The consequence of this disconnection is that children lose the capacity to restore their own health and wellbeing through relaxing in the natural world. Further, these children are likely to have a reduced capacity to develop an affinity with nature and therefore do not acquire responsible behaviours that are essential for ongoing environmental care and management.

A common assumption of the 'getting back to nature' movement is that children should forgo their fascination with modern technologies, such as computer games and television, in order to interact with the environment in a pure state. In this paper, however, we question the premise that technology and nature are diametrically opposed. Rather, we see technology as a tool that, when used creatively, can actually help young children to make connections in the bush kinder nature setting and then be used as a medium for sharing their understanding and ideas about the bush when they return to their lives in a urban context.

2. THEORETICAL FRAMEWORK

2.1 The Nature Education Movement

A renewed interest in connecting children to nature is being felt across the early childhood educational sector around the world. As far back as Froebel, the "Grandfather of Kindergarten", in the early nineteen hundreds (Ebbeck and Waniganayake, 2010), preschool was seen as the child's gateway to nature. This connection, however, faded during the corporatisation of early childhood environments in the nineteen eighties and nineties, when cement, artificial grass and synthetic ground cover became the dominate surfaces of play in

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early childhood settings. As the first decade of the new century approached, it was noticed that children were losing important affiliations with the natural world around them.

While children usually oscillate between indoor and outdoor play activity, it was noticed that children were spending progressively more time indoors and less time outside (Clements, 2004). This shift from active outdoor play towards a passive and inactive lifestyle generated concerns about the health of children. It was identified that childhood obesity was an increasing issue (Ellaway et al, 2007) and the physical fitness of children and the development of motor skills were in decline (Fjortoft, 2001). Another concern was that children were engaging less in creative, imaginative and make believe games (Clements, 2004; Fjørtoft, 2001). It was also noted that when children did participate in outdoor activity, it was more likely to be in an organized sport that was heavily managed by adults rather than freeform outdoor play (Clements, 2004). This meant that rules and structure were imposed on children rather than being child-initiated and negotiated.

The benefits of outdoor play for contemporary children have been well documented. Davis et al (2010) identify that health and wellbeing goals for young children can be clearly linked to "green" outdoor play. This play gives children the opportunity to develop physical skills, such as strength and flexibility, and physical self-awareness (Clements, 2004). Additionally, risk-taking in a natural space allows children to extend both physical and mental boundaries (Sandseter, 2009). Kellert (2005) also identified that play in a natural space supports the development of self-esteem and helps to build resilience against stress and adversity. This was reinforced by Maller and Townsend (2006) who suggested that hands-on contact with nature could benefit the mental health and wellbeing of children.

It has also been suggested that interactions with nature are beneficial for cognitive and social development (Strife & Downey, 2009). Sustained play in a natural setting is said help to improve concentration and facilitate the process of learning (Wilson, 2012). Further, unstructured play with improvised materials supports the development of imagination, creativity and cognitive development in general (Wilson, 2012). Playing with other children in an outdoor, natural setting offers further opportunities. Dowdell et al (2011) suggested that unstructured imaginative play in nature supports the development of positive relationships, provides a platform for social negotiation and helps children to learn skills and strategies for cooperation.

A key premise for nature play is that a meaningful and connected understanding of the natural environment is an essential precursor for young children to develop a "stewardship of the planet" perspective. Davis et al (2010) identified that sustainability education is fundamental in order to engage future adults with the rising issues of climate change and environment degradation. This was reinforced by Ernst and Theimer (2011), who made tangible links between a child's early engagement with nature and later life environmentalism. Sustainability education can lead to short-term activism where children ensure that they don't waste water, recycle rubbish etc. but it is also likely to have more far reaching outcomes (Lester and Maudsley, 2007). Logically, it seems to make sense that children who experience and develop an affinity with nature are more likely to develop long-term responsible environmental behavior that will protect the environment for future generations.

2.2 Technology and Nature

About the same time as outdoor and nature play went in to decline, the use of technology by children for entertainment rose to prominence. This phenomenon is seen as a direct connection in the literature. For example, McCurdy et al (2010) reported that the health and fitness of children declined as they spent more time indoors using electronic media and less time engaged in outdoor unstructured play. Larson et al (2011) identified that electronic media consumption, including internet use and texting, was the most common reason children gave for not spending time outside. This disposition is embodied in a well-known Richard Louv quote attributed to a 4th Grader: "*I like to play indoors better 'cause that's where all the electrical outlets are"* (Louv, 2005).

While it is likely that time spent inside using computer games and entertainment technology does encroach on time that could be used by children to engage in outdoor and nature play, it is important that the focus remains on the actual activity rather than the technology per se. Computer games and other electronic entertainment technologies such as Wii, Nintendo and iPad apps can be incredibly captivating and, while this activity arguably can have merit in regards to skill development, persistence and problem-solving, concerns relating to the time consuming and addictive nature of these pastimes are also valid (Plowman et al, 2010). It does, however, needs to be recognised that research in the area of the use of technology by young children identifies that this sort of activity is only one in a spectrum of applications.

Digital technology has revolutionized how children learn and interact with their world and there are plenty of instances where technology is used to extend learning opportunities and facilitate new ways to engage, create and communicate (Plowman et al, 2010). Di Blas et al (2013), for example, described a digital storytelling project in Italy where kindergarten children collectively author digital stories to communicate ideas about a shared experience. In a similar approach, Leinonen and Sintonen (2014) identified that media technology is a considered an everyday resource in the Finnish kindergarten where they supported children to use technologies such as digital cameras and audio recording devices for media production.

Typically the ‘nature education revolution’ calls for a reversal of the technology/outdoor play nexus. That is, children need to put down the technological devices and go outside to interact with nature. To some extent this philosophy is reflected in the ‘no toys, no tools’ approach that is implemented in nature schools in order to connect children with the natural objects in the environment. Is this either/or approach the only option available to children? Technology, by definition, is the process of inventing tools and mechanisms that support humans to interact with the world around them. If we look at people who interact with nature in significant ways, either for leisure, such those who undertake wilderness trekking, or professionally, for example, scientists who participate in expeditions to the Antarctica, they don’t actually forgo technology to do this. What they do is select and use technology that is carefully designed and purpose built for the task.

Is it possible that we can use technology in a natural outdoor environment in ways that demonstrates authentic application to young children? In a project with slightly older children, Williams et al (2005) used mobile technologies to create “soundscapes” in outdoor environments. In the project, the children used digital recording devices to create a sequence of sounds on a mobile device that would trigger from sensors as the device was moved around an outdoor space. Cumbo et al (2014) engaged children to design a digital resource based on an outdoor play space. In doing this they required the children to identify key features of the environment to reproduce in a fantasy themed digital game design. Cumbo et al identified that their motivation for this project was to “get the children ‘off the couch’ and outdoors into their local natural places” (np), therefore establishing a connection between the natural and online worlds.

In the project reported in this paper, we investigate how educators and children can use mobile devices to access ‘just in time’ reference material during a bush kinder session. We propose this as an authentic use of technology that supports the core philosophy of nature education and therefore demonstrates that technology and nature education are not necessarily opposed.

3. RESEARCH DESIGN

3.1 Methodological Approach

The discussion presented here is framed by a case study and uses an ethnographical approach, informed by participant observation in order to consider how the use of technology might support the goals of a nature-based kindergarten. Brewer (2000) identified that Ethnography is a qualitative style research that requires the researcher to establish a close association and familiarity with the context. While ethnography doesn’t necessarily require actual involvement in activity, it is usual for the researcher to be situated within the context in the role of ‘participant observation’. This methodological approach was a natural fit for this study because the two researchers, both qualified and experienced early childhood educators, had expertise in the context. One researcher specialised in nature play and sustainability education while the other had research interests in the applied and creative uses of digital technologies with young children. Both researchers had an active interest in the bush kinder program and had already established connections with the kindergarten, the teachers and the families of children in the program.

For the research described in this paper, the two researchers visited the case study site on several occasions. A primary goal was to consider how the technology might be used to support the program but to also act in the role of a teacher/mentor to use technology devices with the children when relevant. This involvement equated to an “active participant-observer” role (Johnson et al, 2006) because of the authentic nature of the interaction.

3.2 The Setting

In Australia the term ‘bush’ is commonly used to describe natural bushland or forest. Consequently the Australian equivalent of a nature kindergarten is a ‘bush kinder’. The bush kinder reported in this study is aligned with a conventional kindergarten program in the outer suburbs of a regional city in Victoria. The bush program commenced with a successful pilot program in 2013 and was then implemented fully in subsequent years. The bush kinder children attend the kindergarten at the site on one day for three hours of fifteen hours of kindergarten attendance per week. The setting is located on what was once a rural school site, owned by the Victorian Education Department. It is approximately eight kilometres from the kindergarten and is almost three hectares of natural bushland bordered by small farms.

The sessions are held each week on location. Parents deliver their children directly to the site and then return to collect them at the end. Early childhood educators conduct the sessions, with an adult to children ratio of approximately 1:5 at each session. The old school building is still on the site in a clearing in the middle of the bushland, however, the kinder group does not access this building at all and the activity is situated entirely in the surrounding trees. At first glance the site seems to be undistinguishable from any other section of bush, however, the children are acutely aware of the physical boundaries of their ‘classroom’, which are marked with fallen logs, key trees and a natural parapet. The ‘entrance’ to the site is guarded by a ‘portaloo’ (temporary toilet) perched on the escarpment and the children know that they must not pass through this gateway unless accompanied by the adult that collects them at the end of the session.

The bush kinder program is managed by a sub-committee who work with the educators to determine the philosophy and curriculum. The children bring drinks and snacks but are not usually allowed to bring toys or other equipment in to the setting. The educators provide a large tarpaulin for the children to sit on but in keeping with their ‘no toys, no tools’ philosophy, they rarely have other teaching tools or materials. Additionally, they don’t allow the children to take any natural objects away from the setting. If materials are collected in the environment, they are left there for the next visit. Finally, the children need to be prepared for all weather conditions and bring warm clothes or wet weather gear if the weather is inclement. The only time bush kinder is cancelled is when it is very windy and there is a danger of branches falling.

3.3 The Study

The study described in this report was conducted over a period of 12 months, spanning two kindergarten cohorts as data was collected in the second half of one year and the first half of the next. In 2013 (the pilot implementation), the bush kinder cohort consisted of 13 children in their kindergarten year (aged 5). In 2014, the cohort was expanded to 26 children. In both years the children attended bush kinder on a Monday morning for three hours from 9.00am to 12.00pm. The minimum adults in attendance for the pilot cohort were three, two educators and one volunteer helper, while the larger group had three educators and two volunteers. On occasions more adults participated in a session, for example when the researchers visited, however, the teaching team were very careful not have too many adults interacting with the children.

As described in 3.1, the two researchers visited the bush kinder sessions together or separately a number of times. On two of these occasions, a videographer also attended to film child activity and/or researcher and child interactions. For the other visits, the researchers took their own recording devices, a digital camera and/or a video camera to record activity when required. The intention of these visits was to collect data for several purposes, including immersing the researchers in the bush kinder culture, collecting footage for teacher education resources, observing the work of the educators in the program and, as presented in this paper, the application of mobile technologies in a nature education setting.

The bush kinder educators hadn’t previously used technological devices in the setting, however, for the purpose of the study, the lead teacher asked permission from the bush kinder committee to allow the researchers to bypass the ‘no tools’ policy to use some technology in the setting. On two occasions the researchers took a mini-iPad with cellular data access to the site in addition to the digital camera and the video camera. The researchers also provided two magnifying glasses for children to examine specimens. The researchers were free to interact with the children as they saw fit and any learning moments using the technology were spontaneous rather than planned. Typically, a researcher would initiate an activity with a child or a group based on a topical interest or an observation and then children might join or leave the group as they wished. These learning events were recorded, either by the videographer or the second researcher.

4. FINDINGS

Two vignettes of learning events where the mini-iPad was used to support authentic investigations of nature in the Bush Kinder setting (see Figure 1) are presented in this section.

Figure 1. Using the iPad in the bush kinder setting

4.1 Let's Look It Up!

In the first learning event, a group of three children had found a partial eggshell under a tree. The children were excited by their find and were imagining what animal might have hatched from the shell. One of the researchers scaffolded their discussion as they cycled through possibilities. The children quickly came to the conclusion that it would belong to a snake, because it was found on the ground. The researcher suggested to the children that they could use the iPad to look up pictures of snake eggs to confirm or refute their hypothesis. The second researcher joined the conversation, as they looked through the images.

Child 1: *This is a snake egg*
Child 2*: I think the snake might be near!*
Researcher 2: *What have you found?*
Researcher 1: *We found this (shows the eggshell to Researcher 2), and everyone is being so gentle with it, and we were just trying to match it to some pictures. Do you think that is a fairly close match?*
Child 3: *(holding a down feather that he found) Look at this! Do you know which bird this comed (sic) from?*
Researcher 2: *Do you think it is from a bird or a reptile, a snake?*
Researcher 1: *At this stage (Child 2) thinks it might be a snake, but we aren't sure, so let's have a look at bird eggs.*

The group google 'bird egg identification' and find a page from the Museum of Victoria "Identifying birds eggs". They recognise that the found eggshell is far similar to the bird eggshell pictures.

Researcher 1: *We have to wait a while for the Internet to load. Here we go…*
Child 1: *Oh no. Too different.*
Researcher 1: *Is our shell anything like that (Child 2)? Can you see any similarities? Have a look at the patterns…What about these ones…Are there any here that look similar?*
Child 1: *No…Wait, wait! That one.*

The children and Researcher 1 looked carefully at the picture. She showed them how to use their thumb and finger to zoom in on the page. The children all had a turn at operating the zoom in mechanism. The children decided, however, that the picture didn't match their egg. They continued to look until they find a picture of a Tawny Owl egg that was almost identical. They read the information on the Tawny Owl and found out that it is a nocturnal bird and lives in the local area. The children then decided that the eggshell should be placed in the 'Bush Museum', an arrangement of found natural objects displayed on a tree stump.

4.2 Identifying Plants

In the second learning event, Researcher 1 worked with two boys in the group and they were examining flowers under the magnifying glass. She again used the mini iPad with them to identify the specimen.
Researcher: *We want to find out what this flower is called. (Child 2) will you come over and help me please? OK, guys, do we have the specimen handy? (Child 1), can you put it under your magnifying glass? (Child 2), are you having a good look? Now, I'm going to show you some pictures…*
Child 1: *Then we can see what we can call it…*
Researcher: *Yeah, we want to find its real name.*
Child 1: *So we can call it something.*

The two boys look carefully through the magnifying glass and the researcher points out the various parts of the flower. They look at the images on the ipad again.
Child 2: *I think it looks like that.*
Researcher: This one? What do you think (Child 1)?
Child 1: *I think it is that one (points to another flower).*
Researcher: *Do you? OK. We need to investigate.*
Researcher: *OK, let me tell you a bit about this one. It is called the Prickly Wattle and it blossoms in the spring, which is now.*

The group looked through the information displayed about the Prickly Wattle and decide that their specimen matches the photograph and description.
Researcher: *OK, are we happy with this name?*
Child 2: *Yes.*
Researcher: *Alrighty. I want to have a look at the other one you spotted. Where was that?*
Child 2: *Over there.*
Researcher: *OK, lets go. (The group walks through the bush)*
Researcher: *Where is it? (Child 2 shows the researcher)*
Researcher: *Wow it is too. And that is different! What is different?*
Child 1: *It is different because it has big leaves!*
Researcher: *Did you notice that too (Child 2)? The leaves are quite different. The leaves on our other Wattle were quite small and these leaves are large. And it is certainly higher, it is taller!*
Researcher: *So lets see what we can find…the leaf is quite different on this one isn't it?*
Child 1: *But the same model!*
Researcher: *Yeah. Similar flower, different leaves.*

5. DISCUSSION

The two vignettes presented here show that it is viable to use connected mobile technology as an investigative tool to solve authentic problems in a natural setting. In these scenarios, the ipad were used by early childhood educators (the researchers) to engage young children in scientific investigation processes. In these learning events, the children were asked to wonder about objects they found and hypothesise about where they might belong in the natural world. They were also required to examine the characteristics of the objects and compare and contrast to online photographs for classification purposes. In these conversations they also learnt about natural processes such as life cycles and seasons and they used nomenclature and scientific terminology such as 'specimen' and 'similarities'.

The first learning event was instigated by a discovery, the partial eggshell. The children assumed that the egg belonged to a land animal (a snake) because the eggshell was found in leaf litter and so the 'just in time' information provided on the iPad helped the educators to address this misconception and steer them in a more appropriate direction of inquiry. This activity also gave the educator an opportunistic moment to teach the children more about using the iPad and supported the children to practice physical skills required to zoom in and position pictures on the screen. Additionally, the event helped to highlight authentic connections between the Museum of Victoria, the source of the information, and their own Bush Kinder Museum.

The second learning event was more devised by the educator (Researcher 1). In this activity, she addressed the scientific practice of naming species with the children. Rather than simply identifying all flowering plants, as ‘flowers’, or by colour, ‘yellow flowers’, she used the iPad connectivity to introduce early concepts of biological classification and to help the children to differentiate between similar species. It was interesting to see that in this vignette the children didn’t pick or even touch the flower they were examining. They examined the specimens in situ and then used the iPad to photograph the plants for future reference.

As described previously, these two events were spontaneous interactions between the children and the researchers rather than planned curriculum activity by the bush kinder educators. They do, however, provide a useful insight in how mobile technologies may be used to support the early childhood curriculum in a nature education setting. Not only can this type of technology use support just in time investigations by giving children and educators access to online information, it is possible to use the technology to capture the moment for extended reflection. The educators could bookmark the relevant websites at the time in order to revisit with children later in the week at the conventional kindergarten. They could also photograph the objects, video the children’s interactions or record on the spot reflective observations for later reference. The Bush Kinder program has a policy where objects are not removed from the location and so digital collection is a way to build connections and extend learning back in to the kindergarten sessions. Further, the children from the bush kinder could use digital media to represent their own stories about bush kinder. This will also enable them to reflect on their experiences in the setting and share them with family and friends.

An added advantage of using technology in the bush kinder setting is that educators can also use it to reflect on their own teaching practices. During the ‘Let’s look it up’ learning event while the group were debating whether the egg was from a bird or snake, one of the children (Child 3) was holding a down feather that he found in the same location as the eggshell and asked ‘do you know what bird this comed (sic) from?’ Neither of the researchers noticed him at the time, but the feather was distinctly from an owl and if his contribution had been included in the conversation, it would have been a valuable clue to the identity of the eggshell! It is important that early childhood educators are informed about the natural environment they are working in order to support the children they are working with (Grogan, 2014). The use of technology to record interactions in the bush is an effective way to raise awareness for educator reflection on teaching moments and curriculum planning.

6. CONCLUSION

The ‘no technology’ position taken by nature education advocates stems from some fundamental concerns about sanctity of childhood and the diminishing connection that children have with nature. Technology is seen as an unwelcome distraction for children as they are sucked in by pervasive entertainment technologies that are mind numbing and addictive. We respect this concern and also lobby for the ‘back to nature’ movement where children can explore and connect with the natural environment. We, however, believe that games and electronic entertainment offer a very narrow perspective of technology and it is important that educators recognise the powerful ways in which the broader spectrum of technology can be used to support learning in any context. We consider that technology, and particularly mobile technology devices such as iPads can provide exciting possibilities in a nature education context and we are truly grateful for the opportunity to explore this avenue in our bush kinder.

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MOVING IN TIME TO A DIGITAL TUNE: A CRISIS IN OUR IDENTITY?

Dr Breda Mc Taggart
Institute of Technology Sligo

ABSTRACT

The higher educational landscape nationally and internationally has changed over the last decades, moving from an elite to a mass higher educational system (Trow,1984). Currently this system and the organisations within it are contending with new external influences on their future structure—the arrival of the technological revolution and digitalisation of learning. Technology has taken global access to our living rooms. Many embrace digitalisation of learning, but others are not so positive. Using identity theory, we examine the potential impact of this shift within the Institute of Technology sector in the Republic of Ireland with a particular emphasis on exploring the impact of learning technology on organisational and academic identity, concluding that exploring this impact is the first step on the journey of digitalisation of learning.

KEYWORDS

Digitalisation of learning, image, identity

1. INTRODUCTION

The purpose of higher education is the belief in individual and societal value, where theorists cite benefits including economic returns, improved life outcomes, and opportunities for individuals (United Nations Educational, Scientific and Cultural Organization (UNESCO), 1991). This is supported within the Republic of Ireland as is evidenced in the most recent higher educational landscape strategy, where it concludes:

> "Higher education is central to the economic renewal we need to support individual well-being and social development… The quality of their learning experiences and the environment in which students learn will shape the future development of our society. They are also citizens who will add to the richness of society – as parents, community leaders and teachers– and in their chosen area of work they will be the productive engine of and prosperous economy" (Higher Education Authority (HEA, 2011; p. 9).

The impact of this agenda on individual higher educational institutions is the requirement to provide programmes of learning that meet the needs of society and the learner. This has led institutions to reflect on the business they are in, how they are doing, what they are doing, and should they be doing something else to achieve the above. Such reflections have led to the realisation that the space higher education exists in has shifted and will continue to shift in the future, where Ireland's higher educational system must become more flexible in provisions of both time and place and one that facilitates transfer and progression through all levels of the system (Higher Education Authority (HEA), 2011).

With this comes the understanding that flexibility and accessibility of provisions are limited within this space, where programmes of learning are primarily delivered face to face within specific institutions (HEA, 2011; p. 38). Recently, however, there are isolated examples of programmes that are available on a flexible online basis. This use of digitalisation to make learning more accessible is advocated at government level, where the sector undergoing transformation concludes that in "the years ahead, students will choose to learn in a variety of ways– full-time or part-time; on campus or off campus; class room based, blended, online or accelerated learning" (HEA, 2012; p. 54).

Therefore, the question has emerged as to whether institutions are ready for this shift into flexible and more accessible learning, which represents a significant cultural and operational challenge. Are they able to reshape themselves to embrace rather than rebuff this agenda? (McCarthy and Samors 2009). This is tandem with our children who are growing up as digital natives (Presnky, 2001; National Association for the Education of Young Children (NAEYC), 2012) and as such will support the notion of a digitally based pedagogy even from a young age (McTaggart, Cavaliero, and Pender, 2014). With some theorists concluding that not only will it improve the flexibility and accessibility of higher education, but it will also ensure that today's teaching and learning is delivered in a way that is relevant to today's population by offering the potential to reach out and engage 'the other half' of the young population as well as to reach out to adults who have not previously benefitted from higher education. Therefore, the belief is that this will provide a fairer, faster higher educational system that is more in tune with contemporary society (O'Connor, 2007; Selwyn, 2014).

Evidence would indicate that, even within this acknowledged potential, concerns exist regarding the impact of digitalisation on the notion and legitimacy of higher education institutions. This paper examines these concerns by exploring the impact of digitalisation on the identity of both the organisation and the academic, with the goal of providing a knowledge base that will help to successfully manage this shifting space within the Institute of Technology (IOT) sector in the Republic of Ireland. As the stronger an organisation's identity, the better their knowledge, attitude, and behaviour regarding the achievement of organisational objectives.

2. LOCAL CONTEXT

The Republic of Ireland's higher educational system has been loosely considered a binary system (two higher education institution types) in that the majority of provisions exist in the traditional unified university sector of which there are seven or more applied and career-focused IOT's (14) (Mulcahy, 1981; Lillis and Morgan, 2012). While they still have an underlying core ethos of vocational and technical programmes from their originations as regional technical colleges, the IOT sector is now similar to their university colleagues, as they too have the authority to deliver degrees at undergraduate, masters and doctorate level. Some can do this independently; others require validation by the Higher Education and Training Council (Taylor, Brites Ferreira, de Lourdes Machado, Santiago). In addition to the main higher education providers above, a number of other third-level institutions deliver specialist education in fields such as art and design, medicine, business studies, rural development, theology, music, and law.

From a geographical perspective, three of the universities are located in the capital city, Dublin, an additional university is in Co. Dublin, and the remaining three are located in the largest cities in the country: Cork, Limerick, and Galway. Comparatively, IOT's (similar to historical poly techs in the United Kingdom) are more regional in focus, located often in areas of higher unemployment and social disadvantage (Burns, 2013).

Participation in higher educational programmes of learning has risen steadily from a base of full-time enrolment in 1967 of 21,000 to its most recent figures of over 160,000 full-time enrolments (Orichesta Research and Library Service, 2014). This indicates that 50-55% of 17 to 18 year olds enter higher education (O'Connor, 2007). In a breakdown, the IOT studentship makes up almost half of the higher educational provision with University studentship numbers at just under 77,000 and IOT's at just over 73,000 (Orichesta Research and Library Service, 2014).

While these figures are positive, the profiles of the learner groups who attend particular higher education institutions are different. The university sector has traditionally espoused the values of elite higher education, while the IOT's are pluralist and as a such are more reflective of a mass higher educational system, where a significant proportion of their student cohorts are non-traditional and/or are the first generation to higher education (Mooney Patterson, O'Connor, and Chantler, 2010). Within this frame changes are underway in the IOT sector, where if these institutions meet a number of key requirements, including capacity (critical mass student numbers and future protections), capability (staff qualifications and research), and expertise, the HEA has committed to allowing them to apply to become a technological university. This technological university is intended to be:

"(Internationally, a technological university is) a higher education institution that operates at the highest academic level in an environment that is specifically focused on technology and its application" (HEA, 2011; p. 103).

Meeting the criteria of capacity and critical mass will require institutes of technology to merge often with significant geographical distances between. Consequently, the role of digitalisation not only supports the needs of modern day learning and non-traditional study arrangements (part-time, e-learning, etc.); but also supports a restructure of the sector, which is now at the forefront of institutional agenda. This is not necessarily to allow for programme rationalisation, but to allow students accessibility to programmes from a wider campus than may be possible in their own regionally based campus, thus meeting the capacity requirement (HEA, 2011; Marginson Report 2011; p. 28) and ensuring fit for purpose in a rapidly changing, globalised world.

A small number of institutions have embarked on this journey and have submitted their expression of interest. Some have progressed to Stage 3 i.e. Evaluation of Plan stage of this process; however, concerns still exist within the entire IOT sector regarding what this restructure and these requirements will mean to all key stakeholders inclusive of the organisation itself and its academics. Anecdotally, the part that appears to evoke significant fear is the role and the method that digitalisation of learning may play in restructuring of the sector.

3. IDENTIFYING AND IDENTITY

While research clearly indicates that digitalisation will not cause the disappearance of campus-based teaching and learning, it will transform the way education is delivered and supported (Economist Intelligence Unit, 2008). From an organisational perspective, the principal direct impact of digitalisation and learning technology is the scope to significantly change how higher education delivers in terms of volume and distance. Specifically, the ability to reach a greater number of students with fewer resources and to reach students over much longer distances while maintaining direct interaction in real time through shared online spaces is possible (HEA, 2011; University UK, 2014). While this has its advantages in terms of critical mass and economic opportunities, the impact on how such a shift can cause confusion to existing organisational identity should not be ignored. Organisational identity is understood as shared beliefs about the organisation's central enduring and distinctive characteristics (Bauman, 1996; Wiesenfeld, Raghuram, and Garud, 1999), which can enhance organisational effectiveness and performance and serve as a source of sustained competitive advantage (Barney, Bunderson, Foreman, Gustafson, Huff, Martins, Reger, Saranson, and Stimpert., 1998). This identity is shared by members and is created and developed through a continuous process of claims and counterclaims regarding the concept of what the organisation is (Whetten and Godfrey, 1998). This leads to the question, what it a university, and what is an IOT?

By allowing and facilitating students to not attend a classroom and as such move to something that we cannot identify with in terms of the normative student experience where students are educated not within a physical structure, this challenges the traditional image of higher education, its distinctive characteristics, and its abstract and concrete identity (Reger, 1998). Abstract identity is understood as components that help to establish an organisation's context and reflect their culture and values that transcend over time (i.e., why we do what we do in the way we do) as well as the legacy of it. Concrete identity elements are tied to a particular time and set of environmental conditions, product strategies, and environment scope (i.e., tied to the historical perception of higher education and elitism pluralism) (Stimpert, Gustafson, and Sarason, 1998; p. 91).

Additionally, within the IOT sector, abstract and concrete identities (Stimpert et al., 1998) are based on foundations and legacies from regional technical colleges, where it has held and continues to hold, the value and belief that they are local institutions who serve the needs of local populations. Consequently, this shift to technological university status requires a critical mass and an improved use of technology to support learning opportunities, which may challenge the notion of what is local, may be inconsistent with those expectations, and has the potential to create tension within the organisation and within the sector (Golden-Biddle et al., 1997). Selwyn sums this up by concluding that digital technologies challenge and question the very essence of what is a university (Selywn, 2014). On this occasion, the introduction and use of digitalisation that deviates from the expectations associated with this organisation's identity are challenging, as identity is intertwined in the routines, procedures, and beliefs of both organisational and external bodies, and efforts to shift identity in order to accommodate identity-challenging technology are difficult to achieve (Tripsas, 2009).

Equally, organisations gain legitimacy with internal and external stakeholders when they demonstrate the normative identity of (in this case) higher education, but this can cause unease if it varies too much from what is expected from the organisation (Navis and Glynn, 2011).

4. WHAT DOES THIS MEAN FOR THE EDUCATOR?

A key part of organisational identity is that of those who teach in that space and their academic identities, which (at the core) relate to teaching and research activities that they deliver (Deem 2006, p. 204). While much of this identity is informed by disciplinary specific knowledge commonalties in values and beliefs are believed to exist, these include but are not limited to academic freedom, the community of scholars, individual autonomy, and service to society through the production of knowledge, transmission of culture, and education of the young (Kuh and Whitt, 1986, p. 76; Whitechurch and Gordon, 2010). The introduction of any new change challenges and redefines some or all of these values: freedom, autonomy, and transmission of culture. None could be seen as more challenging than the introduction of technology to support digitilisation of learning (Adams, 2012), which ultimately impacts on their symbolic order, understood as "the form that the various species of capital assume when they are perceived and recognized as legitimate" (Bourdieu, 1989, p.17). This order allows academics to recognise themselves in, or identify with, the image presented in the ideology and behave accordingly to who they are within a given context (Zizek, 1989 pp. 43-44; Runions, 2000; p. 197).

This challenge to identity is exacerbated by the generation gap of the technological revolution. While most who teach are of the generation of the digital immigrant, this is at sea to our digitally native students who currently use technology based devices earlier than they hold a pencil and often with more ease and proficiency (Lauricella, 2011). Added to this is the reality that "academics form an unusually independent profession, one that draws heavily on traditional ideals about its proper role even as its present-day operating realities in many countries have become increasingly diverse" (El-Khawas, 2002). A tradition of traditionalism is asked to embrace something that is inherently different, which many feel impacts on their legitimacy; it is easy to see why anxiety can and does occur (Levy, 2003). This ultimately compels those delivering programmes to confront existing assumptions of teaching and learning in higher education (Garrison and Kanuka, 2004).

5. IDENTITY REFORMATION

While firms and (in this case) higher education institutes have a current understanding of organisational identity, they also have a desired or ideal concept of identity (Stimpert, Gustasfon and Sarson, 1998). This existence of an identity gap can be useful in a transformation process. On this occasion, members of the organisation and stakeholder groups can be supported to develop a conceptualised identity that embraces digitalisation in a newly configured technological university. Successful strategy renewals can allow an organisation to discard some concrete identities that are no longer of value, while simultaneously adding new concrete attributes that build on the abstract identity attributes and offer the potential of new advantages. Within this IOT transformation process this could include building on the abstract identity that accords the value of education and is entwined with the organisational belief system of making higher education more accessible to non-traditional groups. This philosophy can be supported through digitalisation's ability to increase student capacity in a medium that is relevant for today's population. This change will add a competitive advantage to the concrete identity, while preserving a number of unique characteristics (Gioia, 1998; p. 22).

The concept of organisational identity, therefore, motivates actions as well as strategic choices (Ashforth and Mael, 1996) and is something that should be considered. Identity is who we are and the current and future strategy details with the actions to take us to who we are to become, "a generator for strategies, a screen, a constraint, a filter, an enabler and an influence on strategy" (Barney et al., 1998; p. 166). This is a lesson that can be learned in the current shift within Ireland. The key is to ensure communication and training to support the shift, while maintaining the symbolic capital that is imperative to support and protect the identity of the organisation and its members (Henkel, 2005).

For those who have taken this leap, the new place has proven not that scary, recognising that this change is occurring and the reality is that if we do not embrace it, we run the risk of being left behind.

6. CONCLUSION

While the future higher educational landscape remains unclear, early research indicates that we will remain the same, but different than what we were. This will be the greatest challenge to accept—challenging the notion of our identity. This will provide institutions with the opportunity to contribute to a new identity formation, taking into consideration shifts that are inevitable due to the arrival of the digital age, to be viewed as an opportunity rather than a threat. We must imagine our future within this new future of the technological university where technology will be the key to its success, not demise. The potential of digitilisation to facilitate the accessibility of education to those who may not get this opportunity is one advantage, but another advantage is the potential of digitilsation to change the way we do what we do. If considered a tool to support effective pedagogy, it can become less threatening and may have little impact on the identity of the lecturer. The future of who and what we can be should be the early focus of any restructure with the vision not constrained by what we can do, but inspired by possibilities and opportunities.

7. RECOMMENDATIONS

A next phase in exploring the impact of digitalisation of learning on academic identity within the IOT sector requires the collection of primary data in this field. This has commenced, where the author is currently undertaking an interpretive study with a number of participants who recently began their journey to digitalise their pedagogy and programmes within a case study institute. The study, through participants own narrative, examines their pre-knowledge and expertise in this area, their experiences before and during this process, any barriers or supports to this change in their pedagogy, its impact on their academic identity and any recommendations they may have to make this transition a success into the future.

Early results indicate that the key to the success in this transition process is training, mentoring and support before such a change occurs, where participants concluded that such training reduces the anxiety and threat that this transition can bring to them and their professional identity.

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EXAMINING THE EFFECTS OF FIELD TRIPS ON SCIENCE IDENTITY

Leila A. Mills[1] and William Katzman[2]
[1]St Edwards University, Austin, Texas, USA
[2]Louisiana State University, Baton Rouge, Louisiana, USA

ABSTRACT

The purpose of this work-in-progress study is to examine science identity of elementary school students in relation to participation in science. The questions asked in this initial analysis were: How will a field trip to a science research and learning center affect students' desires to learn and participate in science and does interviewing scientists alter this effect? A total of 151 elementary school (Grade 5) students (76 female and 75 male) participated in an experimental study. Participants were randomly assigned to two different experimental groups: 1) The experiment group attended the field trip and had the opportunity to meet and interview scientists. 2) The control group attended the field trip and did not meet and interview scientists. Results showed that all field-trip participants reported greater interest in their desire to become a scientist and participate in science after the field trip. Additionally, after the field trip, students who interviewed scientists were significantly higher in their desire to become a scientist than students who did not.

KEYWORDS

Role model, science identity, science participation

1. INTRODUCTION

How can we increase participation in science? A review of the literature provides an extensive list of factors thought to influence attitudes toward science. Determinants of who would like to learn science from a young age include gender, family, ability, youth culture, popular culture, education, support systems, personal interests, experiences, and time-use.

Interest in science has been related to how students feel about what they are studying, the learning environment, and concept of self (Bloom, 1976; Hurd, 1978). Opportunities to develop a sense of being *someone who does science* (Aschbacher et al., 2010) are considered important to science identity. Research on dimensions of science-related interest indicates that students' access, activity, achievement, and attitudes are key to interest in studying science (Hanson, 1996).

Additionally, participation and a place of learning are considered to be of interest to students' academic achievement and participation. Non-classroom activities are thought to enhance academic achievement (Campbell & Wolbrecht, 2006). Participation in science is generally related to a complex set of structural factors and contextual characteristics (McNeal, 1999). More specifically, participation in school extracurricular activities is thought to strengthen student ties to academic achievement, and opportunities for participation in science learning outside the school will provide additional opportunities for development of academic interests. Parents, mentors (formal and informal), heroes, and *adults of interest* have all been recognized for their influence on students' sense of self and academic achievement (Pleiss & Feldhusen, 1995). Finally, studies indicate that students express positive attitudes toward science when they experience success and receive support from others whom they consider to be important (Aschbacher et al., 2010). The current research presents an experimental study that was designed to compare the change in a student's desire to become a scientist between students who attend an out-of school science-related field trip with those who are randomly selected from the group to also meet and interview working scientists during the field trip.

2. CONCEPTUAL RATIONALE

2.1 Science Identity

Identity is comprised of components of adolescent development that serve to form identity for occupation and support the solidification of person in Super's (1980) life-span view of an articulated framework for vocational development. Merolla and Serpe's (2013) study of science-related enrichment programs and science identity among 654 graduate students reported that while gender, race, socioeconomic status, and psychological factors affect probabilities of girls entering a STEM profession. *Science identity* (or self concept) magnifies the influence of academic achievement on enrollment in graduate university programs. The success of STEM enrichment programs are thought to be intertwined with the social psychological process by which students may come to self-identify as scientists (Carlone & Johnson, 2007; Egan et al., 2012). Carlone and Johnson (2007) conducted an ethnographic study of science identity among successful women of color and reported that recognition of self as a scientist is an important component of success. Egan et al. (2012) drew from a study of 1,133 aspiring STEM college freshmen that emphasized the importance of the establishment of science identities at the earliest time. They reported that science identity promoted academic success by increasing the likelihood of participation in valuable activities and experiences, such as early research and time with professors, which would in turn nurture their STEM identities.

Aschbacher et al. (2010) suggest that it is important to provide students with opportunities to develop a sense of being someone who does science. Possible selves have been linked to academic achievement (Oyserman et al., 2006). Evidence suggests that the number of academic possible selves declines across the school years and that "Low income, rural and Hispanic youth are at risk of having few academic or occupational possible selves, or having such general possible selves in these domains that they are unlikely to promote self-regulation." (Oyserman & Fryberg. 2006, p. 1). It is therefore important to provide support for science interest to students in such at-risk populations.

Possible science selves are metaphors of self for being a person of science. Future possible selves are of particular interest as socially unverified aspects of being that are relatively impressionable components of self-regulation, motivation, and behavior (Markus & Nurius, 1986). Science selves are of interest for gauging student attitudes toward science liking, science learning, and participation. Smith (2006) examined possible selves in relation to expectancy theory and posited that possible selves are the driving force within self-concept that "should play a central, systemic role in the operation (self-regulation) of self-concept on a day-to-day basis" (p. 60) and can therefore play a key role in a student's participation in and learning of science.

2.2 Role Models

Sjøberg (2002) identified factors contributing to what he describes as disenchantment with science and technology (S&T) among young people today. He attributed the trend toward insufficient recruitment in S&T to contemporary youth culture within social and political phenomena that varies and is best described individually by country. Sjøberg offered a tentative list of rationale that relates to the larger social trends in participation in S&T. Three of the 13 items on his list relate to science stereotypes and role models: 1) The role models in many cultures are not employed in S&T. 2) Scientists and engineers are no longer heroes and are sometimes blamed for "evils of environmental degradation, pollution, global warming, etc." 3) Stereotypical images of scientists and are as follows, "Scientists (especially in the hard, physical sciences) are by pupils often perceived to be authoritarian, closed, bored – and somewhat crazy" (Sjøberg, 2002, p. 4).

A study that focused on providing middle school students with exposure to women in science found that students became more positive in their attitude towards scientists and the role of women in science after the exposure to women in science (Smith & Erb, 1986). It is suggested that teachers of science in the middle school/junior high grades should periodically bring community resource people who use science in their careers to the classroom to act as role models. Additionally, they recommended that all students should be included among the groups of professionals who visit students so that the attitudes of both male and female students toward scientists and women in science might be improved.

A review of the literature examining role models among gifted children reported gifted students benefited from relationships with successful adult role models and heroes within their areas of interest. They report that there are educational benefits for gifted children who have the opportunity to interact with and imitate behaviors of scientists (Pleiss & Feldhusen, 1995).

2.3 Participation in Science

A number of studies have focused on factors that create interest, encourage participation, and foster a sense of being someone who does science among young people. Research indicates that participation in science activities, such as library/museum visits, have a significant direct effect on science attitudes (George & Kaplan, 1998).

Persistence in continued participation on the science-related track is also an area of interest because many students who are initially interested in science eventually decide not to stay on the science academic path. Aschbacher et al., (2010) examined students' persistence in the science-oriented academic pipeline. They identified high, low, and lost groups by persistence, which were found to be different in terms of interaction and experience within three science communities: in school, outside of school, and within the extended family. Students who participated and found support for science in multiple communities were more likely to have science identities and to persist in science learning (Aschbacher et al., 2010). Persistent science interest and achievement has also been associated with having solid support for science interest at home, at school, and in extracurricular activities (Schneider & Stevenson, 1999).

2.4 Research Questions and Hypotheses

As previously mentioned, research indicates that participation in science learning activities outside of school can increase interest in learning science. Exposure to people of science (Smith & Erb, 1986) and receiving support for science interests, by people of interest, are both associated with the strengthening of science-related attitudes among young people (Aschbacher et al., 2010). Additionally, role models and adults worthy of imitating can influence students' sense of self and academic achievement (Pleiss & Feldhusen, 1995). Therefore, it is expected that students who attend the science field trip will become more positive in their self-concept for being a person of science. In addition, it is expected that students who also have the opportunity to participate in a small group discussion with and to interview scientists will have the most positive change in science attitudes as measured post experiment. In particular, the following hypotheses are proposed:

Hypothesis 1: Students who attend the field trip will be more positive in their perceptions of possible science self for *desire* to become a scientist pre-post field trip.

Hypothesis 2: Students who attend the field trip will be more positive in their perceptions of possible science self for *participation* in science-related activities pre-post field trip.

Hypothesis 3: Students who attend the field trip and meet/interview scientists will be significantly more positive in their perceptions of possible science self for *desire* to become a scientist after the field trip than students who only attend the field trip.

Hypothesis 4: Students who attend the field trip and meet/interview scientists will be significantly more positive in their desire to participate in science activities after the field trip compared to students who only attend the field trip.

3. METHODS

3.1 Participants

A total of *N*=151 primary school students took part in the study. The students who participated were enrolled in Grade 5 at a public school in the United States. Participants were almost evenly split by gender (76 girls and 75 boys). The participants in this study were part of a larger group of 324 students attending the field trip. Study participants were students for whom the following could be matched: 1) study permission slips, 2) pre-surveys, and 3) post-surveys. These participants were all from the larger field trip group, which comprised the entire 5th grade of one school district, excluding a small number of students staying back at their campus due to In School Suspension or because they failed to provide a field trip permission slip.

3.2 Measurement and Instruments

This study employed multiple methods to gauge students' science identity for being a person of science. The following instruments were administered to test participants' predispositions and changes of dispositions over time. These instruments were measured on a 5-point *Likert*-like scale with a response scale ranging from *strongly disagree* to *strongly agree*: 1) Possible Science Selves (PSS; 20 items; *desire* factor Cronbach's alpha=0.86; *participation* factor Cronbach's Alpha=0.80; Beier et al., 2012). 2) Creative Tendencies (13 items; Cronbach's Alpha=0.84; Mills et al., 2011). 3) Career Interest Questionnaire (12 items; Cronbach's Alpha=0.84; Bowdich, 2009).

The question items for the PSS factor for *desire* (hope) possible self are as follows:

- I have always hoped to have a job in science one day.
- Having a job in science one day is very important to me.
- I expect to go to college and get a degree needed for a job in science.
- It is very likely that I will get a job in science in the future.
- I expect to have a strong professional career in science in the future.

The question items for the PSS factor for *participation* (strategic) possible self are as follows:

- I want to take as many science classes as possible next year.
- If possible, I would get involved with a science club.
- If possible, I would want to attend a science camp.
- I would be interested in participating in a science fair.

In addition to participating in the experiment and completing surveys, students also drew a scientist and responded to open-ended response items to describe both a scientist and an engineer prior to attending the field trip. Preliminary findings from the field trip experiment are presented here.

3.3 Design

This is an early report from work-in-progress research on *Who wants to be a scientist?* conducted among students in primary school Grade 5. The relationship between an out-of-school science experience and science self-concept is explored. For the first phase of this study, students drew a scientist, listed characteristics of scientists and engineers, and completed pen and pencil survey instruments to provide responses to items of the PSS, Creative Tendencies, and CIQ instruments. These activities were completed at the students' home school. The experiment to test the effects of meeting and interviewing scientists was implemented during the field trip. Students participated in the various field trip activities in two groups: control and treatment. Approximately one-half of the students were selected at random to receive the treatment, which was meeting and interviewing scientists. The treatment group viewed an introductory movie, met/interviewed scientists, toured the working control room of the science facility (with scientists present), participated in hands-on science activities, and explored the interactive exhibit hall in the facility's science education center. The control group participated in the same activities; however, they did not meet/interview scientists. Instead, they met with a science educator who presented information on the research activities of the science facility and demonstrated aspects of physical science applied for the research. Students in the two groups were not aware of the difference in field trip activities.

The treatment group of students participated in 30-40 minute sessions, during which small groups of students (10-20 students per group) met and successively interviewed three science-related professionals who are employed in the research work of the field trip site. The science-related professionals who met with the students were both women and men of varying ages from a wide range of geographic locations. The topic of the interview session between the students and the science-related professionals was *becoming a person of science*. Students were provided with a script of suggested interview questions. Discussion was not limited to the scripted questions.

3.4 Data Analysis

For each participant, initial (pre-field trip) Creative Tendencies and Career Interest Questionnaire scale scores were determined along with matched, paired pre-post PSS desire and participation scale scores. Data were examined by analysis of means procedures pre- to post-field trip and between control and treatment groups.

4. RESULTS

Paired samples *t*-test analysis was conducted to compare students' scientific self-perceptions for PSS desire and participation pre- to post-science field trip by control and treatment groups. Additionally, analysis of variance was conducted to compare differences between the experiment and control groups in PSS desire and participation factors post-field trip.

4.1 Pre-post Analysis

Control group analysis of *t*-test pre-post data (for students who attended the field trip only) revealed a significant difference (increase) on the academic *desire* PSS factor pre (M=2.53, SD=.939) and post (M=2.82, SD=1.04), $t(75)=-3.40$, $p=0.001$. This would be considered a small (0.291) Cohen's d (1992) effect size. A significant difference (increase) on the academic *participation* PSS factor pre (M=2.53, SD=1.02) and post (M=2.81, SD=.942), $t(80)=-2.84$, $p=0.006$ was also identified. This would also be considered a small (0.285) Cohen's d (1992) effect size.

Treatment group analysis of *t*-test pre-post data (for students who attended the field trip and met/interviewed scientists) revealed a significant difference (increase) on the academic *desire* PSS factor pre (M=2.59, SD=.870) and post (M=3.28, SD=1.16), $t(58)=-5.246$, $p<0.001$. This would be considered a large (0.668) Cohen's d (1992) effect size. Also, a significant difference (increase) on the academic *participation* PSS factor pre (M=2.50, SD=.771) and post (M=3.03, SD=1.13), $t(62)=-2.84$, $p<0.001$ was also identified. This would be considered a medium (0.553) Cohen's d (1992) effect size.

4.2 Experiment and Control Groups at Post-test

Analysis of variance, one-way between subjects ANOVA for post-test data, was conducted to compare the effect of meeting and interviewing scientists on PSS *desire* and *participation*. There was a significant effect as a result of the treatment on PSS *desire* at the $p<.05$ level for the two conditions [$F(1,138)=5.531$, $p=0.020$)] treatment and control. The mean score for the treatment condition (M=3.239, SD=1.172) was significantly different (higher) than the control condition (M=2.787, SD=1.045). This would be considered a small-to-medium (0.404) Cohen's d (1992) effect size. There was not a significant effect as a result of the treatment on the PSS *participation* factor at the $p<.05$ level for the two conditions [$F(1,145)=2.135$, $p=0.160$)]: treatment and control.

5. DISCUSSION

Student preferences, as the effect of liking science-related content, and student learning, as cognition, are separate yet related (Zajonc, 1980) aspects of students' attitude towards content areas such as science or STEM. These aspects are both elements of informal learning. Recognizing the importance of informal leaning to student attitudes towards STEM, this study examined participation in STEM activities that provide students with opportunities to interact with science-related content and to develop a liking for STEM in the real world—outside the classroom context. Positive science experiences, such as science field trips and exposure to interesting persons of science, will support positive attitudes towards science (Aschbacher et al., 2010; Pell & Jarvis, 2001). Preliminary findings from this study indicate that students' perceptions of being a person of science and their interest in doing science became more positive after a science field trip experience. This confirmation of students' more positive perceptions of being a person of science (one who will participate in science) as the result of an out-of-school science experience emphasizes the importance of providing students with opportunities to have these science-related experiences and also to feel supported in science interests in multiple communities (Schneider & Stevenson, 1999; Aschbacher et al., 2010). Additionally, results of the experiment showed that students who met and interviewed scientists in small groups were significantly more positive in their desire to become a scientist than students who did not have small group interaction with scientists — emphasizing the value of giving students the opportunity to see and meet role models (Smith & Erb, 1986).

Students will naturally aspire to imitate persons who are considered important, such as heroes and celebrities (Pleiss & Feldhusen, 1995; Sjøberg, 2002). However, there is some question as to whether or not scientists are considered to be important and interesting role models. In order to understand how students view STEM professionals, it is important to understand students' stereotypes of scientists. The stereotypes that students have of scientists have been previously examined through *draw a scientist* studies in order to allow an understanding of how people, especially children, picture scientists. Findings from this study support the notion that students who have the opportunity to become familiar with people of science (Smith & Erb, 1986) and have positive support for science-related interests by scientific role models whom they view as being interesting will have more positive science-related attitudes (Aschbacher et al., 2010). In addition to examining students' science self-concept after meeting STEM role models, participants in this study also drew a scientist. Study participants were found to be more positive regarding their science identities. Additional analysis is planned to compare the drawings of these students to other student groups in order to see if study participants differ in stereotypic views of STEM professionals from other student groups. The authors suspect that students who have the opportunity to meet scientists, as did the participants from this study, may tend to have less stereotypic depictions of STEM professionals. Additional research conducted by these authors will include the analysis of possible relationships between students' views of scientists and their own scientific identities. Ongoing research on factors that support science identity for participation in science is also suggested. The authors recognize that it will be difficult to gauge the long-term impact of informal learning activities, such as meeting scientists, being supported in science interests, and experiencing science-related field trips, will have on students. However, there is evidence to suggest that experiences that support a strong, positive science identity are not only related to younger students' interest and participation in science but are also related to persistence and success in attaining science-related academic goals as a part of students' higher education.

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EDUCATION ON THE CLOUD: RESEARCHING STUDENT-CENTERED, CLOUD-BASED LEARNING PROSPECTS IN THE CONTEXT OF A EUROPEAN NETWORK

Hercules Panoutsopoulos[1], Karl Donert[2], Panos Papoutsis[1] and Ioannis Kotsanis[1]
[1]Doukas School, 151 Mesogeion St., GR 15126, Maroussi, Attiki, Greece
[2]Innovative Learning Network Ltd. Blackwood Avenue, Liverpool L25, UK

ABSTRACT

During the last few years, ongoing developments in the technological field of Cloud computing have initiated discourse on the potential of the Cloud to be systematically exploited in educational contexts. Research interest has been stimulated by a range of advantages of Cloud technologies (e.g. adaptability, flexibility, scalability, accessibility, cost effectiveness). For these reasons, there have already been efforts concerned with the educational uptake of the Cloud at different scale levels (mainly at the institutional and regional level). Apart from that, there are also larger-scale initiatives taking the form of research projects (e.g. the Rural School Cloud project). Nevertheless, most practices have been mainly shaped by the application of economic policies rather than systematic research. In this emerging situation, the aim of this paper is to present the activities of a European network, which has been set up to research how education should adapt and respond to advancements in Cloud computing. The innovative character of the network is that it attempts a holistic approach to the investigation of the effects of Cloud technologies on formal education by targeting at all involved stakeholders, and contexts of use, at all educational levels. By analytically presenting the adopted methodology and network members' vision for Cloud-based, student-centered learning and teaching, our aim is to provide a detailed account of the network's research activities.

KEYWORDS

Cloud computing, Cloud-based education, European network, student-centered learning.

1. INTRODUCTION

During the last few years rapid technological advancements have taken place with unprecedented effects on the ways in which people communicate and socialize, get informed, work, conduct their everyday exchanges, and, of course, learn. Technological developments and their impact on everyday lives and habits of people in general, and young people particularly, have major implications for decision-making and strategic planning on the quality and nature of educational services offered by formal education establishments. Personalization of learning is at the core of challenges that formal education faces with the focus being on supporting learners develop and carry out learning plans at their own pace. In this context, Saveri (2013) proposes the "*create-your-own-school*" movement as a future educational trend. With the use of this term, specific emphasis is posed on the need for schools to adapt to students' preferences, interests, and learning needs, as well as to their surroundings and particularities of communities in which they belong. Similarly, the NMC Horizon Report (Johnson et al, 2015) lists the broad adoption of a blended-learning approach, by higher education institutions, as a key, short-term challenge. In this way, educational organizations will be able to promote and facilitate instruction and learning beyond the confines of traditional classrooms and rigid time schedules, at each student's convenience. On the other hand, financial crisis has led to significant reductions in public expenditures on education. Despite the increasing demand for education and training, austerity puts significant limits in the funding of educational organizations, which have to "*do more with less in the coming years*" (OECD, 2013). Moreover, due to fast-paced technological changes, the need to maintain infrastructure and keep it up to date entails costs that may not be within an educational institution's budget (Sultan, 2010).

In this emerging landscape, Cloud computing promises to improve the efficiency of organizations and actors involved in education and optimize the technology-enhanced learning experience in an affordable way. Cloud computing is defined as "*a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interactions*" (Mell & Grance, 2011). According to the proposed definition, the Cloud is composed of "*five essential characteristics*" (namely, on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service), "*three service models*" (namely, Software as a Service – SaaS, Platform as a Service – PaaS, and Infrastructure as a Service - IaaS), and "*four deployment models*" (namely, private Cloud, community Cloud, public Cloud, and hybrid Cloud). Cloud technologies have the potential to improve the quality of provided educational services by allowing: (i) access to anything from anywhere in anytime on any device by anyone, (ii) sharing of knowledge that facilitates collaboration, (iii) remote interactions and monitoring of learners' progress, (iv) processing of large data sets through the availability of increased computational power, and (v) access to state-of-the-art tools and services without the need of purchasing and maintaining hardware or installing and updating software (Sultan, 2010).

Given all the above, the aim of this paper is to provide a detailed account of the activities of a European network, namely the School on the Cloud network (http://www.schoolonthecloud.eu/), which has been set up to investigate how formal education should adapt and respond to Cloud computing developments and whose activities are funded by the European Commission under the Lifelong Learning Programme (Information and Communication Technologies Action – Key Activity 3). More specifically, our intention is to focus on issues regarding the methodology through which network members research the potential of the Cloud to facilitate student-centered, personalized learning. To this end, after reviewing existing Cloud-based education efforts and initiatives, we proceed with the description of: (i) the network's structure and operation, (ii) findings of a survey among network members, and (iii) the context in which personalization of learning on the Cloud is envisioned.

2. EXISTING CLOUD-BASED EDUCATION PRACTICES

There are a number of Cloud-based education implementations and initiatives that have taken place in various contexts, and at different scale levels (Donert & Bonanou, 2014). Sultan (2010) provides accounts of Cloud-based solutions that have been embraced by educational organizations with higher education holding a greater proportion in Cloud use cases. For instance, the University of Westminster has turned to the adoption of a Cloud-based e-mailing service, because of the scarce use of the institutionally hosted e-mail system, as well as the provision of a suite of communication and productivity tools (namely instant messaging, shared calendar, word processor, spreadsheets and presentations applications) able to support collaborative learning activities. Budget requirements for the implementation of the recruited solution were low and consequently, provision of quality services in a cost effective way became feasible. Apart from that, another advantage of Cloud-based services is the availability of computational power for processing large data sets in an affordable way. This was the rationale behind the strategic decision of the Medical Center of Wisconsin Biotechnology and Bioengineering Center, in Milwaukee, to rent processing time on Cloud servers. As a result, analysis of research data became less expensive, whereas sets of raw experimental data along with results of conducted analyses become accessible to the wider research community.

Cloud-based education initiatives have also taken place in school education contexts. An indicative case is that of Kentucky's Pike County district, where Cloud computing solutions were adopted by its schools in an attempt to reduce public education expenditures. Among others, schools benefited from the transformation of a large number of old computers into fully functional virtual machines. With no need for purchasing and upgrading hardware, as well as keeping installed software up to date, available computers could be reused by receiving processing power and software from Cloud servers. As a result, teachers and students were able to become more productive by focusing on their tasks and activities without any concerns about infrastructure maintenance issues. Another example is that of Brescia House School (in South Africa) presented in the official website of Microsoft (https://customers.microsoft.com/Pages/CustomerStory.aspx?recid=300). By substituting the previously used LMS for a more usable and flexible platform, hosted by Microsoft, school authorities managed to provide teachers and students with device-independent functionalities for accessing and sharing resources, e-mail services, personal storage spaces, as well as the potential to communicate and collaborate even through the use of social media. Apart from the above, there are large-scale efforts that have been concerned with the investigation of the Cloud's educational potential, such as the Rural School Cloud project (http://rsc-project.eu/). This project targets at the examination of methods of providing optimized IT solutions to schools that are located at rural areas, or away from cities, with heterogeneous populations. Based on EU-driven strategies that emphasize the importance of enabling schools with special needs (e.g. schools in rural areas) to access networked digital technologies, the Rural School Cloud project seeks to explore how Cloud technologies may offer learning solutions to highly diversified student populations.

All the above described cases of introducing Cloud-based technologies in formal education, or examining the educational potential of the Cloud, are different in terms of scale levels and incentives. Except for the Rural School Cloud project, most Cloud-based education initiatives have taken place with the aim to address issues faced at the local (e.g. institutional) level. Larger-scale implementations (e.g. at the regional level) have indeed been based on policies which, however, have been mainly formatted by economic reasons and not by systematic research. The innovative character of the School on the Cloud network's research is that it attempts a holistic approach to the investigation of the effects of Cloud computing technologies on formal education. By targeting at all involved stakeholders and contexts of use, as well as all levels of education, and by focusing on the individual learner, the network's intention is to raise awareness about potential benefits, provide guidelines and inform, and stimulate further research.

3. DESCRIPTION OF THE SCHOOL ON THE CLOUD NETWORK

3.1 Definition of the Research Problem

The School on the Cloud network targets at investigating how formal education should respond to fast-paced technological advancements and especially to the proliferation of Cloud technologies. More specifically, the intention is to narrow the existing divide between Cloud computing developments and their uptake by formal education establishments. To this end, the following two research questions are attempted to be addressed:

- How should formal education establishments respond to Cloud Computing developments?
- What is the impact of available Cloud Computing technologies on exercising educational policy, teaching practices, and on facilitating individualized learning processes?

3.2 Methodology

For the purpose of addressing the above stated research questions, a European network (namely, the School on the Cloud network), in which all educational sectors and levels are represented and almost all categories of educational stakeholders are included, has been set up to undertake a three-year research project (January, 2014 to December, 2016). The School on the Cloud network, whose development is in alignment with the Lifelong Learning Programme's ICT - Key Activity 3, consists of 57 partners including 21 Universities and teacher training departments, 9 NGOs, 8 schools, SMEs, research institutes, adult education and VET providers, a European professional association, and a library. Tasks of the network are: (i) the research of "state-of-the-art", (ii) the production of a series of core publications on the exploitation of Cloud in different educational contexts, (iii) the production of guidance resources, (iv) the establishment of methods and means for network members to share their findings and expertise, (v) the dissemination of research outputs within and beyond the confines of the network, and (vi) the establishment of links with other European-wide or nation-wide initiatives.

Research by adopting different points of view (i.e. the educational organization administrator's, teacher's, and learner's point of view) is achieved through the assignment of network partners to four Working Groups (WGs) according to their fields of expertise and interests. These Working Groups are: (i) the innovative Manager (i-Manager) WG, (ii) the innovative Teacher (i-Teacher) WG, (iii) the innovative Learner (i-Learner) WG, and (iv) the innovative Future (i-Future) WG. In order to optimize the project's management and better monitor progress, a leader has been assigned to each WG. WG leaders along with the project coordinator form the project's Steering Group. Table 1 below contains descriptions of each Working Group and their tasks in terms of assigned Work Packages (WPs) and associated deliverables. Each deliverable of each WP constitutes part of one of a four-phase workflow that dictates a sequence for the implementation of each WG's tasks. These phases are: (i) awareness raising/motivation, (ii) review of literature/best practices/ available tools, (iii) development of guidelines, and (iv) dissemination of results and transfer of expertise. Deliverables marked with an asterisk have already been developed and are available to the public through the project's official website and dedicated social media websites.

Finally, given the number of participating institutions, an issue of concern is the coordination of members of the network and their collective activities. To this end, a number of events, planned to take place at regular time intervals, have been scheduled. These events are: (i) *network summits*, which are open to the public and take place on an annual basis with the participation of all network members, (ii) *WG meetings*, in the context of which members of each WG share outcomes of ongoing, or completed, activities and monitor progress against agreed upon time schedules, and (iii) *Steering Group meetings*, conducted with the participation of WG leaders and the project coordinator with the aim to evaluate progress and prioritize next activities. Figure 1 below illustrates key tasks relevant to the project's development.

Table 1. Description of the School on the Cloud network's Working Groups and their project-related tasks

WG name and description	Assigned Work Package (WP)	Associated deliverables
WG1 (i-Manager): Examines aspects of educational leadership, management and organizational change. Aims to identify and share technological, social, economic, cultural and other experiences in different educational contexts, as well as provide guidance to educational organizations.	**WP2**: Leading/ managing Cloud-based developments	**D2.1**. Education and the Cloud – a summary leaflet for leaders and managers (*) **D2.2**. Publication: policy, leadership and management issues **D2.3**. Implementation guidelines and advice **D2.4**. Workshop
WG2 (i-Teacher): Explores the impact of the Cloud on the roles of teachers and trainers and examines how Cloud-based developments can find their way in education. It attempts to identify barriers and required competences, review learning and teaching approaches, and provide practical and essential guidance for teachers and teacher trainers.	**WP3**: i-Teacher: innovative-Teacher	**D3.1**. Presentations on the impact of Cloud-based teaching and teacher education on teachers and trainers (*) **D3.2**. An online catalogue of platforms, tools and apps for teachers, trainers and educators (*) **D3.3**. A guidance leaflet on Cloud teaching and Cloud learning **D3.4**. Workshop on teachers' needs
WG3 (i-Learner): Brings together teachers and educators, schools, colleges, and adult education organizations with the aim to exploit the opportunities resulting from both formal and informal learning situations. WG3 will define personalized learning, and from existing best-practice case studies, will develop a guide on how to facilitate it.	**WP4**: Integrating the Cloud: personalized learning	**D4.1**. State of the art literature review of personalized learning and the Cloud (*) **D4.2**. Case studies of personalized learning **D4.3**. Guidance on personalized learning **D4.4**. Workshop on personalized learning
WG4 (i-Future): Deals with topics like the role and the impact of open (education) resources through the Cloud, new generation Cloud-based tools, and issues such as ethics. Efforts aim to attract the interest of organizations such as education and teacher associations, NGOs, and museums, as well as researchers, educators, school administrators and policy makers.	**WP5**: Future scenarios for Education on the Cloud	**D5.1**. A review of Cloud-based futures and methodologies (*) **D5.2**. Workshop on "Futures: thinking on the Cloud" **D5.3**. Cloud-based education: scenarios for the future **D5.4**. "The Future of Education on the Cloud"

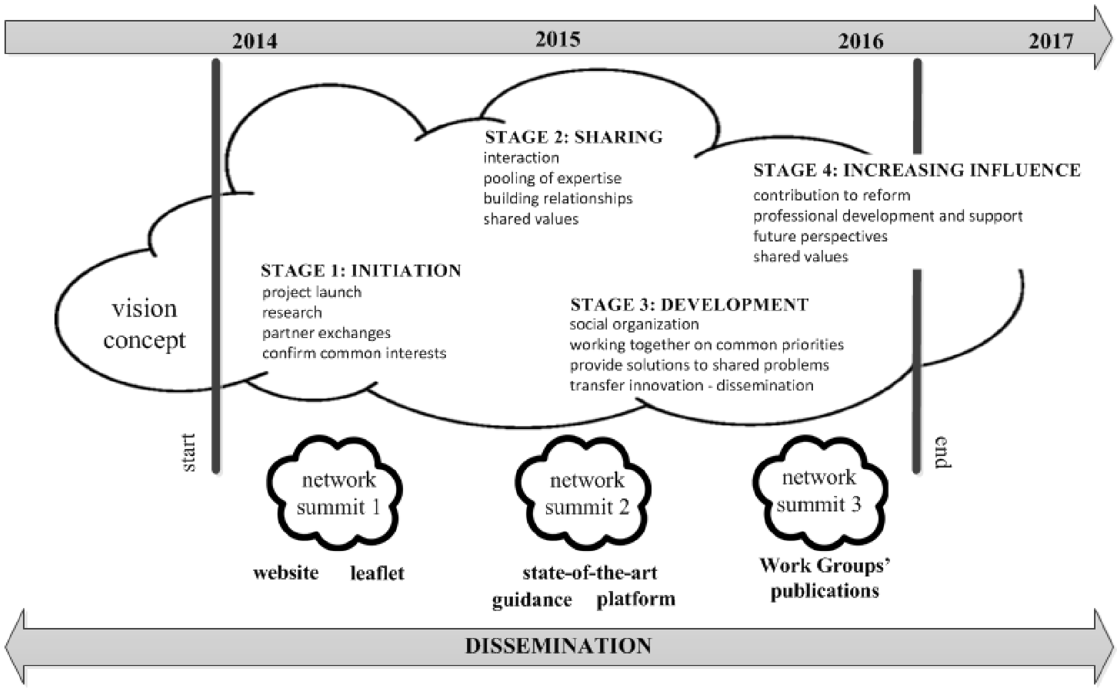


Figure 1. Tasks related to the adopted by the network methodology

3.3 User Needs Analysis: Perceptions of the Cloud and its Educational Potential

A user needs analysis was conducted prior to the first network summit (took place in March, 2014) with the aim to investigate perceptions of the Cloud and its characteristics, perceived educational affordances, beliefs about potential impact of the use of Cloud technologies on the roles of teachers and trainers, and reasons that may hamper uptake by organizations. This formal process also facilitated the reflection of network members on their expectations and offered a starting point for all Working Groups' research by providing input to defined tasks. User needs analysis was implemented through an online survey and with the participation of a sample of N=59 representatives of all network members.

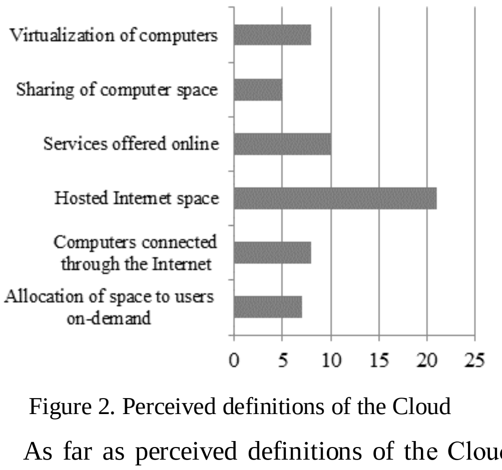


Figure 2. Perceived definitions of the Cloud

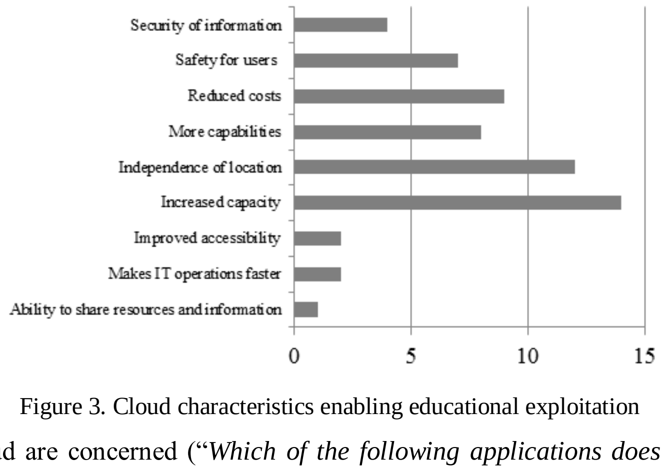
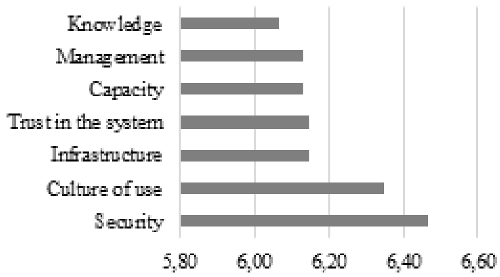


Figure 3. Cloud characteristics enabling educational exploitation

As far as perceived definitions of the Cloud are concerned ("*Which of the following applications does Cloud computing mean to you?*"), 35.6% of participants replied that the Cloud relates to hosted Internet space, 17.9% replied that it relates to services offered online, and 13.6% of responses offered views of the Cloud as computers connected through the Internet or virtualization of computers. Responses to this question are illustrated in Figure 2 above. With respect to characteristics that may facilitate use of Cloud technologies in educational contexts ("*Which of these characteristics does the Cloud offer for education?*"), the most frequently cited responses were "*increased capacity*" (23.7%), "*independence of location*" (20.3%), "*reduced costs*" (15.3%), and "*more capabilities*" (13.6%). An analytical presentation of results is offered in Figure 3 above. Additionally, from responses to the question "*From your perspective, what makes using the Cloud in education innovative?*" the following list of issues arose: (i) freedom from hardware and disc storage, (ii) use in all forms of learning situation, (iii) potential for learning beyond traditional classroom situations, (iv), many innovative apps and tools, and (v) open access – MOOCs.

A key target of the user needs analysis process (having direct implications for research undertaken by the i-Teacher WG) was the investigation of perceptions of the impact that Cloud-based education may have on the roles of teachers and trainers ("*What impact does Cloud-based education have on the roles of teachers and trainers in education?*"). Data gathered from participants' responses reveal that a shift towards a Cloud-based education paradigm implies that teachers need to adopt the role of a catalyst for change, mentor/coach, co-learner, information manager, and facilitator of the learning process. Apart from that, a focus on issues impeding the uptake of Cloud-based solutions by institutions could not be left outside of the survey's scope. To this end, respondents were asked to rate, on a 0 to 9 scale, a number of potential reasons made available as part of a specifically-defined question (namely, "*On a scale of 0-9, consider the relative importance of these possible issues in influencing the take up of the Cloud for education in your organization.*"). Reasons that were rated the most, were: (i) security (6.47), (ii) culture of use (6.35), (iii) infrastructure and trust in the system (6.15), and (iv) capacity and management (6.13). Figure 4 below presents the full range of responses.



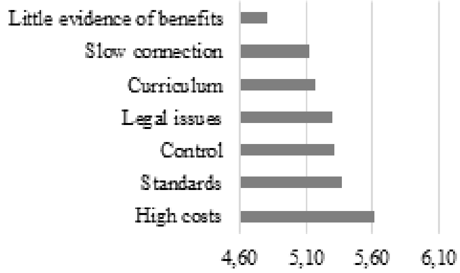


Figure 4. Issues that may hamper adoption of a Cloud-based paradigm by formal education establishments

A cursory review of survey findings reveals that perceived Cloud definitions and characteristics, as well as reported impacts and reasons affecting the Cloud's educational uptake, are in line with issues presented in literature. This conclusion has provided a good starting point for the network's efforts with ongoing research having the potential to lead to multiscale, sustainable Cloud-based educational solutions.

3.4 Focus on the Learner: Facilitating Cloud-based Personalized Learning

It is generally admitted that we cannot envision the future of education (on the Cloud) unless a paradigm shift (i.e. a fundamental change in methods of delivering education) takes place. In simpler terms, full exploitation of the Cloud in education may only be achieved through a paradigm shift from the teacher-centered approach to Cloud-based, student-centered teaching and learning (Koutsopoulos & Kotsanis, 2014). In this context, the aim of this section is to present the School on the Cloud network's vision for a Cloud-based, student-centered model of learning by attempting to draw links between affordances of Cloud technologies and contexts of use focused on the individual learner and specified by existing instructional strategies.

To begin with, services and tools made available through the Cloud can be utilized in support of direct instruction approaches. More specifically, according to Gonzalez-Martinez et al (2015), Cloud-based video-on-demand services can be exploited by educational organizations with the aim to deliver lectures to their students. Video-recorded lectures may benefit learners by allowing them to interact with educational content anytime, anyplace, at their convenience. By having immediate access to video-recorded educational material, learners are able to go through presented concepts as many times as they need and thus, develop knowledge at their own pace. Apart from that, provision of increased computational power through the Cloud offers the potential for interactions with demanding, in terms of required hardware resources, learning environments, such as simulations (Gonzalez-Martinez et al, 2015). With the processing taking place in the Cloud, learners can get involved in simulation-based learning scenarios where learning occurs in a meaningful way through interactions with the medium.

Cloud technologies provide affordances for learning that not only fits the behaviorist learning paradigm, but their main advantage is that they are capable of facilitating learning in social contexts. As Denton (2012) points out, functionalities of Cloud-based applications and tools that support and promote collaboration and communication allow learners to become involved in joint learning activities. For instance, Cloud service providers offer online suites of tools with collaborative features, able to be accessed simultaneously by many users, which can significantly enhance the experience of remote interactions. Besides, according to the socio-cultural learning theory, learning at the individual level involves making meaning as part of the learner's engagement in appropriately structured, collective processes. Social interaction is an "*essential component*" of the problem-based learning approach (Eggen & Kauchak, 2006, p. 252) and can significantly enhance the benefits of involvement in project-based learning (Boss & Krauss, 2007, p. 65). Hence, incorporating Cloud-based applications and tools into appropriately designed problem-based and project-based learning scenarios facilitates learning in a way that is meaningful to the learner and relevant to real-world contexts.

By taking advantage of Cloud technologies there is also potential to maximize benefits from the delivery of inquiry-based learning scenarios. More specifically, lower-level Cloud services, such as storage spaces in the Cloud, can be used by learners (and teachers) to store, share and immediately access sets of data produced from their involvement in scientific inquiry (Abrams, 2012). By this way, learning activities are not confined to the school/university science laboratory and are not limited by strict time schedules. Additionally, through the provision of Cloud-based suites of productivity tools learners can engage in data elaboration processes, individually or in collaboration with peers, and present their findings. Elaboration of scientific data resides at the core of inquiry-based learning (Joyce, Weil, & Calhoun, 2009, pp. 159-187) and thus, providing learners with the appropriate Cloud-based tools and applications helps them to focus on inquiry-based activities rather than being bothered with issues of practical and technical nature.

However, the contribution of Cloud technologies to the personalization of learning can also be considered in terms of the means provided to teachers for the delivery of quality learning experiences. In such a context, the Cloud's potential lies at the emergence of Cloud-based Learning Object Repositories (LORs), able to balance supply and demand, improve availability of resources, respond better to queries for learning objects, and facilitate interoperability (De la Prieta et al, 2014). Furthermore, the existence of providers of Cloud services specializing in storing and managing of specific types of digital resources (JISC, 2012) may lead to new, decentralized LOR models enabling the storage of different types of learning objects to fit-for-purpose spaces. Developments of this kind offer teachers the opportunity to access quality material, either stand-alone or as part of integrated modules and courses, anywhere, anytime, according to their needs (Silva & Donert, 2015). Thus, teachers can create, edit and share innovative learning scenarios, with the use of media-rich content, by taking advantage of quality Cloud-based services and tools.

4. DISCUSSION AND IMPLICATIONS FOR FURTHER RESEARCH

During the last few years, educational organizations have begun to embrace Cloud-based solutions mostly in their attempts to reduce expenditures (Sclater, 2010; Sultan, 2010). However, the Cloud's actual potential lies at a number of affordances able to facilitate learning in many different contexts and based on a broad range of instructional strategies. For instance, Cloud technologies offer opportunities for individualized learning by allowing for anytime and anyplace access to media-rich learning resources, state-of-the-art tools and virtual learning environments. Furthermore, communication and collaboration functionalities of Cloud-based tools and applications help learners to make meaning at the individual level as part of their active participation in collaborative learning activities.

In this emerging landscape, the School on the Cloud network has been formed to explore how education should respond to new IT developments. Through a rigorous research methodology, the network's activities target at a systematic review of "state-of-the-art", considered both in terms of available Cloud technologies and existing Cloud-based educational initiatives, and the provision of guidance and support to stakeholders.

However, full exploitation of the Cloud in education requires careful reconsideration of the roles of teachers and learners. Therefore, by focusing on the individual learner, and with the help of well-established processes of expertise sharing among network members, the intention is to develop a body of knowledge regarding the impact of the educational use of the Cloud, as well as potential issues of concern. Research activities aim to result, among others, in publications providing incentives and guidelines for broad uptake of the Cloud and proposing sustainable solutions at various scale levels. There is much to do for bridging the gap between current practices and the School on the Cloud network's vision for Cloud-based, student-centered learning. To this end, the project consortium pursues dissemination of knowledge and expertise, by establishing links with other research initiatives, as well as stimulation of further research on a number of issues, such as: (i) evaluation of future scenarios of education on the Cloud, (ii) design, application, and evaluation of context-specific Cloud-based educational solutions that span across all levels of education, and (iii) development and testing of Cloud-based services and tools able to cater for special educational needs (e.g. assessment).

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UNIVERSITY AND FLIPPED LEARNING TIC&DIL PROJECT: FRAMEWORK AND DESIGN

Stefania Pinnelli and Andrea Fiorucci
Università del Salento, Via Stampacchia 46, Lecce (Italy)

ABSTRACT

The flipped classroom approach (FC) is for the educational world a chance of recovery and improvement of pedagogical student -centered model and collaborative teaching methods aimed at optimizing the time resource and to promote personalization and self-learning in a perspective of autonomy.
The paper moving from a pedagogical reflection on innovative methodology for the improvement of teaching in schools and universities, presents the model of Flipped Classroom activated during 2014-2015 at the University of Salento in the experimentation of the E -Learning in the University by focusing on the pedagogical model implemented: theoretical framework, research objectives, development phases and testing

KEYWORDS

Flipped Classroom, technologies, university, pedagogical student -centered model

1. TEACHING SKILLS AND FLIPPED CLASSROOM APPROACH

Today schools and universities face challenges and demands more and more articulated that reflect the complexity of the systemic and social model which try to respond, according to the paradigm of constructivism, to new instances from the world of production and the multiple needs of new generations of students.

In the conclusions of the work of Lisbon the European Parliament, in 2000, indicated some ways to renew teaching, considering that transmissive teaching often generate in students demotivation, alienation and disaffection for study (Da Re, 2013). In the Recommendations of 18 December 2006, are set out in a definitive way the eight key competences for European citizenship by defining the concept of competence as "a combination of knowledge, skills and attitudes appropriate to the context [...] those which all individuals need for personal fulfilment and personal development, active citizenship, social inclusion and employment". Teachers are asked to promote students learning through experience and through induction processes, whether by encouragement for knowledge representation.

According to many studies Italian university students have to be structurally considered as digital natives (Cavalli et al., 2009). Considering that, in order to effectively offer students opportunities useful to build the expertise it is necessary to provide tools, techniques and strategies centred on competence.

Alongside the lessons it is necessary to provide discussions, group work, case studies, solutions of problems of experience, taking of decisions, realization of meaningful tasks, because the learning motivation is the result of two conditions: perceive to be able to tackle the task and feel that the effort required has a value and meaning (Brophy, 2003).

This structure often not combined with a limited time in the classroom or the limit of credits assigned to the discipline, but digital technology can be a valuable ally.

We know a lot about the phenomenology of technological innovation, that are generated at each wave peak expectations, accompanied by recurrent mythologies, were followed by failures and advent of new waves (Oppenheimer, 2003; Ranieri, 2011).

Asked if there is a positive relationship between technology and learning the answer is negative: often we find that the use of new technologies in school is not in itself effective; consequently are the methods and not the technology itself that make a difference in learning outcomes (Clark et al., 2006; Hattie, 2009), however, among the technologies the main benefit is presented in the use of interactive video (Calvani, 2012).

Looking at the contribution of teaching methods, the cooperative approach and the laboratory didactics are those that the scientific literature and best practices attest as functional and productive. It is educational settings designed to make students think and act on deliveries active.

Recent education research is focused on how teachers can improve their didactics and use the class-time more efficiently than the traditional lesson. A way to create a didactic more interesting through the use of technology is the flipped classroom or flipped learning.

The flipped classroom structure gives students the opportunity to practice in-class what they are learning, which is consistent with the constructive alignment approach recommended by Biggs and Tang (2007).

The flipped classroom structure demands active engagement both from the students and teachers. Sam and Bergmann suggest that teachers "flip" their class to utilize the time most effectively. They propose that that students, prior to attending class should read a chapter, watch a video or explore a new topic. Then, the teacher may facilitate a discussion based on this information to deepen the students' understanding. Looking at the contribution of the cooperative approach teaching methods and teaching laboratory are those that literature and best practices attest as functional and productive.

An educational structure able to recover time and experiential workshop classroom to dedicate it to the activation of cooperative tasks, peer learning, workshops and educational problems, is given by Flipped classroom (class upside down).

The FC approach refers to an inverted teaching, ie a model which locates in face to face teaching not the transmission of knowledge, but rather the deepening and sedimentation of learning through exercises and critical reflections downline of an individual study, but structured that the student performs independently choosing time and space for learning according, however, to time ranges and specific deliveries proposed by teachers. The study, therefore, is not a proxy by the teachers, but a chance for students to personalize and self-regulate his learning process (Franchini, 2014), while teaching, traditionally represented by the combination of explanation-homeworks, becomes a process in several stages aimed on the one hand to accompany the learning through the promotion and realization of learning materials prepared ad hoc (video-classes, network resources, books etc), the other hand a moment to dispel concerns through dialectical discussions and to support the learning through exercises and groupal or individual in-depth analysis (think of the teaching laboratory and cooperative learning) by promoting to students thinking (Khan, 2012) and self-management (Fulton, 2012) skills increasingly complex.

Therefore the entire educational process to undergo a real inversion in response - these are the premises from which the promoters are started - to the needs of the teachers to optimize and not waste time in the classroom. The teachers, indeed, are increasingly gripped by school programs endless that steal their time limiting the moments of study and exercise to isolated and episodic experiences.

The FC approach is not a pedagogical model, it doesn’t have an epistemology well-defined: it is the result of a multitude of experiments and best practices empirically poorly controlled and comparable to each other, created to satisfy the needs that come from the world of education and aimed recovery pedagogical model learner-centered aimed to customization and sharing of learning (Bloom, Vygotsky or teaching methods as Peer-Assisted, Tutoring, Collaborative and cooperative learning) according to a perspective of optimization of the school time and empowerment the autonomy of the student.

This autonomy is not only about the approach to the study, but it affects the democratization of knowledge and, therefore, the sphere of student participation in the co-construction and sharing of knowledge

Franqueira and Tunnicliffe (2015) performed an exploratory study on this topic following the Critical Interpretive Synthesis methodology for analysis of the literature.

According to them words like flipped learning and flipped classroom are often used interchangeably as an indication of innovation, flexibility, creativity and pedagogical evolution and they indicated that the term “Flipped Learning” is misleading and that, in fact, the synthetic concept behind it is “Flipped Teaching”. They realized a synthesising argument, in the format of two synthesis models, of the potential benefits promoted by flipped teaching and the potential issues which affect its success in practice.

2. FLIPPED LEARNING IN HIGHER EDUCATION

Despite the FC appears more prevalent in the context of school, the world of higher education promotes more and more experiences of research and teaching that refer to this approach.

In fact, in recent years in academic and lifelong learning have been launched several experiments aimed at guide the student in the process of acquisition of knowledge and skills of disciplinary knowledge highly codified (mathematics, physics, chemistry, etc.) in which the risk of failure of learning and dropouts is very high.

In that sense, if in school this approach responds to a need to rationalize and optimize the limited time available, in the academic context, characterized by a high degree of freedom and management (which does not mean autonomy) of time and learning, this approach performs a specular function: return to students, through precise training deliveries, assigned by the teachers, the "weight" and the "sense" of learning time, orienting them, then, to a self and competent managing of it.

Such operation, if in one hand is intended to contain the wasting of resource time and, consequently, to empower students, on the other hand gives them the ability to customize their own learning process according to their educational needs (styles earning, special needs, etc.) and life needs (business and familiar needs).

In response to these needs, the FC approach uses structured learning contents and disseminated in asynchronous mode that become preparatory to the recovery of the content in the classroom. Most educational experiences FC refers to an educational e-learning or blended learning and uses video lessons and learning materials available and shared across the internet.

There is an extensive literature on the attitudes and perceptions of students about the use of video lessons in education (Bolliger et al., 2010; Fernandez et al., 2009; Hill & Nelson, 2011; Lonn & Teasley, 2009; Chester et al., 2011), while a scientific debate about FC approach is lacking. Bishop and Verleger (2013), indeed, have examined 24 empirical studies on this issue highlighting that a strong methodological and content heterogeneity often are not supported by empirical data.

In contrast, however, in recent years on the web it is observed a proliferation of blogs, websites and videos aimed at the promotion and sharing of FC teaching (like Flipped Learning Network).

3. TIC & DIL PROJECT: FRAMEWORK AND DESIGN

The Tic & DIL project: Information Technology and Communication and Teaching of Reading, has been developed by the working group of the Center on New Technologies for Inclusion of the Dpt. of History, Society and Human Studies within a PON for the development of E-learning in the University.

The flipped classroom approach used in this study was undertaken in Semester 2 (February-June 2015).

The project aimed to develop a learning environment/workshop for students of the undergraduate and graduate program of the Faculty of Education.

The course was organized in two interdisciplinary thematic unit (ITU) implemented according to the flipped classroom model.

Common theme of the two ITU was: LANGUAGES and READING, i.e. insights and workshops aimed to promoting in the university context interdisciplinary links about learning languages mediated by technology of dyslexic student (fig 1).

The ITU bound bachelor students has involved teaching and teachers of literary theories and methods of education and teaching methods Laboratory.

The ITU intended for students of degree involved teachings and teachers of the Laboratory of educational planning and of theory and techniques of observation of behaviour in education.

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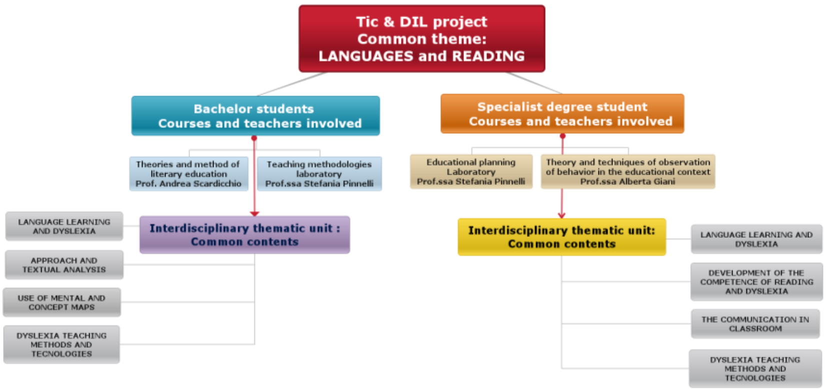

Figure 1. Interdisciplinary thematic unit (ITU)

The online learning has been divided into multimedia and thematic lectures designed with an hypertextual logic with videos and simulations in order to encourage the interaction among students.

For the construction of educational activities the students have been used proprietary and open source software (Camtasia, eXeLearning, Edpuzzle, Storyline, Xerte, Prezi) that have allowed to reuse video assets available on major web portals.

The project and teaching activities have lasted 5 months (February-June 2015) and were designed to recognize and evaluate: the learning outcomes achieved by students in both groups (see the experimental model); the effectiveness of the FC teaching model; the critical elements about technological choices adopted.

4. EXPERIMENTAL MODEL

The project was implemented through the use of the Moodle platform of the University (http://formazioneonline.unisalento.it/) (Fig. 2).

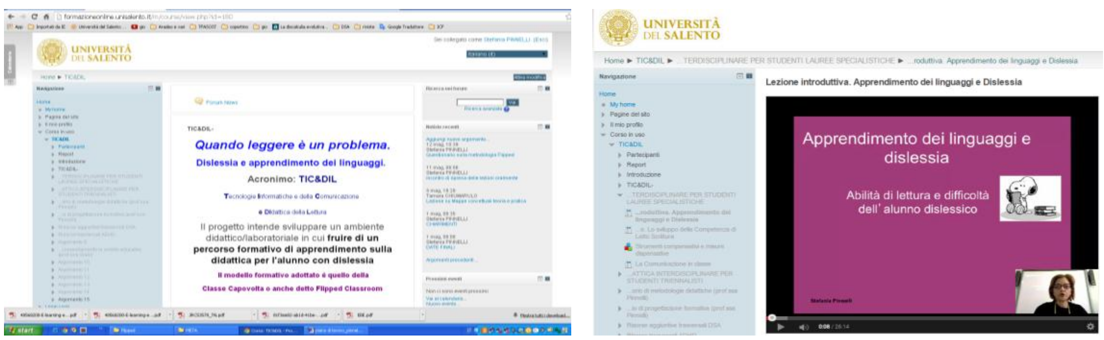

Figure 2. Entry page in Moodle and video lesson example

The investigation involved a total of 380 students. The experimental design included a control group (CG) and an experimental group (EG): the CG included those who voluntarily entered to the experimental model (260 between graduate and undergraduate students); CG (120 students) included those who had chosen to follow the traditional teaching model.

Inside the EG there was activated a second level of testing. A portion of the EG (25 students), followed a blended learning, so that for some activities, the contents that would have been the subject of subsequent lessons were anticipated with handouts or videos online.

4.1 Planning and Time

The two groups attended a similar program in terms of content from March until late April, based on a traditional teaching (lectures) and workshop activities in the classroom. The EG used the Moodle platform in order to support teaching (access to learning materials used in class, handouts and maps of synthesis) and in support of the interaction (personal messages and group activities for the survey data with questionnaires; intermediate deliveries of papers and projects).

The CG has been able to acquire the documentation materials through the online message boards of the teachers. Every student prepared a learning unit (project work) online that was subsequently discussed in the classroom. From the last week of April, the CG continued its activities for another two weeks as usual.

The EG has stopped the face to face lessons in late April and enjoyed ITU online in the first week of May; during the second week of May these activities have been taken up in the classroom with workshop experiences.

This structure has allowed us to transform the classroom into a research community in which students, guided by the teacher have been involved in a discovery learning, and themselves become content creators (Maglioni & Biscaro, 2014). In the third week of May all the students (CG and EG) were evaluated. Each ITU provided three video lessons created with the software Camtasia; two hypertext lessons made with the software Exelearning, and some concept maps created with the software Cmap tools.

4.2 Monitoring and Assessment

The project articulates its assessment on three levels: I LEVEL assessment of learning outcomes, II LEVEL assessment of the two methods (blended and flipped), III LEVEL assessment of the students perception of the FC model and evaluation of the approach of studying of digital students.

4.2.1 Level 1

During the lessons the two groups EG and CG were urged to produce deliveries, i.e. construction of some elaborate, plans, maps, etc. As regard the tools we used: SW Camtasia, eXeLearning, Cmaps tools, Mindomo, Freemind. Although both groups prepared good quality products the exchange of e-mail and communication with the guys in the presence of EG have been much higher. Furthermore it has been activated a forum (fig. 3) where students could communicate doubts and uncertainties about the path of learning but also to communicate with each other.

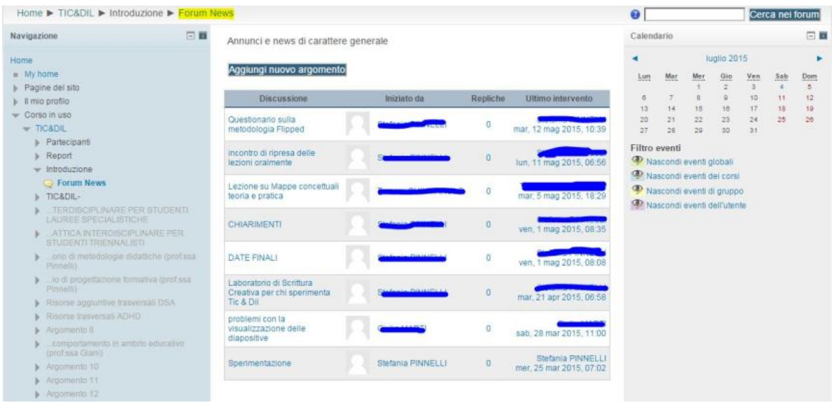

Figure 3. TIC&DIL Forum-Chat

Regardless from participation in the experimental model, students who participated in the pedagogical area workshops have taken part in a teaching workshop. The workshop setting, in fact, was the first gateway for direct passage from teaching (ITU) to design (Laboratory).

Through a selection of technological resources and instructional strategies experimented in the field, it has allowed the students to try their hand with open applications, whiteboard (LIM) and intervention models for language teaching for dyslexic students.

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This environment produced several design ideas for teaching and for technologies to support people with dyslexia. The student, following a bottom-up process, has been called upon to produces ideas in a design format that launched it to a process of shared and collaborative planning.

Specifically, the students during the workshop activities have responded to the educational delivers by the teachers on the topics: after the study of the planned materials (theoretical contents and explanation of the use of technological tools), they have produced the papers: concept and cognitive maps (Fig. 4), audio books, video tutorials with the interactive multimedia whiteboard (Fig. 5) etc.

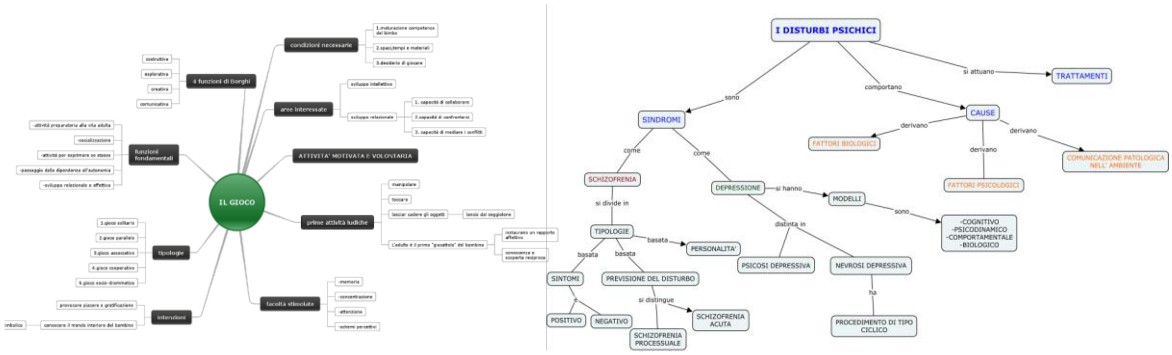

Figure 4. Conceptual map made using MINDOMO (left) and using CMAP (right)

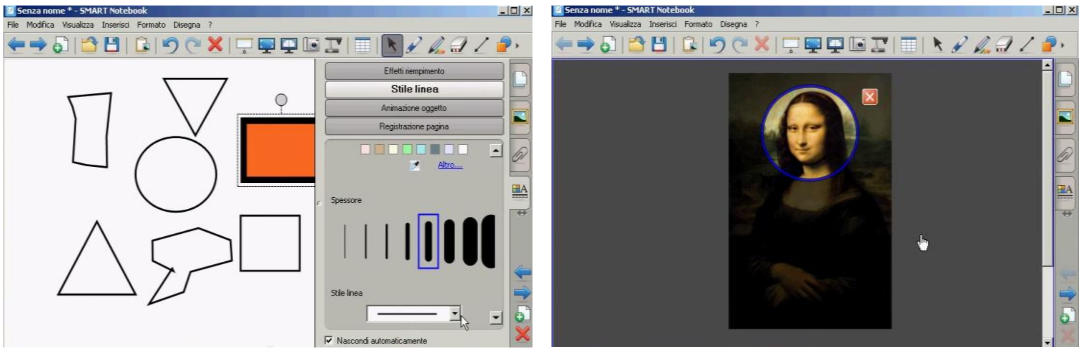

Figure 5. Example: production of video tutorial using the IMW

4.2.2 Level 2

At the end of the path the final evaluation on learning outcomes for both groups started.

The students responded to a multiple-choice questionnaire. The CG was evaluated on the program presented in class, the EG on the program disbursed until late April and on the ITU. It has compared: Learning traditional (face to face training and workshop); Blended learning (face to face training and workshop integrated with educational materials at distance); Flipped learning (distance learning mode videotaped and the next part in presence). Research shows the benefits of the FC model in university education about on the learning outcomes.

The EG had more consistent performances relate to the production and evaluation. In both groups (EG and CG), the traditional model lesson with workshops works better if supported by blended learning. While the blended learning did not affect the didactic based only on face to face lectures.

4.2.3 Level 3

Furthermore this level evaluated the experience of teaching according to the FC and Blended Learning approach. The research group has drawn up and administered an Assessment Questionnaire on the flipped experience (QFC) (Pinnelli & Fiorucci, in press), semistructured tool organized by 40 items divided into 6 areas (Tab. 1):

Table 1. Assessment Areas explored by QFC

Assessment questionnaire on the flipped learning experience (QFC) (Pinnelli & Fiorucci)	
I AREA: Socio-demographic data of the students	Items:1-7, 21
II AREA: Perception of the learning experience with FC	Items 8-15, 23
III AREA: Technology assessment	Items: 16-20, 22
IV AREA: Self-assessment of the cognitive component of the process of access to knowledge	Items: 24-28
V AREA: Self-assessment of the organizational management of access to knowledge	Items 29, 30, 33, 34
VI AREA: Self-assessment of the social and motivational component	Items 31, 32, 35, 36, 37, 38

The questionnaire also included two open items (39, 40) in which the students could express personal opinions about the strengths and weaknesses of the experience.

This level settled out the results in terms of strategies to approach the study of a sample of 129 university students.

Furthermore, this level had seen the investigation of the metacognitive skills that characterize digital students (see Pinnelli & Sorrentino, in press).

5. CONCLUSION

According to Aaron Sams and Jonathan Bergmann (2013) “in light of the principles of Universal Design for Learning (CAST, 2012) [in order to] accommodate all learners, videos, textbooks, problem sets, and other activities should became optional resources for learning rather than required activities. Students [should use] the resources that best suit them to master learning objectives”.

As stated by Tucker (2012) teachers agree that viewing the recorded videos before class time is not enough to make the flipped model successful. Consequently it’s very important how the teacher creates and manage the didactic and the relationship with the students globally.

The Project shows an overall very positive perception of the FC experience (see Pinnelli, Fiorucci & Sorrentino in press).

The students, in fact, see in this approach a “novelty” that can stimulate, motivate them and make them autonomous about the learning management (time, place, tools of enjoyment).

In contrast, however, it can induce a sense of loss, isolation, depersonalization and it can accentuate the relational distance among peers and with the teachers.

In addition the research shows that this approach is strongly influenced by: a careful design process and planning activities (in plenary and individual study); an accurate time management; the choice of subjects; the ways and means of teaching contents, educational deliveries and assessments etc; Cognitive-cultural elements and learning and teaching styles, learning environment; technological expertise; the recovery of the emotional and relational aspects.

The approach FC, beyond the involvement of innovative tools, must primarily considerate from the whole context of education - Teachers and students - the acceptance of a cultural learning and teaching model that in classroom practice, but especially in the minds, ought to be “flipped”.

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TECHNOLOGY-ENHANCED PEDAGOGICAL FRAMEWORK FOR COLLABORATIVE CREATIVITY: ANALYSES OF STUDENTS' PERCEPTION

Manoli Pifarré, Laura Martí and Andreea Cujba
Universitat de Lleida, Av. De l'Estudi General, 4, 25001 – Lleida (Spain)

ABSTRACT

This paper explores the effects of a technology-enhanced pedagogical framework on collaborative creativity processes. The pedagogical framework is built on socio-cultural theory which conceptualizes creativity as a social activity based on intersubjectivity and dialogical interactions. Dialogue becomes an instrument for collaborative creativity processes development, and processes as: distributed leadership, mutual engagement, peer assessment or group reflection become triggering processes of collaborative creativity expression. Two cases studies were conducted in which two secondary classrooms followed a creative project. We explored the role of technology in shaping collaborative creativity processes and we unpacked students' perception about the collaborative and creative processes developed during the educative project. Our preliminary findings showed that the technology-enhanced pedagogical framework scaffolded the development of collaborative creativity processes. Students reported key divergent and convergent process to solve the social and group challenge. And students highlighted key learning to learn processes related mostly with group reflection and mutual engagement.

KEYWORDS

Creativity, collaboration, ICT, secondary education.

1. INTRODUCTION

We live in changeable world, a world in motion and these changes can be seen at all levels of our life and our society. Many educational researchers highlight that it is under these changeable circumstances that creativity becomes much more present and more important than before and it is claimed to help us achieve our goals as individuals, as organizations, as societies (Westwood & Low, 2003).

Creativity has been theorized from different theoretical paradigms (recent revisions: Sternberg, 2003; Kaufman y Sternberg, 2010). Our study is based on socio-cultural psychology of creativity, conceiving creativity as a fundamentally relational, intersubjective phenomenon. One of the purposes of this paper is to be a contribution to the social and cultural nature of creative acts and how technology can enhance these creative behaviours.

In this line, our study bases on *We-paradigm* of creativity proposed by Glăveanu (2010). From this paradigm "creativity takes place within, is constituted and influenced by, and has consequences for, a social context" (Westwood & Low, 2003). Therefore, the role of social factors in the creative process is investigated.

Our study falls on this line of research and has as a main objective the design, implementation and analyses of a technology-enhanced pedagogical framework for collaborative creativity in Secondary Education. We are interested to know, on one hand, how the pedagogical framework designed has a positive impact on students' development of key collaborative processes. On the other hand, we want to study what role technology plays in mediating the development of these processes.

2. COLLABORATIVE CREATIVITY FROM SOCIO-CULTURAL PSYCHOLOGY

Socio-cultural psychology stresses the role of the social context in shaping humans brain. Vygotsky (1960/1997) pointed to the importance of cultural mediation through tools and signs for the development of all higher mental functions. What transpires from the cultural-historical perspective is that creators use culturally constructed symbols and tools to produce new cultural artifacts (Moran & John-Steiner, 2003). Furthermore, Vygotsky was primarily interested in the ontogenesis and microgenesis of creativity and in creativity as a process occurring in real-life “collaborations”.

As a synthesis, Glâveanu, (2010) highlighted three aspects that have to be considered in the socio-cultural psychology conceptualization of creativity, aspects that are important in designing technology-enhanced pedagogy:

1) It considers creative acts as socio-cultural in nature and origin. Cultural traditions, social practices and social artifacts regulate, express, transform and permute the human mind (Shweder, 1990). There is a strong interdependence between individuals and their socio-cultural context. Therefore, the transactions, interactions and activities between these two “systems” are the origin of collaborative creativity. In Cole’s (1996) words the mediated action in context is the sociocultural genesis of mental functions.

2) Socio-cultural psychology conceptualization of creativity stresses the role of intersubjectivity and dialogical interaction in the creative expression. Glâveanu (2010) claims that creativity is located in the space of interrelations. We have to investigate how creativity emerges in relations and how dialogue becomes an instrument for collaborative creativity processes development. The communicative and social dimension of collaborative creativity is highlighted by Sonnenburg (2004) theoretical framework for creating in collaboration. Participants have to be mutually engaged in the process of communication during the collaborative resolution of a task and they have to present a working style distinguished by a serious of dispositions that can favour the emergence of creativity in collaboration. This author highlights an open and free communication in which all collaborators have the same chance to contribute to the course of performance, and the same right that his contributions are taken seriously. Mutual trust and risk-taking are other key dispositions in collaborative creativity. Wegerif et al (2010) in a research in which a dialogic perspective of analysing creative thinking in online dialogues was adopted; claims that the creative process in a collaborative learning situation depends more on a tension between different perspectives rather than a shared framework. Thus, creative thinking emerge when further entails opposing ideas and disagreements being thoroughly discussed, in such a way that differing opinions and conceptions are related to each other. In such a process of collective learning an elaborated understanding of the learning topic can emerge.

3) Socio-cultural psychology conceptualization of creativity looks at how cultural symbolic elements come to form the texture of new and creative products. Creators use culturally constructed symbols and tools to produce new cultural artifacts (Moran & John-Steiner, 2003). Zittoun (2007) developed the notion of symbolic resources; the thesis of this notion is that a group of people when facing a challenge they re-elaborate meaning using symbolic tools and cultural artifacts in a newly way that lead them to externalize a new and creative outcome. In our work, we emphasize the use of technology as cultural and symbolic tools that might help groups to create new artifacts to reach innovative solutions to social challenges.

All these basic premises are at the core of the design of the technology-enhanced pedagogical framework for collaborative creativity presented in the next section.

3. A TECHNOLOGY-ENHANCED PEDAGOGICAL FRAMEWORK FOR COLLABORATIVE CREATIVITY

One important challenge that education has to face is how to develop a pedagogy that could promote the development of creative thinking of young people, and equip them to face the new challenges that the changeable world in which we are living is presenting every day and in the future. Our study is facing this challenge and has developed a pedagogical framework in which technology and collaboration have a central role in the developing of creative thinking.

Our technology-enhanced pedagogical framework is framed on socio-cultural theory presented in the previous section and is based on Sawyer's creative process (Sawyer, 2010) who conceives the creativity "in" and "as" action. Creativity takes place over time, and most of the creativity occurs while doing the work in a joint activity, and is both facilitated by human social relations and improve them.

The technology-enhanced pedagogical framework for collaborative creativity developed for this study involves the next seven axes and depicted in Figure 1.

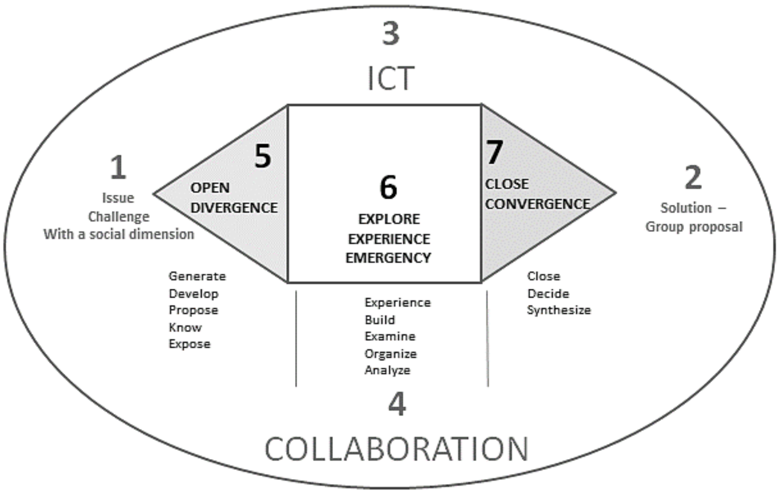

Figure 1. The seven educative variables embedded in the technology-enhanced pedagogical framework.

1. Challenge: The departure is proposing and defining a social challenge to solve collaboratively and creatively. The challenges proposed are: "Creative writing story" and "beautify a patio wall".

2. Solution: Students have to define a solution to the proposed challenge which will have a value for society, with a transformative orientation and students have to define how they are going to communicate to the society their transformative and valuable solution.

3. ICT: Specific use of ICT as mediator of collaborative creativity processes. Our project used 2.0 web tools that allow creative organization of group ideas and enhance the construction and the structure the different phases of the creative process. For example, students used the tool named "Cacoo" to collect information, organize, structure and plan it.

4. Collaboration: Creativity emerges on interaction with other people and with high dialogue quality. Social conception of creativity stands out by: a) the importance of group work: agreement of the rules of team work or "ground rules" (Mercer, 2000); b) the importance of dialogue and language in the creative communication between students. In our project we worked on these aspects as follows:

- Stimulating students into creating their own ground rules in order to promote all group members active participation and work.
- Giving students well-designed scaffolds to improve dialogue and better collaboration.

5. Divergent phase – "Open the mind": Quantitative phase for idea generation. Well-designed activities to promote group idea generation. For example: visualization of images in order to decide the theme of the "beautify the wall" project

6. Exploration phase – "Emergency": The students work together on the ideas that were proposed in the previous phase and on new relevant information.

7. Convergence phase – "Close" the process: It refers to the moment in which the ideas and information are evaluated in a critic and realistic way, in order to converge in one decision and action. This phase should conclude with a tangible and defined product. The methodological strategies that define this phase are: a) the explicit argumentation of the proposed ideas; b) democratic voting and selection of the members. For example: students design book trailers as a way to communicate the creative pieces of writing that they created collaboratively.

4. OBJECTIVES OF THE STUDY

1. To implement the technology-enhanced pedagogical framework for fostering collaborative creativity in Secondary Education.

2. To explore the role of technology in shaping collaborative and creative processes: what technology students used to orchestrate their collaborative and creative project? And how students used this technology?

3. To unpack students' perception about the collaborative and creative processes developed during the educative project.

5. RESEARCH METHODOLOGY

Two case studies were designed in which participated two ordinary secondary classes. In the first study, 2 language teachers and 26 students of year 8th (13-14 years old) participated. Both teachers conducted a project about creative and collaborative writing. The social challenge proposed was: a real editor came to the school and asked for students' collaboration on writing short stories that could be interesting to teenagers. Students should write the stories and explore how to rise teenagers interest on their stories.. The most interesting story would be published on-line in the publisher web and the group of students would have pocket money to spend in a popular bookshop.

In the second study, 3 secondary teachers (one taught technology, the other taught English Language and the last one taught Science) participated. All teachers conducted in an interdisciplinary perspective the project with one group of 25 students of year 7th (12-13 years old). The social challenge proposed was: the environmental school committee asks to the class to think a proposal for decorating one of the walls of the playground. This proposal has to be respectful with the environment and has to include the wall design, materials and budget, and has to be communicated to the school community in English and in Spanish. The proposals and their presentation would be uploaded in the school web side.

In both case-studies students worked together in groups of 4 students.

5.1 Data Collection and Analyses

We collected different kind of qualitative data, however for the purposes of this paper we will base on three types of data: a) the work students did on computer; b) the type of technology they used and for what purposes and c) the responses of a questionnaire that all students answered individually. This questionnaire was formed for seven questions in which students were asked about their perception about what and how they have learnt in relation to the three main axes of our study: creativity, collaboration and technology.

In order to inform about our second research objective - what technology students used to orchestrate their collaborative and creative project? And how students used this technology? - we carried out detailed analyses of the students' products in the different technology they used. We will present the list of technology students used and some examples to illustrate the objectives students had when they used this technology to solve the challenge creatively and collaboratively.

In order to inform about our third research objective -to unpack students' perception about the collaborative and creative processes developed during the educative project- we carried out a detailed content analyses of the students' answers in the questionnaire. A coding scheme was used to characterize students' contributions. The coding scheme is presented in Figure 2.

The coding process consisted of two steps: a) dividing students' responses into meaningful units, and b) assigning a code to each unit. We decided to segment the notes into units of meaning by using semantic features such as ideas, argument chains, and discussion topics, or by regulating activities such as making a plan, asking for an explanation, or explaining unclear information. Validity and reliability aspects were considered in the study.

Our coding scheme has two axes:

a) Creativity axe. In this variable we analysed students' awareness and perception about the two main creative processes: divergent and convergent (see Figure 1).

b) Collaboration axe. In this variable we analysed students' awareness about the learning to learn together processes. We have characterised 4 categories: 1) *distributed leadership:* efficient organization of the team, so that all the members take the same responsibility and by exchanging roles based on that moment necessities; 2) *mutual engagement:* the members attitude based on mutual respect, opinion exchange and helping disposition; 3) *peer assessment*: altogether analysis of the work group; and 4) *group reflection:* students' positive and participative attitude, in order to promote group wellbeing, reflection on the process and being able to regulate.

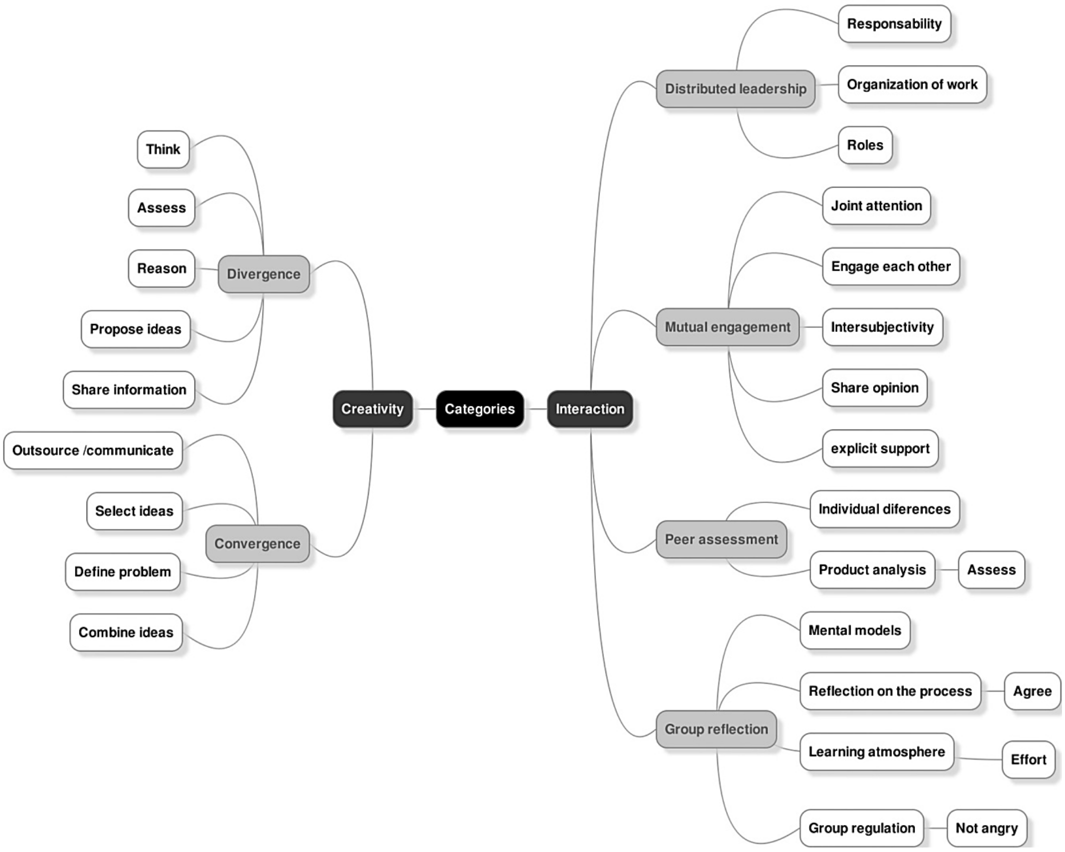

Figure 2. The coding scheme

5.2 Results and Discussion

5.2.1 Technology Students Used to Orchestrate their Collaborative and Creative Project and How Students Used this Technology

Table 1 shows the different technology students used, the cognitive categorization of its use according to the main objective that the students had in order to resolve the challenge in a creative and collaborative way, and a screenshot that exemplifies the use of the technology in our project.

As it can be seen in Table 1, the collaborative use of the technology to solve the challenge triggered a certain way of processing the information and the development of specific cognitive and thinking skills. For example, students used Cacoo to organise and structure the information searched and collected by the different members of the group in order to understand it and make a significant meaning making. And students used Sketchboard tool design the ideas as a proposal for the elaboration of the final product.

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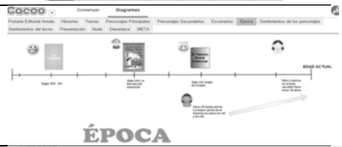
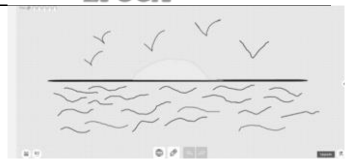
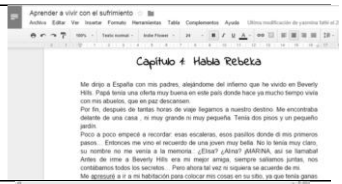
Table 1. Technology used, cognitive processes promoted and example.

ICT	Cognitive use	Exemplification
CACOO	Collect information	
	Organize/ structure	
Sketchboard	Design/ Elaborate	
Drive	Build/ Write. Revise/ Modify. Discuss	
Movie Maker	Synthesize. Communicate. Design.	
QR	Communicate/ externalize	

5.2.2 Students' Perception about the Collaborative and Creative Processes Developed During the Educative Project

Figure 3 and 4 shows the results of each of the two cases studies analyzed and in relation to students' perception about the collaborative and creative processes developed during the educative project. As it can be seen students are aware about the development of key creative processes related with convergence and divergence processes.

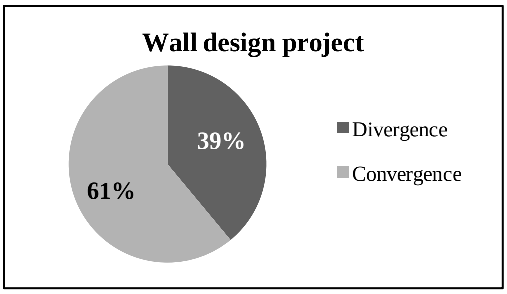


Figure 3. Student's perception creativity

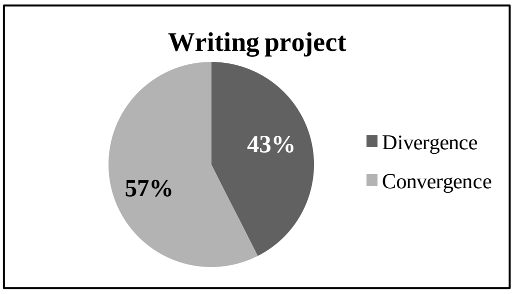


Figure 4. Student's perception creativity

In relation with creativity, students are more aware of the convergence processes developed during the project; more concretely, students stand by the importance of communication and externalization of the final result. The students were aware that the combination of their common ideas to create the final result and the design of a proper communication of the group ideas were two key processes of their creative work. Our data shows that the fact of communicating their projects to the school community has generated an exceptional leader role on students' engagement in creative processes. Some examples of students' answers are the next ones:

- "*yes, by combining my team mate's new ideas with mine, it resulted in more original ones*"
- *"make a book trailer, that is, do the story visually, and make something likeable"*

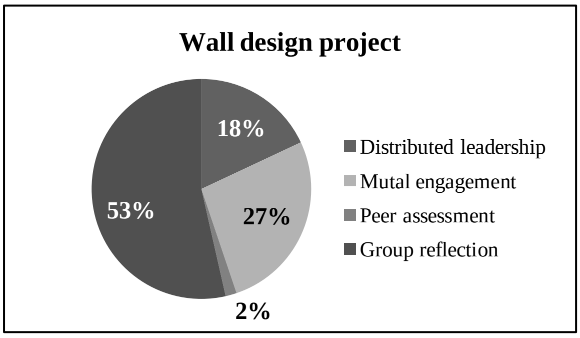


Figure 5. Interaction phases

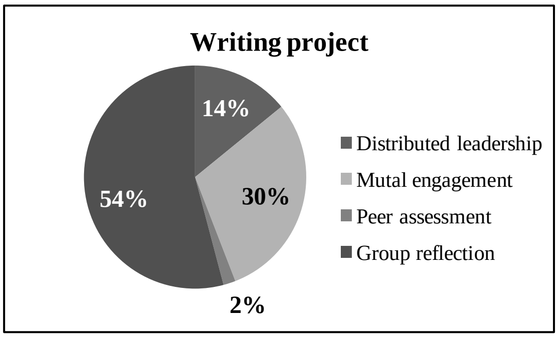


Figure 6. Interaction phases

In terms of interaction among equals, both case studies show similar results, *Group reflection* is the subcategory that stands out the most, as it can be seen in Figure 5 and in Figure 6. Mutual engagement and Distributed leadership are also key processes highlighted by the students. Besides, if we look at the subcategories of our coding scheme, it can be seen that the subcategory "Learning Atmosphere (Group Reflection)" stands out, followed by Group regulation.

We can argue that "learning atmosphere" is higher because students are aware of the importance of group working, and generating a good environment in order to complete their tasks creatively with a social and transformative value. Student have understood the importance of cresting a good working environment to achieve successful learnings, as opposed to the inappropriate manners that only generate conflicts (not listening to each other, getting angry, fight, yell, etc.) that don't allow achieving the best learning results. Some examples are:

- *"not getting angry" / "not yelling" / "not fighting"*
- *"respect others' opinions"*

Addressing Group regulations as a second stand out subcategory in students' opinion, our results show students awareness about the importance of reaching agreements that took into account different ideas in order to work properly and achieve a quality learning result. Example:

- *"we valued each other and we realized what we did wrong and we had to fix"*

Through the use of collaborative dialogue, we could observe the importance that was given to the organization processes: how they organized, planned, regulated, etc., in order to achieve the group task in the best way possible. Example:

- *"yes, due to the fact that we well behaved, everyone wanted to work and do it in a team. We managed to reach an agreement; none of us was in disagreement with another team mate's idea".*

6. CONCLUSION

Our study designed, implemented and analysed the impact of a technology-enhanced pedagogical framework in the promotion of key collaborative creativity processes in Secondary Education.

Our study showed a positive use of technology to orchestrate students' collaboration and creativity actions. In this line, the educative use of the affordances of some web 2.0 tools as Cacoo or Drive has been shown as powerful tools to support (a) the promotion of all students' ideas, (b) to support the representation and organisation of students' ideas in a significant way and (c) to communicate effectively among the members of the group. Besides, our technology-enhanced pedagogical framework has been successful in developing key collaborative creativity processes. Students reported key divergent and convergent process to solve the social and group challenge. And students highlighted key learning to learn processes related mostly with Group reflection and Mutual engagement.

Furthermore, our two case studies showed that the technology-enhanced pedagogical model supported students' creation of a collective and creative solution to the challenge. Therefore, our pedagogy engaged students in a creative and collaborative experience in which they create new and shared knowledge, developed Group reflection skills and positive Mutual engagement strategies. From our perspective, our study shows a promising path in the technology-enhanced pedagogy for collaborative creativity. However the limited sample of our study does not let us to make big claims in this area, our intention is to design a more large scale study.

However, students had to use different technology to get the support to develop key collaborative and creativity processes. From our perspective, there is a need to design technology that can support these key creativity processes in a same and shared workspace. Therefore our study can give powerful insights to technologist to design efficient technology to afford key collaborative and creative processes.

ACKNOWLEDGEMENT

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COLLABORATIVE PROBLEM SOLVING IN SHARED SPACE

Lin Lin[1], Leila A. Mills[2] and Dirk Ifenthaler[3]
[1]*University of North Texas, 3940 North Elm Street, Discovery Park G150, Texas, USA 76207*
[2]*St. Edwards University, 3001 S. Congress Avenue, Austin, TX 78704*
[3]*University of Mannheim and Deakin University , 68131 Mannheim, Germany*

ABSTRACT

The purpose of this study was to examine collaborative problem solving in a shared virtual space. The main question asked was: How will the performance and processes differ between collaborative problem solvers and independent problem solvers over time? A total of 104 university students (63 female and 41 male) participated in an experimental study. Participants were randomly assigned to four different experimental groups: individual & multi-tasking, collaborative & multi-tasking, individual & single-tasking, and collaborative & single-tasking. Results showed that the participants who collaborated and had multi-tasking activities outperformed the others. Additionally, collaboration helped to improve overall performance over time. The study offers insights for collaborative learning from both theoretical and methodological perspectives.

KEYWORDS

Collaborative learning, shared space, split attention, multi-tasking

1. INTRODUCTION

The collaborative learning has been defined as an instructional method that allows pairs or small groups of students to work together towards a common goal (Gokhale, 1995). “Collaborative learning” has been reviewed for the potential to enhance active exchange, critical thinking, and achievement (Johnson and Johnson, 1986; Totten et al, 1991). However, complex technology-mediated communications environments, increasingly employed for collaborative learning, is also thought to pose challenges for students who must split attention and engage in media-induced task switching (Rosen et al, 2013). Closer examination of the constructs within complex environments for shared space has been suggested as the key to understanding the role of the computer for effective learning collaborations in technology-mediated, virtual shared spaces (Roschelle and Teasley, 1995). Therefore, the present experimental study examines a complex, technology-based problem-solving setting for the effect on students’ problem solving while participating in collaborative learning in collaborative multi-tasking and independent single-tasking modes.

2. CONCEPTUAL RATIONALE

2.1 Collaborative Learning in Context

Collaboration can be viewed as a process by which we negotiate and share meanings relevant to problem solving (Roschelle and Teasley, 1995). In the broadest terms, collaborative learning is a situation in which two or more people learn or attempt to learn something together (Dillenbourg, 1999). Kaye (2012) characterizes collaborative learning as being a secondary outcome of a task-oriented activity. However, collaboration for learning does not necessarily take place simply because students are co-present (Roschelle and Teasley, 1995; good collaborative practice will depend on the development of reciprocity and cooperation among students (Chickering and Ehrmann, 1996).

Increasingly, communications technologies provide both synchronous and asynchronous technology tools that support a more abstract view of collaborative, active learning. Technology-mediated collaborative learning extends collaborative learning beyond face-to-face environments (Alavi and Dufner, 2005) and going beyond that, supporting the flexible learning paradigms that were once dependent almost solely on email and computer conferencing (Collis and Moonen, 2001). Computer-mediated communications for new learning paradigms are also associated with shifting philosophical foundations, from objectivist to constructivist views, in fields of learning theory and instructional design (Jonassen et al, 1995). Bruffee (1999) points out that collaborative learning in higher education is creating a need for a reexamination of the role of the existing assumptions regarding knowledge, authority, and institutions within a social construction framework. Gokhale (1995) posits that collaborative learning is most effective when the primary objective of a teacher is not transmission of information but rather the development of a students' ability to learn.

2.2 Collaboration for Problem Solving

"Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem," (Roschelle and Teasley, 1995 pp.70). *Talk* is the primary resource in the process, allowing the production of shared knowledge, divergent understandings, and resolution of problem-solving impediments (Roschelle and Teasley, 1995) by the use of constructive dialog. Collaboration in problem solving is thought to promote creative thinking skills and to reduce problem-solving anxiety (Gokhale, 1995). Coordination is essential to problem solving. Barron (2000) conducted a study to describe the types of interaction that promote coordination. He attributed differences in the performance of problem solving to the degree to which collaborators will have 1) shared task alignment, 2) joint attention for solution, and 3) a mutuality and reciprocity of contribution.

Within the larger framework of goals in education, the skill set required to participate in teamwork and solve problems collaboratively is considered a precondition for success in many learning and working contexts (National Council of Teachers of Mathematics, 1989; National Research Council, 1996; Rummel and Spada, 2005). The ability to define and solve problems is a highly valued skill in the knowledge-based, interdisciplinary, and distributed work of today (Barron, 2000).

2.3 Virtual Shared Space

The place of learning, no longer limited to a surrounding or local space, is uniquely defined for technology-supported collaboration. Resta and Laferrière (2007) characterize collaborative learning as being a complex concept often implemented in technology-supported virtual workspaces. Stahl et al (2006) examined the complexity of computer support and collaborative learning that utilize a collaborative communication channel bridging time and space. Wegerif (2006, p.156) recognized changing patterns in contemporary work and life practices, such as student participation in online dialog in spaces of reflection. Teasley and Roschelle (1995) suggest that collaborative problem solving enables students to construct a shared conceptual structure or *joint problem space*. A joint problem space, which provides the benefits of computer-supported collaboration in a meditational framework, is dependent upon participant sharing of: 1) a common language, 2) a common situation, and 3) a joint activity (Teasley and Roschelle, 1995).

2.4 The Current Study

With the current study, we hope to obtain a better understanding of collaborative problem solving in a complex setting. In this regard, the first aim was to determine the degree to which the perception of collaboration will develop over time. We assume that collaboration will increase over the course of learning (Hypothesis 1). The second aim was to empirically document the degree to which collaboration would influence students' performance. We assume that collaboration is positively related to the overall problem solving performance (Hypothesis 2).

3. METHODS

3.1 Participants

Study participants, *N* = 104, were university students (63 female and 41 male), who were enrolled in an intermediate-level teacher education course. Their mean age was 23.49 years (*SD* = 4.22).

3.2 Materials and Instruments

The current experiment had students solve analytical reasoning (AR) problem tasks that are samples of Graduate Record Exam (GRE) problems. As shown in Table 1 below, AR problems require an understanding of a given structure of arbitrary situational relationships for subsequent deduction of new information from the given relationships for constraint-satisfaction (Kaufman et al., 2001). The AR problem questions were assigned a difficulty rating, on a scale of 1 to 6, where 1 = least difficult and 6 = most difficult, based on guidelines for analysis of content characteristics to the difficulty and discrimination of GRE problems (Chalifour and Powers, 1989).

Table 1. Two examples of sample GRE reasoning tasks from lowest and highest difficulty levels, and solutions

Task	Example	Solution
T_d1	Four of the following five are similar in a definite way and so form a group. Which one of them does not belong to the group? A. Umbrella B. Gloves C. Shirt D. Shoes E. Cap	A. Umbrella
T_d6	A pesticide producing company states that their unused pesticide that gets dumped does not pose a threat to the aquatic life in the surrounding area. If this is correct, then why have local fish been dying in this region? Due to the fact that the pesticide company is not located in a highly fish-populated area, they implicitly admit that the pesticides they produce are relatively dangerous to the nearby aquatic life. Of the following statements listed below, which one would be most likely to weaken the argument of the author if it were true? A. The possibility of pesticides filtering into the local water region was underestimated in the past. B. Funds for environmental company cleanup, which concern waste dumps that are poorly run, are reserved for rural regions only. C. It would be pointless to locate chemical dumps where they would be most harmful, unless they can be proven 100-percent safe. D. Dumps that are located in areas without large fish populations have fewer government interventions and are also less expensive. E. City people are most probable to sue the company if the dumps cause them health problems.	D. Dumps that are located in areas without large fish populations have fewer government interventions and are also less expensive.

Multiple instruments were administered to test participants' pre-dispositions and changes of dispositions over time. These include the following: 1) Verbal ability test (*r* = .96; split-half reliability; Amthauer et al, 2001); 2) Multi-tasking preference inventory or the Inventory of Polychronic Values (IPV; Bluedorn et al, 1999). The IPV has 10 items measured on a 7-point Likert response scale (anchored from *strongly disagree* to *strongly agree*) with higher values indicating a more polychronic or multi-tasking attitude. Conte et al (1999) reported Cronbach's alpha=.822 and higher as evidence for construct validity for this instrument. The retest–reliability coefficient over a 2-month interval is .78 (Conte and Jacobs, 2003); 3) Integrated communication technology learning (15 items, Cronbach's alpha = .605); 4) Formal-to-informal learning scale (12 items, Cronbach's alpha = .695; Author, 2014); 5) Technology affinity scale (22 items, Cronbach's alpha = .624; Author, 2013; and 6) Confidence, effort, motivation, collaboration, tools, and strategy inventory (5 items, Cronbach's alpha = .692).

3.3 Analysis

Initial verbal ability and multi-tasking preference scores were calculated for each student. Each participant's task solution scores were determined at each measurement point. Additional measures were also calculated, including confidence in accuracy of the solution, level of motivation, the problem-solving strategy applied, an estimated of time on task, the estimated degree of collaboration, and the method of collaboration.

4. RESULS

4.1 Development of Collaboration

We computed a repeated-measure MANOVA with the *intensity of collaboration* at five measurement points as a within-subjects factor, and *experimental groups* (CMT, CST) as a between-subjects factor. MANOVA revealed a significant main effect of time on intensity of collaboration, Wilks' Lamda = .782, $F(4, 47) = 3.28$, $p < .05$, $\eta^2 = .218$, and for time x group, Wilks' Lamda = .771, $F(4, 47) = 3.49$, $p < .05$, $\eta^2 = .229$. The sphericity assumption was met ($\chi^2(9) = 11.45$, $p = .25$). The difference between measurements was significant, $F(4, 200) = 2.43$, $p < .05$, $\eta^2 = .046$.

A pairwise comparison of intensity of collaboration at each measurement point (MP) indicated significant differences between experimental groups as follows: MP2, $t(50) = 3.61$, $p < .001$, $d = 1.00$; MP4, $t(50) = 3.17$, $p < .01$, $d = .88$; MP5, $t(50) = 4.64$, $p < .001$, $d = 1.29$ (see Table 2 for descriptive statistics).

Table 2. Means (standard deviations in parentheses) of intensity of collaboration over time

Exp. group	Measurement point				
	MP1	MP2	MP3	MP4	MP5
CMT (n = 26)	4.08 (2.17)	6.19 (2.06)	5.15 (2.03)	5.77 (2.63)	5.54 (1.96)
CST (n = 26)	3.92 (1.77)	4.15 (2.01)	4.19 (1.96)	3.62 (2.26)	3.12 (1.80)

Note. CMT: collaborative & multi-tasking; CST: collaborative & single-tasking

Further, we found a significant interaction effect of time and group on the intensity of collaboration, $F(4, 200) = 2.88$, $p < .05$, $\eta^2 = .054$. Figure 1 shows the interaction effect on the intensity of collaboration. To sum up, results showed that the participants who were confronted with multi-tasking activities outperformed the others. Accordingly, we accept Hypothesis 1.

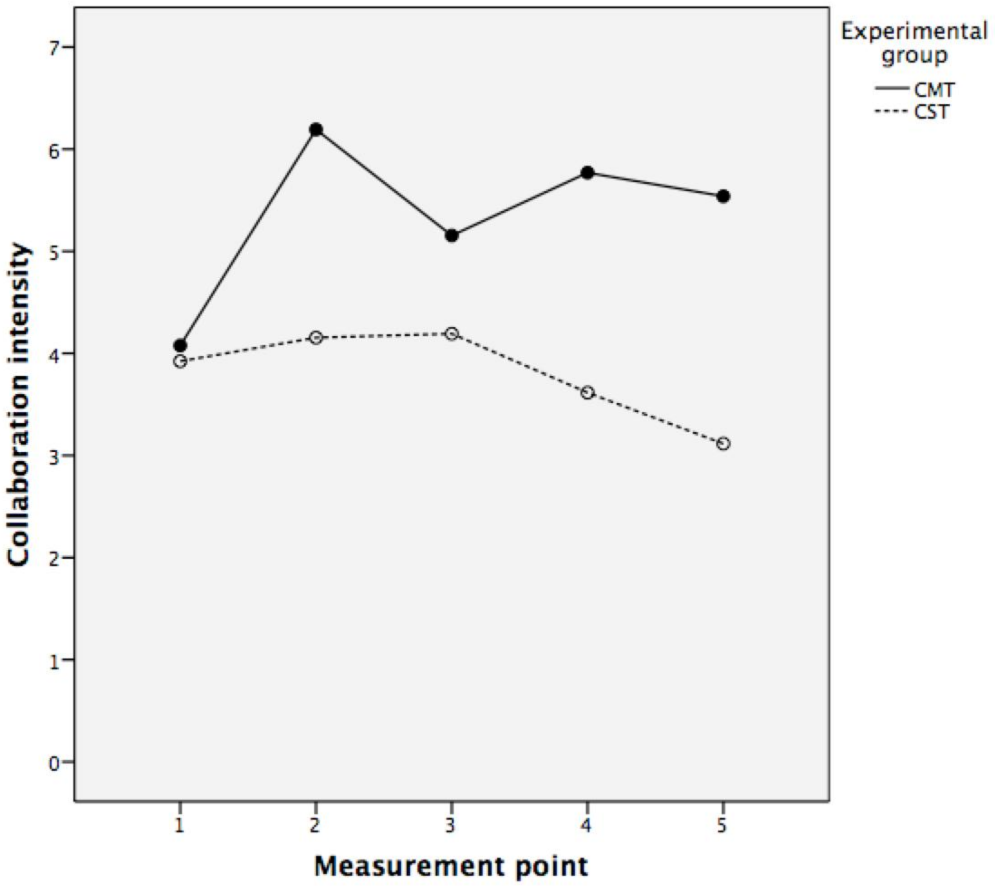

Figure 1. Interaction of experimental group x time on collaboration

4.2 Influence of Collaboration on Performance

The regression analyses results for the acceptance and use of the three examples of learning analytics systems (ALA) on problem solving performance are presented in Table 3 yielding a ΔR^2 of .319. Clearly, collaboration positively predicted the problem solving performance, indicating that the higher the perceived collaboration, the higher the overall problem solving performance. Accordingly, we accept Hypothesis 2.

Table 3. Regression analysis predicting collaboration on problem solving performance

	R^2	ΔR^2	*B*	*SE B*	β
	.333	.319			
Collaboration			.520	.104	.577***

Note. *** $p < .001$

5. DISCUSSION AND CONCLUSION

This study examined how technology-supported collaboration would develop over time, as well as the effects of collaboration on problem-solving performance. The results of the study showed that 1) the participants who were confronted with multi-tasking activities outperformed those who did single tasks; 2) the higher the participants perceived collaboration, the higher they demonstrated overall problem solving performance.

In general, students became increasingly more collaborative over time, and collaboration was a strong predictor for overall performance.

This study is significant in several ways. From a theoretical perspective, with the increasing complexities of learning environments being afforded by new technologies, it is important to examine aspects of collaborative learning and problem solving in flexible and multitasking environments. Methodologically, it is important to advance an understanding in this area of learning by testing hypotheses and conducting experiments to obtain results that may assist educators and learning technologists to advance understanding of how best to design and support a student's ability to coordinate, collaborate, and problem solve in new distributed workspaces.

Helping students to "develop their capacities for productive engagement in collaborative problem solving is both an educationally and socially important venture" (Barron, 2000 p.433). The new spaces of study and work are increasingly virtual and visited by individuals who are distributed in time and place (Resta and Laferrière, 2007). These technology-supported workspaces enable new models of flexible collaboration for learning and problem solving, although they could potentially increase cognitive overload as well. It is important to examine elements and dynamics of such workspaces to ensure smart learning environments for the learners.

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A SOCIAL NETWORKS IN EDUCATION

Blanka Klimova and Petra Poulova
University of Hradec Kralove, Rokitanskeho 62, Hradec Kralove

ABSTRACT

At present social networks are becoming important in all areas of human activities. They are simply part and parcel of everyday life. They are mostly used for advertising, but they have already found their way into education. The future potential of social networks is high as it can be seen from their statistics on a daily, monthly or yearly increase in the number of their users. The purpose of this article is to provide a short description of the concept of social network and its classification according to the way how they function or their main purpose. In addition, the authors discuss two main approaches to teaching and the educational theories out of which connectivism is the first theory which takes into account the existence of computer networks and considers all knowledge and abilities as a result of mutual interconnection of information and people. Thus, it is the theory which enabled the implementation of ICT into education and has completely changed the traditional teaching and learning. In conclusion, the authors also explore a few already existing educational social network sites and their benefits for education.

KEYWORDS

Social networks; education; approaches; theories.

1. INTRODUCTION

At present social networks are becoming important in all areas of human activities. Every man is a member of social network when he is born in the relevant community, i.e. in the family. Later, man comes in contact with the so-called Internet Social Networks (SNSs). The object of SNSs can be just a classic e-mail or more complex web tools aimed at service promotion, sharing, information search and communication among their users.

Social network can be perceived from different points of view. From the sociological point of view, social network is a connected group of people who can influence one another. In most cases the group is based on common interests. It can also originate for family reasons when the group members are relatives. The concept of social network was used already before the rise of the Internet. It was defined by the sociologist J. A. Barnes in 1954. Barnes was researching the relationships among the Norwegian fishermen. Thus, the primary meaning of the social network was sociological which served to the description of social structures connected for different reasons (Pavlicek, 2010). Barnes defined the social network as a set of points and some of these points are mutually connected by lines (relationships – bonds). They afterwards form a total network of relationships, the so-called social network (Rulf, 2013).

According to Pavlicek (2010), the social network contributes to mutual influencing and enrichment of the whole group. He claims that the group identity accompanies a person all his life and he usually becomes a member of more than one group at the same time. And in each group he behaves and communicates differently.

With the arrival of new information and communication technologies, the social network acquired a completely new meaning. The advantage of the Internet social network is that people can communicate independently on their location and time, and thus keep in touch anywhere. Moreover, they have easier access to contact their friends and find information about them.

The online social networks have many definitions. One of the most frequently used is provided by Boyd and Ellison (2007) who define SNSs as web-based services that allow individuals to construct a public or semi-public profile within a bounded system; articulate a list of other users with whom they share a connection; and view and traverse their list of connections and those by other within the system. The Czech expert in social networks Bednar (2005) defines the online social network as follows: The online social network is a system which enables to create and maintain a list of mutually connected contacts, friends. Each user of such a system has his own characteristic features which are publically available to other users. Within this system people can search for one another and form a virtual community in this way. A more advanced form is the browsing of the list of friends. The social network also enables searching for former colleagues or virtualization of working teams. In addition, there is a possibility to upload different kinds of information or photos.

Since 2003 there has been a myriad of social networks out of which some are really popular nowadays such as MySpace, YouTube and, of course, Facebook (Pavlicek, 2010). Consult Fig. 1 for the historical milestones in the development of social networks.

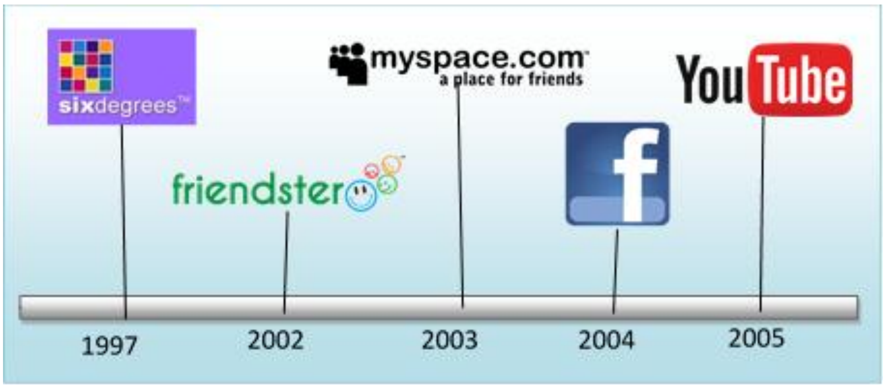

Figure 1. Historical milestones in the development of social networks

2. CLASSIFICATION OF SOCIAL NETWORKS

Social networks can be divided into several types according to the way how they function or what their main purposes are (Platko, 2010). Among the principal categories there are social networks based on the profile, content, the so-called white label networks, microblog or virtual networks (cf. Childnet International, 2008). Fig. 2 provides a graphic illustration of the classification of SNs.

Figure 2. Classification of social networks

Profile based social networks **-** these are the networks in which it is important to interact with people. The personal profile has its significant role in this because thanks to it, people can keep in touch with other people, share their opinions, photos or some important events (cf. Young People and Social Networking Services, 2005-2015). The most popular networks of this type are undoubtedly Facebook, followed by Google+ (cf. Cerna and Cerny, 2012). Also the professionally oriented social network LinkedIn is among these SNSs.

Content based social networks – the personal profile is not that much important in this case. It is the content which is the key and is shared by people on the social network. This social network can include videos, music or pictures. These media are usually accessible to all, including those who are not registered on these SNSs. Probably, the best known representative of these SNSs is YouTube which enables users to record and share their videos. The portal which aims at photos and is worth mentioning is the mobile application Instagram.

White-label social networks – this is a kind of services which offer an independent development of social network on the basis of the offered platform. Thus, users can create their own mini community, i.e. their small social network. They can make such a social network which would meet their expectations and needs. Thus, they can generate their own Facebook or Twitter in this way. Another name for this social network is Private label (cf. Owyang, 2007). The representatives of these platforms are also PeopleAggregator or Ning.

Microblog social networks – the main feature of these SNSs is publishing of short messages with a chance of adding a video or a picture. This is displayed to all subscribers of a given user. This type of social network is predominantly used on mobile phones and particularly, in case of worse text messaging (cf. Cerna and Cerny, 2012). The main representative of these SNs is Twitter. This network offers a platform both for mobile phones and normal web browsers. The network is becoming quite popular in the Czech Republic. Another microblogging tool is Tumblr.com.

Multiuser virtual networks – these are the categories which are borderline social networks. Their purpose is to enable users to communicate among one another, but not with the help of their profile but with the help of Avatars. Most of these networks are game servers such as World of Warcraft.

3. POPULAR SOCIAL NETWORKS AS TOOLS FOR EDUCATIONAL SUPPORT

The most popular social network nowadays is undoubtedly Facebook. The user who wants to use Facebook services must be 13 years old and above. Therefore the application of this SNS in education is possible for the students of higher classes (8th and 9th grades of the elementary school). Schools often use Facebook as a tool of their presentation in public. Students form groups on Facebook whose size corresponds to the number of students in one class. On this SNS they share study materials, current information about the assigned tasks, tests or other assignments and events.

Twitter also offers practical exploitation during tuition at school as well as at home. Twitter as an educational tool can serve for communication, organization, searching for sources or written communication (Staff Writers, 2011). Some teachers at Northern Illinois University in the USA use Twitter as a noticeboard on which they record current information concerning their classes, for example, cancelling their classes. Therefore, this SNS can be used for setting teacher's consultation hours. Twitter can be also used as a note blog for each class where students can upload their contributions. Students can debate there online and thus, they can receive almost immediate feedback on their discussions. The teacher can ask his students to inform him about what they are learning and what learning difficulties they are having by the so-called tweeting. In this way students create their online diary of learning. In addition, parents can exploit Twitter for an overview of their children's activities. Twitter can be also used for summarizing of the teaching matter on a given day. Moreover, Twitter provides their users with an extensive source of information. Students can with its help communicate with experts. Twitter can also broaden student's horizons, their vocabulary, spoken and written communication. As Twitter has a limited length of messages, it is also a suitable tool for concise and simple expression of user ideas.

YouTube EDU is a special educational channel focused on the educational videos. It is the so-called global video classroom which users can exploit both for school or home instruction. The channel offers interesting videos from all fields of human activity. Users can sort them out not only according to their interests but also according to their level of education. The videos are mostly made by the representatives of various educational institutions or experts in a given issue (YouTube EDU, 2013). Furthermore, teachers can modify the content of the service to their teaching purposes. The content is divided according to individual subjects and difficulty level (YouTube pro skoly, 2013).

4. CHANGES IN THE EDUCATIONAL PROCESS

With the development of ICT, the educational issues have become even more topical. When studying the role of technologies in teaching, two approaches are common: instructive and constructive. In case the teaching is controlled directly by computer, it is the instructive approach. If the activity is based on student's own initiative, it is the constructive method (Brdicka, 2008).

Instructive approach

- Fixed syllabuses and standards
- Learning by drilling
- Everybody does the same
- Testing and grading
- Teacher is the highest authority
- Teacher is a source of information

Constructive approach

- Thematic learning plan
- Learning by understanding the connections
- Individual or team assignments
- Verbal evaluation
- Teacher as a facilitator and coach
- Anybody can be a source of information

In practice the instructive approach prevails. The student is checked by the teacher. However, with the fast development of technologies, the constructive approach is becoming foreground. In this approach the student is responsible for his activities and learning (Brdicka, 2004). Nevertheless, education cannot be defined only by two approaches. There exist far more conceptions, out of which the following three are the most frequent: behaviorism, cognitivism and constructivism, which had been developed before ICT started to have an impact on education. But in spite of these theories, a new theory for suitable implementation of ICT into learning environment was needed. And it was G. Siemens who came up with such a theory, called connectivism (Siemens, 2004). He points out at the limitations of those three theories, emphasizing that the central idea of these conceptions is that learning occurs only inside a person and the fact that the learning can occur outside the person as well is omitted. Moreover, he is critical of the fact that learning theories are just focused on real process of learning, not on the value what is being learned. Connectivism or the theory of education in the social network environment (Brdicka, 2008) has a direct impact on education (Downes, 2014). Thus, connectivism is the first theory which takes into account the existence of computer networks and considers all knowledge and abilities as a result of mutual interconnection of information and people (Brdicka, 2011).

Siemens (2004) has formulated connectivism on the basis of the following eight basic principles:

- *Learning and knowledge rests in diversity of opinions.*
- *Learning is a process of connecting specialized nodes or information sources.*
- *Learning may reside in non-human appliances.*
- *Capacity to know more is more critical than what is currently known.*
- *Nurturing and maintaining connections is needed to facilitate continual learning.*
- *Ability to see connections between fields, ideas, and concepts is a core skills.*
- *Currency (accurate, up-to-date knowledge) is the intent of all connectist learning activities.*
- *Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alternations in the information climate affecting the decision.*

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Part of the learning process according to the theory of connectivism is the so-called Personal Learning Network (PLN). Each pupil creates his own PLN through which he is assessed and evaluated. In fact it is the network which is made by people with whom one shares his experience and knowledge, receives new information or provides opinions.

5. DISCUSSION

As Bloom (1956) states, learning is a process helping pupils in their development from the lower forms of thinking (e.g., knowledge or understanding) to the higher forms of thinking (e.g., synthesis or evaluation). And the social networks can assist in reaching these forms. For instance, Flickr can help in the acquisition of knowledge, Wikipedia in understanding this knowledge and YouTube is suitable for the synthesis.

In addition, social networks can bring many other benefits for all stakeholders such as teachers, students and parents. The Internet social networks are good tools for easier understanding of economic, political and social events. Another advantage is their easy access, which is independent on location and time. Students can log in a social network from cosines of their home and consult all the necessary school issues with their peers and teachers, particularly when they fall ill. The social network may also improve mutual relationships among students.

At present there is a sufficient offer of the social networks which were created to cover both teachers' and students' needs not only during classes but also in case of home learning. These include, for example, itrida (iclass = the Internet class), Edmodo or Schoology. The iclass focuses on basic and secondary schools. At these portals teachers and pupils can find a lot of learning materials. The use of the platforms is free of charge (Krizko, 2013). Particularly Edmodo, which has been in use since 2008, was developed for teaching purposes. Its environment reminds of Facebook. Therefore its users do not have any difficulties in controlling this educational environment (Strnadova, 2012). While working in these platforms, users can be divided into virtual classrooms where they share their notes or materials (consult Fig. 3 for an example). The most extensive is, however, Schoology which offers the most functions (Moldrik, 2013). The only disadvantage for a Czech user is that the last two SNSs are run only in English.

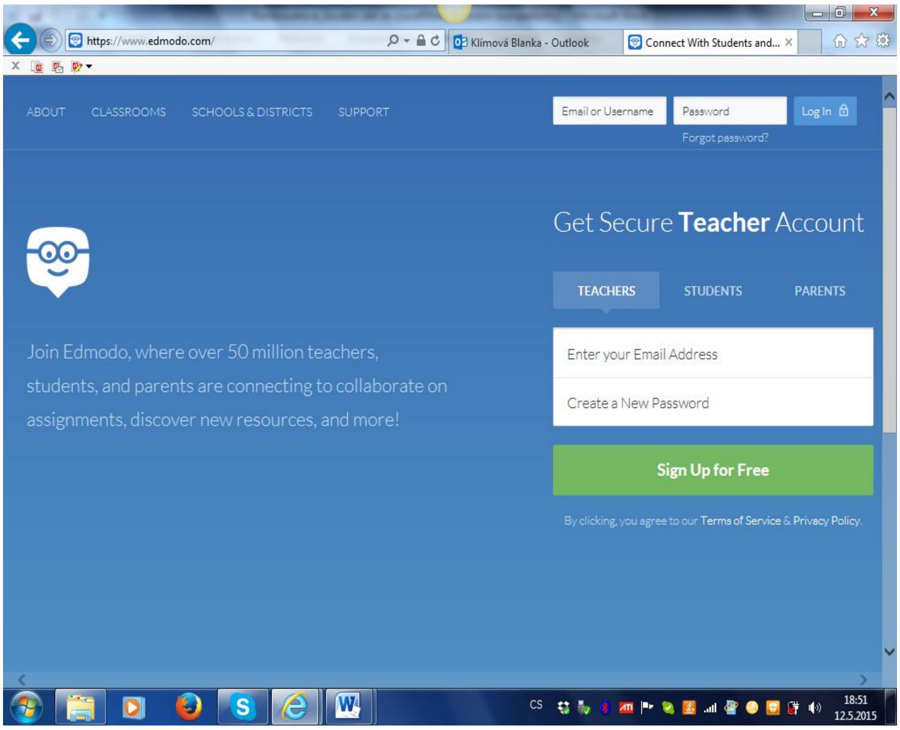

Figure 3. An example of the social network Edmodo (2015)

However, Rambouskova (2015) in her study explored which from the three social networks described above Czech pupils at elementary schools would like to use in their classes. On the basis of their responses, she discovered that they favored Edmodo because it was a good source of information and working in this social network was very attractive. Besides, those pupils who were ill could access their classes online and thus, they did not miss any lessons.

6. CONCLUSION

Thus, technologies in the 21st century and a new theory - connectivism, which enabled their implementation into education, have completely changed the way of teaching and learning. Nowadays, SNSs are part and parcel of everyday life. They are mostly used for advertising, but they have already found their way into education. The Internet social networks proved to be beneficial for education mainly for the following three reasons: easier communication between (teacher-pupil; pupil-pupil; teacher-teacher); improvement of class relationships; and immediate access to information.

The future potential of SNSs is high. It is expected that SNSs will become a common tool in education which will be used at each educational institution. In addition, there are already a few research studies (e.g., Bosch, Preez and Michell, 2009 or Wang et al., 2012) in the field of social networks which prove that SNSs can be very effective learning tools that improve students' performance and motivation to learn.

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Short Papers

THE WORK OF CHILDREN: SEEKING PATTERNS IN THE DESIGN OF EDUCATIONAL TECHNOLOGY

Michael Eisenberg and Zack Jacobson-Weaver
Department of Computer Science, University of Colorado, Boulder CO, USA

ABSTRACT

The vast majority of research in educational technology focuses, justifiably, on what might be described as "short-term" (or perhaps "medium-term") questions: how to improve an existing software system, how to assess a particular classroom innovation, how to teach some current subject matter in a more effective fashion. From time to time, however, it is worth stepping back from such questions and taking a longer view of children's technology: what are the larger patterns by which certain technologies become associated with children's work? In this paper, we examine a broad thematic pattern through which "adult" (or "professional") technologies become progressively associated with children's activities. As an example of how this analysis can be put to use for future design, we describe early steps in an effort to adapt a particularly powerful manufacturing technology ("pick-and-place") for children's crafts.

KEYWORDS

Educational computing, educational 3D printing, children's pick-and-place device.

1. INTRODUCTION: TECHNOLOGIES FOR CHILDREN'S WORK

In the main, when researchers write about educational (or children's) technology, they have a specific technology in mind (e.g., desktop computers, handheld devices, Arduino microprocessors, to name just a few). In the same vein, these researchers tend to have a specific *goal* in mind as well: how to improve the teaching of geometry, how to make a particular interface more usable, how to teach children to program. This approach is a staple of educational technology research, and deservedly so: it represents the means by which steady progress is made in the field at large.

At the same time, however, it is occasionally worthwhile to stand back and take a longer view of children's technology–to look at patterns that play out over a period of decades or longer in the landscape of tools, techniques, and materials available to children. From the vantage point of the present, children are often described as "naturally drawn" to devices such as computers: there is a default assumption, in adult discourse, that children acquire a level of comfort with novel technologies that is unavailable to their hidebound elders. It wasn't always so, at least in the case of computers. In John Markoff's [2005] book *What the Dormouse Said*, focusing on the early history (and pre-history) of the personal computing era, he writes about a former aerospace engineer, Bob Albrecht, who taught Fortran programming to children in the 1960's:

> Along with his other chores, [Albrecht] began to teach a small group of high school students how to program... The class became extremely popular, and soon the University of Colorado was offering an extension program that involved more than one hundred high school kids. Albrecht took his class on tour, at one point accompanying some of his students from the original Denver school to a National Computer Conference meeting. There they demonstrated their programming skills on the CDC 160 machine, shocking the high priests of computing. At the general conference meeting, there were subsequent complaints that someone had even considered turning children loose on computers! [Markoff, p. 181]

This anecdote is worth quoting at some length because it is remarkable to reflect on how the conventional wisdom has been almost completely inverted in a mere half century. The attitude of Markoff's "high priests" was born of an assumption about what technologies were appropriate for adults–more specifically, for adult professionals–and what technologies were "for children". Since computers were highly expensive instruments, programmed at the time by trained technicians, it was unthinkable for children to use them.

Before we take too condescending an attitude toward the prejudices of the "high priests", we might wish to reflect on our own present-day assumptions of which technologies belong, or do not belong, to the realm of children's work. For the computer professionals described by Markoff, setting children loose on computers was anxiety provoking as, among other things, a matter of cost: these things are expensive! What if the kids touch the wrong toggle switch and (heaven forbid) *break* them? Looking at the current landscape of professional technologies, it is not hard to ferret out similar reflexes within ourselves. Should children, for example, be permitted to play with a high-speed camera? With an electron microscope? With a supercollider? Note that in such scenarios, the immediate concern is not primarily for the safety of the *child*: we don't expect that the child will be hurt by (say) the electron microscope toppling on her. Rather, the concern is for the safety of the *device*. A child working with an electron microscope? Absolutely not: these things are expensive.

The purpose of this paper is to explore, at least in an initial and tentative way, several of the issues raised by Markoff's anecdote, and by reflections on the long-term development of children's technology. To state our thesis briefly: there has been a recurring pattern over the past century or more of technological transition, from *professional* or *industrial* technologies to children's technologies. The most prominent example of this pattern is the computer, but the same thematic trends can be identified with other technologies–the camera, the color inkjet printer, and (a recent and striking case) the 3D printer. Repeatedly, technologies that were formerly associated with specialized professional training have come to be used by children. In many cases, the barriers to be crossed were both economic (making the technologies cheaper) and cultural (re-imagining the potential interests and abilities of children). It is our belief that by examining these historical patterns, we can spark our imagination toward the creation of novel, unexpected technologies for children's expressivity. In the final section of this paper, we outline our own early steps toward employing this design heuristic for the creation of a novel, child-focused version of the (hitherto industrial) pick-and-place machine.

2. THE TRANSITION FROM PROFESSIONAL TO CHILDREN'S TECHNOLOGY: KEY THEMES

The previous paragraph sketched the foundations of a recurring pattern in the evolution of children's technology. In this section, we expand on that basic pattern by finding commonalities and contrasts with the work of other researchers.

2.1 Leisure-oriented Technologies for Adults

In one sense, the appropriation of professional technologies by youngsters might be interpreted as simply a by-product of a larger phenomenon by which such technologies are "democratized" more generally (cf. Mumford [1934], p. 278). After all, not only do modern-day children use computers, but so do adults of all ages, and for an endless variety of (serious and "non-serious") purposes. Thus, we might argue that it is primarily *adults*, not children, that have led the way in the de-professionalization of computing technology. In the more recent case of 3D printing, children are being introduced to the technology in tandem with its adoption by the "maker movement" of hobbyists and amateur builders. In such cases, then, we might argue that the real phenomenon of interest is the (adult) movement of professional activities toward independent, leisure-oriented uses.

Some of these themes are suggested by Rachel Manes' [2009] *Hedonizing Technologies*, an indispensable book-length treatment of the transition of certain activities from industrial to leisure contexts. Manes' focus is almost exclusively on adults, with a focus on the (primarily female) audience for textile crafts such as knitting and embroidery. Manes coins the term "hedonizing" to denote the process by which formerly work-related activities become pursued primarily for fun, as hobbies. Her discussion of the process is especially perceptive, and suggests some avenues of continuity with children's technology: "Unlike industrial workers, hobby artisans have complete control over what tools and materials they use, and since efficiency of production and marketability of product are rarely issues, they buy or make the tools and materials they most enjoy using. Leisure theory and sociological sources illuminate the kinds of pleasures artisans experience in their craft, which include control and mastery, the beauty or the individuality of the product, the sensual enjoyment of the task...the escapist quality of immersion in voluntarily chosen work, and socialization opportunities with other crafts enthusiasts." [Manes, 2009, pp. 13-14]

Clearly there are parallels here with the transitions common to children's technology; but there are also interesting points of difference. For one thing, as Manes notes, many of the hedonized technologies whose history she traces are in fact not *state-of-the-art* industrial technologies, but rather *old-fashioned* technologies made obsolete by the process of high-volume industrialization. Thus, leisure-oriented textile work represented a pleasurable return to an older, pre-factory style of activity; and one can identify (as Manes notes [p. 122]) an element of nostalgia in at least some instances of democratized technology.

With children, the emphasis is different. Youngsters, after all, are not particularly given to nostalgia; and often, the cultural emphasis in adapting professional technologies for kids is expressly to celebrate the very novelty of the technology, and quite possibly the presumed job skills associated with its mastery. (No parent would object to his child's playing with 3D printers on the grounds of the devices' uselessness or obsolescence.) Moreover, even when focusing on (say) computers, the re-thinking of the professional technology has a somewhat different flavor when the audience is composed of children. A particularly vexing element is the sometimes tense relationship between true leisure activity for children–what one might call the "hedonized" version of children's computing–and school or classroom usage. A "child's computer" might look like a somewhat different instrument when associated with home or hobbyist usage and with classroom usage. Adult leisure technologies rarely exhibit this kind of dual vision in the lives of their users.

2.2 Consumer Technologies and Creative Technologies

A second theme worth touching upon in this discussion is the distinction between certain types of *consumer* technologies for children (notably television, electronic toys, and video games), and technologies that, adopted from professional settings, thereby expand the presumed capacities and expressive range of children. To interpret the distinction in a somewhat broad-brush way, the advent of children's radio (cf. Cross [1997], p. 107) or television shows, while of historical interest, is not an especially apt example of the pattern we are focusing on in this paper. In these consumer-oriented cases, some advanced technology is adopted primarily for children's play, entertainment, or education; but there is no reason to think that children are modeling or re-inventing professional or adult creative activities for themselves.

To put the distinction in a slightly different way, and focusing on the example of television: adult anxiety about children's television might be said to focus on (mental or emotional) safety concerns. Is the programming appropriate for children? Are shows too violent or disturbing? Are they harming the child's attention span? These are the sorts of arguments that have historically raged around children's television (and have been revived in the case of video games), but they have a different flavor than the anxiety of Markoff's earlier-mentioned "high priests", who were focused on the safety of the *device*. No one worries that a child watching television is potentially risky for the TV; and by and large, the worry is that television will "dumb children down", rather than expect too much of them.

For an illuminating contrast with children's consumer technologies, consider the physicist Freeman Dyson's [2015] advocacy for placing the tools of current-day biotechnology in the hands of children: "The final step in the domestication of biotechnology will be biotech games, designed like computer games for children down to kindergarten age but played with real eggs and seed rather than images on a screen. Playing such games, kids will acquire an intimate feeling for the organisms that they are growing." [Dyson, 2015, p. 3] Dyson's vision may or may not sound desirable (or practical) to some readers, but it fits squarely within the (anxiety-provoking) pattern of adopting advanced professional technologies to empower children.

2.3 Fantasy (Imitative) Technologies and Child-adapted Technologies

A final theme worth mentioning here is that there is a subtle, and not always clear-cut, distinction in this discussion between children's technology as unexpectedly appropriated by children (as in the case of the computer, or 3D printer), and children's artifacts that *imitate* adult technology (as in, say, toy cars, or faux kitchen appliances, or model erector sets). Historically, many toys of the previous century have been based on the assumption (often realistic) that children wish to mimic the work and activities of their elders; thus, a small child might pick up a toy plastic saw and pretend to do "real" carpentry. This sort of design might be called *imitative* design in that it allows or encourages children to pretend to do adult work.

Imitative design is a factor in many children's toys and games; in such cases, technology (where it occurs) is generally imaginary, fantasy-oriented, or miniaturized. A fantasy toy oven, for instance, might be non-operational, or operate only at safely low (light-bulb-produced) temperatures. In contrast, children's computers are *real* computers; indeed, they are machines of far greater power and versatility than those that Markoff's "high priests" themselves used. Similarly, the adoption of such devices as 3D printers for children represents a true democratization of technology: the printers might be less powerful and high-resolution than their professional cousins, but they are most definitely *real* printers.

There is much more to say about these themes (and others left unmentioned), but for now we can sum up the implications of our discussion for design: namely, that we can look to the professional or industrial world for powerful technologies that can be adapted, without excessive loss of power or performance, to the creative activities of children. The express goal of this sort of design is to expand the creative and intellectual capacities of children–to make their worlds more enjoyable and challenging–while taking due account of the cognitive and physical limitations (and sometimes advantages) of children vis-à-vis adults. The final section of this paper presents an example of the sort of novel design project that we have in mind.

3. AN OPPORTUNITY: A CHILDREN'S PICK-AND-PLACE DEVICE

The previous discussion might conceivably be interpreted as of "theoretical" interest only: having identified a pattern in children's technology, what can we do with it? Our argument is that surfacing such a pattern can act as a springboard for design. As a consequence, we have recently begun work on a child-friendly version of a hitherto "professional" computer-controlled device: a pick-and-place machine. In industrial settings, such devices are employed to rapidly place objects (such as electronic components) onto surfaces with high precision; in essence they are automatic assembly devices for complex multi-part objects. In our " child-oriented" version of pick-and-place, we envision a device that children can program, and through which they can rapidly create complex 3D constructions made of standardized sets of small pieces (such as hexagonal chips, cubic elements, or mosaic tiles). The device is still in its earliest stages (and a paper devoted to its operation is in preparation); but crucially, the impetus for its creation is precisely due to the historical reflections described in this paper. Our goal, in keeping with the earlier discussion, is to place in children's hands a device that can tastefully expand and challenge their creative range. Pick-and-place is just one example of this design heuristic; one might likewise look to the design of novel materials, or (with Dyson) biotechnology as a source of professional technology for adoption. In any event, the transition from professional to children's technology should provide a rich source of inspiration for future designers.

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TOWARDS SUPPORTING COMMUNICATION IN RELATIONSHIP AND SEXUALITY EDUCATION THROUGH A VLE

Marion McGinn and Inmaculada Arnedillo-Sánchez
School of Computer Science & Statistics, Trinity College Dublin, Ireland

ABSTRACT

Formal sex education is a key strategy to help prevent unplanned teenage pregnancies, sexually transmitted diseases, sexual abuse and social discrimination. However, research highlights human sexuality is a difficult issue for educators to communicate with young people in traditional class settings. The growing tendency for young adolescents to communicate in online social settings presents opportunities to explore whether technology may be employed in this area. This paper presents a study investigating the use of a virtual learning environment to support communication between teachers and students in a Relationship and Sexuality Education class setting.

1. INTRODUCTION

Relationship and Sexuality Education (RSE) in schools has become an internationally important issue given the prevalent global rise of HIV/AIDS, sexually transmitted diseases (STIs) and unplanned pregnancies among the 15-24 age group (WHO, 2006). Barriers to providing comprehensive sexuality education such as high level of discomfort among teachers and students in discussing sensitive sexual issues (Mayock et al; 2007) and lack of communication associated with inhibition experienced by both cohorts (Hyde & Howlett, 2004) persist (Selwyn & Powell, 2007). Lester & Allan (2006) argue that the discomfort some teachers experience delivering sex education results in textbook teaching and reluctance to answer questions or enter into discussions with students. This is compounded by the fact that the language and terminology used by teachers in the classroom is often not the same as the language of adolescents, and this in itself can create a communicative barrier in the teaching of RSE (Mannix McNamara & Geary, 2003). Given that 24% of girls and 30% of boys have had sexual intercourse by 15 years of age (WHO: 2008), it is essential that we ensure all adolescents get informed sex education.

Kanuga & Rosenfeld estimated that 75% of youth had used the Internet to look up health information and 44% to search sexual health information (2004). Although computer based sexual health websites are widely available, the ease of finding sexual health information on the web has raised several issues of concern such as: inaccurate or irrelevant information; lack of interactivity; and potential harm due to the ease of adolescents to stumble across sites with nefarious intention (Kanuga & Rosenfeld, 2004). This work presents a study on the development and adoption of a school-based virtual learning environment (VLE), moderated by qualified counselors, to tackle the difficulties of communication between students and teachers of RSE, and evaluate its effectiveness in overcoming barriers of communication presented by traditional classroom teaching.

1.1 Computer Mediated Communication (CMC)

CMC is communication mediated by interconnected computers, between individuals or groups separated in space or time (Luppicini, 2007). Its primary advantage is its potential to enhance communication by bypassing limitations of temporal and spatial constraints. The mechanism through which CMC brings about enhanced communication includes asynchronous and synchronous communication capacity, high interactivity and multi-way communication (Lee, 2010). While face-to-face (f2f) discussions may be dominated by one or two participants, CMC can be inherently democratic allowing participants to participate equally in conversations (Herring & Stoerger, 2013). Furthermore, the Internet enables anonymity it provides a forum where it is possible to be less inhibited and intimidated (Christopherson, 2007). Joinson (2001) defines this as the on-line disinhibition effect because without having to deal with f2f encounters, people can express themselves more openly. Thus, the socially anxious consider CMC more appropriate than f2f communication in potentially embarrassing situations because it may also reduce anxieties around negative evaluation from others (Yen et al; 2012).

Critics of CMC argue the absence of non-verbal cues hinders communication and makes CMC a less rich form of communication (Dreyfus, 2008). However, the absence of non-verbal cues is an emancipatory factor allowing clearer communication by encouraging participants to be their true selves when on-line (Georgakopoulou, 2011). Also due to the lack of social cues, such as age and physical appearance, in CMC the level of self-disclosure is higher than in f2f communication (Saunders & Chester, 2008). It would be imprudent to claim that communication in real life situations is the same as CMC but it could be plausibly argued that CMC may well fulfil the needs of those teachers and students who feel anxious about discussing sensitive topics in a traditional f2f classroom setting.

The objective of this case study was to explore whether the integration of aVLE into an RSE class would support communication between teachers and students. VLEs have been defined as "a *software system that combines a number of tools that are used to systematically deliver content on-line and facilitate the learning experience around that content* "(Weller, 2007, p.5). They have acquired a significant relevance as support tools for learning (Melton, 2006) by enabling collaboration, and the inclusion of constructivist strategies of collaborative learning into the instructional environment (Escobar-Rodriguez & Monge-Lozano, 2012) and are among the most widely adopted technologies in education (Risquez et al; 2015).

2. METHOD AND RESULTS

A four week study with 3 teachers and 28students (16 male, 12 females; average age 16 years) participating in an RSE class was conducted. A Moodle VLE was used for the study and the participants used the site from home to cover topics in the RSE curriculum including friendship qualities, self-esteem and sexual behaviour with educational activities (quizzes, videos, podcasts and fact sheets) designed to prompt discussions To encourage communication the users could engage in dialogue through email, a chat and a discussion board and could communicate anonymously using computer generated names. Anonymity is particularly beneficial for users discussing sensitive personal topics because it allows them to freely express their opinions and feelings in a confidential setting. Participants were encouraged to communicate on the site to discuss any issues relating to RSE that they felt was relevant to them. The 3 RSE teachers also used the VLE to respond to questions posed by the students and offer support where needed. In addition, the study presented the students with several tasks relating to RSE issues. Each week during the study the teacher posted a topic relating to the following week's class. To support them, the students had access to suggested readings. These were provided in the form of short articles, typically consisting of one or two brief paragraphs relating to the topic. Quantitative and qualitative methods to address the research question were used to provide rich material for examination while supporting the trustworthiness of the findings through triangulation (Yin, 2003).

Most students 75% (f=11, m=10) reported they communicated more in the on-line RSE class compared to a traditional class. This finding was confirmed by teacher 3 who stated that "*only about 5 or 6 of the class leaders would talk in class. Rarely would you get a whole class talking*." In addition, when comparing this result with statistical analysis from the on-line discussion forum (1857 posts in total and an overall average of 22 posts), results suggest that a high level of interaction took place. Almost all the sample 86 % (f=9 m=15) reported they felt more comfortable discussing topics of a personal nature on-line than in the classroom. With respect to less feelings of embarrassment in the on-line environment, the overall result was 82 % (n=23) with 36% (n=10) of females and 46% (n=13) of males reporting this. Several explanations may be surmised for this high score. Anonymity was perceived as the key factor by the majority of participants 82% (n= 23) for communicating more in the on-line environment, "*It was easier to talk about stuff cos you're not embarrassed and knowing that nobody could find out who you was great." "Sometimes it is embarrassing to ask things face to face. If I had to put my own name up there I don't think I would have been so open*."

79% (n=22) of the participants (f=12 m=10) reported that they felt able to talk about topics on-line that they would not normally talk about in class. A comparison with the teacher's perception of the students' interactions elicited this comment from Teacher 1 "*Its funny how you think you know people and yet on the site there are so different than they are in class. The people you think are shy in class have behaved differently on the site and able to use words that they wouldn't use in the classroom*." A comment from one of the students confirms this: "*I just wouldn't ask those questions in class and you don't really know if the teacher would answer the question or if the teacher would want to talk about those kinds of topics*." There was a difference among the teachers' perceptions of the f2f interactions versus on-line interactions. Teacher 1 noted, "*I like the fact that you didn't have to answer a question there and then. Sometimes you just don't know how to answer or if you do, you know that whatever you say will cause messing in the classroom, so I really liked that as it saved me a lot of embarrassment.*" Teacher 3 found it easier to talk about topics on-line that she felt would cause embarrassment to both her and the students. "*I think the biggest fear as a teacher in a situation like that is being asked a question that you just don't know how to answer"* For teacher 2, this was at odds with his usual pedagogy approach and questioned whether this may potentially damage his existing f2f rapport with pupils. He stated, "*I think I would miss the cut and thrust of conversation that goes on in a normal class*". However, it should be noted that this is at variance with the students' perception of a traditional class. They reported that teachers did not welcome dialogue or debates in class. The narratives of the young people in this study imply that the common didactic style of teaching does not engage them or encourage them to ask questions. Comparisons with comments from two of the student interviews illustrate this difference: "*Ye, in class, they just tell us about things………..but we can't really ask them any questions". "In a normal class the teacher does most of the talking with little time for us to ask questions or discuss things that are important."*

3. DISCUSSION

First, an important finding of this study is that development was driven by the needs and concerns of the students. Based on the students' own accounts of their reasons for communicating they perceived the VLE as a space to express their concerns about topics that they wanted to know about but felt too inhibited to discuss in a traditional classroom. This supports Campbell & Aggleton's, (2000) primary argument that to be effective sexuality education must meet the needs and interests of young people as conceptualized by them. Most students (82%) reported on the absolute significance of anonymity for communicating in a less inhibited way on-line. The reason for this becomes apparent when taking into account the research literature on the effects of anonymity (Joinson, 2001). Such a high reportage of less embarrassment (82%) may be attributed to what Suler (2004) refers to as the online disinhibition effect when people don't have to worry how others respond to what they say with gestures such as a frown, a sigh or other signs of disapproval. This can be especially beneficial in an RSE class where individuals who find it difficult to communicate about sensitive topics can express their thoughts and concerns without fear of negative consequences. This may have important implications for RSE education as students are more likely to communicate more under these conditions. For many students the on-line class was a preferred method of communicating RSE to the traditional class. 75% (n=21) indicated that the on-line class should replace the traditional class. However, it is notable that more males (46%) than females (29%) preferred the on-line class. This may be due to gender differences for sources of information to learn and communicate in various domains (Turnbull et al; 2010). According to Rautopuro (2005) adolescent boys prefer to use computers to learn about sexual matters. Furthermore, while clearly the overall outcome is a positive response there are also two other possible explanations for this result. First, there is the possibility that the students' appreciation was based on the novelty factor and therefore gave it increased attention and the second; students may simply view technology as commonplace and a natural tool to use. However, it may also be plausible that the positive reaction to the site was due to its similarity to the type of social networking sites that have become an integral component of their lives. Regarding the teacher' experience, while the VLE was understood as a valuable communication tool, they tended to view the VLE as external to their regular educational workload. This was reflected in the difficulty they had in fitting the on-line activity into their already busy lives. On reflection, it may be inappropriate to look for a complete shift in the teachers' fundamental approach to teaching and highlights the challenge of creating a truly innovative educational alternative within the context of a conventional school structure. Importantly, it also highlights that a balance is required between advantages for students and gains for the teaching staff in order for this method of teaching to be fully adopted.

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There are several limitations to this study worth noting. The first is the use of a single institution for the data collected. This limitation may reduce the external validity of the results and somewhat limit the generalization of the findings. Second, it was only one relatively small study. Further work needs to be undertaken with a larger sample to provide additional evidence.

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THE DEVELOPMENT OF COMPUTATIONAL THINKING IN THE CONTEXT OF SCIENCE AND ENGINEERING PRACTICES: A SELF-REGULATED LEARNING APPROACH

Erin E. Peters-Burton[1], Timothy J. Cleary[2] and Anastasia Kitsantas[1]
[1]*George Mason University, College of Education and Human Development, Fairfax, VA 22030, USA*
[2]*Rutgers, The State University of New Jersey*
Graduate School of Applied and Professional Psychology, Piscataway, NJ 08854, USA

ABSTRACT

A quality educational experience for secondary students involves more than an acquisition of content knowledge; it entails providing students opportunities to develop a variety of thinking skills that enable integration of knowledge and the promotion of student self-directed learning outside of the classroom. One critical skill that is often underemphasized in education is computational thinking. The purpose of this conceptual paper is to discuss the parallels between the processes of computational thinking and self-regulated learning, and the corresponding implications of this integrated framework for instruction in secondary classrooms. Guiding our analysis is the premise that because computational thinking processes can be viewed as goal-directed processes, it is possible to use self-regulated learning theory as a framework for assessing and enhancing computational thinking. Secondary educators have minimal experience with teaching computational thinking in the United States, so not only is a clear definition of computational thinking necessary in the Next Generation Science Standards, it is also necessary to have a learning theory from which to structure this type of thinking.

KEYWORDS

Computational thinking; Computational practices; Self-regulated learning; Science and engineering practices

1. INTRODUCTION

Teaching content knowledge to secondary classrooms has been the focus of the educational system in the United States for many years, as seen in various national curriculum efforts (AAAS, 1993; NRC, 1996). However, a quality educational experience for secondary students involves more than an acquisition of content knowledge; it entails providing students opportunities to develop a variety of thinking skills that enable integration of knowledge and the promotion of student self-directed learning outside of the classroom. One avenue of thinking skills that is worthwhile to pursue is a literacy of the digital world because it allows the development of self-awareness of the symbolic nature of our world and the processes of one's own learning otherwise known as metacognition (Wheeler, 2012). Along this line, a key thinking skill that is underused in the United States is computational thinking (CT), which is broadly defined as a way of "solving problems, designing systems and understanding human behavior by drawing on the concepts fundamental to computer science" (Wing, 2006, p. 33). Since few U.S. educators have much experience with CT, it is important to not only clearly define this term but to also examine and conceptualize this type of thinking from the lens of learning theories. Further, because it is important for students to be able to initiate and guide their use of CT, we believe that self-regulated learning (SRL) theories provide an ideal framework from which to explore how students engage in the computational thinking process (English & Kitsantas, 2013; Zimmerman, 1990). The purpose of this conceptual paper is to discuss the parallels between the processes of CT and SRL, and the corresponding implications of this integrated framework for instruction in secondary classrooms. Guiding our analysis is the premise that because CT processes can be viewed as regulatory, goal-directed processes, it is possible to use SRL theory as a framework for assessing and enhancing CT.

2. OVERVIEW OF COMPUTATIONAL THINKING

There are three dimensions to computational thinking: computational concepts, computational practices, and computational perspectives. Computational concepts are the notions students use as they engage in design, such as iteration and parallelism; computational practices refers to the processes students develop as they engage with the concepts, such as debugging; and computational perspectives which includes the learners' formation of viewpoints about the world and themselves. For the purposes of this paper, we are interested in the component of computational practices because they represent goal-directed behaviors and skills that comprise processes key to computational thinking. Such skills, defined in Table 1 (Grover & Pea, 2013), include the consideration of the benefits and limitations of the resources in an environment, reformulation of a difficult problem into one we can solve, and recursive thinking about correctness, efficiency, and aesthetics (Wing, 2006).

Table 1. Computational Practices and Description

Computational practices	Description
Abstractions and pattern generalizations	Examining a group of patterns and describing them in a way that is clear and efficient
Systematic processing of information	Using heuristics to make sense of an event
Symbol systems and representations	Portraying an often abstract event with a simplified concrete object
Algorithmic notions of flow control	Managing data using a specified procedure
Structured problem decomposition	Breaking down a complex problem or system into parts that are easier to understand
Iterative, recursive, and parallel thinking	Repeating thinking in cycles to meet a goal (iterative), think about your thinking (recursive), and ability to focus thinking in specific directions (parallel)
Conditional logic	Asserting that the occurrence of one event depends on the occurrence of another
Efficiency and performance constraints	Considering hindering and beneficial factors involved in a process
Debugging and systematic error detection	Engaging in a methodical process for finding and reducing defects

Because novices are often unaware of the many tactics embedded in computational practices (CPs) and will also struggle to use the strategies that they learn in class to solve problems, a framework is needed to delineate the *process* through which students engage in CT as well as their skill in managing the quality of this type of thinking. Much like any complex problem-solving activity, CT entails an integration of processes such as abstraction, decomposition, separation of concerns, problem solving, using randomization, designing systems, transforming, and simulating solutions. For novices, using these processes in an integrative fashion can be quite overwhelming. Therefore, we advocate conceptualizing CT as a series of goal-directed regulatory processes because it guide instruction and help students become more strategic and self-directed in their explorations using CT. Further, we believe that teachers can help students become "regulated" computational thinkers by providing feedback to students about the processes they use when engaging in this process.

2.1 Self-Regulated Learning Theory

Self-regulated learning (SRL) is viewed by many theorists as a goal-directed process whereby a person identifies a problem, examines relevant data to inform or develop and solution plan, implements this strategic plan, and then evaluates the effectiveness of this plan in achieving one's goal. From our perspective, CPs parallels the regulatory process because it involves making a series of judgements toward a solution to a problem, deploying tactics to iteratively conceptualize problems, identifying patterns in data such as points of divergence and convergence, and troubleshooting problems during the process. Also similar to SRL, to be able to engage in the iterative processes of CT, students must be motivated to do so, possess knowledge of tactics to reach their goals, and be able to effectively monitor and evaluate how well they are proceeding to a problem solution.

Self-regulatory methods of learning have been shown to be effective in aiding learners to explicitly analyze the skills or knowledge that is needed to achieve a particular goal in areas such as academic studying (Cleary & Zimmerman, 2004; Thomas & Rohwer, 1986), use of instructional media (Henderson, 1986), metacognitive engagement (Corno & Mandinach, 1983), athletics (Kitsantas, Zimmerman, & Cleary, 2000), writing revision (Zimmerman & Kitsantas, 2002), and scientific epistemologies (Peters & Kitsantas, 2010). Using the iterative self-regulation model as a lens for CT, the indistinct task of teaching and learning CPs can be made more concrete.

Zimmerman (2000) captured this process in terms of a cyclical feedback loop consisting of three phases: forethought, performance, and self-reflection (see Figure 1). Although this figure highlights abstraction and pattern generalization, any of the CPs could be applicable. The forethought phase refers to influential processes, such as analyzing tasks and setting process-oriented goals, that precede efforts to act and set the stage for action. The performance phase includes processes that occur during learning, such as implementation of task strategies and metacognitive-monitoring. The self-reflection phase refers to the processes that occur after learning or performance, such as the use of standards to make self-judgments about the performance, that collectively influence how a person responds to their performance. Because students continuously cycle through the feedback loop during learning, when students enter successive iterations of the loop, they are better positioned to use forethought, performance, and self-reflection processes in future learning.

2.2 Self-Regulated Learning: Creating Learning Environments that Foster Computational Thinking in the Classroom

Although self-regulatory processes are internally driven, they can be guided and facilitated by mentors and appropriately- constructed learning environments (Zimmerman, 2000), thus allowing a teacher to serve as a model to teach how CT is performed in a directed way. Since CT can be seen as a skill set for students to be competent in a problem-solving process, SRL can be a helpful framework to help students develop and use the tactics they need to employ to think computationally. By using a SRL framework, teachers can help students to organize information and skills, formulate solutions to a defined problem, and reflect on their problem-solving to create a more optimal process in the next iteration of problem solving. SRL is a way to manage the conceptual thinking process; an algorithm which analyzes thinking processes for the most effective path from problem identification to solution generation.

Teachers can help students become "regulated" computational thinkers by helping them to self-monitor their use and application of CT skills and by also providing them with additional feedback regarding the processes they use and need to refine when engaging in CT. Measures of SRL, such as SRL microanalysis (Cleary, 2011), can be used as both an instructional prompt and as an assessment tool of student progress. Unlike traditional questionnaires or rating scales, this structured interview assessment protocol is considered a type of event measure of SRL because it examines students' regulatory processes (goal-setting, planning) as students engage in specific learning tasks or activities. Because this type of assessment generates qualitative and quantitative, process-oriented information about *how* students engage in a task, teachers can use this approach and the corresponding data it yields to generate "actionable feedback" for students. Thus, although we know what CT *is*, we do not yet fully understand *how* to employ CT or how to help teachers better understand how their students engage in CT. Given that SRL microanalytic questions reveal information about how students set goals metacognitively monitor their progress, evaluate their performance, and adapt their CT, this approach can be extremely useful in obtaining information about students' SRL processes while engaged in CPs and in providing information about students' quality of execution of CPs for teacher assessment of student growth.

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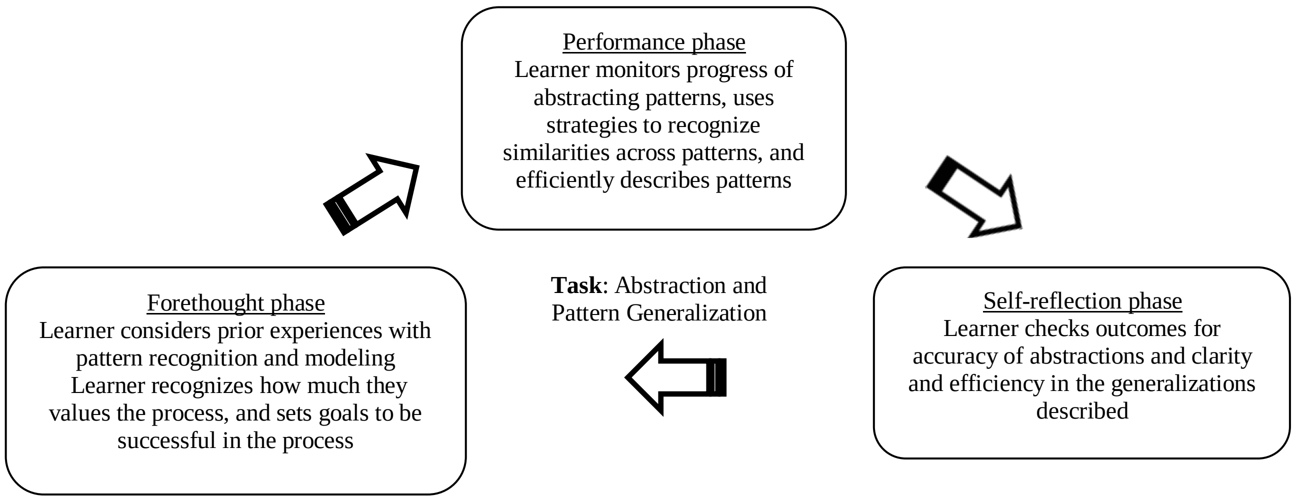

Figure 1. Self-regulated learning in abstraction and pattern generalization (adapted from Zimmerman, 2000)

2.3 Teaching Computational Thinking in the Context of Science and Engineering Practices

The minimal emphasis on CT in secondary curriculum in the U.S. is most readily observed in the most recent national standards in the U.S., the *Next Generation Science Standards (NGSS)*. The *NGSS* weaves together three strands of learning domains: Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices. Disciplinary Core Ideas set the factual content standards that are the building blocks of the curriculum. The Science and Engineering Practices explain the disciplinary process skills that embody the development of science content knowledge, and the Cross Cutting Concepts represent broad themes that help to categorize the other standards into ideas that are essential to science. In this format, the Science and Engineering Practices are central to being able to learn about how content ideas are generated in the discipline of science. As one of the eight practices, *NGSS* defines “Using Mathematics and Computational Thinking” as using mathematics to accomplish investigations, perform analyses, and build complex models (NRC Framework, 2012).

It is notable that NGSS is not aligned to the ways the field defines CT. In fact, it describes CT more in terms of using mathematics. Because these standards will guide all future curriculum development, it is alarming that there is very little resemblance to the ways that the research-base defines CT and the practice of CT as defined in the NGSS. More efforts will be needed to help educators understand the gaps in NGSS descriptions of CT relative to the descriptions used in the field of computer science. We believe that teaching CPs through an SRL framework is one way that CT can be strengthened in curriculum. Strategically approaching how students are engaged in the task requires knowing what key features of CT we want students to know, and CPs provide a tangible, goal-oriented process from which to instruct and assess student learning.

3. CONCLUSION

Not only is CT underused in the United States (Wing, 2006), CT representation in national standards is glossed over and misaligned with the research-based concept of CT. Building students CT is a powerful and necessary component of instruction because it represents a universally applicable skill set. Although CT provides important skills, it is not well-represented in curriculum offered the United States. Secondary educators have minimal experience with teaching CT, so not only is a clear definition of CT necessary in the standards, but a learning theory from which to structure this type of thinking is also of vast importance. SRL theory provides a compelling and integrative framework from which CT skills can be taught. Constructing a mental toolkit of strategies from various perspectives to solve problems and design systems results in people who are better thinkers and learners.

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A PROGRAM COMPLEXITY METRIC BASED ON VARIABLE USAGE FOR ALGORITHMIC THINKING EDUCATION OF NOVICE LEARNERS

Minori Fuwa[1], Mizue Kayama[2], Hisayoshi Kunimune[2], Masami Hashimoto[2] and David K. Asano[2]
[1]*Graduate School of Science and Technology, Shinshu University, Japan*
[2]*Faculty of Engineeri , Shinshu University, Japan*

ABSTRACT

We have explored educational methods for algorithmic thinking for novices and implemented a block programming editor and a simple learning management system. In this paper, we propose a program/algorithm complexity metric specified for novice learners. This metric is based on the variable usage in arithmetic and relational formulas in learner's algorithms. To evaluate the applicability of this metric for novice education, we discuss the differences between three previous program complexity metrics and our proposed metric.

KEYWORDS

Algorithmic thinking, program complexity metric, novice education, variable usage, educational aspect

1. INTRODUCTION

Not only in undergraduate schools but also in pre-university education, 21st century skills are some of the most important learning topics [1,2]. In 2009, an OECD report pointed out three ICT related competences for new millennium learners [3]. 21st century skills were one of them. 21st century skills are a framework containing some skills, abilities and knowledge related to ICT. Recently, Informatics/Computing is one of the main subjects in junior or senior high school [4]. In these subjects, algorithms and algorithmic thinking are key topics [5]. However, many tools do not have ways to control the learning process. Also, many tools do not have ways to evaluate and assess student's work.

We proposed an educational method for algorithmic thinking in fundamental education for computer science course students in 2008 [6] and examined the effectiveness of our algorithmic thinking learning support system. This system uses only three flow structure elements: calculation, selection and repetition. Students describe the algorithm using these three elements. To assess learner's understanding, we evaluated each learner's algorithm in detail. As a result, we found eight types of errors in their algorithms. Based on this fact, we think that if an instructor can give an appropriate sub-task to a learner who has misunderstanding or confusion when creating an algorithm, they can revise their mental model or knowledge of algorithm creation. To fulfill this goal, a program/algorithm complexity metric is needed in this study.

This paper describes a program/algorithm complexity metric for our algorithmic thinking course and also discusses some possibilities of our proposed metric as an assessment function for novice learners.

2. OUR APPROACH

We developed a tool called AT to describe algorithms for novice learners. AT can describe the algorithm with block programming. Learners can make ten types of blocks in AT. Three types of blocks (plan, conditional branching and loop) can contain other blocks.

We use three learning items in this class: calculation, conditional branching and loop. In this study, four types of problems are created using a combination of these learning items: calculation problem, conditional branching problem, loop problem and combination problem. The calculation problem uses only calculations. The conditional branching problem uses calculations and conditional branching. The loop problem uses calculations and loops. The combination problem uses all the learning items. In this study, the maximum number of lines in the algorithm is thirty.

The purpose of this study is to explore educational methods for algorithmic thinking conceptual modeling for novices, so we think that it is important to make support problems. Support problems are different from problems for all students who attend our algorithmic thinking class. Support problems are problems that overcome students' weak points. We want all students to understand the algorithms. Therefore, we identify errors in students' answers and teach these points to the students. Then we need to judge their weak points and make support problems to overcome these weak points. To make support problems we need a metric.

There have been proposed some metrics used to evaluate programs. For example, McCabe's cyclomatic complexity metric [7], Halstead's complexity metric [8] and Hakuta's complexity metric [9]. We discuss the problems with these three metrics related to our learning tool. First, the three metrics do not take into account the way the variables are used in calculations and control statements. Second, they can only evaluate algorithms that are complete. Third, they are not suitable when the level of difficulty of the learning item changes. Therefore, we need a new metric to resolve these problems.

In this paper, we write about two points. The first point is to introduce our proposed new metric. The second point is to describe the characteristics and differences between previous metrics and our metric.

3. EDUCATIONAL PROGRAM COMPEXITY METRIC FOR NOVICE LEARNERS: FL

We propose a new metric to solve the problems with the three previous metrics. In this section we describe the characteristics and evaluation method of our metric.

3.1 Evaluation Method

The metric proposed in this study is called "Educational program complexity metric for novice learners" and its abbreviated designation is FL. In this study, calculations are limited to dyadic operations. Therefore, the number of operands and arithmetic operators and the kinds of variables are decided in calculations. Also, conditional expressions in control statements are limited to two operands and one comparison operator. We take into account the way operands and operators are used in calculations and conditional expressions. We also consider nested control statements.

Table.1-3 shows the way we evaluate each learning item. Table.1 shows the levels for calculations. There are six calculation levels defined according to the number of operands and the kind of variables. Table.2 shows the levels for conditional branching, while Table.3 shows the levels for loops. There are two conditional branching levels and two loop levels defined according to the variable or number used in the comparison in the conditional expression.

Table 1. Calculation levels

CL	Summary	Examples
1	Only numbers	a = 0 a = 1 + 2
2	Different variable and a number	a = b a = b + 1
3	Same variable and a number	a = a + 1
4	Two variables	a = b + c
5	Same variable and another variable	a = a + b
6	Same variables	a = a + a

Table 2. Conditional Branching levels

CBL	Summary	Example
1	Compare with a number	if (a < 1)
2	Compare with a variable	if (a < b)

Table 3. Loop levels

LL	Summary	Example
1	Compare with a number	while (a < 1)
2	Compare with a variable	while (a < b)

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The features of our method to evaluate an algorithm are shown here. First, a level is assigned to each line in the algorithm using Table1-3. The levels are denoted by CL, CBL and LL. Second, if each learning item is not a line, the levels of each learning item are added. We call these sums S_{CL}, S_{CBL} and S_{LL}. Third, the levels of the three learning items are added. Finally, if there is a nested control statement, their number is added to the three learning items' levels. We name this value R_{EA}. The upper parts of Figure 1 and Figure 2 show two sample algorithms and the values that result from FL. The left algorithm is a calculation problem and the right algorithm is a combination problem. The calculation problem is to calculate the BMI with two variables (hei and wei) as input numbers. The combination problem is to calculate the product of two variables (x and y) for values of x and y from 1 to 9. If the product is divisible by two, the product is output. Sample calculations of FL are shown for the two algorithms in the upper parts of Figure 1 and Figure 2 in the lower parts of both Figure 1 and Figure 2. From this result, the R_{EA} of the combination problem is higher than the calculation problem, so the combination problem is more complex than the calculation problem.

<Calculation problem>

```
hei = 0;                CL 1
wei = 0;                CL 1
bmi = 0;                CL 1
#
input (hei);
input (wei);
#
hei = hei * hei;        CL 6
bmi = wei / hei;        CL 4
#
  output (bmi);
```

$S_{CL} = 1 + 1 + 1 + 6 + 4 = 13$
$S_{CBL} = 0$
$S_{LL} = 0$
$N_{ncs} = 0$

$R_{EA} = 13 + 0 + 0 + 0 = 13$

Figure 1. Result of calculation

<Combination problem>

```
x = 1;                  CL 1
z = 0;                  CL 1
z2 = 0;                 CL 1
#
while (x < 10) {        LL 1
 y = 1;                 CL 1
 while (y < 10) {       LL 1
   z = x * y;           CL 4
   z2 = z mod 2;        CL 2
   if (z2 == 0) {       CBL 1
     output (z);
   }
   y = y + 1;           CL 3
  }
 x = x + 1;             CL 3
}
```

$S_{CL} = 1 + 1 + 1 + 1 + 4 + 2 + 3 + 3 = 16$
$S_{CBL} = 1$
$S_{LL} = 1 + 1 = 2$
$N_{ncs} = 2$

$R_{EA} = 16 + 1 + 2 + 2 = 21$

Figure 2. Result of combination

We take into account the way operands are used in formulas and conditional expressions in control statements. Because FL sets levels for each learning item, we can evaluate each line in an algorithm. Therefore, we can evaluate incomplete algorithms. Also, because FL can transcribe error algorithms, it can make support problems in this study.

3.2 Comparison of Result between Previous Metrics and FL

Table.4 shows the characteristics of the three previous metrics and FL. There are two points of view and seven items. The two points of view are structural point of view and educational point of view. The structural point of view looks at the structure of algorithms. The educational point of view is concerned with support problems.

Metrics that have the characteristics (a)-(g) have a ✔ in the corresponding column in Table.4. First, McCabe's cyclomatic complexity metric cannot evaluate algorithms from a structural point of view and educational point of view in this study. Second, from a structural point of view, Halstead's complexity metric can evaluate operands and operators in an algorithm. However, it cannot evaluate nested control statements. From an educational point of view, it is impossible to change algorithms, so (e)-(g) do not apply to this metric. Third, from a structural point of view, Hakuta's complexity metric can evaluate algorithms because there are measures that evaluate operands, operators and algorithm length. From an educational point of view, the metric also does not apply to (e)-(g). Finally, FL sets levels in detail according to operands and operators. Therefore FL can evaluate algorithms from a structural point of view. Also, by adding the number of nested control statements, FL can evaluate them. Therefore, FL can evaluate algorithms like previous metrics. From an educational point of view, FL sets levels to evaluate each line and each learning item, so all items apply. Therefore, FL is the only metric that can be used to make support problems.

Table 4. Characteristic of previous metrics and FL

Evaluation points		Previous metrics			FL
		McCabe	Halstead	Hakuta	
Structural points	(a) Uses the number of variable types		✔	✔	✔
	(b) Uses the number of variables and numbers		✔	✔	✔
	(c) Metric changes with program length		✔	✔	✔
	(d) Considers nested control statements: there are two types of algorithms			✔	✔
Educational points	(e)Designed for use on unfinished programs				✔
	(f) Can evaluate program subsets: to make support problems				✔
	(g) Can evaluate different learning item levels				✔

The purpose of this study is to explore educational methods for algorithmic thinking conceptual modeling for novices. Therefore, it is necessary to make support problems. Support problems are made based on errors in students' solutions, so it is necessary to change the levels of problems. From Table.4, all items apply to FL. Also, four items apply to Halstead's complexity metric from a structural point of view. Therefore, we use FL to make support problems and use Halstead's complexity metric to choose support problems suitable for each student.

4. CONCLUSION

In this paper, we proposed a program complexity metric based on variable usage for algorithmic thinking education. The features and problems of three previous metrics were discussed. The main problems with previous metrics were the three metrics do not take into account the way the variables are used in calculations and control statements. To avoid these problems, we developed a new metric for novice learners' algorithmic thinking education. The characteristic of our proposal is that each learning item can be evaluated. Moreover, unlike previous metrics, our metric can evaluate each line in an algorithm. Therefore, we decided to use FL to make support problems for novice learners who submit algorithms with errors.

We think this metric is suitable for evaluating novices' algorithms. However, we did not evaluate the effectiveness of our metric in real educational situations. In the future, we will make rules to make support problems. Using these rules, we will make support problems according to the error levels in students' solutions. After giving the support problems to students, we will check whether students' understanding improves.

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APPS. ACCESSIBILITY AND USABILITY BY PEOPLE WITH VISUAL DISABILITIES

Eva María Olmedo-Moreno and Adrian López-Delgado
University of Granada

ABSTRACT

The increasing use of ICT devices, such as smartphones and tablets, needs development of properly software or apps to facilitate socio-educative life of citizens in smart cities: Adaptive educational resources, leisure and entertainment facilities or mobile payment services, among others. Undoubtedly, all that is opening a new age with more information and autonomy for each individual, but the point is if these apps are accessible for the whole population. And when we talk about accessibility in an App, we are not only considering if the user is able to switch it on or unfold it main menu, we consider interface aspects that can present difficulties for some users.
This study analyzes accessibility and usability of 15 Apps for people with visual dysfunction, because this difficulty has the greatest influence on the effective and efficient use of them. Data are collected through a descriptive scale made by a deductive-inductive process on four categories with a wide use of Apps. Social and specifically social-networking category is the largest consider accessibility on their apps, being highly demand by users and cost-effective for companies. Other categories are evaluated as completely inaccessible by users.

KEYWORDS

Accessibility; APP's; Usability; ICT; Digital inclusion; Software evaluation; Visual impairment.

1. INTRODUCTION AND ESTATE OF THE TOPIC

On the last decades, the internet is used by most people to exchange information, compare and search for data or as a single entertainment, being this procedures as something absolutely socially accepted. But although, the internet has been remarkably successful like ubiquitous and universal mass media, there are still a lot of aspects to work out. Dominigue (2011) states, it is necessary to go forward on new ideas to satisfy investigation and society, to accept new challenges and chances of the digital society.

The blooming emergence and use of Information and Communication Technologies (ICTs) by people, especially smartphones and tablets, brings a need to development properly smart software or apps, to get the best achievements on these devices, which have been well received for making our everyday life easier.

The creation of hundreds of mobile applications try to make easier the city life, from discovering available entertainment venues every single day, to finding out the petrol station with lowest price, to the roads conditions at any time time. It is a fact that ICTs are opening a new age, improving and facilitating the information our personal autonomy.

But what is exactly an "app"? This word comes from "application", defined by Gil and Rodríguez-Porrero (2013), as the software application used in mobiles devices and .specially designed for mobiles phones and tablets, accessed by a touchscreen. You can downloaded free or paid for, from websites of companies of these devices, although one of the widest world used is by Company Google, called "Play Store". Also, they have easy installation, automatic updating, small file sizes and minimum storage capacity on the hard disk, despite their quite intuitive interface. Therefore only in a few minutes, the users can try these apps, erase and look for another one more suited to their interest on different platforms or apps stores. They can look for several tools, according to personal needs and abilities, turning their phones in a useful and powerful tool to facilitate their daily life.

Are these new technologies actually accessible to everybody? The concept of accessibility is a pretty broad term and covers different fields. Broadly, it could be defined as the capacity of objects or places of being useful for any user, regardless of their abilities. Alonso (2007) defines it as "the possibility of going where it's required or achieve the things we wish (...) in the context of disability the term acquires an aggressive touch when it refers to rights" (p.16) As Alonso explains, this process of removing barriers implies quite complex interventions and it involves a high cost many times, because they are only aimed to a little percentage of population. On this way, an app is really accessible when the user can interact with all applications elements, regardless a physical, psychological, sensory disability or any other disability.

The application elements means all the application's interface elements, including the overview when you start the application, keys of control and so on.

And the app's accessibility is not only switch on, open and access to the application main menu, it means an easy interface to facilitate surfing on all elements of app, without barriers for some users. Also, Gil y Rodríguez (2013) explain other points to be considered by apps' designers, such as organization of application, popups texts, visual appearance, color or contrast, because all of them have a direct influence on the accessibility and usability of the application.

2. MATERIAL AND METHODS

This study analyzes accessibility and usability of 15 Apps (see table 1) by people with visual disability, taken by an intentional selection of a large number of available at Google Play (Android operating system), App Store (iOS operating system) and iTunes Store (iOS operating system) rankings of most used applications of year 2014.

Table 1. Apps' sample

App Store (iOS)	Google Play (Android)	iTunes Store (iOS)
Facebook Messenger	Duolingo	Facebook Messenger
Snapchat	Facebook	WhatsApp Messenger
YouTube	MyFitnessPal	Telegram Messenger
Facebook	Netflix	Facebook
Instagram	Pandora	YouTube
Pandora Radio	NFL Mobile	Google Maps
Google Maps	Flipagram	Instagram
Flipagram	TripAdvisor	Spotify Music
Spotify Music	Candy Crush Saga	Shazam
2048		Wallapop

The apps are grouped according to their environment of use: Educational environment (Google and Dropbox and Duolingo); Social environment (Facebook, Twitter, Youtube, Wallapop, EsAccesible and Fever); Health and Sports environment (Endomondo and MyFitnessPal) and Travelling environment (TripAdvisor, Blablacar, Madrid Metro/Bus/Cercanías and Google Maps). After their descriptive analysis, we can establish their accessible and usable level by these visual disabled citizen.

This difficulty has the greatest influence on the effective and efficient use electronic devices. They appear because of malformations, diseases or injuries at the sight organ of hereditary origin, dominant- recessive, or linked to gender. Depend on its severity, causes low-vision or blindness (Lou, 2011). The World Health Organization (WHO) (2014) divides vision ability in 4 levels in its briefing note 282: Normal vision, moderate visual disability, severe visual disability and blindness. Gathering the third from last and the second to last under "low-vision" that represents visual disability cases together with the blindness term. We can find

285 million people suffering from visual disability all around the world, 30 million blind and 246 low-vision rated. In light of this data, a large part of world population suffers with this disability, so thinking and look after these people is an obligation when it comes to the time of creating and designing open spaces, buildings and technologies, among which we can find the Apps.

The descriptive scale, as instrument to register data, consider eighth indicators of accessibility. The following table 2, about education field, is showed as a single example one of the apps assessed on this field.

Table 2. APP's Accessibility Indicators on EDUCATION FIELD

Indicators	Google Chrome		
1. Images description	1. Images, Graphics, colours and videos are not equally described. X	2. Images, graphics, colours and videos are described in some situations.	3. Images, graphics, colours and videos that appear are described.
2. Media content	1. It doesn't let you make images, graphics nor videos big.	2. It only lets you make content big in specific situations.	3. It lets make all images, graphics and videos big. X
3. Contrast, brightness and colour	1. Levels of colour, brightness and contrast are unchanging. X	2. Only some of the levels can be changed and just in some situations.	3. It allows to change colour, brightness and contrast levels.
4. Auditory signals	1. There's no auditory signal that guides the process. X	2. In some cases there are auditory signals.	3. The app accompanies the information with auditory signals all the time.
5. Touch surface	1. The keys don't have at least 9mm.	2. Only some keys have at least 9mm.	3. The keys have at least 9 mm. X
6. Customizable controls	1. Interface doesn't allow to modify controls on colour and size. X	2. Some controls are alterable on colour and size.	3. Every control is alterable on colour and size.
7. Text	1. It doesn't let you make the text bigger.	2. Some texts allow you to make its size bigger.	3. Every text let's you make its size bigger. X
8. Clear messages	1. Too much information. More than one phrase per informative act.	2. Generally, information is specific but sometimes there's too much text. More than one phrase per informative act.	3. Information is specific and self-explanatory. It's expressed with words, getting the message through. X

3. OUTCOMES

In the educational field this study consider the wide world uses browser Google, the cloud application Dropbox and the online languages course Duolingo. Although all of them are commonly used in the Educational context, they can be also easily included in other fields.

Regarding their **images description**, none of them give any additional information and they just attach their contents. Something similar happens to increase **size of media contents**, except by Google Chrome, because its navigation function on the touchscreen to enable the size by a finger touch.

Contrast, brightness and color are basic point to facilitate accessibility to a large group of people to these applications. Nevertheless, anyone of them lets user adjust it. That could be half justified because the control of these on the device's control keys, although the app should make it easier.

The **beeps and sounds** are really important to make a difference, for visual disable people, to be able to manage or not an application. Anyone of applications analyzed give this options. The opposite happens about a **minimum touch surface**, fulfilled by all of them.

Another essential point is capacity to increase **size of letters, texts and messages**. That is only facilitate by Google Chrome, due to its function, however the other apps do not it.

Also, the three apps analysed in the educational field, show something common. That is the indicator 8 about **clear messages**, because all the information displayed on the apps is clear and concise.

As an overall outcomes on all environments analyzed, Apps can be organized in four categories, depending on the relation of citizen and users with them:

- **Full Accessible App**. App interface facilitate adaptation of several points required by users
- **Partly Accessibility App**. App does not facilitate accessible elements. So, users need special tools to adapt and transmit the content, such as Talk-Back.
- **Twin Accessible App**. App created along the original for specials users to make up its lack of accessibility.
- **Non Accessible and Usable App**. App interface cannot facilitate ant adaptation for users who requires it.

This work concludes on two main ideas: Firstly, some accessible points all usual in all apps analyzed, such as a touch surface of 9 mm or clearance of information displayed, but most of the points about accessibility are not so good. And regards the accessibility issues, all points on the apps should be balanced integrated, if not a couple of positive points, do not count for rising this points.

And, Apps used on a social field are widely businesses by software companies, trying to give users several possibilities to their demands, and therefore, these apps have usually more accessible points than others. Being important for instance, possibility of rising size of the texts or media contents. On this social field are located social networks, the most used by the world's population, despite not being totally accessible most of them or having important points to work on.

Summarizing, this work show shocking data about the ICTs in present days, widely used by everybody, with major investments by governments and private companies, and on which the citizen hopes for help to make theirs life a little easier. But yet, for part of the population with disabilities, the digital divide is getting wider every day.

Considering that communication and information technology make everything easier on a daily basis for people. However the digital divide is growing every day. Disabled users can't be an active part in their society, that separates them and makes them be just passive agents.

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COMPARING LEARNER COMMUNITY BEHAVIOR IN MULTIPLE PRESENTATIONS OF A MASSIVE OPEN ONLINE COURSE

Silvia Elena Gallagher and Timothy Savage
Trinity College Dublin, The University of Dublin, Ireland

ABSTRACT

Massive Online Open Courses (MOOCs) can create large scale communities of learners who collaborate, interact and discuss learning materials and activities. MOOCs are often delivered multiple times with similar content to different cohorts of learners. However, research into the differences of learner communication, behavior and expectation between multiple presentations is scarce. This is of importance to MOOC developers, academics and moderators, as an understanding of these differences could have an impact on content provision, community moderation, course delivery, learner interactions, and completion rates. This case study of two presentations of a Futurelearn History MOOC examined learner activity data, and pre and post course learner survey results (n=10,449). Differences in learner survival rates, behavior, expectation, recruitment, experience of online learning, demographic makeup, reasons for non-completion, and comment activity were identified. These results form a preliminary exploration of learner community differences between multiple MOOC presentations that guide future analyses by identifying areas of comparative interest and importance.

KEYWORDS

Massive Online Open Course, Online Learners, Online Education, Learner Community Behavior

1. INTRODUCTION

Massive Open Online Courses (MOOCs) are a relatively new learning phenomenon where learners access freely available online educational multimedia resources online, and connect with large numbers of other learners asynchronously via social networking tools such as discussion forums (Liyanagunawardena et al., 2013). These forums are used to facilitate course understanding, support learner problem solving, and build a community of learners. MOOCs are often repeated in multiple presentations with new cohorts of learners. Exploring and identifying where learner and community behavior is different between these instances can help MOOC moderators, academics and administrators in their development, implementation and evaluation of MOOCs. This paper provides a comparative analysis of learner behavior and demographics in two presentations of the same MOOC. It contributes an understanding of differences in learner community behavior across multiple presentations of a MOOC, and forms a preliminary basis for further work within this space.

Although there have been comparative analyses across different MOOCs, comparative research is lacking on learner behavior, communication, and demographics within repeated presentations of the same MOOC. This could have an impact on MOOC content design, resource provision, community moderation, course delivery, learner / educator interactions, and completion rates. Comparative research across multiple MOOCs has explored learner activity rates and peer interaction (Hew, 2015), forum activity (Brinton et al., 2013), and pedagogical practices (Toven-Lindsey et al., 2015). However, little research has been conducted into repeated iterations of the same MOOC. Previous research into repeated versions of a MOOC has explored demographic variables (Liyanagunawardena et al., 2013), and has found that participation initially declines by 43% between the first to the second MOOC presentation (Ho et al., 2014). However, little comparative information as to community and learner activity, communication, survival and behavior, with a focus on multiple presentations of the same MOOC is available. MOOC providers often have data across multiple MOOC presentations; however, at present it is unknown which comparative variables are of importance, and what are the implications of differing MOOC learner populations.

2. RESEARCH AIM

This research aims to examine differences in learner communication, behavior, demographics and survival across multiple presentations of a MOOC; the inaugural presentation, and the second presentation. It questions whether different cohorts of MOOC learners behave differently, and in what way. Identifying variables for comparison across MOOC presentations could help future research and guide content provision, community moderation, course delivery, learner / educator interactions, and completion rates.

3. METHODOLOGY

Two presentations of the 'Irish Lives' MOOC were delivered on the Futurelearn platform in September 2014 (P1) and March 2015 (P2) by Trinity College Dublin, Ireland. This was a six week Irish History MOOC, with four hours recommended study time per week. Assessment was based on two peer review essays, and completion of MOOC steps. A pre course and post course survey were administered to learners in both presentations. The pre course survey consisted of 20 questions related to demographic information, experience of online learning, expectations of online learning, and interest in history. The post course survey included 29 questions on course activity and satisfaction with online learning experience. Table 1 describes the sample of the pre and post course surveys, and the total number of joiners within both MOOC presentations (a joiner is defined as a learner course enrolment). Both presentations of the MOOC had the same content and moderation, except for one addition in the first step of P2 where learners were asked to introduce themselves.

Table 1. Number of participants in pre course and post course survey responses and response rates

MOOC presentation	Total Number of Joiners	Pre course survey participants	Post course survey participants
P1	18,264	3,834 (20.9%)	1,722 (9.4%)
P2	11,085	4,458 (40.3%)	435 (3.9%)

4. RESULTS

The results of the comparative analysis of multiple presentations of the Irish Lives MOOC suggest differences in learner survival, expectation, recruitment, experience of online learning, demographic makeup (age and gender), and educational level. Additional variables that suggest difference in MOOC presentations include reasons for non-completion, learner activity types, and comment activity.

4.1 Learner Demographics, Experience, Expectation, and Recruitment

The pre-course survey described significant differences between the two presentations in gender, age, educational level and experience in online learning. Table 2 describes how learners from P1 were older, had a lower educational level, and the majority were geographically based in Ireland. A greater percentage of learners were female and from the United States in the P2. It also describes that P1 had less experience of online learning than P2.

Table 2. Demographic Information and Experience of Online Learning

	P1	P2
Gender*		
Male	1,605 (41.9%)	1,608 (36.1%)
Female	2,030 (52.9%)	2,656 (59.6%)
Other	4 (0.1%)	8 (0.2%)
Age**		
0-35	652 (17.8%)	858 (20.1%)
36-55	1,324 (36.2%)	1,552 (36.3%)
56+	1,680 (45%)	1,869 (43.7%)

Educational Level*		
Primary	110 (3.1%)	75 (1.8%)
Secondary	950 (26.6%)	1035 (24.8%)
Third Level	2,512 (70.3%)	3,061 (73.4%)
Geographical Location		
Ireland	1,679 (46.2%)	975 (22.7%)
US	844 (23.2%)	1,754 (40.9%)
UK	652 (17.9%)	861 (20.1%)
Other	455 (12.5%)	691 (16.1%)
Experience of Online Learning*		
Yes	1,045 (27.2%)	1,559 (35%)
No	2,592 (67.6%)	2,736 (61.4%)

*p<0.001 **p<0.01

Significant differences in learner expectation also emerged in the responses ‘learn new things’, ‘try out learning online’, and ‘supplement my existing studies’. P1 learners expected to try out learning outline to a greater extent than P2 learners, whereas P2 learners had a greater focus on career and study development. There were observed differences in how learners were recruited in P1 than P2. Learners from P2 were recruited to a greater extent from online sources, whereas P1 learners were recruited from print media and word of mouth. The post-course survey results found that there were significant differences in learner dropout rationale between the two MOOC presentations. These differences were apparent in the responses ‘didn’t have enough spare time’ and ‘couldn’t keep up with the course’, with P1 having significantly higher responses to these questions (p>0.01). Significant differences were also identified in ‘satisfaction with learner activity’. P2 learners enjoyed discussing content with other learners more than P1.

4.2 Learner Survival

Activity data extracted from the Futurelearn website found that there was a much higher dropout of students in the first day of the MOOC in P1 than P2. Figure 1 describes the day of the last step that a learner was active within. The majority of P1 dropouts were in the first day of the MOOC compared with the end of the first week in P2. This finding suggests that the behavior of learners in the first presentation of a MOOC can differ from the second. In effect, P1 learners tend to drop out earlier than P2 learners.

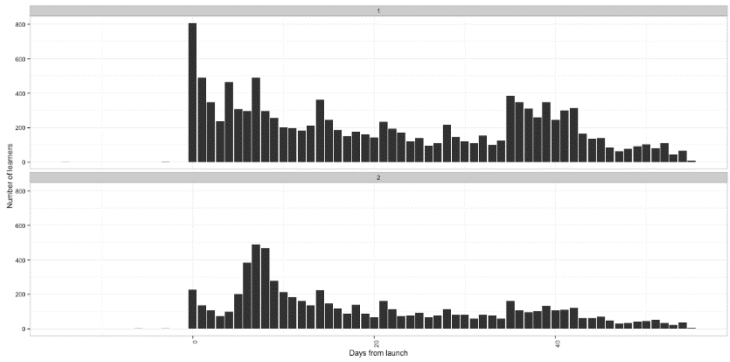

Figure 1. Comparing last step progress in P1 and P2

4.3 Learner Behavior

Comparing the number of learner comments in each step of the MOOC identified some interesting results (see Figure 2). Although most of the results are very similar, a spike can be seen in the third step of the first week in P2. This was due to the inclusion of additional text asking the learners to introduce themselves that was not in P1. This finding demonstrates how a small change in MOOC content across multiple presentations, can drive changes in learner comment behavior.

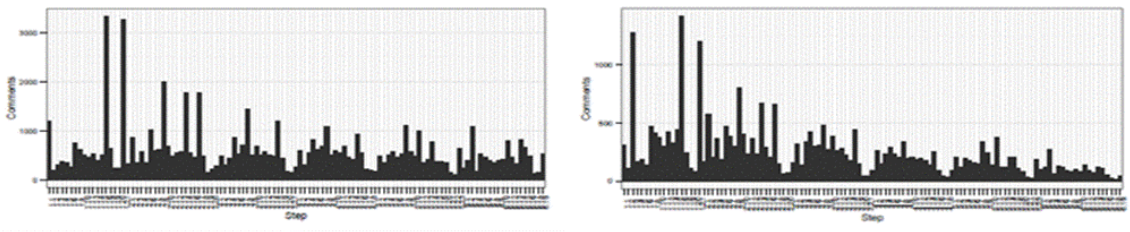

Figure 2. Comparing the number of comments in each step of the MOOC between P1 and P2

Learner behavior also differed between the two presentations, in particular between social learners (a learner is one who has made at least one comment) and participating learners (a learner who has completed the majority of the steps). P1 had greater numbers of social learners (41%) and participating learners (25%) than P2 (36%;16%).

5. DISCUSSION AND CONCLUSION

This research suggests that MOOC iterations can differ in learner expectation, learner recruitment, experience of online learning, demographic makeup, reasons for non-completion, learner activity types, comment activity and learner survival. Identifying these variables could have implications for MOOC design, implementation and evaluation. The practical implications of these results suggest that pre course surveys could be analyzed prior to the commencement of the MOOC to guide MOOC moderation. Post course surveys and MOOC data analysis can identify areas of importance for future MOOC iterations. We are curious to discover whether similar findings of difference will be apparent using data from other MOOCs. The following research questions have emerged from this analysis that warrant these future investigations:

- Are learners from inaugural presentations more motivated to complete or comment on a MOOC than subsequent presentations (i.e. social and participating learners)?
- Are inaugural learners more likely to drop out earlier than second presentation learners, and if so, why?
- Does experience of online learning differ across multiple presentations, and if so, why?
- Should MOOCs be compared across their presentation iteration rather than as an aggregate (i.e. first presentations be compared with first presentations, second with second)?
- Are there patterns of demographic differences across MOOC presentations, and if so why?
- Does learner activity and satisfaction with learning activities differ between presentations?

This research described differences in demographic composition, survival, communication, activity, and behavior between MOOC presentations. The research is limited to one case study, however future research will examine these questions in additional MOOCs. This could determine whether there are common behavioral differences in MOOC presentations which could have an impact on their design and implementation.

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DEVELOPING ADOLESCENTS' RESISTANCE TO SEXUAL COERCION THROUGH ROLE-PLAYING ACTIVITIES IN A VIRTUAL WORLD

Marion McGinn & Inmaculada Arnedillo-Sánchez
School of Computer Science & Statistics, Trinity College Dublin, Ireland

ABSTRACT

This paper explores the use of a three dimensional virtual world (3-DVW) to delivery assertiveness training to young adolescents. The case study aims to understand how a sense of presence in VWs facilitates and affect the performance of students role-playing activities to enhance their ability to resist sexual coercion. The results indicate that a sense of presence had a modest influence on participants' verbal interactions while role-playing.

KEYWORDS

3D Virtual Environments, Adolescents, Sexual Coercion, Assertiveness, Role-Play

1. INTRODUCTION

Adolescence (10-19 years) is a period of development marked by the emergence of romantic relationships. Over 20% of all adolescents have experienced either psychological or physical coercion from an intimate partner (Centers for Disease Control and Prevention, 2012). When adolescents lack belief in their efficacy to assertively express wishes or initiate discussions around safer sex, they are likely to be coerced in their sexual relationships and be at risk of negative outcomes of sexual behaviour such as HIV/ STIs and unintended pregnancies (Wolfe et al; 2012). Individuals who have experienced sexually coercive behaviour experience considerable traumatic health consequences such as physical and mental health problems, substance misuse, self-harm, antisocial behavior, and sexual behavior problems (Lehrer et al;2013). Victims may also feel violated, vulnerable, confused, betrayed, guilt and shame (DeGue & DiLillo, 2005). Young and Furman (2008) reported that after an early incident of sexual coercion, adolescents' risk for subsequent incidents increased more than sevenfold. Programs focus on reducing vulnerability to sexual coercion by training people on how to protect themselves. Self-protection strategies including communication components aimed at improving the ability of participants to communicate assertively have been found to have some success (Gidycz et al; 2001).

Role-playing is an approach to help individuals develop strategies for dealing with complex social situations (Jouriles et al; 2009). However, it typically involves learning the skills in a classroom setting resulting in an unrealistic and disengaging experience (Sognure, 2004). Students find the scrutiny of the group confronting, and performing in front of their peers frightening and embarrassing (Arnold & Koczwara, 2006). Consequently, behavioral inhibition can impact on the content, style and quality of verbal interactions between individuals practicing role-plays (Hamilton et al; 2014).

1.1 3D Virtual Worlds (3DVWs): Virtual Presence and Virtual Realism

3DVWs are computer generated spaces with affordances for communication activities (Mennecke et al; 2011). Avatars represent the user in the VW and it is the user avatar that actually interacts with the world and other users via a range of synchronous and asynchronous verbal communication channels. These communication and exchange mechanisms in VWs create a sense of 'being there' at the same time and in a 'place' with other avatars (Minocha, 2010).

Presence, the subjective sense of being in a place, is a defining feature of the learners' experience that mediates the nature of communication in VWs (Mennecke et al; 2011). It is encouraged by the layers of sensory information which enable users to transcend the real world to see, hear and feel as if they are actually inside these environments (Blascovich & Bailenson, 2011). Presence is the combination of the technical capabilities of the medium, which encourages user immersion, and the level of psychological sense an individual has of being in the VW. Presence affects verbal interactions in role-plays. For instance, students in VWs take additional turns in conversations and have shorter exchanges in each turn than those in the Face-to- Face (Gao et al; 2008). Also, a sense of presence contributes to the argumentative knowledge construction by participants while role-playing in Second Life (Jamaludin et al; 2009).

The extent to which the realism of the environment enhances role-play interaction has been contested by arguing that imitating reality is not particularly helpful to learning (Dillenbourg; 2008). However, the context of the learning is relevant particularly in the case of role-play pedagogy. For instance a program to reduce sexual victimization among adolescent girls, which used virtual reality headsets, found the medium provided a realistic setting for participants to practice the skills needed to resist sexual coercion since it allowed them to experience a heightened sense of anxiety similar to how they would feel in a real-life sexually coercive situation (Rowe et al; 2015). Similarly, the graphical realism of VWs has been successfully applied to practice role-plays in social situations that individuals may find difficult in the real world such as job interview simulations (Bell & Weinstein, 2011) and teacher training (Gregory & Masters, 2012). Notwithstanding the previous, limitations of VWs such as lack of visual features: facial expressions and subtle movements; may detract from a sense of presence and hence reduced verbal interaction and engagement. Nonetheless, Schroder (2002) argues users are able to cope well with the absence of certain features in the real world or face -to- face. Furthermore, it can be anticipated that advances in technology will generate progress in higher avatar realism to allow the transmission of similar social cues of face-to-face communication.

This exploratory case study aims to develop a more in-depth understanding of how physical presence and sense of realism in a VW is perceived by students to influence their verbal performance while enacting role-plays.

2. METHOD AND RESULTS

17 students (10 male and 7 female) aged 13-14 years, attending a Social Health and Personal Education class participated in the study. None had experience of using Second Life and two students had experience of role-playing. Prior to initiating the study ethical research clearance was gained.

Participants completed a four week assertiveness training course with two components: a) Theory: covering the concepts of assertiveness, aggressiveness and passiveness; and b) Practical: focused on role-plays to teach assertive strategies to resist pressure to engage in negative sexual behaviours. Assertive strategies covered included: assertive responses (speaking clearly, honestly and confidently, saying no, making requests and dealing with aggression). To support the students, an actor of similar age to the participants assisted by demonstrating the skills. Initially, students were provided with eight partially scripted role-plays and asked to respond with what they would say in a similar situation using the communication strategies they observed. Skill prompts in the form of sentence starters were also provided. On completion of the assertiveness course the students participated in the VW component of the study.

The VW sessions took place in a computer lab over 6 weeks and each session lasted 40 minutes. During the first session, the students learnt how to navigate the VW and customised the appearance of their avatars as research indicates identifying closely with one's avatar is a significant element in how an individual interacts with others (Ducheneaut et al; 2009). Once acquainted with the VW, participants role-played the assertiveness techniques learnt, in pairs or groups of three or four. For instance, a scenario for two required students to assertively refuse to kiss somebody they had just met at a party, while a group activity asked participants to convince an individual to send an explicit image of themselves on their mobile phone. The students took turns being the persuader and the person being persuaded. The aim of these scenarios was to practice assertive refusal skills which refer to the ability to effectively communicate through verbal (clarity of expression, tone of voice, inflection and volume, response latency) and non-verbal (body orientation, posture and gestures) an unwillingness to engage in negative sexual practices.

After the VW sessions, the students completed a survey exploring the participants' engagement with the role-plays while in the VW. Users' experience of presence and realism while in the VW was measured by a scales from Slater et al; (1998) and Witmer & Singer (1998) which required participants to rate statements on a five-point Likert scale regarding the participants' perception of how the features of presence and sense of realism helped them enact the role-plays.

Regarding the sense of Presence, the questionnaire results indicated that (n=6) students felt *Much* physically present and a similar number *Somewhat* physically present, while (n=3) students reported they felt *A Little* and (n=2) responded *Not Much.* Concerning how a sense of presence affected their verbal interactions during the role-plays, the numbers were similar. This would be expected as those who reported they did not feel physically present or stated *A little* would not perceive the environment affected them in the same way as those who felt physically present. However, from our data, it is not possible to discern whether the complete lack of physical presence reported by two participants occurred due to a lack of interest in learning in the VW or to the VW itself. While no student reported feeling *Very Much* physically present, (n=2) felt physical presence helped them to speak *Very Much* with confidence, indicating that perhaps it is not necessary to feel completely present in the environment. Regarding how presence helped the students express themselves, (n=4) students indicating *Very Much*, five *Much*, (n=5) *Somewhat*, (n=2) *A little* and (n=1) student indicating *Not Much.* Being in the VW helped several of the students (n=7) to respond quicker during the role-plays. This may be due to several factors: students could practice as often as they felt necessary having plenty of time to work out how to respond during the role-plays; also, face-to-face discussions can present pressures on individuals to respond that perhaps can be managed better in a VW. Concerning how presence influenced tone of voice, (n=7) students reported a sense of presence helped them vary their tone of voice during the role-plays. Communication experts point to the role that anxiety can have on our speech patterns so it may be the case as has been suggested by Vallance et al (2014) that role-playing as an avatar reduces the anxiety experienced in face-to-face role-playing. However, the notion that the employment of avatars in role-plays influences an individual's involvement in the interaction (Bailenson et al; 2006) may also be a contributing factor as speech patterns such as tone of voice are influenced by how engaged individuals are in the conversation.

The findings of this study relating to the participants' sense of realism while in the VW revealed that several students (n=8) felt the environment was *Somewhat* real, although this contrasted with the affect a sense of realism had on their verbal interaction. For instance, while (n=8) students found it *Somewha*t real (n=1) student found the sense of realism helped them speak *Very Much* with confidence. (n=6) students also felt the sense of realism contributed *Much* to speaking with confidence while (n=7) felt it *Somewhat* helped. A sense of realism did not have the same influence on tone of voice as reported with the same question in the presence section with only (n-2) students reporting *Very Much* compared to (n=7) students in the Presence section. Similarly, a sense of realism helped only (n=2) students use a moderate tone of voice compared to (n=6) students in the presence section. All of the students reported feeling engaged with the role plays to varying degrees with (n=6) students reporting they were *Very Much* engaged and (n=6) reporting that feeling engaged helped them express themselves well in the role-plays.

3. CONCLUSION

Teaching sexual coercion prevention strategies to adolescents requires innovative approaches. This study provides preliminary support for the efficacy of 3DVWs for role-play to teach assertiveness skills. We found that a sense of presence coupled with a sense of realism had a modest influence on participants' verbal interactions while enacting the role-plays. While role-playing in VWs may not be better than face-to-face they are certainly comparable. This was an exploratory study with several limitations including a relatively small student cohort and reliance on self-reported data. In addition, while the current work is an initial insight into adolescents' experience of VWs for teaching assertiveness skills, incorporating qualitative data in future studies will strengthen the evidence that a VW is an appropriate intervention for adolescents.

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HOW CAN ONE LEARN MATHEMATICAL WORD PROBLEMS IN A SECOND LANGUAGE? A COGNITIVE LOAD PERSPECTIVE

Dr. Jase Moussa-Inaty, Dr. Mark Causapin and Timothy Groombridge
Zayed University, Abu Dhabi, The United Arab Emirates

ABSTRACT

Language may ordinarily account for difficulties in solving word problems and this is particularly true if mathematical word problems are taught in a language other than one's native language. Research into cognitive load may offer a clear theoretical framework when investigating word problems because memory, specifically working memory, plays a major role in solving problems successfully. The main purpose of this study was to investigate the influence of language when solving mathematical word problems while taking into consideration participant's limited working memory. The participants' main role was to solve word problems in a format that depended on the group they were assigned to. The study utilized a qualitative method approach and involved three phases, a pre-testing, acquisition, and testing phase. Predominant findings from this study show that there was a statistically significant difference between the various groups participants were assigned to.

KEYWORDS

Cognitive load theory, mathematics, second language, and problem solving.

1. INTRODUCTION

The issues involving teaching college level mathematics in the United Arab Emirates (UAE) pose many challenges for teaching faculty and also highlight the need to thoroughly understand these challenges in an attempt to provide instructional guidelines that may help in enhancing student performance scores in mathematics. One of the most obvious challenges would seem to relate to teaching and learning mathematics in a second language. For instance, Emirati students wishing to join Zayed University (ZU) - a federal institution in the UAE- are required to enrol in several mathematics courses. Since the language of instruction is English, mathematic courses are taught in English despite the fact that for the majority of ZU students, English is a second language. To date performance scores have not been very promising and recent investigations have sought ways to improve the learning of mathematical word problems.

2. LITERATURE REVIEW

2.1 Cognitive Load Theory

Cognitive load theory (CLT) may offer a theoretical framework for understanding how materials and the way in which they are presented may in fact impact learning. Cognitive load theory draws on the work of Atkinson and Shriffin (1968), which highlights a limited working memory that can be overloaded based on how information is presented. CLT research has identified a number of instructional designs, two of which are particularly relevant to this study: redundancy effect and modality effect (Sweller, 2004). The redundancy principle suggests that it is more effective to replace multiple information sources that can be understood on their own with just one source of information (see Moussa-Inaty, Ayres, & Sweller, 2012). The modality principle suggests that learning might be enhanced by replacing written explanatory text and another source of visual information with a spoken explanatory text and a visual source of information.

2.2 Mathematics and Language

When solving mathematical word problems students not only need to know the correct mathematical operations in order to answer the tasks at hand, it is also essential for them to be able to successfully deal with the linguistic components - the lexis and syntax. The links between mathematics and language and indeed mathematics as a language have long been studied (see Halliday, 1978; Pimm, 1987). Lexical problems can be compounded by the fact that teachers in the UAE education sectors are from a wide variety of backgrounds (McKinnon, Moussa-Inaty, & Barza, 2014) bringing a number of first languages into the classroom.

3. METHODOLOGY

3.1 Purpose of this Study

The general purpose of the study was to extend the research into the redundancy and the modality effect by specifically examining the impact of spoken and written text in English only vs. spoken and written text in English and Arabic when learning how to solve mathematical word problems.

3.2 Participants

A sample of one hundred and thirty two undergraduate female students from a federal institution agreed to take part in this study (see Table 1). Though the language of instruction was in English, the participants' first language was Arabic, but they were all able to speak and understand English with an average IELTS score of 4.6 for reading and 4.9 for listening, indicating that participants are moderate users of English. All participants were registered in a university college course (MTH 101) that mainly covers secondary mathematics and is specifically designed as a remedial class prior to taking the first year general mathematics courses.

Table 1. Number of participants per treatment group

		n
Groups	Listening Only - English	**18**
	Listening Only - English & Arabic	**20**
	Reading Only - English	**20**
	Reading Only - English & Arabic	**25**
	Reading & Listening - English	**26**
	Reading & Listening - English & Arabic	**23**

3.3 Materials and Procedure

The experiment consisted of three phases, a pretest, an acquisition phase and a testing phase. For the pretest, a set of multiple-choice questions related to finding percentages were asked. For each activity in the acquisition phase both reading and auditory materials were required. For the testing phase, a combination of questions that tested for transfer was presented. To measure cognitive load, a 9-point likert scale was administered after a three phases of the experiment was complete. Students were assigned to one of six treatment groups, namely Read in English (RE), Read in English and Arabic (REA), Listen in English (LE), Listen in English and Arabic (LEA), Read and Listen in English (RLE), and Read and Listen in English and Arabic (RLEA). The format of the materials was presented based on the group the students were assigned to. The analyses focused on aspects of the problems presented that potentially increased cognitive demands for second-language learners.

4. RESULTS AND DISCUSSION

Table 2 shows the mean rank for each treatment group only for those with significance below 0.05.

Table 2. Mean Rank

	Treatment	n	Mean Rank
Acquisition 3&4	Reading Only – English	20	63.53
	Reading Only – English and Arabic	25	69.62
	Listening Only – English	18	49.36
	Listening Only – English and Arabic	20	66.28
	Reading and Listening – English	26	57.77
	Reading and Listening – English and Arabic	23	89.17
	Total	132	
Acquisition Total	Reading Only – English	20	62.08
	Reading Only – English and Arabic	25	69.14
	Listening Only – English	18	47.97
	Listening Only – English and Arabic	20	66.93
	Reading and Listening – English	26	61.50
	Reading and Listening – English and Arabic	23	87.26
	Total	132	
Acquisition MER	Reading Only – English	19	57.61
	Reading Only – English and Arabic	25	54.52
	Listening Only – English	18	99.19
	Listening Only – English and Arabic	19	65.66
	Reading and Listening – English	26	69.62
	Reading and Listening – English and Arabic	22	49.30
	Total	129	
Post-Test 2 Total	Reading Only – English	20	77.70
	Reading Only – English and Arabic	25	65.20
	Listening Only – English	18	69.31
	Listening Only – English and Arabic	20	58.75
	Reading and Listening – English	26	53.75
	Reading and Listening – English and Arabic	23	77.13
	Total	132	

Kruskall-Wallis (KW) test results showed that there was a statistically significant difference between the distributions of Acquisition 3 & 4, Acquisition Total, Acquisition Mental Effort Ratings, and Post-Test 2 Total. For each test with statistical significant differences, pairwise comparisons between treatments were conducted. For Acquisition 3&4, the results for RLEA was higher than LE ($p = 0.003$) and RLE ($p = 0.018$), while without the BC, RLEA was also higher than the rest of the treatments which included RE ($p = 0.013$), LEA ($p = 0.027$), and REA ($p = 0.045$). For Acquisition Total, RLEA was higher than LEA ($p = 0.011$), while without the BC, RLEA was also higher than RLE ($p = 0.015$) and RE ($p = 0.026$). For the Acquisition Mental Effort Rating, RLEA, REA, and RE were all lower than LE ($p < 0.000$, $p = 0.001$, and $p = 0.009$), while without the BC, RLEA was also lower than LEA ($p = 0.006$) and RLE ($p = 0.009$). The extremely low scores overall for Post-Test 2 among students make these last results less certain. Overall, these findings suggest that among the treatment groups, RLEA had the most significant positive impact on student performance during the acquisition phase. On the other hand, LE had the most negative impact.

5. CONCLUSION

The results of this study demonstrated students in a dual mode of instruction outperformed those in a single mode of instruction, but it is important to note the treatment groups that performed the best were engaged in tasks that required *reading* while the treatment group that performed the worst was engaged in tasks that required *listening*. These results can be explained by considering what Moussa-Inaty, Ayres, and Sweller (2012) called the transient nature of auditory material where additional processing may be required to remember previously heard information. The transient effect of listening can hinder learning since learners have no control over what they hear, which is not the case when learners read. But even though Moussa-Inaty et al. (2012), stressed that for foreign language learners, the simultaneous presentation of spoken and written text should be avoided, in the case of the current study, results showed that students benefited from learning how to solve mathematical word problems when written and auditory materials were simultaneously presented. Results also showed that when solving mathematical word problems, students performed better when two languages were presented simultaneously.

In conclusion, this study supports the use of cognitive load-reducing strategies when learning how to solve mathematical word problems in a second language and this is particularly relevant in countries where English is the language of instruction but not the learners' first language. When teaching how to solve mathematical word problems, the study can confirm that at least some form of reading should be involved and that auditory material should be avoided and not be presented alone as it may impose high cognitive load. The language in which mathematical word problems are presented in this study showed that it did impact student performance, but the unintended added time students in some treatments groups had, may have also been a contributing factor to enhanced performance.

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ONTOLOGICAL RELATIONS AND THE CAPABILITY MATURITY MODEL APPLIED IN ACADEMIA

Jerônimo Moreira de Oliveira[a], Laura Gómez Campoy[b] and Lilian Vilarino[b]
[a]*J & M – Assessoria e Consultoria Pessoal e Profissional Ltda, Brazil*
[b]*Universidad Católica de Murcia, Spain*

ABSTRACT

This work presents a new approach to the discovery, identification and connection of ontological elements within the domain of characterization in learning organizations. In particular, the study can be applied to contexts where organizations require planning, logic, balance, and cognition in knowledge creation scenarios, which is the case for the scenario we are proposing here as the primary one to consider in universities and academia. The model we are focusing on and proposing is grounded in the establishment of existing connections among people, processes, and technology, which form the compounds of the model being what we understand for the Experiential Learning Cycle (ELC) and the Imaginary Experiential Learning Cycle (IELC). Hence, a diagnosis method is proposed in the form of a 'harmonograma', which will serve as the basis to establish what we consider the Dynamic Balance Point (DBP) as a tool to be applied to identify the characteristics that mobilize cognition, and for which points need to be improved. Therefore, individuals (i.e. a person as a conceptualization) are concerned with personal knowledge, skills, experiences, and with the technology and processes that enable dealing and managing it. We certainly believe that the application of DBP as a self-diagnosis model could successfully contribute to this interaction of Technologies, Processes and People in the cognitive-behavioral perspective.

KEYWORDS

Ontology, experiential learning, dynamic balance point

1. INTRODUCTION

Davenport and Prusak (1998) have already stated that knowledge is an unrivaled asset, which is not consumed with use, but quite the opposite: through the use of existing knowledge it increases its value. This study presents a new approach to integrate relevant aspects of people, technologies and processes through Dynamic Balance Point (DBP) [1]

The theme will focus from the information theory to the consideration of the argument of the opponent. The argument of the opponents is that it is the functions of the brain that help in the process of perception between the inner and outer world. Together in this process is the interaction of gender archetypes. These archetypes of gender have spiritual and social power for civilizations that culture, and can be studied scientifically. These functions allow interaction with CAV (Experiential Learning Cycle), with the processes of perception that arise in interpersonal communication between the technologies and processes and people on the construction of cognitive behavior.

I would divide into four types with clearer punctuation. In the structure of CAV, the triggers of cognitive behavior in human beings are the characteristics that mobilize entrepreneurial cognition. The characteristics that mobilize are divided into four main types: the awakening, which leads the skills that will help in planning, guiding the decision, which is a difficult issue because researchers are undecided on a solution, but the uncertainty principle is intrinsic to the event, the decision is a logical response to the needs of CAV the answer may not be applicable, the plan puts into practice free will through action: the structure, which consists of and symbolic logic, consistency with the practice of understanding in the process of kinesthetic action in behavior: running, whose character implies putting into practice the knowledge to improve the

[1] First introduced as PED from its original Portuguese translation (Ponto de Equilíbrio Dinâmico)

quality of life experienced in CAV. The theoretical basis of CAV was developed through experience gained in Solid State Physics (electromagnetic fields), the behavior of natural phenomena seen and understood through learning cycles in the TRANS-disciplinary process, applying inductive and deductive logic of knowledge in neuroscience. CAVI was theoretically established to encourage the study area of the thesis in the process of experimental psychology of perception he complexity of the behavior of the algorithm is not a time polynomial. An ontological relationship between CAVI and CAV was developed with the principles of the theory of quantum physics, hence arises a 50% probability of belonging to the phenomenon of CAVI, the other 50% belong to the phenomenon of CAV (uncertainty principle). However, cognitive-behavioral psychologies, physics, ontological phenomenology, were heuristic research and this research contributes to 'trans-disciplinary events'.

CAVI and CAV have contributed to the theoretical point of dynamic balance (DBP) among cultures (interpersonal relations), technology (the imaginary) and processes (for the syncretism of ideas) of being human. Concluding and first answer from CAV and CAVI, within the holistic vision of the cognitive study of alchemy, one can initially see the need to define the layout that flows and balance. CAV (the real world physical body) is experiential learning cycle, which begins in behavior, fulfilling the algorithm of the first cycle.

2. CONCEPTUAL RELATIONS IN DYNAMIC BALANCE POINT (DBP)

The Dynamic Balance Point (DBP) was coined by Oliveira (Oliveira, 2002) and it is a powerful way to manage, in an integrated manner, the interactive forces that exist when people, technology and process are involved. It is shown in figure 1.

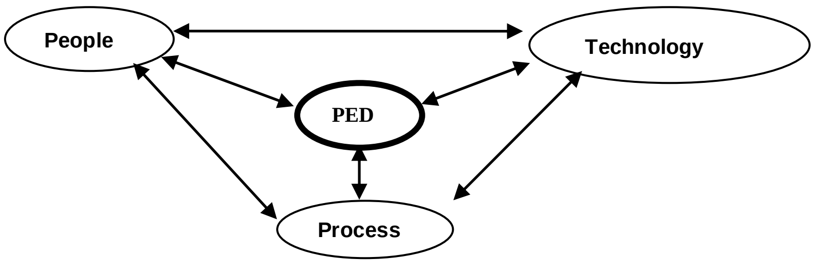

Figure 1. The DBP Model structure

The DBP focus is identify mobilize characteristics related to people's behavioral features like goals, persistency, planning and commitment (Oliveira, 2004). When working with people, we have the integration and balance between cognition and their ability through self-diagnosis. By working with technology, there is a DBP Model. This integration between people when they use technology is the cognition that occurs through the transformation of technology into desired results. When working with the process, there is DBP and this integration is the cognition that occurs through the methodology that was developed with flexible learning to acquire organizational knowledge. A final concept to consider in relation to knowledge management from the technological point of view would be the automated processing of knowledge, including through the use of an information technology system, in order to increase the value of collections of knowledge. The relationship between the People -Technologies, is a relation: [is - a], knowledge can be transformed by moving up the hierarchy of knowledge, a higher state in the same, that is, to what we might call "knowledge integrated" through a distributed system and easy access. As an example, we can transform the rules of data or cases using techniques of machine learning and data mining. The development of this rule is to give understanding of the philosophical questions that sometimes seem esoteric, but whose reasoning applied science in practice and often pass through pragmatic before going through the analyzers of our brain that are: Lexical - recognizes words; Syntactic-recognize the combination of words in the sentence; Semantic recognizes the meaning of words; Pragmatics the use of words. 'Human language uses sounds, symbols, gestures. Moreover, the signs of language are organized as a syntax-specific to each language or dialect. 'The language that compiles the human brain: is kaleidoscopic and for science can be seen as - Geometric Computing.'

3. DBP - MODEL ONTOLOGICAL RELATIONS AMONGST HUMAN RESOURCES IN PRACTICE

3.1 Conceptual and Behavioral Relations in DBP

Classical logic (first order) itself is a simple language with a limited number of basic symbols. The level of detail depends on the variety of predicates, which, strictly speaking, do not belong to logic. In this paper we will use the DBP Model and ontological methodology to model all the relevant entities that are considered and represented. Different varieties of predicates represent the DBP Model and the ontological commitments.

For example: 'Person (P) is a (is-a) living, but every living being is a person '; 'Person is part of (part-of) of an organization'; 'Technology is part of (part - of) an organization', because technology is a (is-a) tool to achieve success. But not every tool is technology; 'Process is part of (part - of) an organization, it is a process (is-a) means to achieve success.' But not all processes lead to success. 'Technology, when there is a failure, (is-a) problem to be solved by a HR (Human Resources) expert'; For DBP Model, staff management is unique because it depends on each HR (person - person or people - people). The framework of this model is Personal Planning and is different for each individual, but not separate from part of the universe, it is the set of personal values and behavioral, to which they relate.

It then gives the relations between the elements described above as a method of confirmation of actions and plans chosen by the organization that is managed by HR. C_1: equipment (a). It is a conceptual relationship of Person - Person. The HR is part of a team. Then, the behavioral relationships in the model DBP are satisfied. This does not mean they are alike, but belong to the same sets of successes/problems as 'a whole', as part of an organization and/or project, sharing everything (people, technology and process). Let a = b, then b = a. The successes and/or problems are symmetrical, having the same degree of similarity. They are transitive: if a = b and b = c then a = c. C_2: interpersonal (b). It is a conceptual relationship of person - person. HR are related in a civilized manner, it is a peer relationship, cooperation, integration and participation. C_3: performance (c). In relationships, person - technology and/or person - process, HR relate, so that their motivation levels are very high, planned, structured and with a mastery of subject knowledge to solve. C_4: Work (d). In the conceptual relationships, Person - Person, Person - Technology; Person - Process, Technology - Process, HR interact seamlessly with the DBP Model and ontological methodology.

3.2 Ontological Relationships and Mathematical Properties of DBP: Dynamic Balance Point

Ontological relationships and mathematical properties applied to Knowledge Manage are Human Resource practices in People - Processes, which are in balance in the model concept DBP work. In this concept described relations are satisfied with the respective properties as shown in table 1. HR is considered an entity of the relationships that satisfies the properties of reflexivity, transitivity and similarity: People Management (process) is related to work (action) of HR. Examples of relationships that occur in the organizational context can be found below: - Equivalence between the concepts Person - Process: If the person (**a**) is member of a team (**b**), part-is the team (**b**) relates to the process(**c**); $\mathbf{a\ R\ b \wedge b\ R\ a \rightarrow a,b\ R\ c}$; - Topological between the concepts Person - Person, Person - Process, People - Technology (which fulfills the properties of reflexivity, symmetry and transitivity). These relations consider the infrastructure, the environment and machines; -Functional, between the concepts Person - Person, Person - Process and People - Technology. For example, a director (person) is the owner of an organization that relates to equipment experts (people) of quality software development (CMM-process) and great technology; - Purpose. For Human Resource to achieve its goals, it is necessary to know the purposes of the organization. With the globalization of the economy and the advancement of technology, organizations are under pressure in their production processes and negotiating new agents, less cost and greater efficiency, highlighting the cost-performance.

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Table 1. Ontological relations and their properties.

RELATIONSHIP/PROPERTIES	REFLECTIVE	MIRROR	TRANSITIVE
EQUIVALENCE	X	X	X
TAXONOMY			X
DEPENDENCE	X		X
TOPOLOGICA	X	X	X
CAUSAL			
FUNCTIONAL			X
TEMPORAL			X
SIMILAR	X	X	
CONDITIONAL			X
PURPOSIVE			X
THINGS/OBJECT			
COMPONENT/OBJECT			X
MEMBER/COLLECTION			
LOT/EARTH			
LOCATION/AREA			X
ACTIVITES FEATURES			X
PHASE/PROCESS			X

4. ACKNOWLEDGEMENT AND DISCUSSION

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HARMONOGRAMA DBP MODEL: The main objective of the methodology presented in this proposal is the determination of dynamic balance point (DBP) of Harmonograma namely the harmonic graph between organizational elements, whose scheme is shown in practice. The interrelationship between the vertices of Harmonograma has been the starting point for research that has developed through doctoral thesis at the Catholic University of Murcia-Spain.

5. CONCLUSION

Cognitive organizational education is similar to the DBP Model in quantum physics. Quantum physics works with imaginary, mathematical forms (CAVI), which represent physical possibilities in the real world (CAV). The DBP Model: Dynamic Balance Point between people, processes and technologies in cognitive education, with the possibilities that we can feel, associate, calculate, integrate and interact with processes in the transactions of life. We analyze the equilibrium of the body to what is defined by feelings, we classify CAV to the feelings and sensations CAVI, and consequently, what we call the sensation of CAVI to feelings that come from an energy transformation. We have cognitive sensation, which is the feeling of Organization in Education. The cognitive sense is the movement to find a balance point, which implies the existence of a mobilizing event. Education becomes an element that will evaluate feeling, which will shift more or less according to the process, and with people.

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COGNITIVE CURATIONS OF COLLABORATIVE CURRICULA

Amy S. Ackerman, Ph.D.
School of Education - Instructional Technology, Stockton University, Galloway, New Jersey, United States

ABSTRACT

Assuming the role of learning curators, 22 graduate students (in-service teachers) addressed authentic problems (challenges) within their respective classrooms by selecting digital tools as part of implementation of interdisciplinary lesson plans. Students focused on formative assessment tools as a means to gather evidence to make improvements in the learning process. Floor plans of rooms in houses were used as metaphors by each group to contain the various digital tools that they selected. This paper includes descriptions of the final curations with samples of the digital assessments tools, as well as lessons learned for future applications.

KEYWORDS

Curation, assessment, digital, web2.0, online learning

1. INTRODUCTION

Content curation may be defined as the act of finding, grouping, organizing or sharing the best and most relevant content on a specific issue (Bhargava, 2011). Although we probably perform curation without deliberate thought, curation has only recently been applied to the learning (Gadot & Levin, 2012) and performance field (Fulton, Botticelli, & Bradley, 2011). Bhargava identifies five models for using content curation: 1. aggregation, 2. distillation, 3. elevation, 4. mashups, and 5. chronology. This paper focuses on graduate course assignments that extend beyond aggregating and filtering into value-added selections of digital tools to facilitate and assess learning (Rosenbaum, 2011; Mihailidis & Cohen, 2013; Callens, 2014; Green & Green, 2014; Literat, 2014; Greener & Wakefield, 2015; Ibrahim, Atif, Shuaib, & Sampson, 2015) with formative feedback to help people grow (Weisgerber, 2012; Niess & Gillow-Wiles, 2013). Topics in this paper include the background and definition of learning curation; a description of the audience and environment where the course was conducted; the course Assignment including the floor plan and rooms metaphor; web2.0 open sources, identification of digital tools that were selected for the container and instructional tools; screenshots of sample products; and results/lessons learned for future replication of the Assignment.

1.1 Definition of Terms

Curate – pull together, select organize, and look after items in a collection; select, organize, and present using expert knowledge; act as curator, organize and oversee; take charge of or organize

Formative evaluation- range of formal and informal assessment procedures employed by instructors during the learning process to modify teaching and learning activities to improve student attainment

1.2 Audience and Environment

The paper focus involves 22 graduate students in a Master of Arts Instructional Technology program in the United States, with a course titled, Educational Hardware & Software. Participating students included K-12 teachers (age 22-72) with three representatives from higher education, business, and the military. Class members were grouped into teams of 2-3 people who shared the same discipline. For student convenience, class attendance options included face-to-face, online synchronous, online asynchronous (using *Blackboard and Collaborate*). The next section includes the Assignment given to the graduate students during a 10-week semester.

2. ASSIGNMENT FOR CURATOR CREATION

The term curator comes from the Latin term meaning *take care.* This term is widely used relating to a person who works in a gallery, museum, historical site, zoo, etc. and serves as the content specialist. The role of a curator in a museum is to arrange objects in a particular way that demonstrates a specific theme or tells a story.

Recently, curators have become a popular term in the educational field as they play the same or similar role to a person in a museum. Since educators have access to exponential information it is hard for the learner to select what is important and what is not. As a result, the curator plays a vital part in the ecosystem of a learner by gathering and selecting the best examples to learn a particular concept and create the framework for the learner.

The purpose of the educator is to assemble specific tasks to complete in a real, rigor, and relevant manner that is easy to navigate and engage all. In addition, infusing technology through this process enables educators to permeate global interaction through the use of social media.

Throughout this course, you will serve as the Educational and Technology Curator. Your role is to work in a team (2 or more) who share the same discipline (science, math, language arts, social studies, etc.) or area of expertise. Each discipline will have its own floor (For example, floor one might be math, floor two is science, floor three is business, floor four is language arts, etc.) with customized rooms (Gaming Gallery, Fun Room, etc.) to meet the needs of the learner and the framework designed by the curator (Please see examples of possible rooms, yet feel free to create your own titles).

2.1 Within each Floor, include a Minimum of the Following

- Complete a lesson plan template integrating 9 events of instruction (See Gagne' for further details)

- Create a specific assessment using Bloom's Taxonomy (authentic, MC/T/F, etc.) using a free web 2.0 tool of your choice

- Create an activity integrating social media that will increase collaboration

- Create something (aka global wild card) on your floor that is original and not previously discussed (Each floor will be different)

- Create a container or *hub* to house your information (iBook author, wiki, wix, weebly, livebinder, google site, eportfolio, edmodo, schoology etc.) for sharing with all of your classmates during our Synergistic Showtime. See Figures 1 and 2 for examples of room types to think about for your own floor plan.

This slideshow may provide some background to get you started on what this is all about.
http://www.slideshare.net/corinnew/reenvisioning-modern-pedagogy-educators-as-curators-11879841

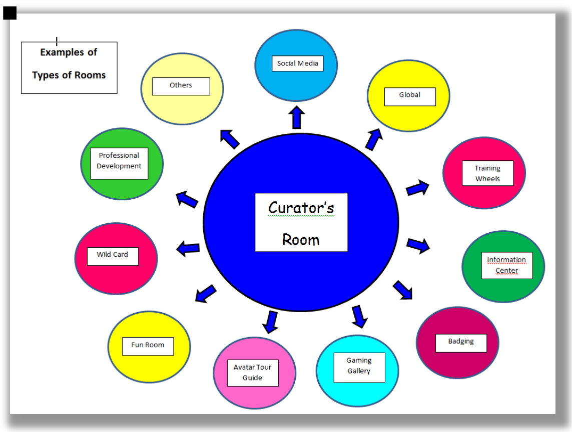

Figure 1. Room types

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Figure 2. What's in each room?

2.2 Examples Screen Shots of Curated Containers (Hubs)

In this section, selected products are shown as screenshots within the container that the student used as a floor plan to house the various rooms to address his/her instructional problem (challenge). Figure 3 is a Time Management sample; Figure 4 is a Project Management sample; and Figure 5 is an Algebra sample.

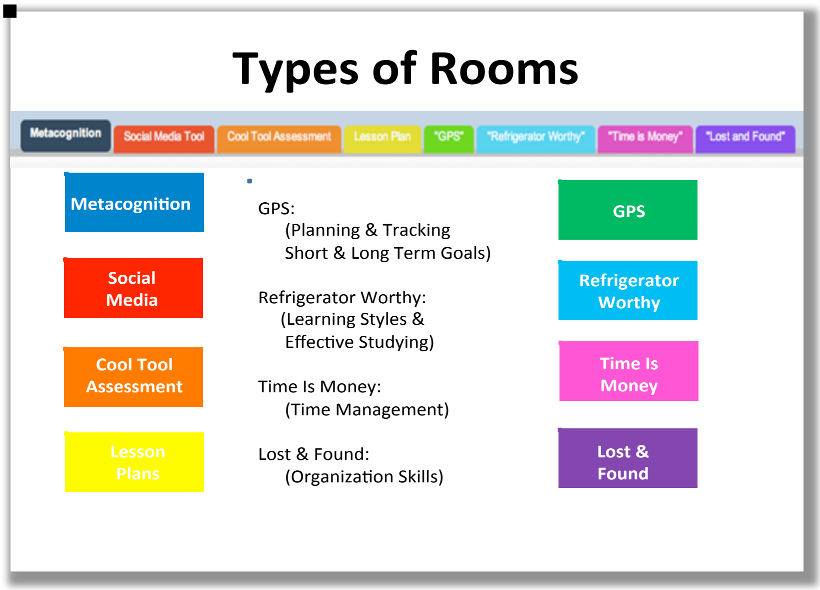

Figure 3. Time management sample rooms

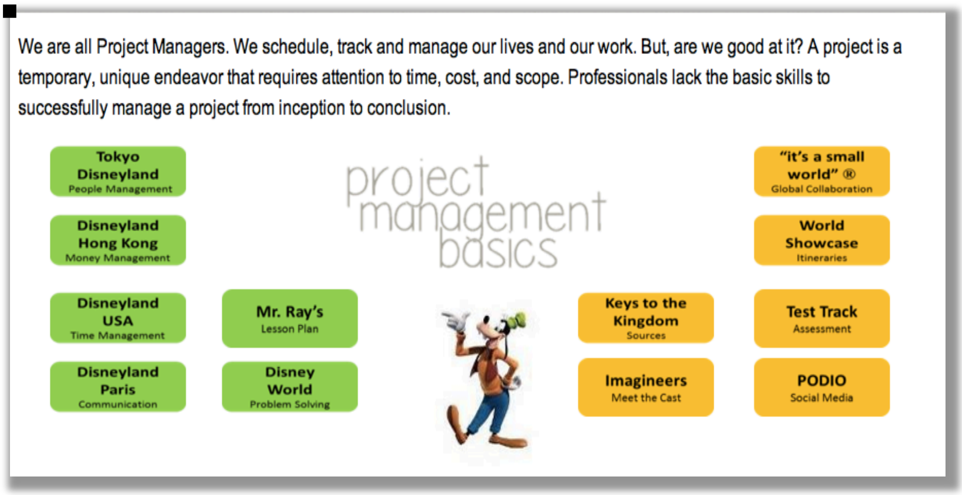

Figure 4. Project management sample rooms

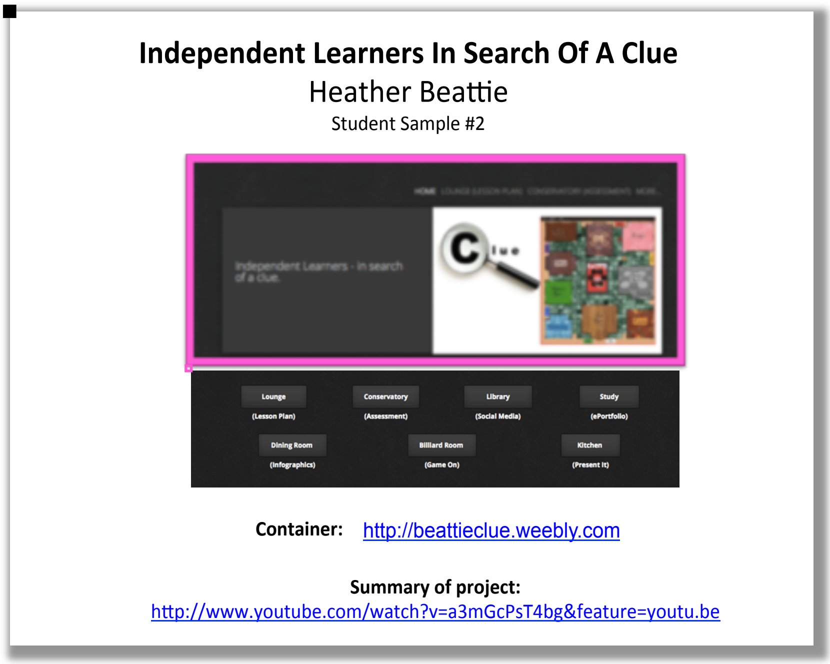

Figure 5. Switch to Independent Learners - Algebra

2.3 Tool Selections

As part of the Assignment, students selected a tool to serve as a container to house the rooms as well as free web2.0 tools for use in the instructional design to address the various challenges. The multitude of free assessment tools was an enlightening part of the project since the focus was to use formative assessments to help identify weak areas that could benefit from improvement. Sample tools they selected during the creation were as follows: scoopit, symbaloo, edmodo, quizlet, socrative, powtoon, emaze, pixton, edpuzzle, nearpod, pear deck, kahoot, quia, quill, zondle, quiz revolution, quiz bean, piktochart, creaza, twitter, wordpress, weebly, diigo, and pearltree.

3. RESULTS/LESSONS LEARNED

As part of the formative evaluation of the project creations, these observations and questions emerged:

- Many students ignored some of the directions such as word length, room components, creative titles, and thus lost points in the grading rubric. A question that may emerge is whether they curated the best or took short cuts to go for low hanging fruit—maybe a more in-depth rubric for tools selection could be used in the future.
- Too many previous examples may have been available, and possibly confusing them (picking a handful of strong examples might be a superior method).
- Check points – adding them with a ½ way freeze point in the semester may reduce procrastination.
- Teams – working together may have contributed to a fragmented vs fully integrated, consistent approach for some products that evidenced format issues across containers (dividing work assignments in piecemeal without seeing the entire picture may have been a detriment in the long run).
- Lack of clearly defined team roles and responsibilities, work plan… caused confusion, conflict/dysfunction.
- Future plans — require creation of a team project plan in writing with agreed on charter, roles, and milestones to track the progress.

4. SUMMARY AND CONCLUSIONS

This paper included the background and definition of learning curation; a description of the audience and environment where the graduate course was conducted; the course Assignment including the floor plan and rooms metaphor; web2.0 open sources, identification of digital tools that were selected for the container and instructional tools; screenshots of sample products; and results/lessons learned for future replication of the Assignment. Many of the suggested revisions will involve more structured planning and implementation to keep the students on track so they may avoid becoming so engaged with the Assignment that they do not pace themselves for final housing of their curated products into their selected tool container.

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HOW OLDER ADULTS USE VIRTUAL PERSONAL LEARNING NETWORKS TO SUPPORT INFORMAL, SELF-DIRECTED LIFELONG LEARNING GOALS: A RESEARCH PROGRAM DESCRIPTION

Dirk Morrison
University of Saskatchewan, Saskatoon, SK, Canada

ABSTRACT

This short paper will describe the details of a SSHRC/IDG-funded research program currently underway (2015-2016) that will investigate how older adults (65+) use Web 2.0 tools and Internet-based resources to establish and expand their virtual personal learning networks (PLNs) for the purposes of enriching their expertise and knowledge within the framework of their particular informal, self-directed learning goals.

KEYWORDS

Older adults; lifelong learning; virtual PLNs

1. INTRODUCTION

Global census data indicate a rapidly growing demographic trend: the percentage of older adults (age 60 and older) will rise in developed countries from 22% of the population in 2010 to 29% in 2030 (World Economic Forum, 2012). The Canadian context is parallel, with predictions indicating that 23.6% of the population will be over the age of 65 by 2030 compared to 15.3% in 2013 (CBC News, 2014; Kembhavi, 2012). Accompanying these demographic shifts are some sobering implications for society, including diminished quality of life for a large portion of the population and increased demands on human services. It follows that an important consideration for any society facing such challenges will be to identify and understand factors that favourably impact the mental and social well-being of older adults (Pike, 2011; Hare, 2014). While successful aging is multidimensional, the research is clear: maintenance of high cognitive function, sustained social engagement and the pursuit of meaningful activities are essential factors that contribute to our mental and social well-being as we age (Rowe & Kahn, 1997). Notably, *informal, self-directed lifelong learning* provides an effective conduit to achieve mental and social well-being; Merriam and Kee (2014) claim "learning in older adulthood not only reduces dependency on government-funded social services but actually enhances personal and community wellbeing" (p. 133). While sufficient evidence exists linking lifelong learning to increases in both social capital (Field, 2009), we have a very limited understanding about how older adults have transitioned to using Web 2.0 technologies to become more knowledgeable and socially engaged. This proposed research aims to explore how older adults use Web 2.0 tools to create and maintain personal learning networks (PLNs) to enhance their personal and community wellbeing.

2. DESCRIPTION OF RESEARCH

2.1 Research Context

2.1.1 Older Adults' Online: Informal Lifelong Learning

While it is true our concept of lifelong learning for older adults needs to incorporate all types of learning, Merriam and Bierema (2014) claim: "most adult learning is through non-formal and informal means" (in

Merriam & Kee, 2014, p. 138). Non-formal learning includes structured but non-credentialed educational events or programs sponsored by community, civic, and voluntary organizations (e.g., Diabetes Society offering screening and nutrition education). Informal learning is that which occurs in one's day-to-day living, and includes incidental learning but, importantly, also includes more *systematic self-directed learning* activities (e.g., a person designs his or her own learning project with concrete goals and outcomes) (Merriam & Kee, 2014). Older adults tend to meet a wide range of learning needs (e.g., health and wellness, leisure, personal interests, 21st century computer and media literacy, etc.) via informal and self-directed methods. Evidence shows that, contrary to stereotypical perceptions of this phase of life, the majority of older adults are healthier, more economically independent, increasingly "computer-savvy" and that they actively pursue lifelong learning opportunities to enhance their lives (Kembhavi, 2012; Sadler & Krefft, 2008; Seals, et al, 2008) or to "make meaning" of their lives (Fisher & Wolf, 2000, p. 483). Dench and Regan (2000) found that the most important reasons older adults gave for engaging in learning activities were *intellectual*: learners reported wanting to increase their knowledge, keep their brains active, enjoy the challenge of learning new things and learn about something they had always been interested in and for personal satisfaction (p. 1). An additional finding from the above research was that 80 percent reported a positive impact of learning on at least one of the following areas: their enjoyment of life, their self-confidence, how they felt about themselves, satisfaction with other areas of life and their ability to cope (p. 4). While such evidence is encouraging regarding the potential impact of lifelong learning activities on older adults' mental, physical and social well-being, there is a paucity of research regarding older adult learners' adoption and adaptation of Internet-based learning tools, techniques and resources that support informal, self-directed lifelong learning goals. Field (2000) warns us to not neglect such groups, risking exclusion, inequalities and erosion of human capital, and instead argues that we must embrace this widening participation in a learning society. This research proposes to investigate how older adults *expand* and *enrich* informal, self-directed lifelong learning goals via the creation, expansion and engagement of their personal learning networks (PLNs) using Web 2.0 tools.

2.1.2 Research Objectives

The specific objectives of this research, followed by associated questions, are as follows:
Objective 1: To investigate and describe older adults' personal learning networks (PLNs):
What Web 2.0 tools are included in the PLNs?
How do they create their PLNs?
Who they are connected to in their PLNs?
What resources are used and exchanged in their PLNs?
Objective 2: To investigate and describe older adults' informal, self-directed learning processes:
What are their motivations for learning?
How do they set learning goals?
How do they manage their learning (both content and process)?
How do they communicate with others in the process of learning?
What are the impacts of PLNs on their informal, self-directed learning?
What are the impacts of these informal self-directed learning efforts on their personal and community well-being?

2.1.3 Theoretical Approach

This research draws upon a variety of theoretical constructs, conceptual frameworks and application contexts. Given the older adult demographic of this study, the use of adult learning and transformation theory (Baumgartner, 2001; Knowles, Holton, & Swanson, 2011; Meizirow, 2012), especially as it relates to informal, self-directed learning (Brookfield, 1985; Candy, 1991; Merriam, 2001; Marskick & Watkins, 2002) will be informed by a complementary background of theory and research specific to ageing and gerontology (Fishback, 1988/1999) to add power to analyses and interpretation of the data. In addition, because this research will investigate the use of Web 2.0 information and communication technologies, it will rely on current theory and best practices gleaned from Internet-based learning (Hill, Wiley, Nelson & Han, 2003) and social media applications in education (Hung & Yuen, 2010) to organize, synthesize and evaluate the findings. Finally, drawing on social capital theory as a component of the conceptual framework of this study, "the proposition that networks of relationships are a resource that can facilitate access to other resources of value to individuals or groups for a specific purpose" (Balatti & Falk, p. 282) will ground examination of older adults learning together in online environments.

2.1.4 Methodology

The proposed program of research will utilize a mixed methods approach, with the collection and analysis of relevant qualitative and quantitative data from a representative sample of 384 Canadian older adult learners, 65 years and older, who use Web 2.0-based personal learning networks to support their informal, self-directed learning projects. These participants will be invited to complete an online survey.

To be included in the study, participants will: a) have had at least one online learning experience, b) have experience in using one or more Web 2.0 learning tools, such as PLNs, c) be willing to participate in the full research project, and d) be age 65 or older. Demographic data such as gender, time since retirement, marital status and level of educational attainment will also be gathered by the full online survey but will not influence selection for participation.

Phase 1 of this research will address Objective 1: To explore and describe older adults' personal learning networks (PLNs). The Principal Investigator (PI) and one qualified Master's-level graduate student will work directly with the University of Saskatchewan's Social Sciences Research Lab (SSRL) to design and construct an online survey, using the *Qualtrics* Online Survey Programming tool. Survey questions will be designed to address the questions outlined under Objective 1 listed above. The team will also consult with members of the Computers and Technology Lifelong Learning Program of the *Saskatchewan Council on Aging (SCOA)*, to solicit feedback regarding the survey instrument questions.

Following the distribution and completion of the national online survey, analyses will include quantitative data and qualitative data.

Phase 2 of the research will address Objective 2: To investigate and describe older adults' informal, self-directed learning processes. This phase of the research will include 10 in-depth, online focus groups, consisting of five participants each, designed to examine participants' qualitative descriptions of methods employed and tools used (e.g., Web 2.0) and perceptions of the relative value of these (e.g., PLNs) in support of their informal, self-directed learning goals.

2.1.5 Data Analysis and Interpretation

The rich variety of quantitative and qualitative data collected via the national survey and focus group interview transcripts across the two phases of research will be analyzed and interpreted with the goal of thoroughly and accurately describing older adults' use of PLNs to achieve their informal and self-directed lifelong learning goals. Data analyses will be supported by a variety of tools and processes available to the researcher and graduate students such as participant *interaction mapping* and social network analysis methods. Focus group interview data will be organized, managed, and coded using the qualitative analysis software *NVivo*™ enabling a detailed, rich content analysis, and the discovery of complex relationships among and between these rich data sets.

3. CONCLUSION

This research explores older adults' use of Web 2.0-enabled *personal learning networks* (PLNs) for the purposes of *informal, self-directed learning* and data from this new research will enable a rich analysis, both of the longer-term impact of PLNs on older adults, and of the relationship between individual use of PLNs and their general wellbeing. Non-profit and government-sponsored organizations whose mandate it is to serve the social and lifelong learning needs of older adults (e.g., The Saskatchewan Council on Aging, Saskatoon, SK; Saskatchewan Senior Centre, Regina, SK etc.) could use such findings to better inform their programming initiatives.

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SIGNIFICANT CHANGES IN THE ENVIRONMENT AND IN TEACHING METHODOLOGY OF AN E-LEARNING DISCIPLINE TO AVOID DROPOUTS IN A COURSE AT THE FEDERAL INSTITUTE

Gustavo Prado Oliveira[1], Päivi Aarreniemi-Jokipelto[2] and Ricardo Soares Boaventura[1]
[1]*Federal Institute of Triangulo Mineiro - IFTM*
[2]*Haaga-Helia University of Applied Sciences – Haaga-Helia , School of Vocational Teacher Education*

ABSTRACT

The research is conducted in a public institute of education and technology to boost graduation especially with the help of an e-learning environment adopted. The Directory of E-learning Education from Federal Institute of Triangulo Mineiro coordinates all administrative and pedagogical aspects of 4000 students registered in 11 e-learning courses, including federal government programs like e-Tec and Open University from Brazil (UAB – Universidade Aberta do Brasil). Although, e-learning has helped to solve students' mobility problems, there are remarkable problems in dropout rates of the virtual courses. The solution of the study aims to attenuate the dropout rates by adopting different learning methodologies, re-designing the learning environment and utilizing tools to support this new methodology. According to the hypothesis, the novel learning environment adopting a learner-centred approach, will give a voice for the students and give them an active role in their own learning process. Therefore, students' needs, abilities, interests and learning styles are used to determine classroom activities, and consequently it will help to reduce the dropout rates.

KEYWORDS

Student-Center Learning, Project-Based Learning, e-learning, team work, web tools.

1. INTRODUCTION

The problem of dropout rates in vocational and higher education levels has been a challenge for several educational institutions, teacher and students worldwide, and nowadays also at e-learning courses. The "digital natives" term is used to describe students of the 21st century, includes also a claim for new kinds of skills such as digital literacies. To help them, learning methodologies need to be changed too. There are studies reported in the literature where teacher make their approach more learner-centered by giving students more responsibility for their own learning. It gives voice for the students and, therefore, their needs, abilities, interests and learning styles determine classroom activities, and consequently it will help to reduce dropout rates.

In learner-centered learning, students generally work in teams, defining their own roles and goals. Working with individual or group projects aiming to solve problems or, particular questions, make students more motivated, because they work with problems they have chosen. They learn with each other by looking for the best solutions for these problems. This type of learning is commonly called Project-Based learning.

This paper presents the research about how to adopt these methodologies described above using tools to support it, applying in the e-learning environment (starting with a discipline that will serve as an example) at the Federal Institute of Triangulo Mineiro - IFTM.

In an attempt to illustrate how the study will be utilized in this discipline, this paper is organized as follows. The literature review in the section 2 describes the factors that influence dropouts in e-learning courses and illustrates student-centered learning and project-based learning. Section 3 contextualizes the e-learning environment of IFTM and the statistical data about Brazilian scenario of dropout from e-learning courses. Section 4 describes the key changes to be applied at this discipline. Section 5 will discuss about the future works and the conclusion will finish this paper at Section 6.

2. LITERATURE REVIEW

Starting this section, it is necessary to evaluate the factors that influence dropouts in Brazilian e-learning and to explore the skills necessary for the 21st century students. After these it will be possible to describe the approach that can deal with these challenges.

2.1 Factors that Influence Dropout in Brazilian e-Learning

Students' dropouts is a complex phenomenon and it is common phenomenon in learning institutions around the world. It is a huge concern among directors, rector, researchers, parents and students. According to Silva Filho et.al. (2007) the dropout between undergraduate students is an international problem that achieve the learning system, and because this, it become study object around the world, including in 1st world countries.

There is a bigger concern about dropouts in e-learning, mainly because it is quite difficult for the students to deal with a possibility to study in a domestic, social or professional environment, and at same time let students to choose when they want to study. It occurs because there are concurrent stimulus (children, wife, television noise and neighborhood among others) at e-learning, and it depends more directly on students' skills such as, organizational skills and concentration for studies. (Statistical annual report AbraEAD - 2007)

According to AbraEAD (2007) and Lopes et al., the biggest reasons for dropouts in e-learning courses are related to time and financial conditions. Rossi (2008) shows in their researches that the dropout reason form the undergraduate students in courses at Open University of Brazil was time available and the disposal at the end of work day to conciliate the studies.

According to Abbad et. Al. (2010) the factors linked to design of e-learning and blended learning may include following problems: the lack of compliance of personal expectations; the lack of information about the importance of the course; the low frequency of the use of web tools; dissatisfaction with the tutor performance; absenteeism tutors; the lack of assistance from tutor to student; the delay in sending feedback or supply a few information to students; physical separation between teacher and students; the duration and difficulty of the course; the mode of delivery of the course (difficulty accessing the website); the amount of written work required; the level of the course; the lack of face to face activity; the lack of support from the student teaching unit; the poor quality of teaching materials and the lack of interaction with colleagues.

The fact is that more problems are related to the design of e-learning than in other characteristics presented above. Because of that, we intent to highlight some improvements to adopt e-learning courses at IFTM.

2.2 Methodology Approaches: Student-Centered and Project-Based Learning

According to Anderson (2010), adopting a student-centered learning in a classroom places a learner in a central position. The more learner-centered approach is applied by giving students more responsibility for their own learning. It gives a voice for students and, therefore, their needs, abilities, interests and learning styles determine classroom activities. Consequently it will help to reduce the dropout rates, because students are self-motivated.

In student centered learning, students choose projects with which they like to work. Possibly, they define their learning goals, work actively to achieve these goals, and consequently they assess their learning. In learner-centered approach, students often work together in small groups, and they decide by themselves each member's role in groups.

When students are working actively and they have freedom to choose the subjects, they usually work with projects that focus in solving personal or interesting problems. The motivation is based on their background and experience. The problem solving of a particular subject or discipline is not limited and it may be related to other subjects and resulted in additional skills too.

When project works are used as learning activities to seek for solutions to real-life problems, it's commonly called project-based learning. According to Anderson (2010), information communication technology (ICT) rises an increasing interest in PBL, particularly the research opportunity provided by the internet and the array of multimedia tools for assembling and presenting the result of projects.

The characteristics exposed before are convergent with the identified needs about factors that influence e-learning dropout in Brazil

3. IFTM E-LEARNING ENVIRONMENT AND HIGHLIGHTS

The highlights to improve virtual learning environment of IFTM comes up with effective ways in facilitating desirable ICT skills that will be applicable to the students' education. There are four major objectives: (1) improve quality of assessments, (2) enable students to work in teams, (3) improve feedback about learning materials and (4) facilitate feedback for the students. These objectives were found and coincide with the emerging concept of Web 2.0 an so on. Within e-Learning development, the technologies that are being employed in various platforms are also changing. Many agree that a major characteristic of Web 2.0 is the enhanced social connection function of various web applications (Alexander, 2006; Anderson, 2007; O"Reilly, 2007). It is a more dynamic way of both accessing web based contents and connecting web users against the traditionally static and one way information web pages. Many also argue that Web 2.0 applications provides simple to use and easy to maneuver social and networking tools. Therefore, it is more appropriate for creating community-driven and collaborative user experiences (Guzdial, Ludovice, Realff, Morley & Carroll, 2002; Chen, Cannon, Gabrio, Leifer, Toye & Bailey, 2005; Hampel, Selke & Vitt, 2005; Alexanda, 2006; Byron, 2006; Duffy & Bruns, 2006; Levi & Stone 2006; Chao, 2007; Parker & Chao, 2007).

In professor Wilton de Paula Filho's interview, he said that the main reasons to start modifications at IFTM learning environment was: (1) No pattern of virtual rooms in the subjects of the same course, (2) Feature incompatibility. E.g. A teacher offers chat and others not (3) Huge extension of sequential layouts (very large scroll bar) , (4) Constant complaint of students (due to the above mentioned points). The online tool to create the layout for virtual classrooms is free and it is available in www.personalizesuasalavirtual.com . Wilton is an e-learning teacher the developer of the e-learning tool at IFM.

The standardization realized at the e-learning environment was very helpful, but there are other suggestions to improve quality of e-learning courses.

The main existing problem is assessments and as an aim to solve it we decide to apply a formative assessment. Formative assessment is performed during the whole learning process, the opposite summative assessment shows the results at the end. There are several tools to be utilized in formative assessment. According to Vicki Davis, Socrative, Kahoot, Zaption, Backchannel Chat Tools and Plickers are favorite tools for formative assessment.

The main idea is collaborative working with PBL, asking students to bring problems from their real life and community and it will motivate them. Another intention is to apply a SCRUM approach that is a project development approach. According to Rico and Sayani, the use of contemporary software development approaches such as agile methods is growing in widespread use throughout the world. Teams who struck an optimum balance of customer collaboration, use of agile methods, and technical ability, had better productivity.

Feedback for students is usually given when they have finished activities, but we are planning to have a different approach. When the students have finished their mini lectures and watched the video tutorial about the subject, they will make the assessment. Of the psychological-sociological measurement methods that depend on human judgments, rating scale procedures exceed them all for popularity and use. Smith (2013). The purpose is that students can give feedback on all material that they used before and, ranking it to help the teacher to improve the material quality. In their conclusion, Smith (2013) currently suggests that the "best" scale for human voters should have 10 levels and consist entirely of nonnegative numbers ordered increasing from left to right.

In other way, when the students are assessed using Kahoot or other formative tool, the ranking will serve to help the teacher give different feedback for the students. Those students whose assessment has low quality, will receive tips to be sent via Whatsapp.

4. CONCLUSION AND FUTURE WORK

Analyzing the context explained above it is easy to determine that the e-learning environmental alone will not offer the characteristics to motivate the students continuing their course to the end.

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The old-school model of passively learning facts and reciting them out of context is no longer sufficient to prepare students to survive in today's world. Solving highly complex problems requires that students to have both fundamental skills (reading, writing, and math) and 21st century skills (teamwork, problem solving, research gathering, time management, information synthesizing, utilizing high tech tools). With this combination of skills, students become directors and managers of their learning process, guided and mentored by a skilled teacher.

This short paper aims to explain how with some highlights on e-learning environment, we can improve the quality and to avoid dropout among undergraduate students.

The next step is to apply the methodology and tools cited before in an undergraduate e-learning course and compare the result with the same discipline last semester.

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E-FUNDI AS A VIABLE WAY TO DO E-MENTORING

George A Lotter
North-West University, Potchefstroom, South Africa

ABSTRACT

This paper describes E-fundi as a learning management system developed for the now more than 65 000 students of by the North-West University in South Africa. In this paper, it will be proposed that e-mentoring as a recent development of traditional mentoring, may be pursued by way of E-fundi to the enrichment and growth of students wherever they are. The advantages and disadvantages of e-mentoring will also be discussed.
The paper will end by recommending ways the use of E-fundi for e-mentoring purposes may be implemented.

KEYWORDS

E-Fundi, E-mentoring, Mentoring, Learning Management Systems

1. INTRODUCTION

This paper argues for the use of a home-grown African developed learning management system called E-fundi to be used as an effective way to do e-mentoring. Applying E-fundi may be to the academic and personal advancement of the more that 65 000 students of the North-West University, 2th largest university in South Africa and where the majority of these students are off-campus. A short history and description of E-fundi will be undertaken, followed by a thorough discussion of e-mentoring and how that may be implemented towards students of the North-West University and other universities in Africa and globally. Reference will be made to similar recent research on e-mentoring which may be available as a further dynamic development of the age-old practice of mentoring. Advantages and disadvantages of e-mentoring will also be discussed.

Finally recommendations how this may be introduced in other learning management systems starting from the available and existing E-fundi developed program and infrastructure.

The contribution of this paper may lie in showing the possibilities of the extension and maximization of existing learning management systems to the holistic development of students in a university context, complementing the educational use thereof.

2. BODY OF PAPER

2.1 Background and Naming of E-Fundi

Most universities have their own learning management systems which are named differently and may be developed locally or in co-operation with other institutions and/or organizations, often in a globalized context. The focus of this paper will be on the program being called E-fundi which is used by the North-West University in South Africa, where the author has been involved for nearly thirty years and the last few years have been exposed to the use of E-fundi. This involvement made one realize the possibilities of the system and how it may be applied even further and that something like implementing e-mentoring has been under-utilized totally. No specific research had as yet been done to show the *possibilities of using E-fundi* for the purposes of mentoring, but many faculty members use E-fundi as an indirect (and direct) way to mentor students with which they are in contact via E-fundi. The way it operates is where the lecturer pastes some information on E-fundi, immediately creates the opportunity to do mentoring via this communication system where students are compelled to check into in a regular basis. Mentoring can then be done (in groups or with individual students), and the lecturer can decide which way the mentoring should go, while the students have access to it all along. Privacy with regard to mentoring of individual students is of course a matter of concern and caution should be taken about it.

The development of E-fundi as the local learning management systems of the North-West University started in 2004 as per the following announcement (NWU, 2004 http://www.nwu.ac.za/content/new-online-learning-and-collaboration-tool-nwu):

> Education at the North-West University (NWU) will soon receive a new lease of life with the introduction of an online collaboration and learning tool, called e-Fundi. The tool, powered by Sakai (an online collaborative and learning project), is aimed at supporting teaching, collaboration, learning and research in higher education cycles.
>
> Joseph Hardin, director of Collaborative Technologies Laboratory at the University of Michigan and Board Chairperson of the Sakai foundation, was recently invited to the NWU to present a workshop on best ways to implement the tool.
>
> However, according to NWU project coordinator, Boeta Pretorius, the process of putting the tool in place is already underway at the university. "We intend to start with the implementation early next year, if all goes according to plan," he said.

The name E-fundi is derived from the addition of the e- (for electronic) and the South African word *fundi* which means **expert, authority, specialist, professional, master, pro** (informal), **ace** (informal), **genius, guru, pundit** or **buff** (informal) (http://www.collinsdictionary.com/dictionary/english-thesaurus/fundi).

2.2 Mentoring

In introducing e-mentoring it is imperative to first explain what may be called **traditional mentoring** where mentoring actually started with. This has been done by people throughout the ages and the concept may have originated in Greek mythology some 3500 years back when Odysseus, the king of Ithaca asked Mentor, his friend, to take care of and teach his son, Telemachus when he went off fighting the Trojan war (Lotter, 2007:1).

Traditional mentoring always had the following components: someone who is the "senior, older partner" taking the lead and training or guiding the younger, less experienced person who follows the mentor's lead. The mentor is the more experienced person and the one being mentored, is called the "mentee". As Tucker (2007:iii, vi) aptly states:

"Mentoring is a supportive, learning relationship between an individual-the mentor-who shares his or her knowledge, experience and insights with another less experienced person-the learning associate-who is willing and ready to benefit from his exchange".

According to Lotter (2010:6) some different forms of mentoring can be used in circumstances: whatever the *situation* requires be it *informal*, *formal* or in *other spheres* of life, like in a family context. Mentoring may be *voluntary* or it may be within a *very rigid*, tough structured business environment where it is enforced by "from above".

2.3 E-Mentoring

As with many developments in the "digital age", e-mentoring also grew from traditional mentoring and has a life of its own, separate from the origin of traditional mentoring.

Law, Ireland & Hussain (2007:16) explained:

"Another area where the Internet has developed our thinking is in matching pairs of people for collaboration….One of the biggest challenges is in matching learners at a distance and across cultures. The interpersonal relationship between mentees and mentors in which a safe place exists for the mentee to grow is important." When writing about *E-Mentoring as virtual replacement of traditional mentoring,* Lotter 2008:8 also states: E-mentoring started to gain popularity in the nineties when teachers realized that e-mails may be an easier and better way to connect with students around *inter alia* curricular projects, research and preparing students for business.

According to Williams & Kim (2011:80) e-mentoring may either be a relationship, a method or perhaps a process and/or an organizational approached which may be practiced in relationships.
A preliminary definition of Lotter (2008:7) on e-mentoring reads as follows: *E-mentoring is some kind of a relationship that exists between a mentor and someone who is less skilled or experienced, called a mentee, where* ***electronic communications*** *are used, and this interaction is focused on developing the mentee*
(see also the more comprehensive definition of Single and Muller, 2001).

If one only checked the amount of postings using the word e-mentoring on the internet, one realizes how vast this "new" field is and constantly growing as the technology advances.

Where e-mentoring has been used at certain schools as a helpful tool, excellent results followed as is reported in the following quote where Heynes already back in 2007 describes e-mentoring as follows:

> E-Mentoring is a viable and useful additional tool to add to the armoury of all schools who seek to raise achievement. There are significant academic and social benefits of involving older students, PGCE students and staff in e-Mentoring. The costs of e-Mentoring are not prohibitive and the technology is robust and user friendly.

As with many developments in the "techno" – world, all new inventions are not necessary a blessing (*cf* the paper by Lotter [2006] titled *Dehumanization by cyberfication*), and one realizes that with e-mentoring there are advantages and disadvantages as will be discussed below.

2.4 Advantages and Disadvantages of E-Mentoring

The following advantages and disadvantages may be applicable in the use of e-mentoring:

Table 1

Advantages	Disadvantages
• Mentor and mentee may be connected most of the time • Accessibility • Immediacy • Useful tool without taking too much time • Everywhere available, even globally • Availability since via cell phone one can be reached anywhere • Different forms of communication: e-mail, text messages (SMS) or MXit (South African), WhatsApp and skype • Psychological and other support a click away	• One-sided withdrawal by one of the parties (especially the mentor) may let the other feel rejected • Not personal • No connection possible without some kind of electronic apparatus • Co-dependency can develop, where both parties are in permanent contact with each other and cannot cope without this contact • Boundaries may be crossed • Invasion of privacy on both sides is a real danger

3. RECOMMENDATIONS

Definite boundaries and mutual agreement should be set by the mentor and the mentee in the e-mentoring process keeping the following in mind. Recommendations regarding these issues may be the following:

- It should be determined that the learning management system is geared towards the dealing of e-mentoring traffic
- To be successful it will be an advantage if the institution supports the system of e-mentoring
- There should be a mutual agreement about the contents of the e-mentoring being followed
- Boundaries should be set by both parties
- An imperative of respect for privacy and hours should be maintained
- The possibility of a personal meeting (if viable) should always be open to get feed-back on the success of this specific way of mentoring
- Any problems or outstanding issues which may exist, should be ironed out directly and immediately
- It is crucial to agree on the duration of e-mentoring regarding the years, project, equipping and other relevant matters
- There should be the freedom to move out of an e-mentoring situation and relationship at any time one of the parties would choose to do so

4. CONCLUSION

In this paper it was shown how E-fundi as a locally developed learning management system (in co-operation with Sakai) was created and now serves more than 65 000 students of the North-West University in South Africa. It was explained where traditional mentoring came from and how e-mentoring developed within the parameters of the digital enhancement. This rapid development also opens the possibility to use E-fundi for the enrichment and growth of students within a mentoring program anywhere they may be reached in the cyber world. The advantages and disadvantages of e-mentoring had also been discussed.

The paper ends by recommending ways the use of E-fundi for e-mentoring purposes may be implemented.

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HEALTH CARE: ROLE OF ICT IN AUTISM

Hafiza Maimoona Shahid, Sohaib Tariq, Imran Saleem, Muhammad Adil Butt,
Arslan Tariq and Iqra Tariq
Department of Computer Science and Information Technology, The University of Lahore, Gujrat Campus, Pakistan

ABSTRACT

Recently, Considerable advancement has been seen for educating the people with autism. Research has shown that people with autism reveals positive behavior while interacting with innovative information technologies as compared to therapies [5]. This review focuses on the possible use of ICT in the education and development of the people with autism and reducing their difficulties in communication [18]. A variety of different ICT applications for the treatment of autism including the use of interactive virtual environments, devices, computers, serious games and avatars will be discussed in this paper. ICT is a rapidly developing area of research to be used as a therapy for autism. Despite the fact that ICT has exciting positive results, most of the ICT proposals or implementations have limited use, performance and capabilities in actual conditions [6, 18]. Interactive devices, including robotics are being developed and used for the education and development of the people with autism. These devices teach and practice a skill, promote behaviors and provide feedback in specific environments. Development of interactive devices including robots having humanlike abilities and joint attention are the issues that are to be focused in the future research for assisting the people with autism [14].

KEYWORDS

Technology, Autism Therapy, Joint Attention, Learning Disabilities.

1. INTRODUCTION

It has been proved that in the development of a child, social-emotional interactions play an important part [5, 18]. Communication is the key to develop the ability to identify, translate and create behaviors as well as it is the basis of social cognition. In social cognition, a child interprets verbal and non-verbal communication nodes like speech, gestures, facial expressions etc. [10]. It also helps a child to produce such nodes as social and emotional movements, expressions and gestures as well as synchronizing their behaviors with others and the ability of giving everyone a credit according to their state of mind [2].

There are two areas where disorders related to Autism are defined: (1) Permanent problem in social interaction and (2) Repetitive behavior, activities or interests [9, 10]. The main problem in autism is the difficulty in communication and interaction with others due to the lack of understanding or interpreting the expressions, gestures or movements [3]. Especially in children with autism it is observed that they prefer to play alone with their repetitive activities instead of playing with others. So it is big problem for them to keep interacting with human and the environment [6, 9]. Although it is a type of disorder in which positive development is poor but still considerable advancement has been observed in the development of such people with the help of various approaches [18].

2. ICT Applications

2.1 Use of Computers

The focus of ICT applications is to develop an interactive relationship between one user and one computer as well as to improve behavioral disorders related to autism. As computers provide predictability and consistency, so they are helping to motivate the children with autism as compared to humans. Computer is reliable for not sending social messages which create confusion [5]. From the research on students with autism, we concluded the increase in the following: (a) Focused and overall attention (b) Fine and generalized skills and behaviors and decrease in the following (a) self-stimulatory behaviors (b) nervousness [3].

Assistive technology for autism can be used for improvement in daily activities. Hetzroni and Tannos conducted a research on five children and developed a program based on daily activities keeping the communication in main focus. This program showed improvement in learning as well as communicating that lesson in the classroom. ARC (Autism Research Centre) launched an educational emotion software, named Transporters. The Transporter is being used commercially for autism. It is a vehicle based on eight characters which attracts the children while moving due to its mechanical nature. Transporter containing faces of actors with emotions was developed to evaluate the ease in learning as compared to real world. Transporters resulted that this DVD is an effective way to teach the children to recognize emotion and can be generalized to new situations with new faces on the vehicles. Other who were not taught by Transporter resulted in less improvement [18].

2.2 Virtual Environments

Over the last decade, many software related to virtual environments have been produced for autism. VEs have the predictable interaction which minimizes the anxiety. The safe and close to nature scenarios of VEs as well as the animation and voice helps the children to take interest which minimizes the learning disabilities in a better way [11].

In past experiments, Autistic children have proved the successful learning of skills with the help of VE and also enjoyed the technology. Children, especially, are more interested in VE as virtual peers are animated characters with language enabled, computer generated, responding and life-long instead of other toys. Story telling scenario is the most researched area of this technology which gives company to a child [15]. In contribution to this research, a virtual café in which participants have to order a drink, sit and pay was programmed. This was a reality program to understand the social behaviors and examined on the children of teen-age. Different activities were taught and practiced including finding seat in both empty and crowded café and communicating with others in the cafe. It was concluded that more complex programs may provide children with more realistic interaction with social knowledge [17].

Another program in hic a virtual supermarket was created to make children think and play with touching the screen and interacting with objects. This increased the imagination and symbolic thinking of children and the outcome was more positive in sense of understanding and interacting. The multidimensional interaction with touch screen improved the participation of both learners and instructors with natural interaction between computer and child, instructor and child and computer and instructor as well [15].

A multi-user, multi-touch display, Diamond Touch Technology, can be used to engage the children in imaginative scenario where all the actions have real consequences in VE. This technology was further used for the improvement in positive social behaviors including eye contact in terms of both quality and quantity. This concluded that touch screens can be used to promote creativity and in future this can bring great advancements in learning of autistic children [17]. Although it is a reality that VE does not provide real touch of texture and feelings, sensing but still it is a promising improvement for development of disorders as this trains and motivates the child for the real-time interactions [15].

2.3 Interactive Environments

Recent researches have bring advances in this field of collaborative interactive environments through the control and monitoring of the behavior of the autistic child. This brings the skill of collaboration as well as a safe and enjoyable experience for the children because of no judgment issues in such interactions [18]. This is a notable thing and also proved that use of computers provide attractive environment for the purpose of education to an autistic child whereas real-time communication can lead them to problems. During the process of educating, different states of the behaviors of the child are measured with time in case of accomplishment of any goal and can lead to the factors involved in the progress of the child [2].

It becomes more complex and difficult task to educate a child with ASD in real-world interactive environments when the trainer has to think rapidly [1]. Many environments have been developed using pictures and sketches to entertain the child so far with the help of education platforms. Pictures and sketches are used to make the child distinguish the size, shape and color of the things as well as with the help of sound and voices. This type of environment also minimizes the monitoring of teacher due to their verbal and visual guidance [15].

2.4 Special Input Devices

Recent developments of ICT allow more attractive form of input after the research that people with ASD enjoy interacting with computers. That is why now most of the technologies use touch screen instead of mouse or joystick for input or feedback. In recent research, a multi-user touch was introduced that allows two or four user and detect their touch with the help of an antenna activated by all users one by one [17]. 3D environments, remote controlled environment and interfaces with big colored buttons increase the process of development in autistic people. With all such technologies, external devices are used to monitor and evaluate the internal and external state of the user. These external devices can be a wearable measurement device, a camera or a data glove. Video projectors are also an example of attractive virtual worlds that are being used by scientists for the educational purpose to be depicted on a wall [12, 13].

In history, TEACCH was the first program for educating the autistic children which have the principles like behavior changing and development of skill according to the personal need of the person. By recording the education process, these recordings can be further used to educate the other cases of ASD as well even by modifying the process according to the special needs of an individual. Apple, ipads, ipods and similar devices have been used to educate the individuals with ASD [18].

Studies were made on the following domains: (1) employment (2) academic and (3) leisure aimed to (a) deliver instructions and (b) teach to operate the devices. Half of the studies gave positive feedback as well as increase in their level of understanding and recognizing the objects. These studied proved that video modeling on ipads can be an effective technique to teach the students with ASD [16]. Personal Computers, mobile phones and MP3 Players are evaluated for the purpose of communication meditation of ASD. Research related to ipads for communication purpose and their comparison with communication system using picture cards was done by different authors. Similarly, the story telling video clips were used to increase the behavioral skills in the ASD individuals [17].

2.5 Serious Games

Serious games play an important role for the development of ASD as the instructor. Additionally, serious games playing improves the social skills and decision making of the participants [8]. Autistic people are found spending most of their time in games or cartoons and according to their parents, they are aware of cartoons more than people [15]. A game, named Jestimule was developed with heterogeneity to facilitate the children with ASD. Moreover, ICT was also used in a game to teach all kind of students the ability to recognize the emotions and all kind of situations effectively. With the help of this game, the participants improved their ability of facial and emotion recognition in different situations. Such kinds of results helped to improve these technologies for the use in future to train the autistic children [18, 12].

2.6 Telerehabiliation

The method of using telecommunication, operation and computing technologies for the purpose of educating, training or development of the autistic children by serving clinics, clients or systems for assisting them. Comparing the telerehabiliation with traditional approach resulted that telerehabiliation provides more effective ways in creating the supportive environment. In recent years, the biggest advancement have been seen in the field of telecommunication which is a backbone for the telerehabiliation [10].

In a comprehensive review report on the telerehabiliation and its models defined many health services that can be provided across distance which was named as telehealth. Three subcategories of telehealth are: (1) Telehealthcare (2) Telemedicine and (3) e-health/education [17]. The main focus was on the improved telerehabiliation with minimal cost, time and fastest access to the experts. Through this, various technologies involving geographic and economic problems were used for cost-effective health providence in home. This research also showed that telerehabiliation at home is as effective as the service providence in hospitals. These services can include cognitive rehabilitation with the help of internet or movement therapy with the help of using a computer/sensors for guiding through exercises [5, 6].

Most of the interesting or beneficial part of telerehabiliation is seen for the autistic people. Research is being done on this technology to provide assistance for the ASD at home by interacting with the therapists. Some barriers are being faced including the lack of specialists with long list of awaiting persons as well as the distance barrier [6]. Research is continue on telecommunication to provide health assistance to families at home by removing the distance barriers [1, 5].

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By study, we have examined the telemedicine technology used to provide parental guide and teaching modality to support their children in social, communicative or play development. Guide was provided through a video conferencing program or coaching the parents through internet with the ability to see, hear and communicate as well with the specialists [5].

3. CONCLUSION

ICT research has explored many ways for the education, development and treatment of autistic people including the followings:

(1) Assistive technologies and their impact on daily life in cognitive impairment (2) improvement of social cognition through cognitive rehabilitation/meditation and (3) Cognitive computing to help in acquiring social and academic skills [1, 19]. Much of the things are still needed to be explored to have success from the perspective of practical treatment. Most of the ICT applications are limited in performance because of their unnatural interaction and use. Recent research reveals that use of computers, Avatars, serious games, telecommunication interactive and virtual environments generate a high degree impact of motivation and teach a person with ASD or learning disabilities specifically a person who is not willing to be social [6, 7].

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INVESTIGATION INTO UNDERGRADUATE INTERNATIONAL STUDENTS' USE OF DIGITAL TECHNOLOGY AND THEIR APPLICATION IN FORMAL AND INFORMAL SETTINGS

Rebecca Strachan and Sanaa Aljabali
Northumbria University, Newcastle upon Tyne

ABSTRACT

Digital technologies are being increasingly used in wider society including in educational settings. There are many examples that illustrate how universities embed technology enhanced learning within their educational provision. However there has been less research and evaluation of how these and other readily available technology based resources are being used in practice by students. This study aims to provide an in depth understanding of how a specific subset of higher education students, international STEM undergraduates in a large UK university are using digital technologies to support their studies. The results of a survey with a small group of students are reported. Initial findings show that students use technology in both formal and informal settings drawing on university resources but also other widely available resources. They are also routinely using more than one device to support their studies. Although they often use technology to support collaborative learning, more formal systems such as university provided discussion forums are not widely used. The results suggest that higher education should evaluate its use of digital technology and digital learning environments to determine if they are fully supporting their learners' needs and are effective. Furthermore higher education should consider how students are already using other widely available digital technology resources to support their learning and what they can learn from this to inform their own programme design and delivery.

KEYWORDS

Formal & informal learning, technology enhanced learning, eLearning, international student, higher education.

1. INTRODUCTION

Today digital technologies often play a key role in facilitating and supporting students' learning. Digital technologies encompass the range of electronic tools, systems, devices and resources that generate, store or process data and information including social media, online games and applications, multimedia, productivity applications, cloud computing, interoperable systems and mobile devices (DET, 2014). 'Technology enhanced learning' or 'eLearning' are terms often used to refer to a type of learning that is facilitated and supported by digital technologies. The use of digital technologies can not only enhance traditional ways of teaching but also can expose learners to new and different ways of learning. They can facilitate a shared learning environment by enabling learners to collaborate in establishing communities of learners that go beyond the classroom; support the formation of learning environments and resources that cater for different learning styles and approaches; and, ultimately provide students with different learning experiences. They can also provide an opportunity to better understand students and the way they learn.

In recent years UK universities have set out to attract significant numbers of international students. In 2012-2013, around one in eight of all students enrolled in higher education in the UK were from outside the EU (UKUniversities, 2014). They now make up a significant number of postgraduate student numbers: one in four with a total of 91,485 students in 2012-2013 (UKUniversities, 2014). There are also significant numbers at undergraduate level, 69, 640 in 2012-2013 (UKUniversities, 2014) but there has been less focus on how to support this group of students. Anecdotally it has been observed that these students often use and share digital resources such as youtube, facebook and other social media to support their studies. They are also sometimes unaccustomed to the UK's higher education approaches to learning and teaching and can find them strange and potentially challenging to engage with. This study sets out to provide a more in depth understanding of how these students currently use digital technologies to support their learning and what can be learnt from this in order to better support these students in their studies. It focuses on a set of international undergraduate students at a large UK university studying a range of STEM (science, technology, engineering and mathematics) disciplines. This paper reports on the initial findings from this study.

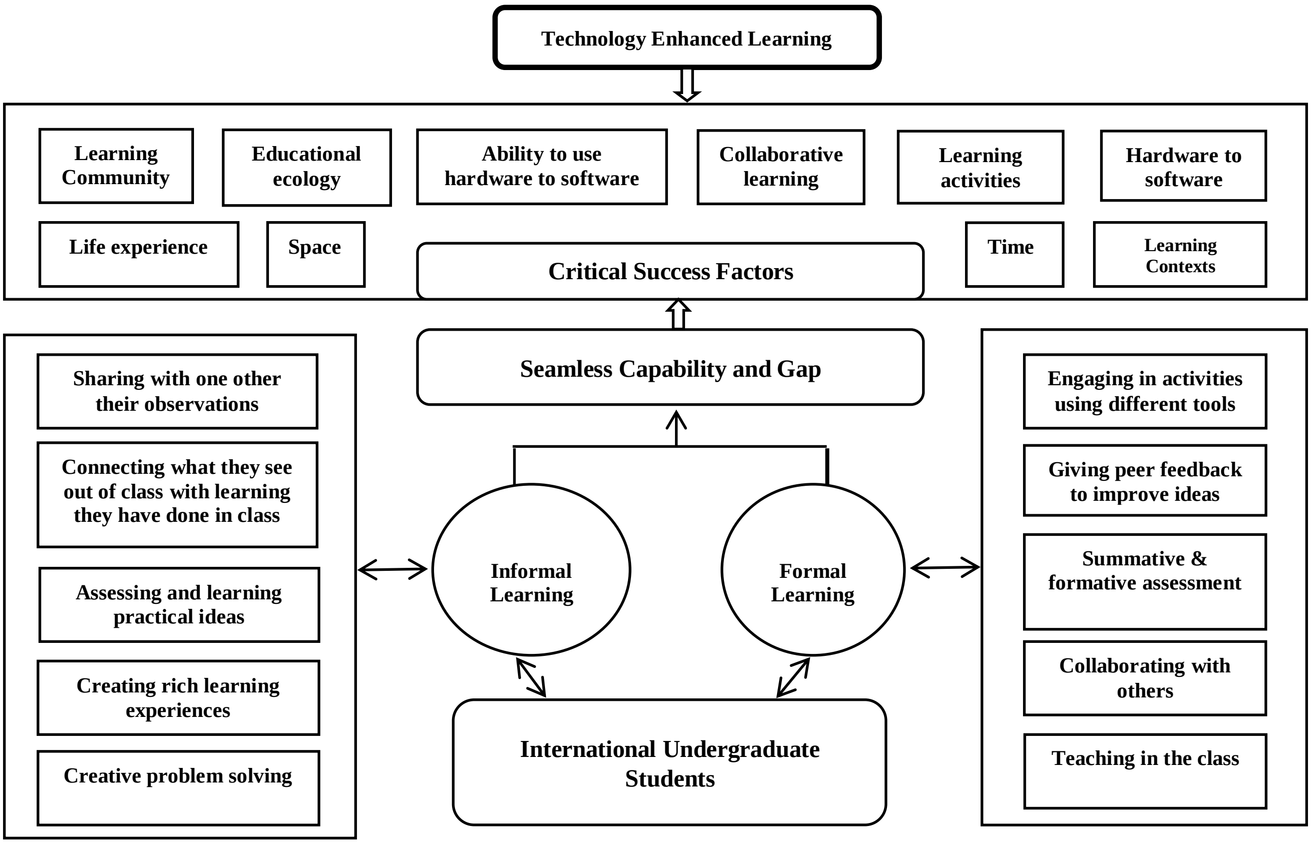

Figure 1. Framework on Digital Technologies and Informal and Formal Learning

2. RESEARCH STUDY

2.1 Research Approach and Framework

The study investigates how students learn in both formal and informal settings. Formal learning sometimes also called university learning refers to learning that takes place in formal settings such as university or tertiary institutions and is highly structured in its curriculum learning activities and assessment and usually leads to a qualification (Lai et al., 2013). It is more difficult to define informal learning, which some regard as all learning outside the classroom, while others regard it as "*a self-directed, intentional interest (rather than curriculum-based), non-assessment-driven and non-qualification-oriented endeavour*" (Lai et al, 2013). There is a growing recognition that a semiotic relationship exists between formal and informal learning and that a student's informal learning can be triggered by their work done in the formal education setting (Gurung & Rutledge, 2014; Laurillard, 2009; O'Mahony, 2010). For the purposes of this study, informal learning refers to learning that happens outside the formal learning environment and support mechanisms provided by the university to support students on their programme. In informal learning situations, whilst learners use the learning strategies gained from formal settings, they also use strategies that are not normally used in university.

The concept of seamless learning is useful as it encompasses the transitions between different learning situations and contexts (Looi et al., 2010). Drawing on previous studies in this area and the integration between formal and informal learning, (Gurung & Rutledge, 2014; Lai et al., 2013; Looi et al;, 2010; Margaryan et al., 2011; Osborne & Dillon, 2007; Sefton-Green, 2004), the authors have drawn up a framework which outlines the main critical success factors for technology enhanced learning and the key activities that underpin formal and informal learning (see Figure 1). This framework has been used to design a questionnaire, the first stage in this mixed methods study. It was distributed among a small cohort (n=11) of international undergraduate students studying a range of programmes across the STEM disciplines. A research survey approach is often used for studying behaviour and thus is appropriate for this study where the authors wanted to explore the following questions: "*what digital technologies do international undergraduate students use to support their learning?*" and *"how do they use these digital technologies to support their learning?"*

2.2 Results and Key Findings

The students were asked which digital tools they use both in a formal classroom setting and outside the university. The results indicate that they use the virtual learning environment, internet, email and standard office suite regularly in both settings. They make very little use of discussion boards and blogging/microblogging (e.g. twitter). Video sharing such as youtube, wikis, ebooks and document sharing are all popular and used more frequently in an informal setting. Table 1 illustrates the use of different types of devices by the students and clearly shows how they routinely use more than one device to support their learning. Students were also asked how many hours they typically use technology on and off campus. The results from this question are shown in Table 2 which indicate they spend more time off campus using technology than on campus. The students were asked how they usually work with other students on their course and/or share ideas with them. Although face to face is still popular, email, messaging (e.g. SMS) and social media (e.g. facebook) are all popular too. Students were also asked to indicate the main purpose of their use technology to support their learning. Their responses, shown in Table 3 indicate that interaction with others is rated highly, both in terms of sharing practice/resources and in seeking help to queries. When asked what issues they had with using technology, the general response was low indicating they had very little issues. However they do seem to make use of helpdesk support and online help, showing they seem to be able to seek out help themselves to any issues they experience.

Table 1. Frequency of Use of Digital Devices by Students (out of a total of 11)

Type of Digital Device	**Use Daily**	**Use Weekly**	**Use Monthly**	**Never Use**
Desktop computer	**7**	**4**	**0**	**0**
Laptop	**10**	**1**	**0**	**0**
Mobile phone	**11**	**0**	**0**	**0**
Tablet	**2**	**1**	**4**	**4**

Table 2. Frequency of Use of Digital Technology by Students (out of a total of 11)

Hours of Use	**1-3 hours**	**4-6 hours**	**7-9 hours**	**10+ hours**
On Campus	**6**	**1**	**1**	**3**
Off Campus	**2**	**3**	**4**	**2**

Table 3. Main Purpose for Using Digital Technologies

Purpose of Using Digital Technology	**Response (out of 11)**
Communicate with other students	**10**
Share resources among students	**9**
Evaluate the work of others	**2**
To support formal assessment	**3**
To ask questions	**10**
To engage in discussion	**8**

3. CONCLUSION

This paper reports the findings from an initial survey of undergraduate international students and their use of digital technologies in both formal and informal settings. The authors constructed a framework of success factors and key activities from previous work in this area and this proved useful for designing the survey for the students. The results from this survey indicate that these set of students are routinely using a range of digital tools and devices to support their learning and that they experience little difficulties with their use of technology. Although they use face to face communication for working with others, digital technologies such as social media and email are also frequently used and they value the opportunity to work with others. A limitation of this work is the small number of students surveyed and further work is underway to conduct a wider survey combined with a more in depth qualitative study to seek out a deeper understanding of the approaches and reasons behind this set of students' use of digital technologies. The results from this and the follow on study will be informative for higher education institutions in how they use digital tools and technologies to support students with a similar background.

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E-LEARNING SYSTEM FOR LEARNING VIRTUAL CIRCUIT MAKING WITH A MICROCONTROLLER AND PROGRAMMING TO CONTROL A ROBOT

Atsushi Takemura
Tokyo University of Agriculture and Technology, 2-24-16, Naka-cho, Koganei-shi, Tokyo 184-8588, Japan

ABSTRACT

This paper proposes a novel e-Learning system for learning electronic circuit making and programming a microcontroller to control a robot. The proposed e-Learning system comprises a virtual-circuit-making function for the construction of circuits with a versatile, Arduino microcontroller and an educational system that can simulate behaviors of robots based on programs written by individual experimenters. The proposed system is useful and effective for comprehensive studies on electronic circuits with sensors and for programming robot control. The usefulness and effectiveness of the proposed system were evaluated by five university students. Results showing positive responses, which indicate the usefulness of the proposed system, were obtained from all students.

KEYWORDS

e-Learning system, virtual circuit making, microcontroller, construction and programming of a robot

1. INTRODUCTION

Teaching and learning both hardware and software are necessary in the field of technology education. Learning to construct an electronic circuit with a microcontroller (microprocessor) and to program machine controls (e.g., robotics) is effective in the study of technologies and increases student motivation to learn engineering. Figure 1 shows techniques needed to construct a robot and to control its motion. Students in the field of technology have to efficiently learn all techniques (1–5) shown in Figure 1. The LEGO Mindstorms system (http://www.legomindstorms.com/) is the most widely used for many educational purposes because it is relatively inexpensive, reusable and programmable (Behrens, 2010; Gómez-de-Gabriel, 2011; Kim, 2011; Takemura, 2013). The LEGO Mindstorms system enables users to easily construct various types of robots using a minicomputer module (RCX, NXT, or EV3) and plastic blocks, and users can study the programming that controls the robots' motion. Therefore, the LEGO Mindstorms system has been used to teach engineering technologies to students from primary to graduate levels. However, conventional LEGO-based systems are not sufficient to use for technical education because of the disadvantages as follows:

- The minicomputers of LEGO Mindstorms are black boxes. Therefore, students cannot learn electronic circuits used in the robots.
- Each minicomputer (RCX, NXT, and EV3) needs proprietary software for programming, and the programming environment is not compatible with the different types of minicomputers.

Moreover, conventional education systems on robotics are not sufficient for comprehensive studies involving technological elements (1–5) shown in Figure 1; and the conventional systems are not applicable to e-Learning. To overcome these disadvantages, this paper proposes a novel e-Learning system for comprehensive studies of robotics, including all technological elements shown in Figure 1. Specifically, the proposed system comprises the technical functions as follows:

(a) A virtual-circuit-making (VCM) function for the virtual construction of a circuit with sensors and a generally used Arduino microcontroller (http://www.arduino.cc/).

(b) An e-Learning environment to study Arduino programming to control a line-tracer robot.

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(c) A learning tool that can simulate robots' motion based on the program written using function (b).

(d) Compatibility with various types of computers and operating systems.

A microcontroller is a small programmable computer board with an embedded integrated circuit (microprocessor), and using a microcontroller is an effective method for students to learn machine manufacturing and programming for machine control. Arduino is a widely used microcontroller, and open-source programming software for Arduino is generally available. The proposed system enables users to study the construction of practical circuits and programming using Arduino without exclusive software. The system was evaluated by undergraduate students in a class at the Tokyo University of Agriculture and Technology (TUAT).

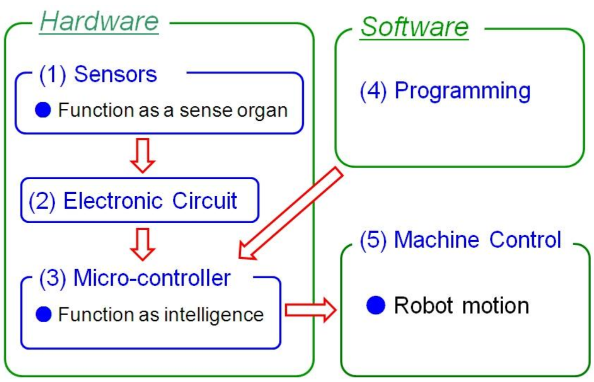


Figure 1. Schematic of technological elements necessary to teach and learn the construction of robots and their motion control.

2. METHODOLOGY

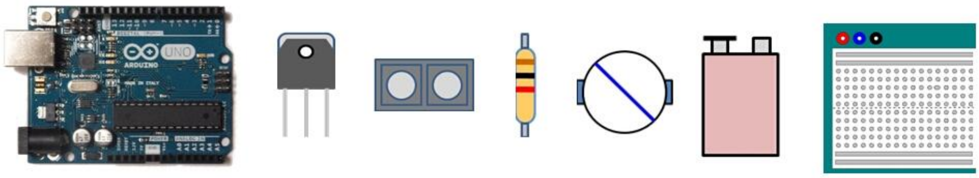
To cover all necessary technological elements shown in Figure 1, the proposed e-Learning system comprises the VCM function, circuit recognition function, and translation and simulation functions of the Arduino program. Technological features of these functions are described in Sections 2.1—2.3. To evaluate the proposed e-Learning system, experiments on a line-tracer robot were conducted by university students (as described in Section 2.4). The line-tracer robot can detect the edge of a thick black line on a white floor and move along the black line.

2.1 Virtual-Circuit-Making Function

The VCM function is useful for users because they do not need to work with physical circuit components to learn designing and construction of electronic circuits. The VCM, proposed in a previous study (Takemura, 2013), enables individual learners to use graphics editors, which are installed on a learner's computer. Therefore, this system does not require the use of proprietary graphics software. To construct a virtual circuit of a line tracer, we improved the previous VCM by increasing the database of virtual circuit components, including a picture of Arduino. Figure 2 shows examples of virtual circuit components that are necessary to construct virtual circuits of line-tracer robots with the microcontroller Arduino. Each experimenter downloaded these virtual circuit components and a template circuit board (breadboard) image. Experimenters used their preferred graphics editor to indicate connections of circuit components on a virtual circuit by placing virtual circuit components on the circuit board image. The experimenters indicated the virtual circuit connections by drawing colored lines on the circuit board image using a graphical user interface.

2.2 Circuit Recognition Function

The proposed e-Learning system performs circuit recognition using image-processing techniques (pattern matching) that compare components in a virtual circuit with each circuit component available in the database of the VCM system. This function searches and recognizes circuit components connected at each node in a virtually constructed circuit. Checking the differences of circuit components at each node between the circuit diagram and the circuit virtually constructed using VCM, this system detects incorrect parts in the circuit constructed using VCM and informs the user of such parts.



(a) (b) (c) (d) (e) (f) (g)

Figure 2. Virtual circuit components: (a) picture of Arduino, (b) MOS-FET, (c) optical sensor (photoreflector), (d) resistor, (e) DC motor, (f) 9 V battery, and (g) breadboard.

2.3 Translation and Simulation Functions of Arduino Program

Arduino is a microcontroller that is widely used for many purposes such as manufacturing, business, and education. The programming environment of Arduino is open source and usable with various types of computers and operating systems (Windows, Mac OS X, and Linux). To program Arduino, a user can use a programming language that is similar to general programming languages such as ANSI-C or C++. Therefore, learning Arduino programming for machine control and robotics is suitable for undergraduate and graduate students in the field of technical engineering. This paper proposes a function that can translate Arduino programs written by individual users into the programming language named Processing (http://www.processing.org/), which is robust for image processing, computer graphics, and animation. Processing is also open source and usable with various types of computers and operating systems (Windows, Mac OS X, Linux, and Android). The grammar of Processing is based on a general programming language such as ANSI-C or C++. Therefore, translating an Arduino program to Processing is possible with some partial rewriting, for instance, the proposed e-Learning system includes a rewritten description of the signal intensity obtained from a sensor into that of the brightness of an image pixel in a Processing program. Based on translated Processing programs, users can check a robot's motion on their monitors. This technique is important because an experimenter can learn about robot motion without constructing a physical robot.

2.4 Experimental Methodology

The proposed system was evaluated by five undergraduate students in a class at TUAT. To evaluate the usability of each function of the proposed e-Learning system, the students were asked to perform the experiments as follows:

A) Each learner downloaded the circuit diagram of a line tracer to be constructed (Figure 3) via the Internet.

B) Using the VCM function of the proposed system, each learner made the virtual circuit of a line-tracer robot, including optical sensors (photoreflectors).

C) Each learner checked whether this e-Learning system indicated incorrect parts in their circuits. If incorrect parts were indicated, the learner corrected such parts and completed the circuit making.

D) Each learner wrote an Arduino program to control the virtual circuit of the line tracer that was virtually constructed using the VCM function. The proposed system translated this Arduino program into the

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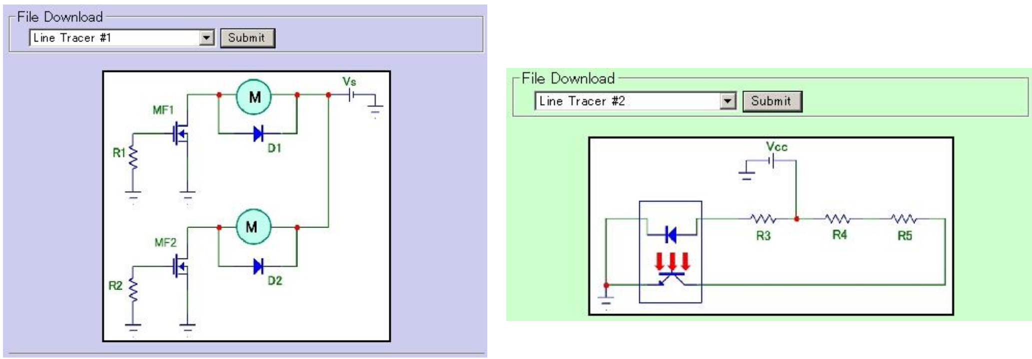
Processing program. The learner studied how the line tracer behaved using the simulated moving image of the virtual robot's motion that was provided by the proposed e-Learning system.

3. RESULTS AND DISCUSSION

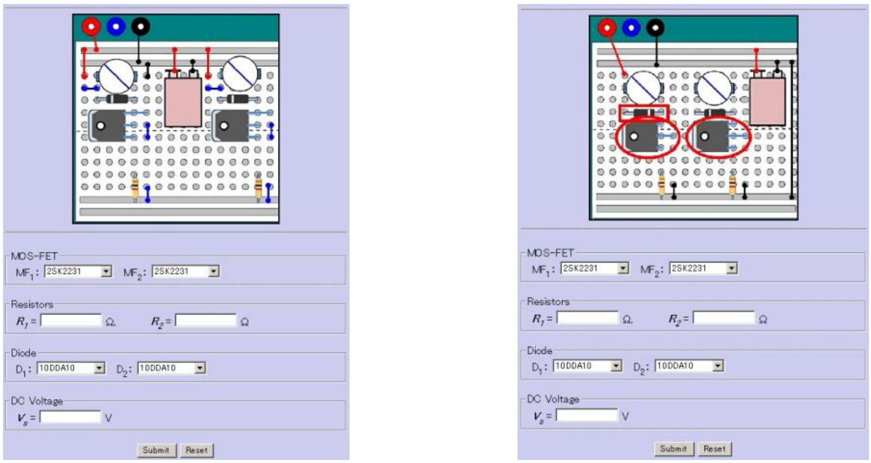
Five undergraduate students at TUAT evaluated the proposed system through the experiments described in Section 2.4. Figures 4(a) and 4(b) show example circuits of line tracers that were constructed by two experimenters using the VMC function. As shown in Figure 4(b), terminals of one of the diodes and a MOS-FET are connected at incorrect nodes, and the proposed e-Learning system shows red indicators to inform this learner about these incorrect parts.

Figure 5 shows the virtual construction and simulation of the circuit of a line-tracer robot. Figure 5(a) shows an example circuit of a line tracer with an Arduino. Figure 5(b) presents the Arduino program written by the same student. The translation function of the proposed system translated this Arduio program into the Processing program and supplied the student with the simulated moving image of the robot's motion based on the Processing program. Figure 5(c) shows a frame that was captured from the simulated moving image based on Program (b).



(a) (b)

Figure 3. Circuit diagram of a line-tracer robot to be constructed using the proposed system: (a) circuit to control DC motors and (b) circuit to detect the degree of brightness (luminous intensity) using an optical sensor (photoreflector).



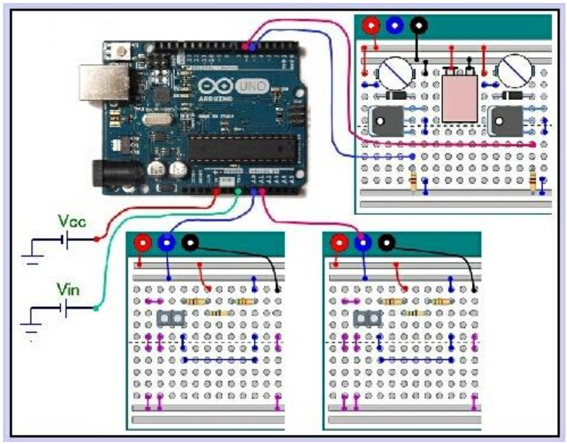
(a) (b)

Figure 4. Circuits of line tracers constructed by two students using the VCM function: (a) correct circuit and (b) incorrect circuit and automated indication of incorrect parts.

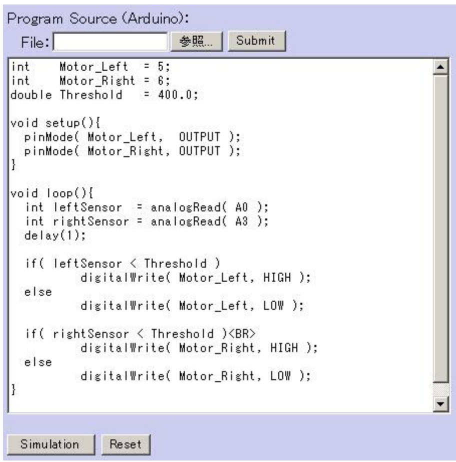
From the results of the evaluation by five experimenters at TUAT, positive responses, which indicate the usefulness of the proposed system, were obtained from all students; the responses are as follows:

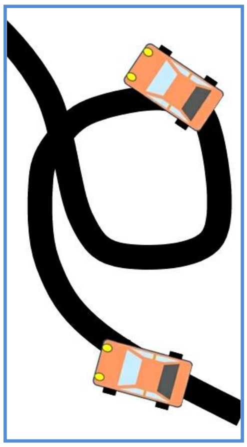
- The e-Learning system was useful for learning the construction of practical circuits with microcontrollers and programming a microcontroller to control machines.
- The e-Learning system was convenient and flexible because all software used in the system was open source.

However, there were also a few technical suggestions for improvement, e.g., to improve the user friendliness of the e-Learning system, a more advanced graphics such as three-dimensional computer graphics should be used.



(a)





(b) (c)

Figure 5. Results of the virtual construction and simulation of the circuit of a line-tracer robot: (a) virtual circuit of a line tracer constructed using the VCM function, (b) Arduino program written by the student, and (c) one frame that was captured from the simulated moving image based on Program (b).

4. CONCLUSION

This paper proposes a novel e-Learning system for learning the construction of electronic circuits and programming a microcontroller to control a robot's motion. The proposed system comprises a system to learn the construction of electronic circuits in a line-tracer robot with the general-use Arduino microcontroller and a simulation system to learn behavior of robots. The usefulness and effectiveness of the system were verified by five undergraduate students in a university class. Positive responses, which pertain to the usefulness and efficiency of the proposed system, were obtained from all students. The steps that are necessary to practically implement the proposed system are as follows:

- Improve the graphical environment, as was reported by the experimenters.
- Enhance the e-Learning system to study more highly developed robots with various types of sensors.

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A STUDY ON THE EFFECTS OF THE RUBRIC ON CONCURRENT DISCUSSION IN WEB-BASED ENVIRONMENT

Jaewon Jung
Hanyang University, Seoul, Korea

ABSTRACT

The purpose of this study was to research the effect of the rubric on the level of learners' cognitive engagement and to explore the effectiveness of Web-based concurrent discussions experienced by learners. The participants were 20 undergraduate students of D Women's University and they were divided into six groups for concurrent discussions in Web-based environment. Three groups of 10 participants were provided with rubric I to conduct self-evaluation and the remaining three groups of 10 participants were provided with rubric II to conduct self-evaluation and peer evaluation. After concurrent discussion in Web-based environment, it was found that the degree of learners' cognitive engagement using rubric II showed higher-level cognitive engagement than the other groups using rubric I. In addition, with regard to the level of learners' cognitive engagement, the groups using rubric II interacted more frequently with one another than the other groups using rubric I.

KEYWORDS

Concurrent discussion, rubric, cognitive engagement, peer evaluation

1. INTRODUCTION

Web-based discussion is considered important in that it contributes to expanding opportunities of convergence through the text-based interaction and promoting critical thinking and problem solving skills, which are important elements to lead successful learning in STEAM education (Lim, 2005; Lim, Yeon, & Kim, 2011; Harasim, 1990). Besides, the contents of discussion in Web-based discussions can be modified because the communication is text-based (Lee & Yang, 2009) and introspective learners who were difficult to participate in face-to-face discussions will be more active (Koh, 2004). In addition, it has positive effects such as the possibility of many-to-many discussions (Harasim, 1990), reduction of the impact of non-verbal elements like appearance and voice (Weisskirch & Milburn, 2003), mitigation of opinion collisions by plain emotional expressions, and the record of the contents of the discussion (Kyungsun Hong, 1999). Despite these advantages, however, most of learners experience difficulty in Web-based discussions. Therefore, various studies regarding design strategies for Web-based learning environment to promote discussions and to develop support tools are required in order to obtain an intended level of learning performance effectively (Park, 1998; Lim, Yeon, & Kim, 2011; Harasim, 1990).

One of strategies for overcoming the difficulties of Web-based discussions and eliciting the learning effect is to provide scaffoldings to support the discussion process. Among them, the rubric has been widely utilized as a strategy for leading discussions effectively and promoting cognitive engagement of a higher level such as critical thinking and problem solving skills. In addition, the evaluation area in the rubric is presented more precisely by describing the execution criteria in detail and it is possible for learners to enhance their critical thinking by evaluating objectively their and others' opinions. In particular, it can promote spontaneous interaction and lead the discussion effectively by inducing the learners' active participation in the discussion and providing opportunities for checking up the demonstration process with clear evaluation criteria (Toth, Suthers, & Lesgold, 2002). This study intended to improve the level of cognitive engagement of learners utilizing the rubric in the Web-based concurrent discussions by focusing on the effect of these characteristics of the rubric. In addition, this study was to explore learners' experiences in the progress of Web-based concurrent discussion. For this, the major research questions are as follows:

First, what are the effects of the rubric type on the level of learners' cognitive engagement in Web-based concurrent discussion?

Second, how do the learners recognize the effectiveness of Web-based concurrent discussions using the rubric?

2. METHODS

2.1 Participants

The participants were twenty undergraduate students in a college of education. There were female students who took the course titled 'Methodology and Technology of Education.' This is a required course for pre-service teachers' training. Most of the students were juniors and had prior knowledge related to learning theories such as behaviorism, cognitivism, and constructivism. The students were randomly assigned to one of six groups.

2.2 Procedures

The independent variable of this study was the type of rubric and the dependent variables were the level of learners' cognitive engagement and the effectiveness of Web-based concurrent discussion using the rubric. The research design of the study is shown in *Table 1.*

Table 1. Research design

G1	O1	X1	O2
G2	O1	X2	O2

G1: the group of self-evaluation
G2: the group of self-evaluation and peer-evaluation
X1: rubric I for self-evaluation
X2: rubric II for self-evaluation and peer-evaluation
O1: pretest to measure the participants' prior knowledge
O2: posttest to measure the effectiveness of the rubric

To examine the effect of the rubric for Web-based concurrent discussion, this study was conducted through the procedure as in *Table 2*.

Table 2. Research procedure

Phase	Procedures
Research design	Design of the research model
Experimental tool development	Development of test tools
Group design	Placed in the experimental and control groups
Pretest	Check the homogeneity of the two groups
Experiment	Web-based concurrent discussion
Posttest	Measure the effectiveness of the rubric
Data analysis	Analysis of the level of cognitive engagement and the effectiveness

2.3 Research Tools

2.3.1 Web-Based Concurrent Discussion Environment

Web-based concurrent discussion environment was implemented using the café service of portal site Daum in consideration of user-friendliness and accessibility for the teacher and learners (see *Figure 1*).

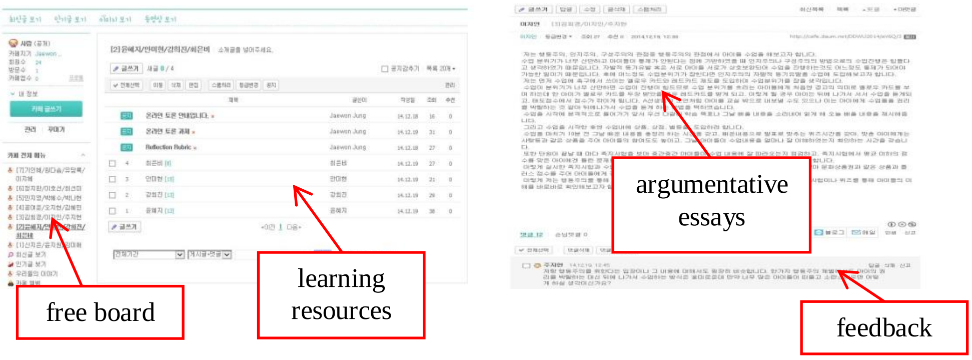

Figure 1. Web-based concurrent discussion environment

2.3.2 Pretests

A pretest was used to measure the learners' knowledge before the Web-based concurrent discussion, and the test consisted of ten multiple-choice questions. The questions were related to discussion topics such as behaviorism, cognitivism, and constructivism. The reliability coefficient of the pretest (Chronbach's alpha) was .51 and identity verification results showed homogeneity between the two groups ($F=.29$, $p=.60$).

2.3.3 Rubric

The rubric has been provided to support self-evaluation and peer-evaluation. Based on the previous studies of Paul and Elder (2013), this study used the rubric to develop subjective questionnaires. The rubric used the same questions for both self-evaluation and peer-evaluation and a 5-point Likert scale was developed to measure five items of the rubric such as clarity, accuracy, relevance, logical order, and depth.

2.3.4 Cognitive Engagement Level

Analysis of the level of learners' cognitive engagement in Web-based concurrent discussion used Lee's (2005) cognitive engagement analysis system of online learning. It consisted of four items such as criticism, expansion, repetition, and unproductivity. In addition, the Discussion Analysis Tool (DAT) by Jeong (2005) was used in order to investigate the effect of the rubric on the flow of Web-based concurrent discussion.

2.3.5 Effectiveness of Web-Based Concurrent Discussion

The perceived effectiveness of Web-based concurrent discussion using the rubric was measured after the discussion through open-ended questions. The open-ended questions were about how the learners recognized the effectiveness of Web-based concurrent discussion and the rubric.

2.4 Data Collection and Analysis

The dependent variable analyzed in this study was the level of cognitive engagement and the independent variable was rubric type. For the comparative analysis of rubric types, χ^2–test was conducted by PSAW Statistics 18 and the significance level for statistical verification was set to .05. In addition, the DAT of Jeong (2005) was used to analyze interaction between the cognitive engagement level and the flow of discussion. Questionnaire analysis was conducted in order to explore the perceived effectiveness of Web-based concurrent discussion using the rubric (see *Table 3*).

Table 3. Research procedure

	Data	Data collection	Data analysis
The level of cognitive engagement	Discussion	Conversations occurring in the progress of discussion	χ^2-test DAT analysis
Perceived effectiveness	Open-ended questions	Survey after discussion	Questionnaire analysis

ACKNOWLEDGEMENT

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BRAIN 3M – A NEW APPROACH TO LEARNING ABOUT BRAIN, BEHAVIOR, AND COGNITION

Ping Li[1], Lauren E. Chaby[2*], Jennifer Legault[1*] & Victoria A. Braithwaite[2]
[1]*Center for Brain, Behavior and Cognition, Department of Psychology, The Pennsylvania State University, PA 16802*
[2]*Center for Brain, Behavior and Cognition, Department of Ecosystem Science and Management,*
*The Pennsylvania State University, PA 16802 *These authors contributed equally to the research*

ABSTRACT

By combining emerging technologies with cognitive and education theories, we are capitalizing on recent findings from adaptive exploration and embodied learning research to address significant gaps in the education of brain sciences for school children and college level students. Through the development of virtual learning tools in combination with innovative education techniques, we are testing novel ways to train students of all ages about the function, anatomy, and evolutionary history of brains. The approach we are taking focuses on key brain regions that are typically taught in college-level introductory courses, as well as a comparative component that introduces features and specializations of other vertebrate brains. By adopting methods grounded in cognitive and learning science theories, we are studying how technology-rich platforms promote better learning and knowledge about the brain. The first phase of the project is aimed at transforming learning by allowing school students to digitally manipulate brain structures, identify real brain images, and 3D print and assemble brain models of different animals. Our aim is to determine how learning in this technology-rich context compares with traditional classroom learning. To test this, we will use behavioral studies that assess the learner's knowledge and the efficacy of knowledge integration into long-term memory. Understanding the brain is a highly interdisciplinary endeavor that bridges neuroscience, psychology, education, biological and medical sciences. We call this approach Brain3M, because it is a combination of (1) virtual brain interfaces in the form of **M**obile device apps (e.g., on smartphones and tablets) and web-based tools for learning; (2) **M**agnetic resonance images (MRI) that connect with mobile and web interfaces, and (3) 3D printing **M**odels and puzzles of vertebrate brains. The goal is to devise technological tools for learning about brains, as well as understanding the mind through investigating learner experiences with the technology. The research represents a significant step in bringing together technology, learning, and the brain.

KEYWORDS

Embodied cognition, adaptive exploratory learning, 3D printing, 3D brain models, virtual brain interface

1. INTRODUCTION

In a typical neuroanatomy class, the learner can become overwhelmed by large numbers of terms and definitions. Brain structures vary in size, shape, and location; remembering the myriad of terms along with their functional and behavioral associations can be challenging for many students. Often, exams are passed after short-term intensive work, but the obtained knowledge does not become integrated into long-term memory. Our cyberlearning and technology-based methods are designed to create learner experiences that result in long-term and highly integrated knowledge representations, making neuroscience more accessible. Ultimately, we plan to capture the outcomes of learning in cognitive representation through both behavioral and neuroimaging methods.

It is now known that self-directed, explorative learning with guidance from well-designed, flexible programs can result in successful learning outcomes. In particular, tools that provide learners with flexibility in navigating and examining the contents of a particular domain (adaptive exploration) are very effective (Chariker et al., 2011; Pani et al., 2013; Naaz et al., 2014). These tools can simultaneously present information, test comprehension, and identify learner-specific interests and difficulties. For example, when learning about brain structures, Pani and colleagues showed that computer-based interactive learning, where the learner explores animated computer graphical models of the brain, yield significant gains with better long-term retention and positive transfer to other related domains of knowledge.

Adaptive self-exploration promotes the learner's discovery and organization of the various anatomical structures and their shape, location, and configuration in the brain. Our Brain3M approach delivers a structured representation of brain parts and functions, providing a more embodied and effective learning experience as compared to current textbook-based teaching methods. In the textbook-based method, concept learning is a symbolic formalization (i.e., “amodal” representations) stripped away from the perceptual and tactile details. Our Brain3M provides an alternative “multimodal” platform for students to learn in a technology-rich context. This may provide a comparable experience to real brain dissection, albeit in a virtual environment with more learner-driven activities and exploration interactions. We argue that Brain3M enables the learner to establish “embodied representations”, through the learner's integration of visual, auditory, kinesthetic, and other sensorimotor aspects of the learning target (Barsalou, 2008; Glenberg & Kaschak, 2002; Kemmerer, 2015). Thus, Brain3M allows one to integrate the obtained knowledge in interconnected conceptual representations, which is achieved through an individual's experiences of bodily sensation, perception, and action in the learning environment (in this case, the technology-rich context).

Embodied cognition theory proposes that cognition arises directly from somatosensory interactions with the real world, dependent on specific modalities (including auditory, visual, motoric, olfactory, tactile, and verbal experiences) that integrate within the system of knowledge representation. Adaptive exploration and embodied learning can significantly enhance learning outcomes, especially with regard to long-term memory representation (e.g., Pani et al., 2013) Additionally, Johnson-Glenberg et al. (2014) found that embodied learning environments, involving kinesthetic, collaborative, and multimodal /sensorimotor engagement, produce superior student learning given the same time period, teacher, and educational content. There is further evidence from cognitive neuroscience that the brain's sensorimotor regions are responsive to multimodal information as a result of embodied representation (Aziz-Zadeh & Damasio, 2008; Borghi, Glenberg, & Kaschak, 2004; Hauk et al., 2004), which is different from the abstract amodal representation housed in the anterior temporal lobe (see Figure 1; Lambon Ralph, 2014).

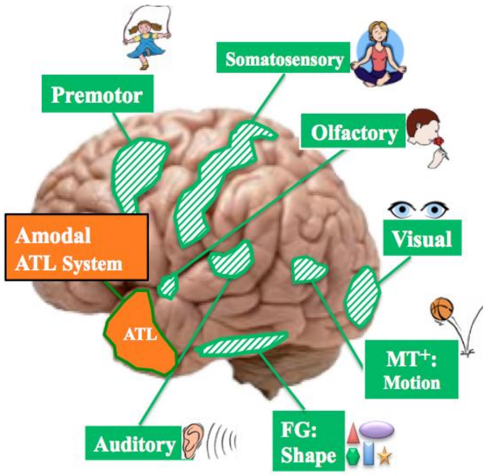

Figure 1. Multimodal, multisensory effects of embodied cognition (green) vs. amodal representation in the anterior temporal lobe (ATL; orange)

Our project, builds on embodied cognition theories, to examine how adaptive and embodied approaches aid learning about brain anatomy and function. Brain3M targets embodied cognition in multiple sensory modalities reaching auditory, visual, and kinesthetic learners. By targeting all types of learners, our model helps to provide all participants with an improved capacity for long-term memory and retention.

2. APPROACH AND METHOD

We use a comparative approach with human and fish brains, to introduce an important evolutionary component to help the learner understand how neural specializations are linked to an organism's environment, or behavioral needs. While the human brain is more familiar to most students, the simpler fish brain is less so. A comparison between them highlights evolutionarily conserved areas, as well as regions specialized for aquatic life or processing alternative kinds of sensory information. The project focuses on specific brain areas (limbic system, cortical and subcortical regions) and their structure and function. For instance, within the limbic system the hippocampus is a highly developed structure in humans, and present, but less well defined in fish. The hippocampus is important for learning and memory and supports other aspects of cognition and behavior. A Brain3M teaching module is being developed to teach middle school students about the function, anatomy, and evolutionary context of the hippocampus (see Figure 2).

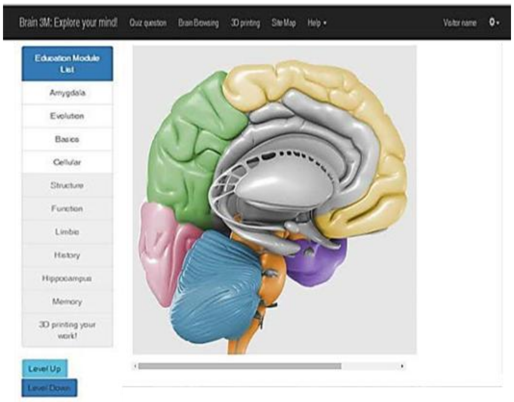

Figure 2. Brain 3M interactive model website. Regions of interest can be manipulated independently or in combination with each other. Clicking a region accesses information about its function, anatomy & connections

The module uses interactive quiz games that can run on tablets and iPads (e.g., www.neurogames.co.uk), and direct instruction, scientific demonstrations and 3D printed materials (e.g., brain puzzles). Knowledge gained through this module is compared to that of students exposed to traditional textbook methods. 20 key facts and ideas about the hippocampus are learned. Half of the material is taught with a traditional method, using Powerpoint and printed text, and half using self-directed methods with the Brain3M approach.

A 'waitlist control' within-subject design is used to conduct the traditional instruction vs. technology-based learning, and different groups experience both conditions with the order counterbalanced (see Figure 3). Midway through the teaching module, the two learner groups switch methods; learners using the traditional methods now learn 10 new facts and ideas through the technology-based method, whereas the Brain3M learners switch to traditional methods. Johnson-Glenberg et al. (2014) and Tolentino et al. (2009) have successfully used this study design. All participants receive learning evaluations at two time points: Pre-test and Post-test. We ensure that the information learned by the two groups is as equivalent as possible.

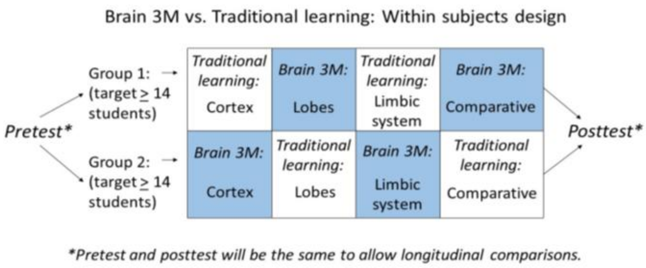

Figure 3. Study design

2.1 Assessment of Learning

Learning is assessed using semantic priming timed response quizzes, allowing us to tap into the learner's knowledge representation structure. Semantic priming is an established cognitive paradigm that tests the relatedness of concepts in mental representation (Neely, 1991). Semantic priming is the backbone of structured conceptual representation according to prominent cognitive theories (e.g., Collins & Loftus, 1975). The learner responds to a 'target' (e.g., parahippocampus) after they have seen a 'prime' word or phrase (e.g., false memory). The dependent measure that reflects the 'priming effect' (from the prime to the target) is the speed of response for identifying correct related pairs, such as "parahippocampus – false memory" compared to unrelated words such as "amygdala – false memory". The faster the response, the more automatic the connection between the prime and the target, as is the case in an integrated knowledge representation system such as our mental dictionary about related words (e.g., honeycomb automatically primes bee). The semantic priming experiment will be programmed using the software E-Prime (Schneider et al., 2002).

This research has implications for student learning, because it caters for individually tailored learning needs (e.g., those with below average spatial ability). In the future, neuroimaging experiments will help identify the neural basis of learning under technology-rich contexts vs. traditional classrooms.

3. CONCLUSION

Our research aims to (a) enable adaptive exploration and embodied learning through multimodal visual and tactile interaction with virtual and plastic models of the brain, and (b) designing behavioral and neurocognitive experiments to understand processes within the learner as they interact with technology.

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LEARNER-CONTENT-INTERFACE AS AN APPROACH FOR SELF-RELIANT AND STUDENT-CENTERED LEARNING

Robin Nicolay[1], Bastian Schwennigcke[2], Sarah Sahl[3] and Alke Martens[3]
[1]*Chair of Information and Communication Services, Institute of Computer Science, University of Rostock, Germany*
[2]*Research Group Communication and Difference, Department of Humanities, University of Rostock, Germany*
3 Chair of Practical Informatics, Institute of Computer Science, University of Rostock, Germany

ABSTRACT

Conceptualization and implementation of computer supported teaching and training is currently not tailored to the paradigm of learner centration. Many technical solutions lack transparency and consistency regarding the supported learner activities. An insight into learners activities correlated to learning tasks is needed. In this paper we outline recent developments in university's higher education concepts. We introduce InterLect as a tool to observe student's activities in lecture content acquisition and describe first insights and questions derived using this tool in a lecture scenario. Based on a new understanding of activity transformation cycles, an elaborated didactical design is modeled, which allows to address and observe learning activities. Ideas for a valid evaluation process are derived in order to investigate efficiency of the digital tool within the didactical framework.

KEYWORDS

Learner Centred Tools, Evaluation, lecture acquisition

1. INTRODUCTION

Digitalization increases in all areas of live and especially in science. This has also initiated a process of change in academic research and teaching. Numerous developments in digital teaching and learning are offering new designs for academic teaching and learning. On the one hand scientists utilize existing digital developments for their own research and interchange with others, on the other hand scientists are involved in the development of new designs for teaching and learning (Donk, 2013). Focused on studies and teaching we describe the dynamic progress of digitalization in the last years with the changed interaction and communication between lecturers and students, students and students or between lectures and lectures: collaborative tools and new digital teaching-learning-offerings are increasing research topics. In recent years, this progress of broken up existing teaching and learning formats has also led in Germany to various approaches and discussions about digitalization on university, see e.g. the Higher Education Forum of Digitalization of the German Rector's Conference. The discussion focusses the adjustment of learning environments related not only with focus on technical aspects.

With this paper we take part in the current discussion of the digitalization of teaching and learning and therefore we present Interlect as a tool for student centered learning.

Biggs teaching model (Biggs, 1999) describes three levels of teaching competences: the first level "What The Student Is?", the second level "What The Teacher Does?", which is defined as the improvement in management of learning and teaching, and the third level "What the Students Does?". This third level explains a learner-centered approach that relies on observation of the learner and learning activities. We adopt the described activities on teaching-learning-offerings and digitalization in a transition from the second level "What The Teacher Does?" to the third level "What The Students Does?". Thus it is no longer a single question of motivation and autonomy of studies with digital learning and teaching. Another aspect is the transparence in processes between the various stakeholders and moreover the analysis of desires and needs of students in comparison with the goals of teachers, the used teaching methods etc. (see therefore (Biggs,

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1999), (Hattie, 2008)). For this purpose we take into account the specific challenge of the observation of learning processes. Therefore we single out this specific challenge in this paper by presenting a learner-content-interface, the so called InterLect-Tool (Nicolay, 2015). InterLect stands for Lecture Content Interface.

The reminder of the paper is structured as follows: In the following paper, we outline the motivation for this tool and give a specification of the existing InterLect-Tool with first outlooks to the didactical design and evaluation of Interlect.

2. INTERLECT - A TOOL FOR STUDENT CENTERED LEARNING

2.1 Description of the Lecture-Content-Interface

In case of a lecture scenario current approaches, such as Tweedback (Vetterick, 2013) or TopHat (TopHat, 2014), establish an interface between audience and lecturer. Classroom response systems are used to interactively quiz the audience by utilizing multiple choice tests or collecting questions from the audience using a ranked question boards. In terms of transparency concerning student's activity in relation to lecture content, these systems are limited due to an aggregation of feedback and limited depth in insights to student's content processing.

Our approach bridges the gap between students' activities and current lecture content. To observe the learner's processing of lecture content in lecture scenarios, we introduced a system named InterLect (Nicolay, 2015). InterLect consists of two major parts. First, a web-based presentation toolkit for the lecturer that allows a straight forward presentation and sharing of lecture slides in lecture scenarios. Second, a web-based audience client receiving current presented lecture slides. The audience client is built to run on any mobile device or laptop without installation and serves as an annotation interface to current lecture content. Received lecture slides are displayed as scrollable list allowing an easy tracking of lecture content and fast lookup of bygone information. Entered annotations are displayed together with the slides and embody a student's lecture script. To annotate lecture content students can select a slide from the list by taping and perform basal marking processes described in the next paragraphs and discussed in detail in section 3.

To increase the narrative density of a lecture, slides can be highlighted by the use of bookmarks. Bookmarks are intended to serve as anchor, highlighting specific sections of a lecture. Displayed as overlay to the list of shared lecture content, they extend tracking of information with a self-defined overall structure.

To quickly mark content, we implemented a set of binary buttons. These buttons can be edited by the student to define a quick access to a solid set of memorizations into further learning iteration steps ”Important for the exam” or ”Look into later”. Furthermore, these buttons can be used to mark content with conflicts such as ”Need examples” or ”Missing information”.

The system allows the annotation of lecture content with notes. A note consists of plain text and can be extended by the use of hash-tags, denoted by a leading ”#”-symbol and references denoted by a leading ”@”-symbol. While the plain text allows input of loose information, a key feature is the use of hash-tags to associate content and annotations to distinctive keywords. These keywords are intended to represent associative nodes interconnecting different pieces of lecture information. References can be used to link additional slides to a note or attach external resources using Unified Resource Identifiers (URI).

Shared lecture content as well as performed annotations by the audience are stored using an anonymous user-ID in our database. Besides these observations of processing information in lecture scenarios, the system allows a qualitative interrogation of performed annotations. Therefore an automatically generated questionnaire can be triggered, which asks students for their reason behind specific inputs.

2.2 First Achievements

As part of a first field test, InterLect was used in two lecture series with topics ”Empirical Evaluation” and ”Cognitive Systems”, at the University of Rostock. Both series took one semester. Each of them was regularly visited by 10-15 students. The system was used by students without instructions on handling and purpose. The aim was to resolve technical issues for the evaluation described in this paper as well as to collect first insights in usability and affordance of the system. Due to the low number of participants, we only collected rough first insights in affordance and usage.

Students showed a very passive utilization of InterLect. At the first lecture of both series the system was introduced as optional tool to receive and annotate lecture slides in order to have a personalized script. In parallel lecture slides have been available via common channels, such as the Universities LMS StudIP (Bohnsack, 2014). Nevertheless, all attending participants to a lecture connected to the system during the lessons to receive and lookup presented slides on their devices. Observations showed, only 2-4 students where actively taking notes during the lessons. All note taking students used InterLect to write and attach their annotations to current lecture content.

A first look into collected notes revealed a primary utilization of free note text and hash-tags. Students did neither bookmark sections of the lecture nor mark content with later processing goals or conflicts. Even though InterLect suggests formerly used hash-tags for reuse and students used semantically similar tags, such as ”measuring”, ”measurement”, and ”measuring-instrument”, we observed students intuitively did not reuse formerly used tags to link different pieces of lecture content to one associative keyword. To verify comprehension and mapping competence of students, exercises where used to enquire students to build mental maps about learned lecture content. All students performed this task successfully.

2.3 Didactical Design

In order to support learning activities by a didactical design we focus on a bottom-up process of planning learning processes to focus on the needs and acceptance of learners. (Sahl, 2015) Those processes should go beyond transfer and documentation of content within a lesson. Our didactical design have to include all activities - from individual works to lessons - and shall adapt to the affordances of any environment relevant to this individual. Bottom-up learning takes place within scenarios of (inter-) action where learners have to apply, reflect and develop their individual skills to solve problems and fulfill tasks. It is based on the individual learning level of a subject, combining formal and informal aspects to a complex behavior and developing dynamically within the scope of needs a learner has and environmental affordances. (Laurillard, 2012)

Against the backdrop of these prerequisites lecture content reception has to be described as an active and generative practice of searching for inter-relations between the situational constraints a learner tries to cope with and material stimuli from a university course or other media of teaching. Reception of lecture content is about building focus and emphasizing areas of interest within given material depending on individual coping with situational affordances. Therefore we have to establish a situational framework (fig. 1) in order to explore how and why students utilize InterLect as a means to run lecture content processing. This framework allows predicting requirements, students have to fulfill within learning tasks. Furthermore it shall describe a unified set of steps, which constitute task-solving processes.

A situational framework of learning is no static entity. According to Activity Theory (Engeström, 2001) (Wansga 2011) (Nouri and Cerratto-Pargman 2015) situated learning takes place where learners run through transformation processes in order to fulfill tasks. These processes, described by Engeström, are accelerated by specifications and contradictions, which arise from coordination between the task and individual abilities of a learner. We plan to apply at least three different, interrelated task sets, which develop from knowledge transfer to knowledge elaboration. These task sets will be featured by different teaching/learning arrangements. In result, transformation processes will be iterated and enhanced at different stages with gradually increasing learner autonomy and responsibility. InterLect will be applied throughout the whole process. Observation and measurement of InterLect usage shall clarify to what extend options like coding, linking and annotation of content support learners to align different modes of content processing with situational constraints they try to cope with.

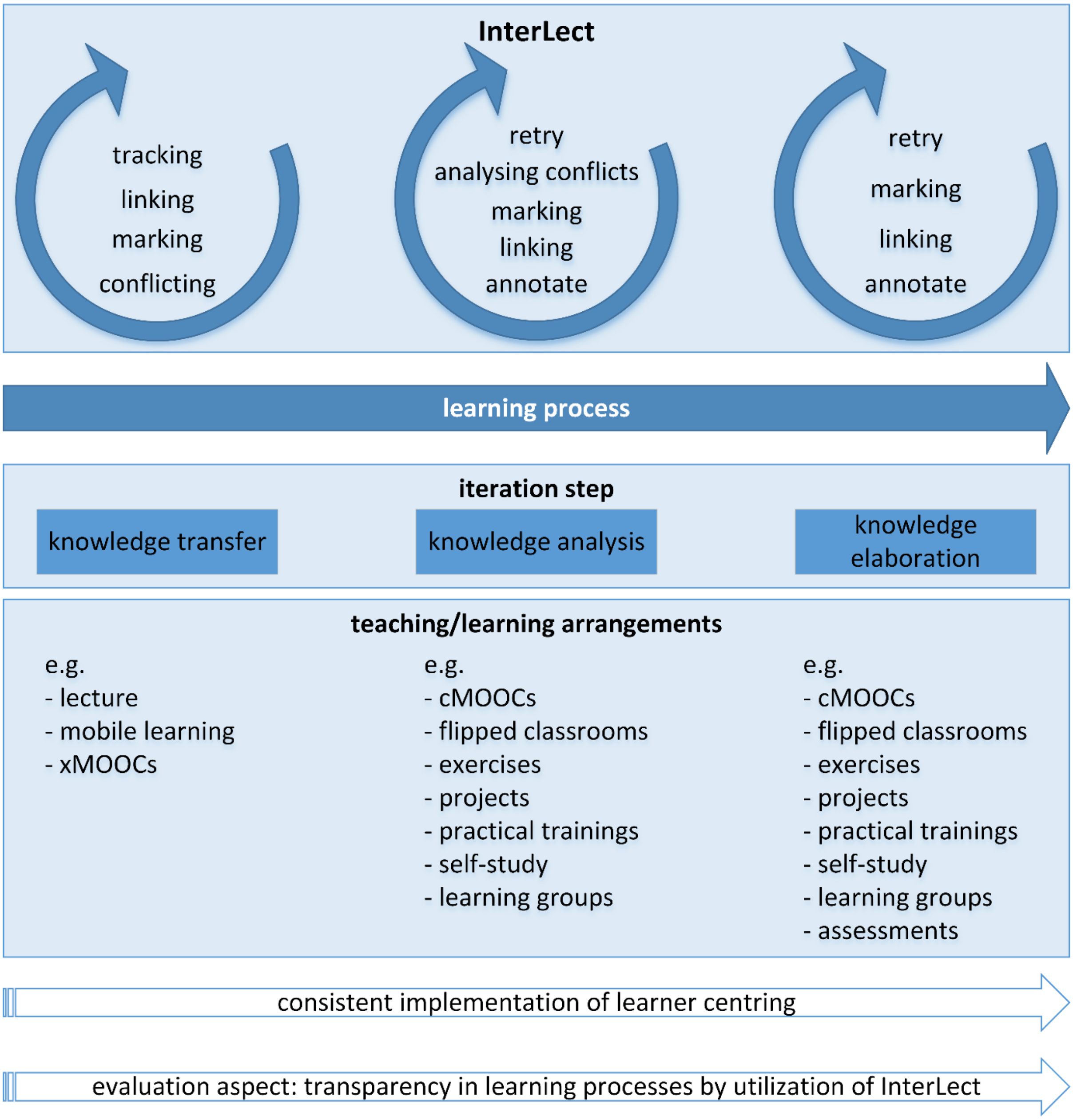

Figure 1. learner-centered application of teaching technologies using the example of InterLect

3. CONCLUSION AND OUTLOOK

First implementation steps proved viability and practicability of InterLect. Analysis of the first experiences revealed decisive benefits that can be expected from a user-content-interface within a learner-centered approach on learning. So far content acquisition relies on situated learning processes, which modify the way, learners adapt their treatment of learning content. A deeper understanding into the way a user-content-interface supports learner activities implies a comprehensive analysis and design of learning processes. Based on activity theory, a didactical framework to implement and evaluate digital support of learner-centered teaching has been developed. That supplies crucial prerequisites to precisely address and observe learning activities within a digitally promoted learning complex.

In the course of the development of InterLect we focus a systematic evaluation of the tool. Basing on the given analysis of the didactical design, we have to develop an evaluation design. For a longitudinal analysis qualitative and quantitative methods have to be considered, to evaluate the acceptance of the tool InterLect. Thereby we also have to focus on the benefits for learners and teachers in using InterLect.

ACKNOWLEDGEMENT

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CACHE-CACHE COMPARISON FOR SUPPORTING MEANINGFUL LEARNING

Jingyun Wang and Seiji Fujino
Research Institute for Information Technology, Kyushu University, Fukuoka, Japan

ABSTRACT

The paper presents a meaningful discovery learning environment called "cache-cache comparison" for a personalized learning support system. The processing of seeking hidden relations or concepts in "cache-cache comparison" is intended to encourage learners to actively locate new knowledge in their knowledge framework and check the logical consistency of their ideas for clearing up misunderstandings. This active engagement is also expected to prevent a) the emergence of cognitive overload and b) the decreasing of the curiosity and willingness to explore as in the meaning reception learning environment.

KEYWORDS

Meaningful learning, knowledge structure, reception learning, guided discovery learning, cache-cache comparison,

1. INTRODUCTION

Evidence from diverse sources of researches suggests that knowledge gets incorporated into human brain more effectively when it is organized in hierarchical frameworks. Learning approaches that facilitate this kind of organization significantly increase the learning capability of learners (Bransford et al., 1999; Tsien, 2007). Ausubel's learning psychology theories (Ausubel, 1963; 1968; Ausubel et al., 1978) define this effective assimilation of new knowledge into existing knowledge framework as the achievement of "meaningful learning". Therefore, how to help learners to efficiently develop their conceptual framework becomes the main issue for fostering meaning learning in e-learning systems.

However, most of e-learning systems organize the knowledge of a curriculum in a tree structure, based on the textbook chapters or based on the arrangement of classes. This kind of tree structure obscure the relations between knowledge points (KPs, a KP is defined as "a minimum unit which can independently describe the information of one knowledge and be understood by its own expression or be acquired by practices" in this research). Especially for those KPs which belong to different branches, it is difficult to emphasize their relations (such as similarities and contrasts) in teaching process. Furthermore, it is also difficult to identify the relevant knowledge a learner possesses before and after a learning activity. To resolve these difficulties, an ontology-based customizable learning support system (CLLSS) which uses a hierarchical map structure to manage the KPs of a curriculum has developed to foster meaningful learning (Wang et al., 2014).

Although in the latest version CLLSS 2.0 already provides visualization supports for the emphasis of the relations between KPs and enables learners to easily locate needed learning material addressing relations. However, CLLSS 2.0 simply provides a meaningful reception learning environment which directly displays the relation map created by experts. It could easily lead to passive learning and lower the learner's willing to explore new knowledge. Therefore, to encourage active engagement, we present a timely guided discovering learning environment called "cache-cache comparison". "Cache-cache comparison" encourages the learner to detect hidden relations between relevant KPs or hidden acquired KPs from given relevant KPs and relations through reflecting the attributes of acquired knowledge. If learners keep making mistakes during the task system will provides hints to help them rethink and get closer to the correct answer. The processing of seeking hidden relations or concepts is intended to encourage learners to locate new knowledge in their knowledge structure and restructure existing knowledge; meanwhile the iterative procedure of confirmation and modification in their own relation map ensure that they check the logical consistency of their ideas and clear up misunderstandings.

2. THE PREVIOUS RELATED WORK

To facilitate meaningful learning, learning materials should be well constructed with concepts presented with examples related to leaner's prior knowledge. On the other hand, the learner must possess a good attitude and motivation for the construction of knowledge framework by comparing new knowledge with acquired knowledge. The meaningful learning will impeded by low attitude and motivation even the knowledge in learning materials are well-organized. Although not only instructional strategies but also evaluation strategies which emphasize and encourage learners to relate relevant knowledge can foster motivation improvement, this paper focuses on the instruction environment in the e-learning system from system design perspective.

In previous work, from the perspective of learners' knowledge structure, we developed a meaningful reception learning environment(Wang et al., 2013) by organizing KPs in a map structure and clarifying all the relations between KPs. In this meaningful reception learning environment (as shown in Fig.1), whenever learners are studying a new KP, they will be presented with the relations between the new KP and relevance KPs especially the acquired ones to assist them to reach correctly understanding.

It is found that the experimental students who learned with this environment achieved significantly better learning achievement than those who just did self-study with textbooks after studying the same target Japanese grammar contents (Wang et al., 2014). This suggested that the new KP can easily be understood and remembered through this visualization support. However, students reported that they felt pressure and disturbed when more than 4 related KPs are shown at one time. In other words, from cognitive load point of view, the e-learning environment need to avoid directly giving a big number of information at one time.

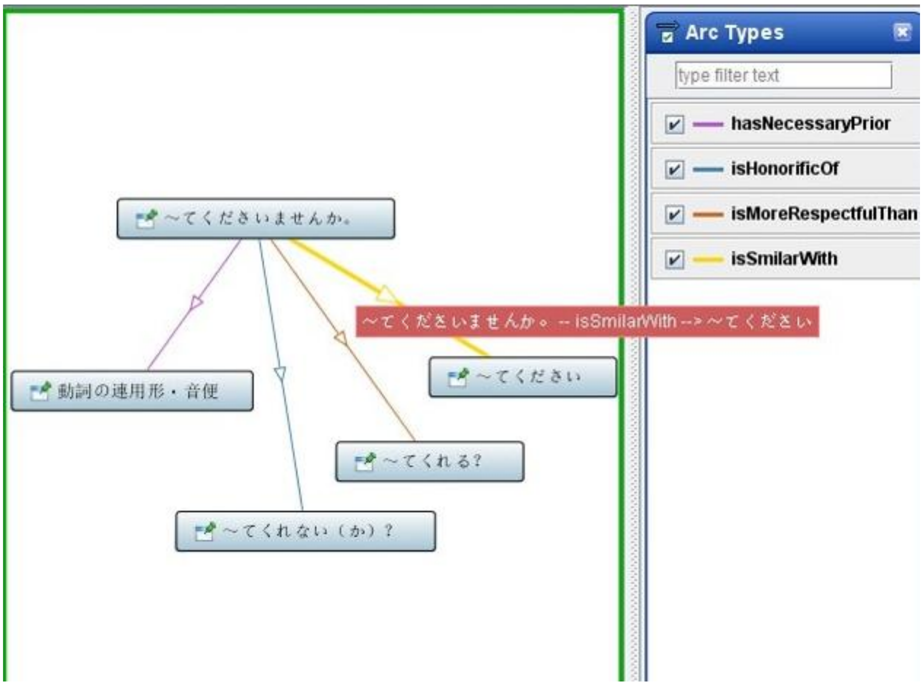

Figure 1. The relation map in CLLSS 2.0

From learning attitude and motivation perspectives, the leaner data before and after studying target grammar contents with the support of CLLSS 2.0, were also analyzed (Wang and Mentori, 2015). By considering learning attitude and motivation before the learning activity as individual difference variables, we found that learners with high level of attitude/motivation perceived a greater effect on developing the habit of "learning from the comparison of related knowledge" and felt more satisfied with the learning mode in CLLSS environment. Moreover, compared to learner with low level of attitude towards Japanese grammar before the activity, learners with high level of attitude perceived significantly lower mental effort while studying with CLLSS and achieved better achievement on the grammar test after. These results confirm that the learning attitude and motivation is an essential condition for meaningful learning.

The analysis of learner data also suggest that not only learners' attitude towards Japanese grammar learning, but also their motivation toward Japanese language learning improved after studying with the system. However, in the interview after the experiment, 19 out of 60 participants expressed that, since the system already provides lots of related knowledge they don't have the urge to actively search more by themselves. Furthermore, for the items about the curiosity and willingness to explore more related knowledge on the attitude/motivation questionnaire, 8 students even were found with post_rankings slightly lower than pre_rankings. The occurrence of this phenomenon is mainly because the version 2.0 of CLLSS simple directly displays all the information of related concepts and relations. The participants made the comparison between concepts in a passive reception way. This kind of passive learning lowers learners' willingness to explore. This reminder us that CLLSS needed to be modified to encourage learners to actively engage in the construction of relation map.

Therefore, for solving the potential problems in both cognitive load and attitude/motivation, "cache-cache comparison" environment is presented for CLLSS 3.0. This environment, which hides some relations or acquired KPs and guide the learners to actively recall their prior knowledge to design their own relation map before comparison with the relations map of experts, is intended to lower the cognitive load and encourage learners' active engagement.

3. CACHE-CACHE COMPARISON

3.1 Why "Cache-cache"?

The word of "cache", which originally comes from French, means "to hide" or "a hidden place" (Chiaki Itoh and Seiji Fujino, 2014). "Cache memory" as a high speed storage device made the word "cache" well known. In French, some words are formed by combining the same word twice, such as "bonbon" or "cache-cache". The meaning of the compound word is different from the original simple word. The origin of this kind of words could be that, it seems quite impressive for little children that a short word is pronounced twice and this impression make the word easier to be remembered. The French word "Cache-cache" means "hide and seek" in English. It is one of the popular children games in which one or more player as seekers tries / try to find several hidden players. Although there are slightly different versions of this game, with a simple rule most of children can immediately participate in it and enjoy the game. Ishare Company from Tokyo has conducted an Internet-based survey to investigate the response to "What is the game that make you feel really enjoyed in your childhood?" 458 Japanese (male 54.6%, female 45.4 %,) with the age from 20 to 40 participated in this survey. The top ranking answer was "cache-cache" with 19.7% of supporters.

Therefore, taking advantage of this familiarity, we propose to apply the word of "cache-cache" to represent a process of "hiding and seeking" similar to the kids' game. As an adult, we sometimes consciously or unconsciously do "hiding" and "seeking" not only in daily life but also in research activities. For instance, in parallelism of numerical algorithms, programs were designed to firstly hide some parts that cannot be parallelize and then, after achieving the objective of parallelism, those parts will be found out again to complete the rest of computation. Accordingly, a "cache-cache balance" technique has been presented (Chiaki Itoh et al, 2014; Seiji Fujino et al, 2014).

From learning support perspective, directly presenting too many information related to a new knowledge will create a high level of cognitive load. As mentioned in Section 3, this phenomenon was also revealed in one of our previous work (Wang J.Y. et al, 2014). Therefore, we suggest to hide some parts of the information at the first stage of learning, and then encourage learners to actively detect them in the second stage. This process involving discovering learning is defined as "cache-cache comparison" in this research.

3.2 Discovering Learning

"Discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relations and new truths to be learned" (Bruner). Bruner (1961) stated that students are more likely to remember knowledge discovered on their own in contrast to those taught directly in reception instruction. A learner experiences her/his individual discovery process by applying exiting knowledge to solving problems. This process which encourages active engagement, can foster the development of creativity and problem solving skills, and promote learning motivation. However, many researchers (Mayer, 2004; Alfieri et al., 2011) also cautioned that unassisted discovering learning lacking of necessary prior knowledge and guidance may easily lead to misconception and cause extra cognitive overload. Timely guidance is needed in discover learning for learners to avoid confusing or frustrating (Kirschner et al., 2006). Learners need to gain confidence that they have the ability to complete the task by providing indispensable knowledge; on the other hand, when confronted with failures they also need to be motivated to learn from mistakes to get closer to the truths.

3.3 Meaningful Discovery Learning Supported by "Cache-Cache Comparison"

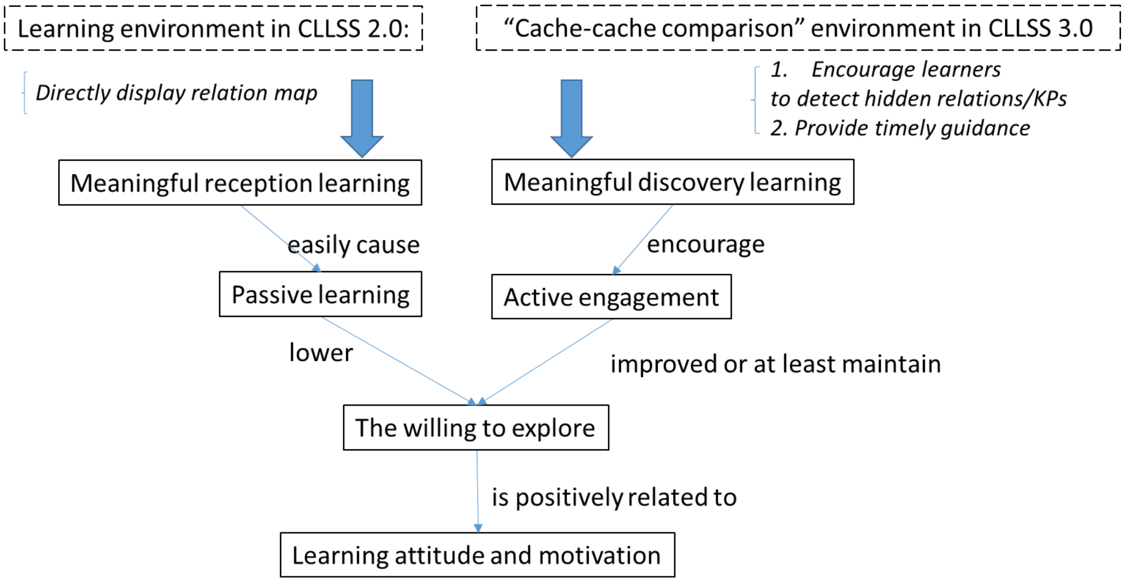

Figure 2. Differences between two versions of meaningful learning environment

To encourage active engagement in meaningful learning, we present "cache-cache comparison" approach by integrating with discovery learning. Considering KPs and relations as the building blocks for relation map of a course, the system hides several blocks in the relation map of experts and guide learners to seek and discover those blocks. Learners are engaged in an active learning process when they struggling to complete the relation map. This active engagement is expected to improve or at least maintain learners' willing to explore and accordingly improve their learning attitude and motivation. Fig. 2 illustrates the comparison between "cache-cache comparison" environment in CLLSS 3.0 and the meaningful reception learning environment in CLLSS 2.0 from learning attitude and motivation point of view.

To lower the confusion and cognitive pressure, from the uncompleted map learners are enable to easily access the explanations and practices addressing each displayed KP or relation. Learners have to ruminate on their features to determine what the missing KPs or linking relations are. Timely guidance will be provided for learners to elicit positive responses toward finding correct answers. While interacting with "cache-cache comparison" environment, learners need to draw on his existing knowledge and compare with the new knowledge in order to find the missing blocks. This process fosters learners to locate new knowledge in their knowledge framework with relations discovered by themselves and avoids the occurrence of misconceptions. The visualization interface of "cache-cache comparison" which can support the learners to actively build up their knowledge framework are still under development now.

4. CONCLUSION AND FURTHER WORK

This paper presents a "cache-cache comparison" environment in a learning support system which encourage learners to detect hidden relations between relevant KPs or hidden acquired KPs from displayed relevant KPs and relations whenever they study a new KP. This learning environment integrates the advantages of meaning learning and discovery learning by providing visualization support and timely guidance to prevent misconceptions and lower cognitive load. "Cache-cache comparison", intended to support the effective construction of learners' knowledge framework, is also expected to prevent the decreasing of the curiosity and willingness to explore related knowledge by encouraging active engagement.

After the development of "cache-cache comparison" environment, further evaluation will be conducted to compare the learning performance differences between learners who studied with "cache-cache comparison" and those who studied with the meaning reception learning environment in CLLSS 2.0, especially in the attitude and motivation aspects.

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CREATING INNOVATIVE, STUDENT-CENTERED PROJECTS WITH APP SMASHING

Dr. Aimee M. Brenner and Ms. Janel S. Hauser
Averett University, Danville, Virginia, United States

ABSTRACT

Students today share a unique characteristic in that they have all been raised in a digital era. Students from all socioeconomic levels have been impacted by digital media in one way or another, and many yearn to be engaged through the use of digital technologies in the classroom. One such digital project has sought to aid in meeting the need to develop such skills in preservice teachers and subsequently transfer these skills to future students. This project has been coined with the term *App Smashing*. App Smashing is the process of developing content on multiple digital applications and then integrating or "smashing" them together in order to create a richer, innovative digital product (Kulowiec 2013). Combining digital apps can be utilized for the process of research, note taking, understanding, creating, and sharing in any grade level classroom or subject matter. This paper seeks to further define the process of App Smashing and examine relevant literature. Lastly, one example of a project that utilizes App Smashing will be described. This project has been implemented in a teacher education course in order to educate preservice teachers about how to actually design a student-centered, project-based assignment and then reflect about the process upon completion.

KEYWORDS

Technology Integration, Teacher Education, Student-Centered Projects

1. INTRODUCTION

In the current and rapidly changing, digitally saturated environment, educators find themselves constantly seeking new ways to teach and engage students in “an ever-changing technology context and…who no longer process information primarily in a sequential manner” (Lambert & Cuper 2008, p. 264). According to Roa and Skouge, technology tools that are used in creative ways have the possibility to become a simple, interactive multimedia-authoring environment for classroom learners (2015). Moylan emphasizes that project-based learning encourages students to ‘learn by doing’ by completing hands-on projects (2008).

Lambert and Cuper state that not only do these challenges affect classroom teachers, but it also makes teacher preparation “increasingly important and increasingly challenging as teacher educators seek new ways to integrate 21st-century skills, nonlinear skills, and digital-age reflections into coursework” (p. 265). Many more recent technologies focus on “creating communities in which people come together to collaborate to learn and build knowledge. This is now influencing the way we communicate/collaborate within the framework of the teacher education programs…” (Mach 2013, p. 2508).

One such digital project has sought to aid in meeting the need to develop such skills in preservice teachers and subsequently transfer these skills to future students. This project has been coined with the term *App Smashing*. This paper seeks to define the process of App Smashing and examine relevant literature. Lastly, one example of a project that utilizes App Smashing will be described that has been implemented in a teacher education course. The assignment seeks to educate preservice teachers about how to design a student-centered, project-based assignment and then reflect about the process upon completion.

1.1 What is App Smashing?

Although not really a new concept in the world of multimedia, Kulowiec introduced the term *App Smashing*, and defines it as incorporating or embedding multiple applications together in order to accomplish a major learning task or project (2013). Young (2014) states that App Smashing grants a student the freedom, through a plethora of choices, to create exactly the type of product they can envision. Some technology projects assigned in the classroom cannot be completed using just one application; some applications require using another application to fill in the gaps to complete a project (Kulowiec 2013). Students can complete App

Smashing projects individually or in cooperative groups. According to Young, App Smashing utilizes the media attributes characteristic of each application; one application's distinctive characteristic may include integrating text and photos, while another consolidates sound with video (2014).

In order to successfully utilize an App Smashing project, Young suggests that both teacher and students need to consider what will be assessed in order to produce a final, appropriate product, as well as identifying learning goals and outcomes with alignment to the App Smashing project (2014). Roa and Skouge (2015) proffer that "with its ability to combine and display media elements – such as photos, video, audio, and text – presentation software can be used purposefully to transform media into tools of learning and engagement for young children" (p.103). Further, Kulowiec (2013) notes that an App Smashing project could even be used in a project-based assignment that takes place over the course of an entire semester or academic year.

1.2 Best Practices for App Smashing

The App Smashing process can also expose the student to project-based learning (PBL) opportunities, which engages students, and allows them to learn in at all six levels of Bloom's Taxonomy; Bloom's Taxonomy includes: knowledge, comprehension, application, analysis, synthesis, and evaluation (Moylan 2008). According to Moylan, "PBL has been identified as a key methodology for closing the gap between current student learning and developing the necessary 21st century knowledge and skills" (2008, p. 287). Further, PBL with multimedia or through App Smashing "provides the benefit of allowing students to use multimedia to construct their own meanings…Researching a topic, evaluating resources, synthesizing core concepts, selecting appropriate media, and creating a product can involve students in higher order thinking and enhance understanding of the topic (Royer & Royer 2012, p. 2326). PBL allows students to be their own teacher; students build a relationship with the projects they create, which encourages them to use their imagination (Moylan 2008). Classroom models and practices, suggested by Price (2011), include making sense of ideas and holding students accountable for generating and evaluating ideas.

The App Smashing process can be used with students of all grade levels and subjects because the variety and number of applications available can be combined or "smashed" in such a way that they meet the instructional needs of all educators (Young 2014). Young also states that App Smashing encourages student excitement and engagement about creating their own project, demonstrating their individual exceptionality, as well as combining products using familiar applications (2014). "App Smashing projects encourage collaboration and innovation – skills essential for success in the 21st century (Young 2014, p. 14). Moylan states, "PBL is especially effective when supported by educational technology, while blended with service learning (learning outside of the classroom), and provides an exceptional PBL educational opportunity" (2008, p. 288).

According to Rao and Skouge, the process of App Smashing or producing multimedia projects meets criteria for the *Universal Design for Learning* (UDL), which includes three main principles: provide multiple means of representation; provide multiple means of expression; and provide multiple means of engagement (Rao & Skouge 2015, p. 104). Young suggests after determining which goals or objectives are to be measured, various apps can function for different levels of higher order thinking skills (2014). For example, Young has used applications such as Skitch and Pic Collage as a first level application to share and manipulate images (2014). Then, Young has included applications such as iMovie and ThingLink to smash all first level applications into one single presentation (2014). As a part of a fifth grade curriculum, students must demonstrate strong skills of analysis in which Young uses App Smashing as an assessment for literary and character critique (2014).

One of the benefits of using App Smashing, as experienced by the authors, is that there are numerous applications that can utilized as far as subject matter; as well as how they are utilized or the function; and even more variety and options exist in the manner in which the applications are combined or smashed. The project can be as complex or as simple as the educator wishes depending on the intended learning outcomes. The body of this paper will detail the project design process assigned by the lead author in a teacher education program for preservice teachers.

2. DESCRIPTION OF APP SMASHING PROJECT

School-age students today have all been raised in a digital era. Students from all socioeconomic levels have been impacted by digital media in one way or another, and many expect to be engaged through the use of instructional technology in the classroom, such as App Smashing. As previously described, App Smashing is the process of developing content on multiple digital applications and then integrating or "smashing" them together in order to create a richer, innovative digital product (Kulowiec 2013). Combining digital apps can be utilized for the process of research, note taking, understanding, creating, and sharing in any age level classroom or content area.

2.1 Purpose and Benefits of the Project

The project that will be described in this paper is assigned in an instructional methods course for both upper class undergraduate and graduate students at an American private, liberal arts university. Classes are typically very small and include students who major in either English, history, math, or science, art or physical education and are seeking an endorsement to teach in that area. The process the preservice students progress through in order to complete the project, which usually takes half of the semester to complete, aligns with the topics they are learning about in class dealing with various instructional strategies, lesson planning and lesson delivery. A major component of this course includes lesson design and delivery of three microteaching experiences.

The purpose of the App Smashing project is to provide these preservice students with the experience of completing a multimedia assignment they could assign to their own students. This assignment could serve as a form of authentic, summative assessment and also allows the preservice teachers' future students to express their knowledge of a specific content area in a nontraditional way while utilizing technology. The learning outcomes for this assignment are multifaceted and include some of the following experiences: 1) backwards lesson planning design; 2) selection of and evaluation of instructional technology tools; 3) assessment design and creation; 4) student-centered and problem-based learning; and 5) reflecting on instructional practice.

From a practitioner's stance, the lead author has found that App Smashing promotes a number of beneficial skills in the category of higher order thinking skills, 21^{st} century skills, and college and career skills. Higher order thinking skills include synthesis, creativity, reflection and critical thinking. The twenty-first century skills category encourages student engagement, development of technology skills, communication, and collaboration. The college and career component provides opportunities to increase skill development in the areas of research and writing, project-based learning, and presentation skills.

This list was gleaned from classroom observation and discussion, as well as post-project reflections. Many of the preservice teachers commented in their reflections about the benefits of learning how to use the various technology tools, as well as some of the other skills previously listed. Specifically, many mentioned that they enjoyed getting the opportunity to explore newer instructional technology tools and learning how to apply them in an academic environment. Lastly, a few synthesized that one of the added positives of creating this project was getting to see the projects of their classmates. This helped them to further understand how the applications can be utilized in various content areas. The resulting project also becomes a quality artifact that the preservice teacher can include in their professional, end-of-program ePortfolio.

2.2 App Smashing Project Process

For this assignment, the preservice teachers are required to select a set of specific standards-based skills that will be assessed for student mastery. For the sake of this course, the preservice teachers create the assignment individually because of the variety of disciplines that may be represented in the course. They are, however, informed of the collaborative nature that many of the technology applications possess, thus increasing their awareness of how such a project may lend itself to being a group project when utilized in their own classrooms. The resulting project assignment could be an extension activity from a unit test, research paper, or other more traditional form of assessment. Once the standards/goals have been selected, the preservice teachers write the behavior objectives for the assignment. The parameters and requirements for the project they design are based upon the behavioral objectives.

The process for the assignment then proceeds as follows. First, the preservice teacher must choose between either Prezi or Padlet as their main presentation platform. This project focuses on the use of free or affordable applications. Animoto and Zaption will be two secondary applications the preservice teachers will utilize to create short digital pieces to further enrich their primary presentation. Optional applications include integrating a word cloud utilizing either Wordle or Tagxedo, or an illustration using Postermywall.

These applications, plus other forms of media like images and text, will be integrated or "smashed" into the main platform, thus the name App Smashing.

Before the preservice teachers begin work on completing their student-centered project and following their identification of standards-based skills and objectives, they must first design the project (following the professor's requirements) and choose evaluation criteria upon which they plan to assess student work in the form of a rubric. The preservice teachers submit and receive feedback on each step of this project before they begin working on the technology components. This also promotes involvement in the backwards design process. Short tutorials are embedded in class meetings for each application, as well as how to integrate the various pieces of the project. The preservice teachers are required to investigate and learn how to operate or navigate each application on their own time. The professor, however, is always available for questions and guidance with regards to the applications.

Because it is important for preservice teachers to examine their own learning and the design process for this assignment, they are required to write a two-page paper describing the parameters of their student assignment, as well as a critique evaluating the usefulness of their chosen platform and the applications as instructional technology tools in the classroom. They must detail how they might improve the assignment and if they feel the chosen applications were useful for student learning in the appropriate content area.

Assessment criteria for the preservice teacher's final product includes the following: 1) a title is present, the purpose is clearly evident, and is linked to a specific standard; 2) incorporates at least <u>ten</u> forms of media, including an Animoto video and Zaption tour, as well as other images, sounds, and videos; 3) the Animoto video is at least two-minutes long and the Zaption tour contains at least four questions; 4) the ten forms of media have a relationship and these connections are demonstrated through text or audio; and 5) the project represents quality work on behalf of the student and it is evident that adequate time was invested in creating it. Each criteria component is worth 20 points, and the preservice students can score exemplary, proficient; developing/needs improvement; or unacceptable.

3. CONCLUSION

In conclusion, incorporating multimedia experiences in the classroom today allows the teacher to enable "the student, through multimedia assessment, to utilize technology in a meaningful way" (Moylan, 2008, p. 288). According to Young, the process and product of App Smashing gives the student the opportunity to challenge himself through the creation of a sophisticated product while empowering their motivational and creativity skills (2014). It is the author's intention to equip preservice teachers with this knowledge by having them participate and reflect upon this experience. The author continues to implement this project each semester with much success, but also continues to utilize new apps, as well as incorporating engaging ways to "smash" the apps together. Each implementation change is based upon research and preservice teacher project reflections.

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SMART LEARNING: ARE WE READY FOR IT?

Petra Poulova and Blanka Klimova
University of Hradec Kralove, Rokitanskeho 62, Hradec Kralove

ABSTRACT

Nowadays learning, particularly the university learning, is supported with modern information and communication technologies. These technologies also enable electronic learning, known as eLearning, which is now firmly established at almost all institutions of higher learning in developed and developing countries. Moreover, at present eLearning is being taken over by the so-called mobile learning (m-learning), which is possible thanks to the rapid growth of mobile devices such as notebooks, smartphones or tablets. In comparison with eLearning, m-learning provides further opportunities for more effective learning in the sense of its wireless connections, mobility and portability, full ubiquity or instant information sharing. The aim of this article is to explore whether university students at the Faculty of Informatics and Management in Hradec Kralove are well-equipped for this new smart learning and whether they use mobile technologies for their studies or not.

KEYWORDS

eLearning; m-learning; smart; survey.

1. INTRODUCTION

eLearning started to be used in the mid-1990s (Garrison, 2003). Originally, its technological component was preferred since it was mainly managed by IT and technical experts. However, later, emphasis was put on its educational value (Simonova, 2010). In this sense eLearning is usually defined although there is not one single definition. For the purpose of this article, the authors follow the definition provided by Wagner who says that eLearning is the educational process which uses information and communication technologies for designing courses, distributing the learning content, for teacher-learner and learner-learner communication and managing the whole process (Wagner, 2005).

Obviously, eLearning brings about a lot of benefits but also drawbacks which were summarized in the study by Klimova and Poulova (2015). The benefits in comparison with traditional, face-to-face teaching include easy access to study materials; easier updating of study materials; further access to additional materials; individual pace, time and place of studying; almost immediate feedback; modern way of teaching; teacher could be absent, therefore if s/he is ill, classes are possible; chance to practice more and verify one's knowledge; more opportunities for communication such as a use of discussion tools and consequently, more electronic consultations; support of teamwork; chance to submit assignments and their almost immediate evaluation; attractively and dynamism of the on-line study material; support of distance learning; higher motivation and stimulation for students; higher prestige of the institution; standardized tuition and teaching environment; cost-effectiveness for institutions; and smaller demand of computers in the traditional classes. On the contrary, there are certain risks which might contradict with the above mentioned statements. These are: a lack of personal contact; problems with technology; time-consuming and demanding for creation and preparation; study materials available only in an on-line form; sometimes inconclusiveness of feedback; absence of emotions which need to be vented; students' reluctance to study on their own; a necessity to determine a ratio between the face-to-face and distance classes; problems with the guarantee of education of good quality; and a need to evaluate an impact on students.

Nevertheless, at present thanks to the rapid development of wireless technologies eLearning moves to mobile learning (Keegan, 2002). In fact, Park, Nam & Cha (2012) see mobile learning (m-learning) as a new and independent part of eLearning where the education contents are handled solely by mobile technological devices. Table 1 below then presents paradigm shifts between eLearning and m-learning.

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Table 1. Paradigm shifts between eLearning and m-learning

eLearning	m-learning
Wired	Wireless
Static	Mobile
Semi-ubiquitous	Fully ubiquitous
Personalized	Situation-based (solving real-life tasks)
Providing fast feedback	Providing instant feedback
Delayed information sharing	Instant information sharing

(Authors' own source)

The authors of this article see m-learning as a natural expansion of eLearning, which is gaining a new added value by this. In this sense Chen et al. propose Black-board's mobile learn application which is a personalized e-learning system that can cultivate learning abilities using a self-regulated learning assessment mechanism that provides immediate feedback response to students and a heteronomy mechanism that comes from the teacher's reminders (Chen et al, 2013).

The aim of this article is to discover whether university students at the Faculty of Informatics and Management in Hradec Kralove are well-equipped for this new smart learning and whether they use mobile technologies for their studies.

2. SURVEY

2.1 Research Questions

Within a larger survey on the use of mobile technologies and social networks, the authors attempt to find answers to the following two research questions:

1. Are students at the Faculty of Informatics and Management (FIM) of the University of Hradec Kralove well equipped for new m-learning?
2. Do they use mobile technologies for their studies?

2.2 Material and Methods

In the winter semester of 2014-15, 317 FIM students were given online questionnaires in order to discover whether they are well-equipped for this new smart learning and whether they use mobile technologies for their studies. The research tools used were as follows:

- online questionnaires;
- descriptive statistical methods of processing the results of the survey; and
- a comparison method of descriptive measures in analyzing the results of the survey.

All students submitted the questionnaires. 159 of them were males and 158 were females, out of which 184 (58%) respondents studied full-time while 133 (42%) of them were part-time students. The biggest group of the students were between 20-29 years old (194 respondents/ 61%), followed by 81 respondents (26%) who were under 19 years old. Then there were 28 respondents (9%) between 30-39 years old and only 13 respondents (4%) were between 40-54 years old.

The main fields of study of the respondents at FIM included: Applied Informatics (AI3); Information Management (IM3); Financial Management (FM); and Management of Tourism (MCR).

2.3 Findings

Within a larger survey focused on mobile devices and social networks, the respondents were asked five questions which were connected with those two research questions mentioned above.

Question 1: What technological devices do you own?

As Fig. 1 below shows, most of the respondents (197 students/62%) own a notebook, followed by a smartphone (145 students/46%) and television (133 students/42%). Then 116 students (37%) have a mobile phone and 108 of them (34%) also have a personal computer.

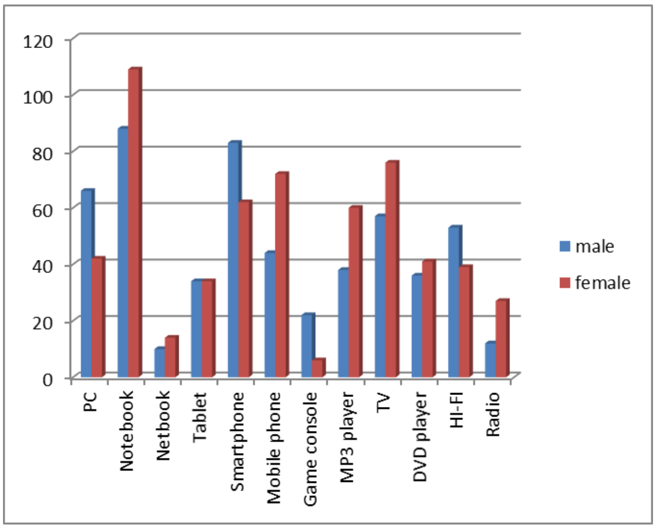

Figure 1. Respondents' ownership of technological devices

Question 2: What technological devices do you use for communication at school/work?

Only in this question students have a limited number of options and could choose only four technological devices. Almost all respondents (297 students/94%) prefer the face-to-face communication. A considerable majority of the respondents (260 students/82%) also use a notebook for their communication; and more than half of them (206 students/65%) a smartphone. Then less than half of the respondents use a mobile phone (154 students/49%). See Fig. 2 below for more information. Fig. 2 also shows that there are no differences between men and women in their preferences for face-to-face contact and using a notebook for communication. However, there are noticeable differences in using smartphones and mobile phones.

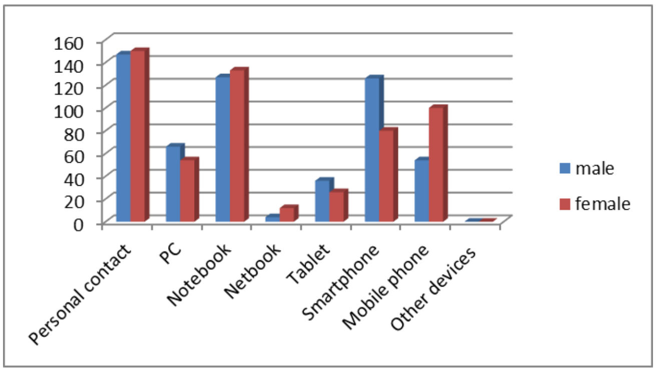

Figure 2. Respondents' communication tools at school/work

Question 3: What technological devices do you use for your university studies?

283 respondents (89%) exploit for their university studies their notebook. 159 respondents (50%) then use their smartphone and 118 respondents (37%) use their personal computer. Far fewer respondents (62 students/20%) also use a tablet for their studies and 55 respondents (17%) a mobile phone. As it has been already stated in Question 2, men in comparison with women prefer smartphones while women rather use mobile phones.

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Question 4: What technological devices do you use for your other studies?

As in Question 3, students use mostly a notebook (271 respondents/86%). This is then followed by using a smartphone (169 respondents/53%) and a personal computer (126 respondents/40%). A number of respondents also watch television (96 students/30%). Then 69 respondents (22%) also study with the help of their tablet and 54 respondents (17%) also use a mobile phone. See Fig. 3 below for further illustration.

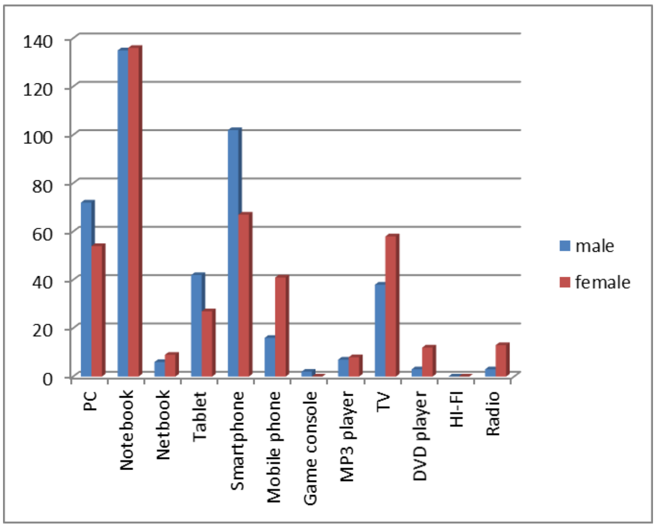

Figure 3. Respondents' technological devices for other studies

Question 5: What sources of information do you use for your university studies?

As far as this question is concerned, 291 respondents (92%) use electronic materials from their Blackboard online course and almost the same number of the respondents (288 students/91%) attend lectures. In addition, 222 respondents (70%) study materials available on the Internet and 199 respondents (63%) use materials on university web pages. 162 respondents (51%) still go to the library to borrow the study materials. But as Fig. 4 indicates, the majority of them are females (106 students/65%). Then other sources of information used by the students are below 50% as Fig. 4 shows.

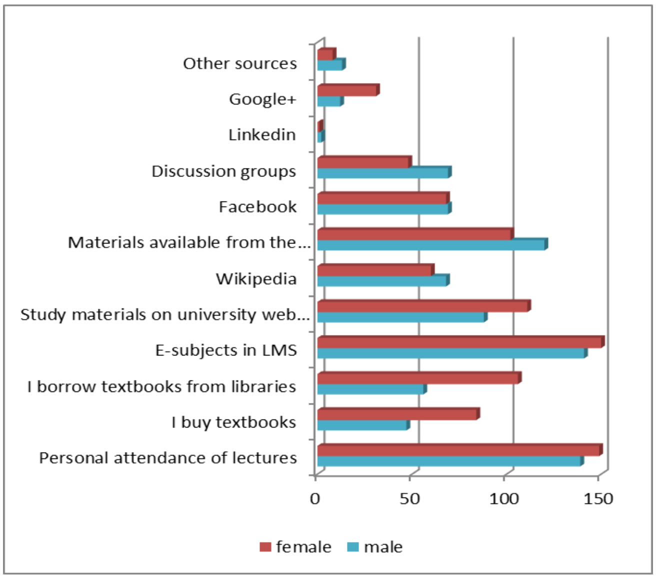

Figure 4. Respondents' sources of information for their university studies

3. DISCUSSION

The findings of the survey show that students are well equipped with mobile devices for their possible m-learning studies. This is also confirmed by other research studies ((Ozdamli and Cavus, 2011) or (Cheung, 2015)) who claim that nearly all students nowadays own mobile devices and about half of them own more than one.

Although 94% of students still refer face-to-face communication, they also use a notebook and a smartphone. Furthermore, they use in particular these mobile technologies for their university and other studies. Not surprisingly, women due to their nature, tend to use mobile phones more because they are usually more communicative than their male counterparts. On the contrary, men who want to catch up with the latest technological gadgets prefer smartphones.

In addition, the sources of information for their university studies indicate that al-most all students use both electronic materials and face-to-face lectures to complete their studies successfully. This is in fact a trend nowadays because the most common form of learning at tertiary institutions is blended learning. Blended learning seems to be on its rise and well established delivered methodology since more and more universities are becoming aware of its benefits such as greater access to students, economical use of faculty space, time and costs (cf. (Porter et al., 2013)).

4. CONCLUSION

The findings of the survey confirmed a positive attitude to the mobile devices. In fact, they are already integrated into daily life, they support distance, lifelong, authentic learning (EDUCUASE, 2010). And thanks to their other attributes such as portability, ubiquity or instant information sharing, they are very popular among the present (young) generation. Thus, it seems that m-learning is gradually taking over eLearning studies. Nevertheless, to make this m-learning really efficient and effective, the developers of mobile technologies should take into account the following aspects:

- *Portability*: The technology is available whenever the user needs to learn.
- *Individuality*: The technology can be personalized to suit the individual learner‘s abilities, knowledge and learning style, and is designed to support personal learning rather than general office work.
- *Unobtrusiveness*: The learner can capture situations and retrieve knowledge with-out the technology becoming overly noticeable or imposing on the situation.
- *Availability:* The learner can use the technology anywhere, to enable communication with teachers, experts and peers.
- *Adaptability:* The technology can be adapted to the context for learning and the learner‘s evolving skills and knowledge.
- *Persistence:* The learner can use the technology to manage learning throughout a lifetime, so that the learner‘s personal accumulation of resources and knowledge will be immediately accessible despite changes in technology.
- *Usefulness:* The technology is suited to everyday needs for communication, reference, work and learning.
- *Usability:* The technology is easily comprehended and navigated by people with no previous experience using it.

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A FUNDAMENTAL STUDY FOR EFFICIENT IMPLEMENTAION OF ONLINE COLLABORATIVE ACTIVITIES IN LARGE-SCALE CLASSES

Ryuichi Matsuba[1], Yusei Suzuki[2], Shin-Ichiro Kubota[3] and Makoto Miyazaki[4]
[1]*Institute for eLearning Development, Kumamoto University, Japan*
[2]*Department of Clinical Psychology, Shigakukan University, Japan*
[3]*Department of Computer Science and Systems Engineering, University of Miyazaki, Japan*
[4]*Faculty of Education, Kio University, Japan*

ABSTRACT

We study tactics for writing skills development through cross-disciplinary learning in online large-scale classes, and particularly are interested in implementation of online collaborative activities such as peer reviewing of writing. The goal of our study is to carry out collaborative works efficiently via online effectively in large-scale classes with more than one hundred students. In this short paper we describe our recent progress of a survey of relevance between a peer reviewing activity and students' characteristics with the perception obtained from investigation of earlier studies regarding the grouping method. We conduct questionnaire surveys regarding the learning style, students' characteristics and adaptability of peer activities, and recognize the perception can adapt to most of students we supposed. Also from the perception if we employ an online collaborative activity in the large-scale classes by using our supporting tool, we consider that it is better to group students arbitrary under a certain condition. We propose a grouping method in which a student pairs with peers who submit his/hers assessment report around the same time as the student hand in own report. We think the grouping may powerfully act the group formation in large-scale classes we supposed, because the grouping need not to demand any additional task for instructors such as preliminary survey of students' characteristics or learning styles widely used in any collaborative learning.

KEYWORDS

Computer-Supported Collaborative Learning, Learners' Characteristics, Group Formation for Peer Activities

1. INTRODUCTION

As is well known collaborative learning activities make a significant contribution to progress of students' deep learning (Beetham and Sharpe 2013). Particularly, it is considered that reviewing or grading among peers whether blind or un-blind plays a significant role of progress in learning of technical writing skills and thinking (Boud, et al. 2001). It unfortunately has specific difficulty to carry out successfully, because there are troublesome tasks for instructors, for example if we conduct blind peer grading, we need to deliver a submitted report by a student to blind peers, then back marks with comments from the peers to the student. Also the activities have subliminally troubling aspects. If we make a group composed students who are dislike or strange collaboration among others, then a collaborative activity may not perform as intended.

There are many researches of computer-supported collaborative learning (e.g., Wessner and Pfister 2001). It supports not only to save the troublesome task, but also to be helpful for students to facilitate both knowledge and skill refinement, since peers more than instructors may be required for the refinement (e.g., Cho and MacArthur 2010). Recently many instructors may recognize that the computer-supported peer activities provide an alternative to the traditional approach of practices with feedback from an instructor or a teaching assistant. In fact, a computer-based grading with peers has been practiced even in some large-scale writing classes of MOOCs (Massive Open Online Courses, Balfour 2013). There also are reports for student grouping in collaborative learning (e.g., Alfonseca et al. 2006). The reports discuss relationships between students' performance in collaboration and the composition of a group depending on students' characteristics including learning style (Zurita et al. 2005, Deibel 2005). Most of them are based on empirical practices or heuristics testing. It is considered that a grouping method shown in a report may depend on circumstances such as number of students in the class, subject matter, etc., so that the method cannot always work well in any class.

We study tactics for writing skills development through cross-disciplinary learning, particularly are interested in online large-scale classes, like MOOCs. We conduct the study in two aspects: One is development of a supporting tool for peer activities via online which provides relieving care of instructors to expense for both receiving and delivering essays among students in the large-scale classes (Matsuba et al. 2014). The other is a survey of preliminary findings for effectively implementation of the activities focusing on both grouping and students' characteristics adoptive to the collaborative works. In this short paper we describe our developed online collaborative activity support tool briefly, then show our recent progress of a survey of relevance between a peer reviewing activity and students' characteristics.

2. A SURVEY FOR GROUPING IN AN ONLINE LARGE-SCALE CLASS

The goal of our study is to carry out collaborative works via online efficiently in large-scale classes with more than one hundred students. We conduct to design and construct a course introduced online peer works. It the effort to the development, we have developed a supporting tool that can automate the painful processes of both receiving and delivering assessment reports among classmates when we carry out peer grading anonymously (Matsuba et al. 2014). The tool is a module of open source learning management system Moodle, so instructors can install it into their Moodle freely and introduce online peer works in their class more easily than that with other computer-supported collaborative learning systems. We also study how well group members work together, and how better to group, because we would provide students the activities as possible as we can.

From investigation of earlier studies regarding the grouping method we obtain some perception as follows;

- Groups composed by students with similar characteristics including knowledge, skills, and interests tend to be better at achieving specific learning tasks,
- Students usually tend to work peers with similar characteristics, if an instructor permits to choice group members by themselves,
- Low-achieving students can learn more in a group composed by students with different (not similar) characteristics than in the group composed by students with similar characteristics,
- High-achieving students can make learning outcomes equally in any group,
- Students, beginners in particular, have difficulty in criticizing friends and perceive grades given by peers to be arbitrary,
- Students worry about variations in how criteria are interpreted, distrust peers' evaluation abilities,

(e.g., Williams, 1992, Webb et al. 1997, Brindley and Scoffield 1998 Zurita et al. 2005). In addition, the research of the relationship between peer works and learning styles of Felder-Silverman (Felder and Silverman 1988) suggests that

- Learning styles seem to affect the performance of the students when working together,
- There is not any clear correlation between the dimensions of the learning styles,
- The tendency seems to be that groups/pairs in the active/reflective and the sensing/intuitive dimensions can work better,

(Alfonseca et al. 2006). Also we understand the efficient number of students in a group empirically. It is that three persons in a group works efficiently, because if we set up four persons in a group, then contribution by a person tends to be little, on the other hand, in two persons group sometime argument may not settle into a consensus. With the perception we consider that if we employ an online collaborative activity like blinded peer reviewing in the large-scale classes by using our supporting tool, it is better to group students arbitrary under a certain condition by three students. We often provide an assessment report submission term for a few weeks so that some of the students upload it in Moodle within a few days, but some of them are in deadline. If we impose a peer activity in the assessment, it is convenient for students to pair with peers who hand it in around the same time. We name such group formation is "marathon like grouping".

In order to reconfirm the perception described above and study relevance of marathon like grouping, we conduct questionnaire surveys regarding with the learning style, students' characteristics and adaptability of peer activities. The object persons are the attending students of a medium-scale class less than fifty where we impose a blinded peer reviewing with a rubric in an assessment, and the questionnaires in the surveys are referred on the results of some different researches (Felder and Silverman 1988, Kikuchi 2007, Pintrich et al. 1991). We can recognize the perception is roughly valid. It means that, though there are some exceptional students, we consider the perception can adapt to most of the students. It is also shown that students with visual style feel available comments by peers, and having high self-efficacy for peer activities. They think peer activities are to be favorable learning activities for them. It is interested that we envisaged that there may be positive correlation between sociality and self-efficacy in peer work, but unfortunately we cannot find clear result for such prediction. We have an indication that we should avoid to employ un-blind peer works if there are many students with high scored social skills in a class, because they tend to hesitate to exchange of unrestrained criticism and comments. When we compare efficacy in progress of students learning between grouping based on students' characteristics or learning styles and marathon like grouping, we consider that the big difference does not reveal whichever we employ. The questionnaire to ask the composition of his/her group members in both grouping implies that even if we may take the marathon like grouping, distribution of students in groups tend to be roughly similar to those we make groups based on students' characteristics. Thus we think the marathon like grouping may powerfully act the group formation in the large-scale classes we supposed, because the grouping need not to demand any additional task for instructors such as preliminary survey of students' characteristics or learning styles widely used in both classroom collaborative learning and computer-supported collaboration. It also found that many of the students have times to discuss or make the report of the assessment with his/her friends having similar characteristics as preparation of the peer work. It indicates that if we announce implementation of a blind peer work beforehand, then students may have twice peer activities including a preliminary work spontaneously. These are tentative consideration so we will try to use the grouping in a large-scale class and, continue to study about such students' behavior more carefully.

3. CONCLUDING REMARKS

We have studied tactics for writing skills development through cross-disciplinary learning in online large-scale classes. We particularly are interested in implementation of online collaborative learning such as peer reviewing of writing. The goal of our study is to carry out collaborative works via online effectively in large-scale classes with more than one hundred students. We conduct the study in two aspects: One is development of a supporting tool for peer activities via online which provides relieving care of instructors to expense for both receiving and delivering essays among students in the large-scale classes. The other is a survey of preliminary findings for effectively implementation of the activities focusing on both grouping and students' characteristics adoptive to the collaborative works.

In this short paper we show our recent progress of a survey of relevance between a peer reviewing activity and students' characteristics with the perception obtained from investigation of earlier studies regarding the grouping method. We show the results of questionnaire surveys regarding the learning style, students' characteristics and adaptability of peer activities. We recognize the perception can adapt to most of students we supposed. Also from the perception if we employ an online collaborative activity in the large-scale classes by using our supporting tool, we consider that it is better to group students arbitrary under a certain condition. We propose a grouping method named marathon like grouping in which a student pairs with peers who submit his/hers assessment report around the same time as the student hand in own report. We think the marathon like grouping may powerfully act the group formation in the large-scale classes we supposed, because the grouping need not to demand any additional task for instructors such as preliminary survey of students' characteristics or learning styles widely used in any collaborative learning. We will try to use the grouping in collaborative works of an online large-scale class in the next survey.

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ENCOURAGING USER PARTICIPATION IN BLENDED LEARNING: COURSE REORIENTATION

Alea M. Fairchild
KU Leuven Campus Brussels, Warmoesberg 26, 1000 Brussels, Belgium

ABSTRACT

Blended learning, structured as a combination of traditional course instruction and additional supporting multimedia course content, can be used in higher education for a variety of reasons. In the case study that we examine, the introduction of blended learning was initiated three years ago with the purpose of creating more resources for coach-student interaction for a heterogeneous graduate student group. However, course results from this academic year have shown a disengagement of the users from the course materials and a reduced number of students submitting the final work for the course. In this research-in-progress, we are exploring why the students have stopped engaging with the course materials at midterm and will try to address how the course could be reoriented to better meet its objectives.

KEYWORDS

Blended learning, course design, engagement, structure, orientation.

1. INTRODUCTION

Blended learning is an integration of face-to-face and online learning experiences; it is not just finding the right mix of technologies or increasing access to learning, although a secondary outcome may be increased efficiency and convenience for students and professor (Garrison & Kanuka 2004). There is evidence that blended learning has the potential to be more effective and efficient when compared to a traditional classroom model (Heterick & Twigg 2003, as cited in Giannousi et al. 2009); Twigg 2003).

The specific problem this research is addressing is the case of a graduate level course where blended learning was introduced for purposes of both effectiveness in meeting student needs and efficiency for a growing programme from a scheduling perspective. Assessment of the course is done via four learning activities, a draft submission of the thesis proposal, and a final submission of the thesis proposal which is graded on a pass or fail basis.

Through assessment, educational strategists can determine how effective their lessons are in teaching students the intended facts and skills (Ballera, Lukandu & Radwan 2014). Assessment designs can greatly influence the learning of the students. It can also be a tool for data gathering and the results gathered can help teachers decide on the performance of the students (Scalise & Gifford 2006). In this case, the assessment activities gave us insight into what level of engagement the students had with the interactive course, and at what point the students stopped interacting with the course materials. In compared to years prior to the structural change for blended learning, we have been losing effectiveness in a lack of engagement.

In seeing both the decline in submissions of the final proposal, as well as a decline in course usage, we determined that the course structure as it is currently is not meeting the objectives of the course in the graduate programme, and that we needed to assess structurally what is not working and how we can reoriented the course structure to better meet the needs of the programme and the students.

This research-in-progress paper is structured to explain the nature of the problem, highlight what literature and tools we will be using for the analysis, and what initial findings we have established as to how to rectify the situation for the coming academic year.

2. LITERATURE REVIEW

The loss of motivation and engagement of students for blended course have been extensively discussed in the literature. Although blended learning offers various advantages in higher education settings, many studies have shown that blended learning also has many disadvantages. One of the biggest problems in blended learning is to maintain students' engagement and motivation throughout the course (Holley & Oliver 2010). In order to decide which factors decide students' engagement and motivation for blended learning, it is necessary to identify blended learning components.

According to Holden and Westfall (2010), there are three main components in blended learning that affect students' learning outcome and satisfaction: instructional, media, and learning environment components:

1. Instructional Component: Used to choose the most appropriate instructional strategies to support the learning objectives. In other words, instructional strategies are the products of learning objectives and ensure the learning objectives to be attained. Therefore, instructional quality is crucial to attain students' learning outcome.
2. Learning Environment Component: A learning environment can be synchronous or asynchronous and aims at ensuring the most optimum use of resources to achieve the instructional goal and learning objectives.
3. Media Component: Media are vehicles that deliver content of instruction.

Reigeluth (1983) provides specific illustration of instruction design: "The discipline of instructional design is concerned primarily with prescribing optimal method of instruction to bring about desired changes in student knowledge and skill" (p.20). Instructional outcome is the way to evaluate whether the instruction enhances students' learning and reaches the purpose of the course design. Instructional outcome are classified in three categories:

1. The effectiveness of instruction, measured by the level of student achievement (defined in various methods).
2. The efficiency of instruction, measured by the effectiveness divided by student time and/or by the cost of the instruction.
3. The appeal of instruction, measured by the tendency of students wanting to continue to learn. (Reigeluth 1983, p.20).

3. CASE STUDY – PROBLEM OVERVIEW

The graduate programme in question is designed for non-economic academic graduates offering a deep insight into all major disciplines of business economics and management. This progamme has an incoming student intake from a very heterogeneous educational background in terms of both previous degree and nationality, and therefore starts with a preparatory term to get all of the students to the same graduate level on several basic subjects prior to their main course work.

The preparatory course *Research Proposal Master Thesis* (RPMT) has been designed to supports the first phase of the completion of a master thesis. The course was developed in 2007-2008 academic year as an introductory course on business research with the purpose of project management for the master thesis. The students must submit a written research proposal where they identify a research question and draft, develop and complete a research proposal. Acquiring a critical research attitude is the leitmotiv throughout the course.

The course accounts for 3 credits (ECTS) and is graded by an academic coach using a framework that the students have access to from the beginning of the course. Note that the master's thesis accounts for 15 ECTS and is evaluated by the thesis supervisor. There are eight coaches for the course and each coach supervises from 25 to 30 students. Online learning materials such as documents and videos are used to transfer knowledge to students, as well as two actual lectures by the Professor who coordinates the course coaches.

In the current academic year, there has been several challenges as the class size was rather large and there were not enough thesis topics or supervisors initially for the incoming class. We believe this may be part of the lack of submission problem shown in Figure 1.

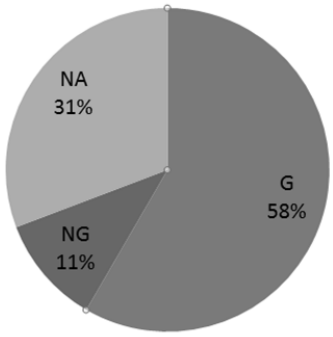

Figure 1. Results of grading students' research proposal for January exam session (G = pass, NG = fail, NA = no submission)

Given its preparatory role, the course is not currently achieving its objectives. Another problem is that many students appear to have reduced motivation for the course. The course materials (online documents, videos, screencast) are useful to assist students to do their RPMT submission; however, after the deadline for submitting their provisional research proposal at midterm, most of the students neglected the course as shown in Figure 2.

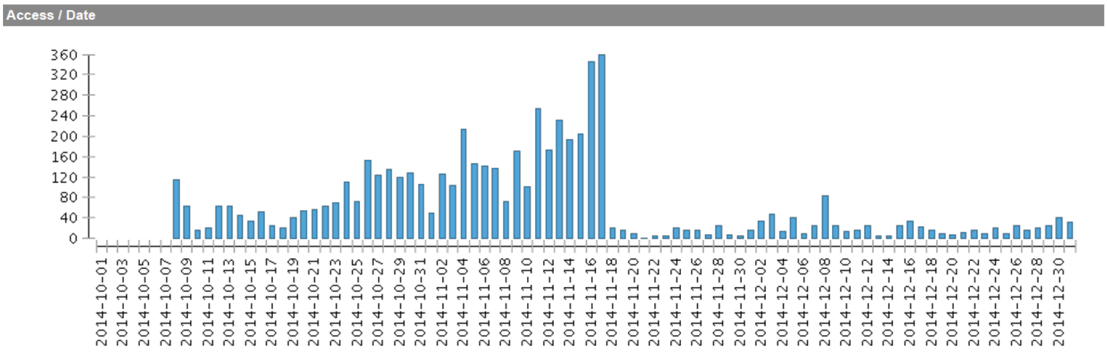

Figure 2. The frequency of students accessing to the course materials

4. RESEARCH APPROACH AND METHODOLOGY

Given the problems discussed with the course, the research questions are designed to address two issues:

1. What are the problem(s) with instructional design of this course that may cause the disengagement?
2. How can this course be therefore redesigned in order to achieve its objectives?

In order to address these questions, the initial methodology has been document analysis to analyze the course materials (texts, website, videos, and screencasts). Merrill First Principles of Instruction is being used as the theoretical framework to evaluate the course and design intervention to address problems because many researchers have shown that First Principles of Instruction can enhance students' learning outcome, engagement and satisfaction (Frick et al. 2007; Gardner 2011).

These are descriptions of Merrill First Principles of Instruction principles:

- **Problem-centered:** Learning is promoted when learners acquire skill in the context of real-world problems or tasks.
- **Activation:** Learning is promoted when learners activate existing knowledge and skill as a foundation for new skills.
- **Demonstration:** Learning is promoted when learners observe a demonstration of the skill to be learned.
- **Application:** Learning is promoted when learners apply their newly acquired skill to solve problems.

- **Integration:** Learning is promoted when learners reflect on, discuss, and defend their newly acquired skill. (Merrill 2012, p.21)

5. CURRENT STATE OF RESEARCH

The first step was a meeting with the course professor to go through a structured interview using the framework of Merrill's First Principles of instruction. The two items which were not positive were:

- Does the instruction require learners to use their new knowledge or skill to solve a **varied sequence** of problems or complete a varied sequence of tasks?
- Does the instruction provide techniques that encourage learners to integrate (transfer) the new knowledge or skill into their everyday life?

After structured interviews with the professor of the course and examining the course materials and reviewing the literature, the initial assessment using the framework of Holden and Westfall (2010) is that the course encounters problems with instructional design such as the effectiveness of instruction and the appeal of instruction (Reigeluth 1983) which hinder the course to achieve its objective.

The faculty members involved in the course are now working to examine how to redesign the instructional components, including shortening the videos and renovating the content to reframe the knowledge and skills provided to better resonate with the students. This will be discussed during the conference presentation.

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ASSESSING PROBLEM SOLVING COMPETENCE THROUGH INQUIRY-BASED TEACHING IN SCHOOL SCIENCE EDUCATION

Panagiotis Zervas[1], Sofoklis Sotiriou[2], Rüdiger Tiemann[3] and Demetrios G. Sampson[4]
[1]Department of Digital Systems, University of Piraeus, 150, Androutsou Str., GR 185 32 Piraeus, Greece
[2]Ellinogermaniki Agogi, Dimitriou Panagea Str. GR 153 51 Pallini Attikis, Athens, Greece
[3]Department of Chemistry, Chemistry Education, Humboldt-Universität zu Berlin, Brook-Taylor-Str. 2, 12489 Berlin, Germany
[4]School of Education, Curtin University, Kent Street, Bentley WA 6102, Australia

ABSTRACT

Nowadays, there is a consensus that inquiry-based learning contributes to developing students' scientific literacy in schools. Inquiry-based teaching strategies are promoted for the development (among others) of the cognitive processes that cultivate problem solving (PS) competence. The build up of PS competence is a central objective for most compulsory education (K-12) curricula and a critical competence for both professional career readiness and effective citizenship. A widely accepted framework for assessing individual students' PS competence at large scale is PISA 2012 Problem Solving Framework (PSF). Nevertheless, PISA 2012 PS competence assessment is primarily summative (one-off assessment) and disconnected from the daily school science teaching practice. Within this context, the aim of this paper is to address this issue by proposing a framework for incorporating assessment tasks of PISA 2012 PSF to the various phases of an inquiry teaching model. This framework sets the ground for supporting domain specific assessment of students' problem solving competence during day-to-day school science teaching practice.

KEYWORDS

School education, science education, inquiry-based learning, PISA 2012 problem solving framework

1. INTRODUCTION

Science education plays a critical role in societies' competitiveness and economic future (Lewis & Kelly, 2014). Developing scientific literacy in compulsory school education requires preparing students in four main strands, namely (Alberts, 2009): (a) to know, use, and interpret scientific explanations of the natural world, (b) to generate and evaluate scientific evidence and explanations, (c) to understand the nature and development of scientific knowledge and (d) to participate productively in scientific practices and discourse.

Within the rich literature on this topic, there are many studies that recognize the advantage of authentic learning practices such as inquiry-based learning towards developing students' scientific literacy (Crawford et al., 2014; Gormally et al., 2009). More specifically, inquiry is the process in which students are engaged in scientifically oriented questions, perform active experiments, formulate explanations from empirical evidence, evaluate their explanations in light of alternative explanations, and communicate and justify their proposed explanations (National Research Council, 2000). To this end, inquiry-based teaching models are recognized as appropriate teaching strategies to support deep understanding of subject domain knowledge and prepare students to apply this knowledge in novel real-life situations (OECD, 2013). Thus, to be able to measure (among others) the effectiveness of inquiry-based learning, assessment of students' problem-solving competences is needed (Scherer & Tiemann, 2014).

A widely accepted framework for assessing individual students' problem solving competence is the PISA 2012 Problem Solving Framework (PSF), which has been developed by the Organization for Economic Co-operation and Development (OECD) to address the need for cross-nationally comparable evidence for student performance on problem solving (OECD, 2013). However, PISA 2012 problem solving competence assessment is primarily summative (one-off assessment) and disconnected from the daily school science teaching practice. Within this context, the aim of this paper is to address this issue by proposing a framework for incorporating assessment tasks of PISA 2012 PSF to the various phases of an inquiry teaching model. This framework set the ground for supporting domain specific assessment of students' problem solving competence during day-to-day school science teaching practice.

2. INQUIRY BASED LEARNING

Inquiry-based learning is often organized into inquiry phases that together form an inquiry cycle. However, different variations on what is called the inquiry cycle can be found throughout the literature (Pedaste et al., 2015). A widely used inquiry learning model is the 5E Model, which lists five inquiry phases, namely Engagement, Exploration, Explanation, Elaboration, and Evaluation (Bybee et al., 2006). In our work, we have adapted the 5E Model by considering also the inquiry cycle proposed by Bell et al. (2010). More specifically, according to Bell et al. (2010), the following inquiry phases have been adopted:

- **Orienting and Asking Questions:** This phase involves the presentation of the problem to be engaged with and aims to provoke curiosity.
- **Hypothesis Generation and Design:** This phase involves the formulation of initial hypotheses from the students based on their own reason and current understanding of the matter at hand.
- **Planning and Investigation:** This phase involves the collection, analysis and organization of the research/experimentation processes and the related tools/resources that will facilitate these. This can be discovered by the students or provided by the teacher.
- **Analysis and Interpretation:** During this phase, the learners engage in experimentations following the processes outlined in Phase 3 and utilizing the tools/resources selected in the same phase.
- **Conclusion and Evaluation:** This phase includes reflective analysis of the learners initial hypotheses based on the newly acquired knowledge and experience. Moreover, it aims to assist learners in gaining a more holistic view of the scenario problem.

3. ORGANISING PROBLEM SOLVING ACTIVITIES IN INQUIRY CYCLE PHASES

The Programme for International Student Assessment (PISA) has proposed a widely accepted framework for assessing individual students' problem solving competence at large scale, namely PISA 2012 Problem Solving Framework (PSF). The PISA 2012 PSF defines four (4) different steps for solving a complex problem namely (OECD, 2013, p. 126), as follows:

- **Exploring and understanding the problem:** this step includes (a) exploring the problem situation (observing, interacting, searching for information and limitations) and (b) understanding the given information and the information discovered while interacting with the problem situation.
- **Representing and formulating the problem:** this step includes (a) selecting relevant information, mentally organizing and integrating with relevant prior knowledge and (b) shifting between representations or formulating hypotheses by identifying the relevant factors.
- **Planning and executing the strategy for solving the problem:** this step includes: (a) clarifying the overall goal and setting sub-goals and (b) devising a plan or strategy to reach the goal state. After that, in the executing phase, the plan is carried out.
- **Monitoring and reflecting the solution:** this final step includes: (a) monitoring the progress towards reaching the goal at each stage including checking intermediate and final results, detecting unexpected events, and (b) reflecting on solutions from different perspectives and critically evaluating assumptions and alternative solutions.

The range of problem solving assessment tasks included in the PISA 2012 PSF allows for describing six levels of problem solving proficiency that can be grouped into three main categories, namely (OECD, 2014, p. 56-60):

- **High Performers (Level 5 and Level 6):** students at this category can: (a) develop complete, coherent mental models of different situations and (b) find an answer through target exploration and a methodical execution of multi-step plans.

- **Moderate Performers (Level 3 and Level 4)**: students at this category can: (a) control moderately complex devices, but not always efficiently and (b) handle multiple conditions or inter-related features by controlling different variables.
- **Low Performers (Level 1 and Level 2):** students at this category can: (a) answer if a single, specific constrain has to be taken into account and (b) partially describe the behavior of a simple, everyday topic.

In order to be able to assess students' problem solving competence (following the PISA 2012 PSF) within the context of inquiry-based learning, it is essential to incorporate appropriate assessment tasks in the various phases of the inquiry cycle (as specified in section 2). Table 1 presents our proposed framework, which comprises: (a) the mapping between the problem solving steps and the inquiry cycle phases (specified in section 2) and (b) proposed guidelines for developing assessment tasks towards assessing each of the problem solving steps at the different phases of the inquiry cycle.

Table 1. Mapping between PISA 2012 problem solving steps and Inquiry Cycle Phases

Inquiry Phases	PISA 2012 Problem Solving Steps	Guidelines for Preparing Assessment Tasks
Orienting and Asking Questions	Exploring and Understanding the Problem	1. Deal with the representation of the problem 2. Deal with relevant information to understand the problem 3. Deal with different levels of understanding of subject domain knowledge
Hypothesis Generation and Design	Representing and Formulating the Problem	1. Deal with the exploration of correlations and dependencies 2. Deal with a precise description of the focused problem
Planning and Investigation	Planning and Executing the Strategy for Solving the Problem	1. Deal with the correct strategies of experimentation 2. Deal with strategies of variable control 3. Deal with strategies for data analysis
Analysis and Interpretation	Monitoring and Reflecting the Solution	1. Deal with application or transfer of problem tasks 2. Deal with possible sources of experimental errors 3. Deal with enhancement of experimental setting
Conclusion and Evaluation	-	-

4. CONCLUSIONS

In this paper, we demonstrated a framework for incorporating and contextualizing within the various phases of an inquiry cycle, the PISA 2012 problem solving framework for assessing individual student's problem solving competence. However, the use of this framework calls for taking up some future challenges, which could be summarized as follows

- **Methods for assessing PS competence:** different methods can be used ranging from traditional paper and pencil assessments (multiple choice, constructed or open response items) to student logs, artefacts and portfolios (Hickey et al., 2012). Additionally, in contrast to the PS competence that is supposed to be subject-independent, the assessment tasks should be designed, so as to be subject-domain oriented and embedded in the respective discipline (Scherer & Tiemann, 2014).
- **Support science teachers for implementing effective assessment of their students' PS competences:** This needs to be addressed by appropriate teacher professional development activities, which should not be constrained only to the process of selecting suitable assessment methods and developing effective assessment tasks, but they must also address science teachers' teaching attitudes that can be a significant barrier to the implementation of the assessment of their students' PS competences (Timmers et al., 2013; Webb et al., 2013)

It is worth mentioning that the aforementioned framework is currently being exploited by a major European Initiative, namely the Inspiring Science Education (ISE) Project (http://www.inspiring-science-education.org/), which aims to assess students' PS competence at large scale, namely by involving a large number of schools, teachers and students from 13 EU member states. More specifically, the ISE project aims to develop a set of digital tools that can support the authoring and delivery of technology-enhanced science lessons which incorporate students' problem solving competence assessment (with appropriately designed multiple choice items) as part of the different inquiry phases during daily science teaching practice.

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MUSIC AS ACTIVE INFORMATION RESOURCE FOR PLAYERS IN VIDEO GAMES

Marian Nagorsnick and Alke Martens
Institute of Computer Science, University of Rostock, Albert-Einstein-Str. 22, 18059 Rostock, Germany

ABSTRACT

In modern video games, music can come in different shapes: it can be developed on a very high compositional level, with sophisticated sound elements like in professional film music; it can be developed on a very coarse level, underlying special situations (like danger or attack); it can also be automatically generated by sound engines. However, in all these approaches, no active adaptation of musical elements to user activities can be found. Context dependent and adaptive music elements are no longer background or emotional support structures, but transform to information resources, which can be actively used by the user. Thus, they become a kind of human computer interface. In this paper, we focus on music as active information resource in video games and game-based learning systems.

KEYWORDS

Music, information, human computer interaction, auditory interface, video games.

1. INTRODUCTION AND ANALYSIS OF GAMES

Up to date video games and game-based learning systems are dominated by visual output and mostly rely on the visual interface to pass information to the player (see Nagorsnick (2012)). Even if this meets the user's expectations in most cases, it does not satisfy the multimedia potential video games have reached by now. The possibility of playing video games without loss of information with the volume turned off is characteristic for the majority of them. The graphical user interface or GUI – as part of the visual interface – provides the player with useful information, often permanently throughout the entire game. Optionally the player can blend or hide parts of the information. Nowadays, video games use special processors on the graphic cards in the computer, to generate the computation intensive visual information, like the background of a virtual world, the non-player characters' movement etc.

In some video games the player must keep track of information at all times. This becomes even more important if time is a crucial game element, e.g. as part of a strategy. Often video games contain such a large amount of relevant information that the GUI is about to become confusing. In really bad cases, the rendered virtual reality is hidden behind all the information-conveying GUI-elements. The cognitive effort to keep track of all this is comparably high, whereas the bandwidth of cognitive input is comparably low (restricted to vision, excluding auditory feedback) (see for example Mousavi et. al. (1995)). Brewster (1994) points out that "[sound] is a useful complement to visual output", because it can "reduce the amount the user has to perceive through the visual channel". Alty (1995) argues, that the use of music in Human Computer Interface design should be considered. And like studies by Brewster (1994), experiments with music representing hierarchical menus (LePlâtre, 1998) or navigation with music (Jones, 2006) show that music is well suited to convey information to the listener. Music as part of the auditory interface of the video game is mostly only used to enhance the atmosphere experienced by the player. If it would be possible to shift some relevant information from the GUI to the music, three effects might be reached:

1. Take human information processing to another level (audio adding to video), potentially also allowing multitasking, and make the game more interesting as multiple cognitive levels are addressed.
2. Reduction of cognitive load on the pure visual level (GUI elements can be reduced).
3. Relieve the visual system of the player an intensify the game experience.

For this approach, we decided to get rid of automatic music generation using Algorithmic Composition techniques, like e.g. in the algorithmic music generators FractMus and SoundHelix (see http://www.gustavodiazjerez.com and http://www.soundhelix.com, last visited June 2015). In contrast to this, our approach is based on human musical compositions for certain situations, combined with an algorithm which steers an automatic situation adaptation and an automatic overlay of compositional parts, to achieve the “music” intended by the human composer as the result, instead of simple alerts in form of earcons or auditory icons (see e.g. Blattner (1989), Brewster (1994), Gaver (1986)).

Music is a regular part of most video games. Either it is specifically written for the video game or it is chosen from public music. As a first research step, we made an analysis of different computer games and investigated the use of music there. For the first step of the investigation we selected 7 major titles, namely: *Dragon Age 2*, *Mass Effect 2*, *Command & Conquer 3: Tiberium Wars*, *Dawn of War II - Retribution*, *Sim City 4*, *Unreal Tournament 3* and *Tekken 6*. All this titles are commercially successful and representative for their genre. We found that the main purpose of the (background) music in this games is to enhance the atmosphere perceived by the player (e.g. tension). To convey information to the player, the investigated games used pre-recorded voice messages, GUI-elements (for instance text or health bars) or graphical elements as part of the virtual scene. To achieve a broader view we also examined videogames with a more intense use of music. The games are *Flower, Auditorium*, *Loom*, *Audiosurf, Guitar Hero 3* and *SingStar Vol. 1*, for which music is a key element of the gameplay. And although those games’ music emerges from mere background music towards a more central role it neither carries exclusive information. We found that among all the examined video games and genres only music games (in this case *Guitar Hero 3* and *SingStar Vol. 1*) established music as an active information resource.

The next step in our research was to extract situations where music can be used as information resource. We chose the CRPG genre as a basis for this investigation, because it combines a large amount of different elements that can be found within the game, e.g. the story told and the story turns, emotions, characters, battles, useable skills, quests, riddles and so forth. Sometimes time is a crucial factor too. And on top of it CRPGs tend to make extensive use of music to fit optimally into the atmosphere. Altogether we examined 9 video games of the CRPG genre, each 3 for a sub-genre. The Classic-CRPGs are *Baldur’s Gate II: Enhanced Edition*, *Dragon Age: Origins* and *Star Wars: Knights of the Old Republic II*. The Action-CRPGs are *Diablo III*, *Dust: An Elysian Tail* and *Titan Quest*. Hybrid-CRPGs, that combine elements of both Classic- and Action-CRPGs, where picked with *Dark Souls: Prepare to Die Edition*, *Mass Effect* and *The Elder Scrolls V: Skyrim*. Some of those feature some special elements but in general they have much elements in common, which we called CRPG-elements. A detailed explanation of this CRPG-elements can be found in (Nagorsnick, 2014). With this CRPG-elements we established a foundation for our approach to make music an adaptive and active resource of information, since information is created by those elements. How this foundation is used exactly will be covered in the following section.

2. MUSIC AS ACTIVE RESOURCE OF INFORMATION

As noted by Collins (2007), moving smoothly from one musical piece (so called cues) to another assists in the continuity of a game and the illusions of gameplay. The current methods applied to video games use pre-recorded musical pieces that are played in a loop or cross-faded to switch between the pieces (Collins, 2008). The problem is that “adjacent” audio files have to match in harmony and time signature (respectively measure) during crossfade, so they can’t cause unintended disharmony or rhythmical stumbling (see e.g. Reese (2012), Collins (2007), Nierhaus (2009), Shan and Chiu (2010)). We decided to take another direction and thus we will introduce Algorithmic Transition as branch of Algorithmic Composition.

The main idea behind is to utilize aesthetical understanding and creativity of human composers in order to skip the boundaries of computable creativity and all difficulties of Algorithmic Composition techniques. To achieve this goal, a human musician composes a certain number of compositional parts. With these parts the final music can be compiled by an algorithm. For this algorithm, we need to define rules, e.g. to define, which parts can be played together (vertical transition) or how parts have to be merged in time (horizontal transition). Next the algorithm has to keep up the compositional coherence during transitions and therefore being able to manipulate the compositional parts the music consist of. This ability of manipulation or alteration of music is also the key to use music as active information resource (Nagorsnick, 2014).

The first concepts are music events, which we consider as auditory events in a musical context, and musical components. Music events can be atomic or molecular. An atomic music event is a single, sounding musical tone or a single rest. They are called atomic because they can't be divided any further. A molecular music event, like a sounding melody, consists of at least two atomic music events. Furthermore each music event needs three musical components: tone, time and timbre. This means that a music event needs a defined pitch (e.g. *C''*), a temporal information that determines when and how long the event occurs (e.g. first semibreve in the first bar) and at last a timbre (e.g. pianissimo cello), that makes the music event sound.

The second concepts are musical parameters, which we consider as modifiable qualities of music events. Like music events, we distinguish between atomic and molecular musical parameters. The former can only be applied to atomic music events, whereas the latter can only be applied to molecular music events. One example: The atomic musical parameter pitch can only be applied to a single sounding musical tone (e.g. *a'*). Pitch would make no sense if applied to a sounding melody that combines multiple pitches. In addition a musical parameter can affect two musical components at a max. Would it affect all three musical components it would be a music event per definition.

To be able to make use of it, we need game events – the third concept. We see game events as derivations of the discovered CRPG-elements. They cause state changes within the virtual reality and are the source of the information actively conveyed to the player by music.

To show the applicability of our approach, we chose three CRPG-elements. To be able to investigate music as active information resource we modelled a virtual test environment using the game engine *Unity3D*. The game events we derived from the chosen CRPG-elements were implemented in the test environment, whereas each game event influences the music via rules provided by a pattern language. Those rules determine which musical parameter is to be used for manipulation and how, e.g. (molecular) melody for major-to-minor change. Furthermore they define when and for how long a manipulation is done. This way we wanted to ensure that the compositional coherence is always kept up. Figure 1 illustrates this by taking the length – measured in bars – of musical themes (each triggered by another game event) into account, both for horizontal and vertical transitions.

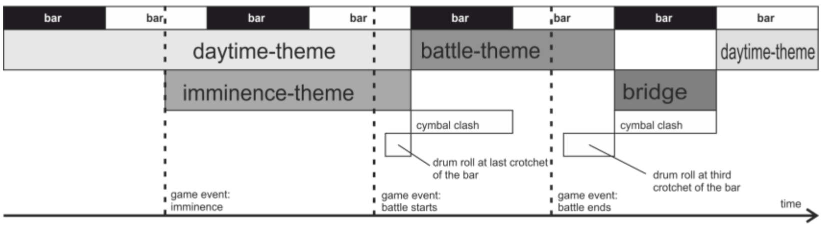

Figure 1. A schematic view for a possible battle scenario.

To be able to make use of the manipulation of music events by musical parameters, we passed music in form of symbolic data to the algorithm, similar to MIDI or MusicXML. To raise our musical themes to the level of music events we used audio samples, representing atomic music events, e.g. a note played pianissimo by a cello. These atomic music events are finally combined to molecular music events conveying information to the player, of course depending on the actual musical themes that in turn depend on game events.

3. CONCLUSION AND OUTLOOK

With our virtual environment we achieved a first successful use of music as an active information resource in video games with the help of Algorithmic Transition. Hence all musical themes are based on a handful of human-composed themes. The rest is successfully created by Algorithmic Transition. The manipulation of music events by means of the musical parameters is working like intended. No music event causes disharmony or other flaws regarding compositional coherence interfered with the experienced gameplay. Even if the audio quality can be improved, our first approach of using Algorithmic Transition to make music an active information resource in video games was successful.

In our current research, we'll put the formal model on a firmer ground and look at the user's performance with musical support (in the form of some smaller evaluations and user observations).

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MAKING CONSTRUALS AS A NEW DIGITAL SKILL FOR LEARNING

Meurig Beynon[1], Russell Boyatt[1], Jonathan Foss[1], Chris Hall[1], Elizabeth Hudnott[1], Steve Russ[1], Erkki Sutinen[2], Hamish Macleod[3] and Piet Kommers[4]
[1]*University of Warwick, UK*
[2]*University of Eastern Finland, Finland,*
[3]*University of Edinburgh, UK,*
[4]*Helix-5, The Netherlands*

ABSTRACT

Making construals is a practical approach to computing that was originally developed for and by computer science undergraduates. It is the central theme of an EU project aimed at disseminating the relevant principles to a broader audience. This involves bringing together technical experts in making construals and international experts in educational technology in organising wide-ranging learning activities. This paper, which complements the tutorial and discussion on making construals in (Beynon et al. 2015a, 2015b), documents issues that arise from this encounter. Its central argument is that making construals offers a significant new contribution to educational technology.

KEYWORDS

Construal; computing education; educational technology; constructionism; software development; radical empiricism

1. MAKING CONSTRUALS

Making construals is a new digital skill that can be seen as complementary to ‘writing computer programs’. The key characteristics of making construals are introduced in (Beynon et al. 2015a), a tutorial paper in which the use of JS-EDEN, a prototype online environment for making construals (the “MCE”), is illustrated by making an elementary construal of shopping activity (a “Shopping construal”). As discussed and illustrated in (Beynon et al. 2015a), many variants of the Shopping construal can be developed with relatively modest computing expertise. These include traditional educational resources that might be used to scaffold learning in teaching ‘life-skills’ and simple educational games.

Making construals is the practical core of a well-established research project (Empirical Modelling 2015) that was first developed for – and by – computer science students at the University of Warwick. It is currently the theme of an EU Erasmus+ project (“CONSTRUIT!”) aimed at dissemination to a wider audience. Adapting resources that were originally conceived for computing specialists for this purpose has entailed a significant shift in emphasis. Though the technical development of the MCE and the construals described in (Beynon et al. 2015a, 2015b) is being led by members of the CONSTRUIT! team at Warwick, it has been informed through dialogue with expert international consultants in educational technology and by several collaborative project activities, including workshops with schoolchildren at SciFest in Joensuu, Finland and with schoolteachers in Athens. This abbreviated version of (Beynon et al. 2015b) summarises the diverse issues that have been raised in this process. These summaries do not necessarily represent a consensus view of the consultants, but inform an agenda for subsequent discussion.

The focus for CONSTRUIT! activity over the first year has been on showing that comprehending and making construals is potentially accessible to the non-specialist. The discussion of a Shopping construal in (Beynon et al. 2015a) illustrates the key principles and techniques involved. Our previous experience of teaching undergraduate computer students to make construals (cf. (Empirical Modelling 2005)) suggests that novices typically begin by exploring an existing construal that is connected with their chosen topic of investigation, and develop their skills through making adaptations. In some cases, this leads them to take ownership of the construal through making their own extensions. In any event, once students have developed the ability to understand and extend someone else's construal, they have the basic competence to start making their personal construals from scratch.

As illustrated in the derivation of a simple game from the Shopping construal in (Beynon et al. 2015a), if we have some explicit extension, modification or specialisation of an existing construal in mind there are three stages in the adaptation:

- **conception**: without reference to the precise syntactic form and structure of their definitions, draw up a plan for the conceptual reorganisation of observables. This may entail re-disposing or replicating visual components, revising existing observables and actions, and possibly introducing new observables and actions.
- **identification**: identify the precise names and definitions of the observables and agents to be adapted through open-ended interaction with the construal. This activity exploits the range of viewers that are available in the MCE – such as the Observable- / Function- / Agent- / Symbol-Lists and Dependency Maps. Domain knowledge may also be helpful in guiding the search activity.
- **reconfiguration**: having identified the relevant observables and agents, modify their definitions according to the plan drawn up at the **conception** stage.

The most important consideration in this process of comprehension and adaptation is that the transition from the initial construal to the revised construal takes place in the maker's stream-of-thought. That is to say, all interactions with the construal, whatever their status (exploratory interactions, revisions, tests, experiments, corrections, aberrations, etc) are conducted with reference to the live construal and its real or imagined referent as depicted in Figure 1.

In practice, the above sequence of stages would not necessarily be followed strictly. Prior identification and exploration of observables and agents in the construal might be required in order to make a plan for revision. In an ambitious development there would also be many phases of the conception-identification-reconfiguration sequence. The MCE provides support for generating the current script (to be saved in the external file system) and for recording intermediate states which the maker can restore if needed.

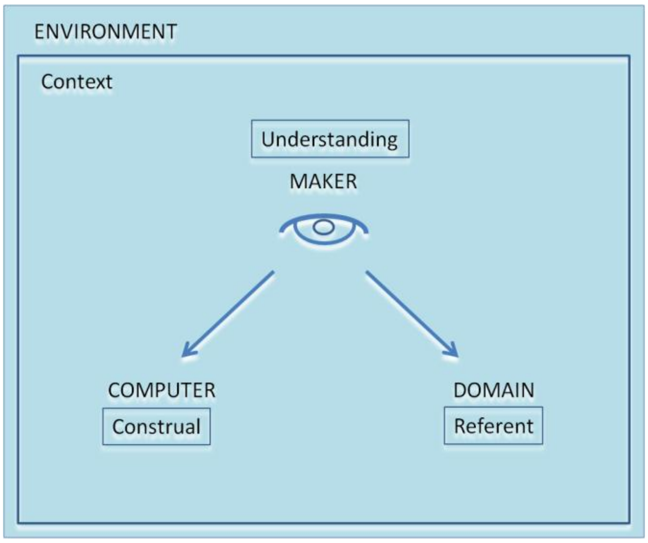

Figure 1. Making a Digital Construal

Figure 1 depicts the relationship between construal and referent as it is experienced by the maker as of one moment in time. The maker's understanding of this relationship, which gives the construal its informal meaning, is built up through interaction with the construal and its referent as these evolve over time. This understanding incorporates expectations about the impact of an interaction that are based on knowledge gained from prior experiment. The maker can in principle change observables in an unconstrained fashion, but in practice only makes such interactions as help to establish and refine understanding of the relationship between the construal and its referent. Refinement will typically involve exploring the perspective of different agents. In the Shopping construal, the customer is not in general able to fix the price of the items for sale for instance – this is a decision for the shopkeeper. The integrity of the construal relies on certain

assumptions about the stability of the context for interaction. For instance, we would not buy perishable fruit by mail order, and in some cultures the price of items would be negotiable. The most appropriate semantic framework for the making activity in Figure 1 regards all semantic relationships as pragmatically determined and rooted in the connections that can be made in the personal experience of the maker. As explained in (Beynon et al. 2015a, 2015b), this is the fundamental tenet of William James's radical empiricism:
"… the parts of experience hold together from next to next by relations that are themselves parts of experience. The directly apprehended universe needs, in short, no extraneous trans-empirical connective support, but possesses in its own right a concatenated and continuous structure."

The Meaning of Truth (James 1907, reprinted 1975), Preface: p.xiii.

2. MAKING CONSTRUALS AS AN EDUCATIONAL TECHNOLOGY

Making construals establishes a close link between how we think about a subject domain ('how we *construe* a situation') and how we might develop software to simulate behaviours and address problems drawn from that domain. In this respect, it represents a new way in which to realise program-like behaviours. When we write a program, its behaviour is prescribed in accordance with a specification. The specification need not be preconceived; it may be fluid and evolving. But – though it may be implicit – it is always present, if only (as in an agile development) as 'what the software does now'. A construal by contrast is an informal representation of the playground for agency within a situation as we currently conceive it. In the construal, there are counterparts for the patterns of agency and interaction that we encounter through experience and experiment. And where the interactions with a program are constrained by a user-interface that is closely aligned with its specification, the ways of interacting with and interpreting a construal are open-ended and informed by what 'makes sense' in the maker's imagination.

Previous papers have built on these ideas to argue that making construals is a 'radical new conception' in educational technology (see e.g. (Beynon 2007)). Educationalists, having seen so much hype around the latest technologies, have a proper scepticism about such claims to novelty. Their wariness may reflect the influence of traditional computer science thinking: from a perspective informed by elementary exercises in programming, developing software can be conceived as 'implementing algorithms to fulfil a preconceived formally specified functionality', and there is an abstract mathematical sense in which any two correct implementations are equivalent. In reality, orthodox thinking about software is very ill-suited to themes such as constructionism (Papert 1980; Beynon & Harfield 2010), adaptable open educational resources (Wikipedia 2015) and transformative practices in online teaching (Ross et al. 2013; Beynon & Zhu 2013). An aspiration for the CONSTRUIT! project is to give an account of computing that does fuller justice to these well-conceived and important educational initiatives and supplies a more appropriate grounding for their practices.

There are many different ways in which construals can contribute to learning about a domain. Making a new construal of your own can be a way of learning, as can interacting with an extant construal. There is much affinity between the skills required for making a new construal – as outlined in the discussion of learning *how to* make construals above – and those required for exploring an extant construal. In the latter context, the focus is on how we learn about a domain or a referent *by* making or adapting construals.

Making construals encourages the learner to adopt an unusual stance. Much technology to support learning is associated with bodies of knowledge that have been well-documented and formalised. The learner's interactions are staged within a frame that has been carefully prepared, possibly even so that there is an intended 'correct' path to follow. The archetypal context for making construals is one in which the learner is invited to act with greater autonomy. Making the connection between a construal and a referent that is depicted in Figure 1 is a personal matter that draws on different aspects of the learner's experience. The concern is not only with what the learner directly observes but with its resonance with everything else to which they are sensitive. And whilst the learner is led to identify observables and dependencies in the role of a model-builder, this is with a view to appreciating the subtlety and richness of their immediate experience of the domain more fully. In sharp contrast, the objective for traditional model-making is to find simplifying mechanisms that can be applied to the referent to serve the specific goal in hand. What is abstracted from the referent in this way is in effect detached from the domain.

In analysing how students learn to program in languages such as Lisp, Prolog, Smalltalk and Logo, three aspects of experience are significant:

- prior experience of implementing algorithms;
- what is being directly experienced in interacting with the tutorial environment;
- what intuitions have been acquired through experience of the subject domain.

In evaluating the quality of the learning experience, it is the way in which these different kinds of experience are brought together that counts. In particular, these three ingredients of experience guide the learner in making the links between familiar and new concepts.

In making construals, the above aspects of the learner's experience have counterparts that are respectively associated with the modeller's understanding, the evolving construal and its emerging referent. A distinctive feature of the MCE is the degree of active control it gives over the way in which these elements are brought together in the learner's experience (cf. the way in which visualisations of states and views of observables can be freely configured). This encourages the student to actively control and optimise the balance between prior and new ("restructured") concepts.

Learning to make construals entails a reorientation that presents a challenge of somewhat the same kind that is associated with adopting a declarative rather than a procedural approach to programming. Not all students will welcome this reorientation, but it potentially has unique value for learning. This stems from the emphasis on helping the learner to rethink topics that might initially appear trivial. This is particularly well-illustrated in the large body of project work that has been developed using the previous variants of the EDEN interpreter (Empirical Modelling 2006; Empirical Modelling 2013) and has yet to be replicated in the online MCE. By way of illustration, consider the construals of heapsorting (Beynon 2008a), elementary group theory (Beynon 2008b) and the Clayton Tunnel railway disaster (Chan & Harfield 2008).

3. THE TECHNOLOGICAL PERSPECTIVE

The relationship between making construals and other established technologies is complex. Many technologies appear to be addressing closely related agendas and delivering superficially similar products.

Making construals is significant as paradigmatic for a particular way of exploiting computer-based technology. Where computational thinking focuses on activities for which the archetype is 'a mind following a rule' (Hodges 2002), making construals is concerned with 'a person making sense of a situation'. The transition from informal personal accounts to formal objective understanding is characteristic of such sense-making. Deriving programs from a construal, as illustrated in (Beynon et al. 2015a), is just one instance of how making construals enables this transition to take place seamlessly. In keeping with the notion that "*The directly apprehended universe needs, in short, no extraneous trans-empirical connective support"* the distinction between the informal and formal components in this transition is in the mind of the maker. In one context (cf. Figure 1): 'this is what reliably seems to be the case' and, in another: 'this is what we can confidently deem to be the case'.

The transition from the empirical to formal perspectives is prominent in many settings. It has a critical role in expert systems (Jackson 1998) and design science (Hevner et al. 2004). Working in close proximity to the formal perspective attracts particular interest because of aspirations for automation and AI. By comparison, the human-centred activities associated with making construals serve a potentially less welcome role – making use of computing to provoke us into thinking more deeply.

Polya's reflections on teaching mathematics (Polya 2014) help to highlight the unusual qualities of construals. As Polya observes, though mathematics is done inductively, it is taught deductively. This can make the subject boring, alienating the learner from the researcher. As an environment that can enable the learner to cope with uncertain and chaotic elements, making construals gives valuable support for exposing the empirical roots of formal results. In keeping with Polya's remarks concerning the importance of reflection and review for learning, the history of interactions with a construal also provides an as-if-live record of the processes of rationalisation and problem-solving.

The narrative of making construals is likewise closely parallel to that of design science (Hevner et al. 2004). The learners are developing construals ("design artefacts") and thus constantly relating their work to emerging demands – perhaps from their own imagination (their "local contribution" in design science terms) and finally, and probably throughout the process, adding to the science ("global contribution"). This is a plausible narrative, but makes challenging demands where the nature of the design artefacts is concerned. In (Hevner et al. 2004, p.89), Hevner discusses a mode of describing the design artefact that is based on searching for solutions to a family of design constraints. He then observes that in general finding such a solution is computationally infeasible and proposes to address this by relaxing constraints. Approaches of this nature, which operate with formal specifications and use sophisticated algorithms, give nothing like the delicate control over details of design and nuances of meaning that making construals affords. As in other contexts, claims concerning the character and quality of methods become rhetorical in the absence of appropriate representations.

The problematic aspect of incorporating the principles of making construals alongside more orthodox approaches is that it creates a fundamental ontological conflict. Though the maker may retain the prerogative to say 'this is what we can confidently deem to be the case' this is of no consequence if the integrity of the enclosing environment is predicated on the assumption that it *is* in some absolute sense the case. This helps to explain why merely adding dependency as an extra feature in an otherwise orthodox programming environment introduces problematic semantic issues (cf. (Roe & Beynon 2007; Tomcsanyi 2003)).

One of the objectives for CONSTRUIT! is to enable people other than computing specialists to make their own software applications. This is in the spirit of Mark Hatch's Maker Movement Manifesto (Hatch 2014), which promotes 'making' as an activity that is accessible to all. Hatch's focus is on making physical things, but computing and its associated technologies have a significant implicit role. As he observes: "The tools of making have never been cheaper, easier to use, or more powerful." ... "It may take some practice to get good at some kinds of making, but technology has begun to make creating easy enough that everyone can make.". Curiously, a better understanding of how technology for computing can support *making* is required if Hatch's thesis is to extend to making virtual products. Making construals is helpful in this respect, as might be expected given the character of the applications of spreadsheets in education in (Baker & Sugden 2007).

In the conception phase, making construals somewhat resembles the activities that have been conceived as ways of teaching computer science principles and concepts without using the computer (cf. 'computer science unplugged' (CS Unplugged 2015) and 'Barefoot' (Barefoot Computing 2015)). In effect, describing computing activities in non-technical human terms abstracts away the technically sophisticated apparatus that enables machines to manipulate and 'interpret' real-world observables and dependencies that a human interpreter takes for granted. This shifts the focus of attention from the purely technical to high-level issues more central to good design practice in computing. By way of illustration, consider how adapting the Shopping construal to allow many instances of each item (Beynon et al. 2015a) highlights a limitation in the representation of the stock of items – it does not allow the maker to record the identities of individual items.

4. CONCLUSION

This paper has argued that making construals is a practice, and an approach to software development, that is more accessible and intelligible for the non-specialist than coding (cf. Granger 2015). It has also argued that making construals is better suited to supporting learning and major themes in educational technologies than are the conventional methods and environments for programming.

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A SEMANTIC BASIS FOR MEANING CONSTRUCTION IN CONSTRUCTIVIST INTERACTIONS

Farshad Badie
Center for Linguistics, Aalborg University, Rendsburggade 14, 9000 Aalborg, Denmark

ABSTRACT

Regarding constructivism as a learning philosophy and/or a model of knowing, a person (learner or mentor) based on her/his preconceptions and on personal knowings could actively participate in an interaction with another person (learner or mentor) in order to construct her/his personal knowledge. In this research I will analyse 'meaning construction' within constructivism. I will focus on a semantic loop that the learner and mentor as intentional participants move through and organise their personal constructed conceptions in order to construct meanings and produce their individual meaningful comprehensions. Subsequently, I will provide a semantic framework for analysing the meaning construction based on personal knowings and personal conceptions within constructivist interactions. This research could propose a new scheme for interpretation based on semantics and on interaction.

KEYWORDS

Constructivism, Interaction, Semantics, Conceptualisation, Interpretation, Meaning.

1. INTRODUCTION AND MOTIVATION

An interaction between learners and mentors as intentional participants could exchange questions and answers concerning, e.g., description, specification, explanation, argumentation, analysing, justification, formulation, theorising etc. The multilevel agreement-oriented interactions among learners and mentors could be considered, be interpreted and be analysed based on the models of the underlying processes involved in complex human learning. As such they could be seen as a radical constructivist account of human cognition and comprehension. They are actually shaping a kind of ontology of human beings. They enable learners (and mentors) to develop their own understandings of the complex real underlying systematic processes, and also of themselves [Scott (2001)]. Learning based on constructivism with reference to Conversation Theory, which is designed by Gordon Pask, the enterprise begins with the negotiation of an agreement between learners and mentors to converse about a given domain and learn about some particular topics and skills in that domain. It could work as an explanatory, heuristic and developmental framework. For more detailed information see [Pask (1975), Pask (1980)]. In fact, learning based on constructivism could heuristically be concerned with the questions focusing on 'What is/does ...?', 'Why is/does ...?' and 'How is/does …?'. A person whose insights are based on her/his pre-structural knowledge, personal knowings and preconceptions may ask these heuristic questions and ask the interlocutor to produce some heuristic answers or some modified heuristic questions. What could be offered by learning based on constructivist interaction is a framework for thought and a semantic model to account for the emergence of the domain of human conceptual knowledge. As an abstract model, it is able to explain how the interactions lead humans to construct personal knowledge. In this framework the learner (mentor) manages to construct her/his personal knowledge within interaction. Consequently, s(he) gains an opportunity to attain a deeper personal understanding and greater motivation. According to constructivism, a learner is highly concerned with active 'creation' of personal mental structures. Constructivism requires negotiation of 'meaning' and 'reflection' of prior and new knowledge. Jean Piaget, the originator of constructivism, argued that all learning was mediated by the construction of 'mental objects' that he called schemata. For Piaget, schemata first emerge as concrete actions and then gradually develop into more abstract and conceptual mental entities [Husen and Postlethwaite (1989), Spiro et al. (1991), McGaw and Peterson (2007), Sawyer (2014)].

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In this research I will, from a new perspective, analyse meaning construction as the most significant production of learning based on constructivism. I will analyse the semantic loop that the learner (and mentor) move through in order to construct their personal meanings. I will deal with how the learner (mentor) (i) organises the personally constructed concepts, (ii) produces meaningful meanings and (iii) attains a deeper comprehension. I will finally provide a framework in order to demonstrate different steps of meaning construction based on personal constructed concepts within constructivist interactions.

2. CONCEPT

I emphasise that there is a general problem concerning the notion of 'concept', in linguistics, in psychology, in philosophy, in metaphysics, in computer and information sciences, but, for now, I assume the use of the expression *concept* to be comprehensible in the context. Walter Parker[1] writes: "concepts are the furniture of our minds. A well furnished mind is a source of success and lifelong learning. When a student forms a concept from its examples, he or she knows more than the definition of a term. This is deep conceptual learning rather than superficial knowledge of a vocabulary word." He also says that "a concept is defined by critical characteristics shared by all examples of the concept. For something to be an example of a concept, it must contain all these critical characteristics" [Parker (2008)].

Generally a concept is an unifying theme for something. In ontology a concept is a fundamental category of existence. Following [Margolis and Lawrence (2011)], concepts could be understood as the mental representations, where concepts are entities that exist in the brain. They could also be understood as abstract objects, where objects are the constituents of propositions that mediate between thought, language, and referents. In my research, a concept is an idea which corresponds to some 'distinct entity' or 'class of entities' or to its 'essential features and attributes'. It can determine the application of a term (especially a predicate), and thus plays a part in the use of reason or language [cf. Rudolph (2011), Baader et al. (2003)]. Analytically a concept as a linkage between linguistic expressions and the mental images (representations of the world, of inner experiences etc.) that humans have in their minds [Götzsche (2013)]. I focus on concepts (classes) because concepts and the relationships between them are used to establish the basic terminology adopted in my modelled pedagogical domain regarding the hierarchical structure. For example, relying on Description Logics [Baader et al. (2003)], the concept 'Mentor' can be analysed as a concept description (descriptions mainly follow the inductive rules) that demonstrates the mentor as a person who has a learner and the learner is a person. Formally: $Mentor \equiv Person \sqcap \exists hasLearner.Person$. This concept construction is able to support the formal, explicit specification of a shared conceptualisation of Mentor based on the constructor's conceptions.

3. DEFINITION & DEFINITENESS

A definition could semantically be seen as a kind of equation whose left-hand side is a concept and whose right-hand side is a description. They are used to introduce symbolic names for complex descriptions. In a pedagogical system learners and mentors could define something based upon multiple concept descriptions. Actually, these definitions could be constructed based on their own conceptions and background knowings. Logically, a set of definitions is (and must be) 'explicit' and 'unequivocal', ie. not vague and not ambiguous. In fact, 'explicitness' and 'unequivocality' are the prerequisites and preconditions for definiteness. So, actually, a set of someone's definitions in a category of her/his constructed concepts could provide a backbone for any construction. Then the provided backbone supports the person in defining more complex concepts and descriptions over abstract concepts. Subsequently, the learner (mentor) could employ inductive rules on her/his personal definitions of abstract concepts in order to produce more complex definitions for more complicated described concepts. For example, considering the description '$MaleMentor \equiv Person \sqcap Male \sqcap \exists hasLearner.Person$', the '*MaleMentor*' has been defined by being associated to a description.

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[1] http://teachinghistory.org/teaching-materials/teaching-guides/25184

4. SEMANTIC INTERPRETATION

Generally the act of elucidation, explication and explaining the meaning of something is called interpretation [Simpson and Weiner (1989)]. Humans need to attempt to provide a way to determine the truth values of sentences. Linguistically, interpretation is the continually adjusted relation between the conventional meanings of sentences/statements and the actual mental universe of the individual (based on accumulated experience of that individual). Logically, an interpretation is an assignment of meanings to non-logical symbols. For instance, it can not assign meaning to logical symbols {Not ($\neg$) , And ($\sqcap$), Or ($\sqcup$), Equality (=), Equivalency ($\equiv$)}. Actually we can not assign any meaning to a description until the non logical symbols are given interpretations. Considering C and D as two concepts and $R(C,D)$ as any possible binary relationship between them, one could have different types of interpretations based on them. More specifically, the interpretation I assigns to C a set that contains the interpretation(s) of C, and it also assigns to R a binary relation between the elements of two sets (interpretation(s) of C and interpretation(s) of D). Actually, in translating from an informal (commonly English) language into a formal language, we need to provide symbolisation keys, which are the interpretations of all the non-logical symbols we use in the translation, see [Prior (1955)]. In case a given interpretation could assign the value TRUE to a sentence (or theory) that interpretation is called a *model* of that sentence (or theory). In fact, designing a proper model can make the definitions adequate.

5. INTERACTION & MEANING CONSTRUCTION

A person who undertakes to learn (train) something within a constructivist interaction primarily focuses on ’concept formation’. S(he) initiates to ask some questions and answer other questions asked by the interlocutor. In my research, the most significant necessity of modelling meaning construction in a constructivist interaction is to consider the personal mental structures (schemata). They have been created regarding what the participants (both learner and mentor) have been affected by. The person inductively develops her/his mental entities. The learner (mentor) finds new concepts for herself/himself. Hearing different words from the interlocutor could be conducive to new conceptions. A person may have formed a concept before participating in the constructivist interaction and then, regarding the feedbacks produced by interlocutor, tackles to reform them. So, in fact, ’forming’, ’transforming’ and ‘reforming’ concepts are three significant matters in constructivist interactions. The individual has to ‘generalise’ from different examples and this may lead her/him to discovering new concept(s). S(he) searches for and lists attributes and properties that can be used to distinguish exemplars from non exemplars of various concepts (classes). But what s(he) really does is more than generalising from different examples that s(he) hears or produces. More specifically, s(he) identifies, specifies and relates the generalised examples and ‘compares’ different examples. In fact, a very efficient way to form a new concept and induce new categorisation rules in constructivism is to compare a few individuals when their categorical relation(s) is known. On the other hand, s(he) could be able to make her/his personal labels of categorising the concepts in order to direct and employ different classes of concepts.

5.1 The Semantic Process

At the beginning the person proposes some ’schemata’ as different types of concrete actions. Then s(he) gradually develops and divides them into more abstract concepts (conceptual entities). A proposed schema describes a pattern of the person’s thought. I have already said that s(he) could either categorise different concepts or follow the categorised concepts. So, in fact, her/his proposed schema could support her/him in managing those concepts. I label the first semantic phase *Concept Construction* (presented in the Figure 1), where the individual constructs her/his personal concepts and conceptions based on her/his personal schemata. Subsequently, s(he) needs to focus on the ’reflection’ of prior knowledge (what have been acquired/created before interacting) and new knowledge (what is being acquired/created during the interaction) and the initial meanings. So, in fact, s(he) ‘searches for the (initiative) meanings’ of the class/ classes of constructed concepts and their significant relationships. See *‘Search for Meaning’* in the Figure 1. So s(he) defines her/his constructed concepts and searches for the initial definitions for the constructed concepts. Consequently, s(he) focuses on the ’interpretation’ of the initial meanings and definitions. From the logical point of view, the interpretation of a constructed concept is a 'function'. Generally this function assigns a 'meaning' to a 'symbol'. Formally: *Interpretation: Meaning* → *Symbol*. The Interpretation functions operate the person's definitions based on her/his constructed concepts. Therefore, they 'activate' the meanings. This phase is presented as *Semantic Interpretation* in the Figure 1. Accordingly, concerning *'Interpretation: Meaning* → *Symbol'*, meaning is the product of the inverse of interpretation function (*Symbol* → *Meaning*). I label this phase *Meaning Balancing* (see the Figure 1). There is a strong relationship between Semantic Interpretation and Meaning Balancing. The person could be able to balance and adjust the initial meanings based on the interrelationships between 'interpretation' and 'inverse of the interpretation'. The conclusions make an appropriate background for verifying the personally found meanings based on personal constructed concepts. Meaning Balancing is quite supportive in balancing the personal definitions and vice versa, see *'Meaning Formulation'* in the Figure 1. The person formulates the balanced meanings based on the balanced definitions for her/his personal constructed concepts. There is an appropriate relationship between formulated meanings and balanced definitions. In fact, a meaning would be given a better shape after checking the balanced definitions. The formulated meanings organise and reinforce the mental structures that the learner (mentor) uses them, as the pattern of her/his thought, in order to develop the individual conceptual knowledge. Subsequently, the formulated meanings are some applicable prerequisites for *Meaningful Conceptual Structuring* (see Figure 1) upon personally formulated meanings based on personally constructed concepts. On the other hand, the meaningful conceptual structures could induce new formulated meanings on higher conceptual levels (presented by the dashed arrow in the Figure 1). And, furthermore, the new formulated meanings are considered as new schemata in constructing higher levels of conceptions. Finally, the meaningful conceptual structures support her/him in providing meaningful meanings. The meaningful meanings highly reflect on the constructor and support her/him in proposing the modified schemata on higher conceptual levels. So, the person moves through this semantic loop in order to organise her/his personal constructed concepts and construct her/his personal meanings and produce meaningful meanings.

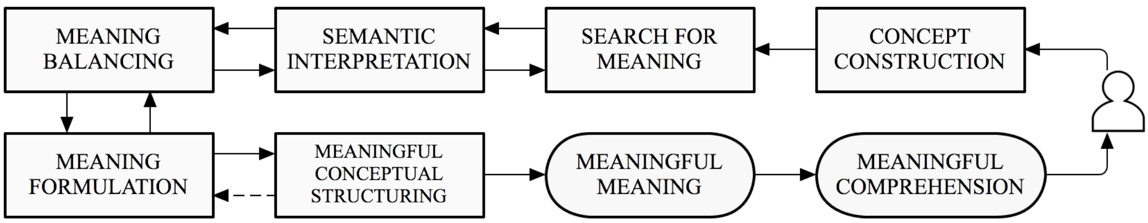

Figure 1. Meaning Construction Within Constructivist Interactions

6. CONCLUSIONS AND FUTURE WORK

Constructivism has been known as a learning philosophy and/or a model of knowing. Concerning constructivism, two persons whose insights are based on their preconceptions and on personal knowings can actively participate in an interaction. The most important objective is to construct their personal knowledge, to learn from each other and to train each other. Therefore, they have an opportunity to attain a deeper personal understanding, comprehension and greater motivation. In this research I have focused on 'meaning construction' as the most significant production of learning based on constructivism. I have worked on a semantic loop that the intentional participant in a constructivist interaction moves through. S(he) constructs her/his personal concepts based on concept formation, defines them (produces individual definitions based on constructed concepts), and organises concepts and definitions in order to construct meanings and produce meaningful meanings. Meaningful meanings support her/him in constructing knowledge, producing meaningful comprehension and reacting more appropriately in front of the interlocutor's acts. I have provided a framework for analysing meaning construction based on individual comprehension and personal concept constructions within constructivist interactions. In fact, the proposed loop semantically transforms multiple constructed concepts into meaningful meanings (and meaningful comprehensions). It could be observed as a new scheme for interpretation based on semantics and on interpretation. Obviously, the proposed semantic loop is self-organised. Equivalently, it promotes itself on higher conceptual levels.

In future research I will focus on the logical analysis of meaning construction within constructivist interactions and work on its formal semantics. I will employ some fundamental descriptions in Concept Language (Description Logics : DLs) in order to analyse multiple semantic concepts within my progress and provide a DLs based formal semantics for analysing meaning construction in constructivist interactions. Subsequently, I will be concerned with semantically analysing meaning construction based on personal knowings and personal concept constructions in constructivist interactions. I will check the validity of the logical descriptions in conceptualising constructivism concerning the 'Structure of Observed Learning Outcomes (SOLO)'. The consequences will make a backbone for better conceptualisation of human's understanding. And, the results will be employed in the analysis of formal semantics in terminological knowledge for pedagogical knowledge representation systems. They can conceptually analyse pedagogical developments in the framework of constructivism and in the context of interactions for promoting human's understanding.

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Reflection Papers

EXPLORING TECHNOLOGY SUPPORTED COLLABORATIVE AND COOPERATIVE GROUP FORMATION MECHANISMS

Mia Čarapina[1] and Ivica Botički[2]
[1]*University of Applied Sciences, Zagreb, Vrbik 8, 10000 Zagreb, Croatia*
[2]*University of Zagreb, Faculty of Electrical Engineering and Computing, Unska 3, 10000 Zagreb, Croatia*

ABSTRACT

This paper reflects on the systematic literature review paper (in progress), which analyzes technology enhanced collaborative and cooperative learning in elementary education worldwide from 2004 to 2015, focusing on the exploration of technology mediated group formation. The review paper reports on only few cases of technology supported methods of group formation, since in the majority of analyzed papers groups are mostly formed before the activity by teachers or researchers. This paper suggests a novel approach by proposing an adaptive model for technology supported group formation.

KEYWORDS

Collaborative learning, elementary education, collaborative group formation

1. INTRODUCTION

Collaborative learning is "a situation in which two or more people learn or attempt to learn something together" (Dillenbourg 1999), whereas in cooperation partners split the work, solve sub-tasks individually and then assemble the partial results into final output (Johnson & Johnson 1999). In order to work together members can be grouped based on various parameters such as gender, learning style or aptitudes forming homogenous or heterogeneous groups. In the context of time groups can be periodically active (for example every week) or continuous through the whole period of the activity. Furthermore, group members can even change during the activity.

This paper focuses on the exploration of technology supported methods of group formation before or during the collaborative or cooperative activity, focusing on elementary education worldwide, analyzing results obtained from a literature review research paper (in progress). The review paper resulted in 118 articles addressing technology supported collaborative and cooperative learning in elementary education of which 5 report on system mediated group formation.

2. GROUP FORMATION MODEL

Based on the review results, the authors detected and defined four methods of group formation which is either organized before the activity or mediated during the activity by the system: 1) system mediated heterogeneous pre-grouping (Huang et al. 2011) where learners are assigned to groups by the system based on their responses to a learning styles questionnaire given before learning activities, 2) random pre-grouping by the system before the activity (Wyeld et al. 2012), 3) dynamic grouping (Nussbaum et al. 2009) as defined by Zurita (Zurita et al. 2005) where members are grouped "during collaborative activity for reaching a given educational objective", and 4) a variant of dynamic grouping (Wong et al. 2011; Boticki et al. 2013) where groups are dynamically established prior to the learning activity. Selected papers are presented in the Table 1.

Table 1. Research papers with automatized group formation and the accompanying grouping characteristics.

Article	Time of group formation	Group characteristics	Group formation
(Nussbaum et al. 2009)	During the activity	Heterogeneous	Dynamic and random
(Wong et al. 2011)	Pre-organised	Heterogeneous	Random
(Huang et al. 2011)	Pre-organised	Heterogeneous	Random
(Wyeld et al. 2012)	Pre-organised	Heterogeneous	Random
(Boticki et al. 2013)	Pre-organised	Heterogeneous	Random

The authors of the paper propose an adaptive model for dynamic group formation (Figure 1). In order to form the groups, the system collects the data about individual learners using this model. The data is analyzed and processed with an adequate learning analytics algorithms and adaptation module to be later used in forming adequate groups for collaborative or cooperative tasks. Once the activity starts, the system collects both individual and group data and dynamically regroups peers if needed. Regrouping outcome can be the termination of group work in order to start individual work assignments, merging of two or more different groups or the combination of group members with members of another group.

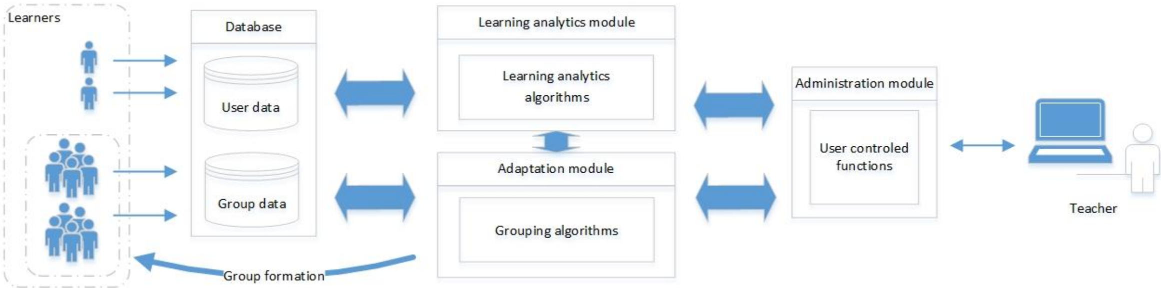

Figure 1. The adaptive grouping mode

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DEVELOPING SELF-REGULATED LEARNERS THROUGH COLLABORATIVE ONLINE CASE DISCUSSION IN EDUCATIONAL PSYCHOLOGY

Dr. Patricia P. Willems and Dr. Alyssa Gonzalez-DeHass
Florida Atlantic University

ABSTRACT

Case study instruction is characterized by centering instruction around the use of hypothetical classroom dilemmas. It uses descriptive stories and invites students to discuss application of course material as they engage in hypothetical classroom problem-solving and teacher decision-making. Teaching is a complex profession that requires high levels of multitasking in order to successfully instruct students and handle classroom disruptions. Because most pre-service teachers do not possess extensive classroom experience when enrolled in teacher education, working with case studies provides opportunities to test theoretical concepts and speculate on making decisions that would affect their future classrooms. The purpose of this paper is to discuss the elements of case study instruction that we have found to be effective in encouraging online learner's self-regulated learning for educational psychology.

KEYWORDS

Case instruction, online learners, educational psychology

1. INTRODUCTION

Case study learning can be viewed as a constructive approach to teaching in which learning, from a sociocultural perspective, takes place in context. Because cases can be written from various perspectives, they offer instructors a multitude of real-world scenarios from which students can learn from while also demonstrating the collaborative nature of teaching by illustrating how a teacher works jointly with the school principal, guidance counselor, and students' parents in order to assist students (Ching, 2011). The use of case instruction in educational psychology, in particular, is a "natural fit" with constructivist principles that views learning as "interactive, socially constructed, collaborative, and problem-related (Sudzina, 1997, p. 207). In addition, case-study instruction has many benefits including student learning, problem-solving, decision-making, critical thinking, self-efficacy for educational situations, cognitive flexibility, and perspective-taking as well as enlightening them to the complex nature of teaching (PytilikZillig, et al., 2011; Ching, 2011; Sudzina, 1997). The published literature discusses a number of ingredients for effective case instruction: collaborative learning, case complexity, perspective-taking, scaffolding critical thinking, revisiting cases and authentic assessment.

2. CASE INSTRUCTION AND ONLINE LEARNING

According to the National Center for Education Statistics (NCES), from 2000 to 2008, the percentage of undergraduate students enrolled taking at least one distance education course increased 12% (from 8 percent to 20 percent) (Radford, 2011).This ascending curve in enrollment is projected to continue, thereby presenting the education community with numerous challenges (Allen & Seaman, 2008). Case discussion can be adapted to the online environment and could take place in synchronous or asynchronous discussion boards and chat-rooms. Past research also indicates case studies can have positive results for educational psychology students' involvement, communication, peer support, and reciprocate interaction among stakeholders that includes students, instructors, and cooperating teachers (Bonk, et al., 1998). In fact, students engaged in either traditional or online case discussion improved in their ability to critically analyze novel cases and outperformed students not being taught using case studies (PytlikZillig, et al, 2011). One element of case instruction particularly important to encouraging online learner's self-regulated learning for educational psychology is case complexity (Gonzalez-DeHass, Willems, & Vasquez-Colina, 2014). Case complexity refers to the case's intricacy and ability to engage pre-professional teachers in problem-solving for real-life situations. It is possible that when students see more utility in what they are learning, they are more willing to apply themselves and take an active interest in their learning. This finding mirrors what others have found in that cases can be intrinsically motivating and promote self-regulated learning if they are realistic, personally relevant, and where activities are seen as valuable and interesting (DeMarco, Hayward, & Lynch, 2002).

3. POTENTIAL INSTRUCTIONAL IMPLICATIONS

The purpose for this proposal is to take the elements of case study instruction that we have found to be effective encouraging online learner's self-regulated learning for educational psychology and investigate teaching strategies that can be used to further scaffold and encourage students to work collaboratively with cases in the online environment. This will include discussion of video-based cases to test theoretical knowledge and encouraging students to participate in collaborative discussions. Computer programs allow for video cases to be manipulated by the instructor to add questions at various points in the case, allowing for the instructor to test students' individually or to offer the opportunity for whole-group collaborative discussions in real-time. Instructors could also design sessions in which only small-groups of students discuss a particular case while he or she scaffolds their learning. Or cases could be used as part of a culminating written project where students reflect on their learning as they complete independent authentic case analyses. Using cases in this manner is directly linked to case complexity, offering instructors various ways in which to expose students to real-life teaching challenges, the multiple perspectives of the different stakeholders involved in the case, and the applicability of diverse theoretical perspectives in educational psychology. These potential strategies add to the discussion of how instructors can incorporate case instruction in the online environment most effectively.

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STUDENT'S PERSPECTIVES ON TAKING COURSES ONLINE, BLENDED, OR A COMBINATION

Catherine C. Schifter[1], Dirk Ifenthaler[2] and Daniel White[1]
[1]*Temple University, Philadelphia, PA, U.S.A.*
[2]*University of Mannheim, Mannheim, Germany*

ABSTRACT

Online education has a relatively short history in the grand history of education. With options for online delivery modes developed over the last two decades, understanding student motivations for choosing one option over another will be helpful to any institution of higher education planning new offerings. This reflective paper presents the beginning aspects of a study at one university in the United States, using a prior study from Australia as a guide.

KEYWORDS

Online students, motivation, United States.

1. INTRODUCTION

While distance learning has a long history, offering courses through online options goes back to when the Internet was effectively available through Usenets and the like. Only since 1993 with the advent of the World Wide Web that both synchronous and asynchronous interactions between students and between students and instructors became available (Ifenthaler, Bellin-Mularski, & Mah, 2015). Over the last 20 years, studies in the United States have mostly focused on how higher education faculty perceived either teaching through online or blended options or the reputation of online courses in general (Allen & Seaman, 2013, 2006; Schifter, 2005. And while there is a wealth of research on why students choose their institution of higher education (Harkera, Sladea, & Harkera, 2001; Cebula & Lopes, 1982; Chapman, 1981; Booth, 1997), little research has been concerned with what motivates students to study through different modes of delivery, including face-to-face, fully online, blended between online and face-to-face (Bailey, Ifenthaler, Gosper, Kretzschmar, & Ware, 2015).

In a paper presented at CELDA 2014, Bailey and colleagues (2015) presented a study of Australian institutions of higher education and motivation for students to study in different modes of delivery. The survey asked students taking courses through different modes of study about motivation to take courses through online modes. This study attempts to replicate the same study, but at one U.S. institution, Temple University in Philadelphia.

The research questions for this study are, what factors influence a Temple University student to take a course through online modes of delivery/learning? And, what technologies are used currently, and which would these students like to see used within a course delivered by online modes? Ultimately, outcomes would facilitate sound programmatic planning that accounted for reported student circumstance as well as their technological preferences.

2. METHODS

The survey used by Bailey and colleagues (2015) was adapted and used with Temple University online students. The survey was reviewed by the Office of Assessment, a pilot study was completed in August 2015 to clarify items, and the full survey was implemented in last September 2015 to all students identified as taking online courses at Temple University. This poster will present the initial findings of that study.

3. DISCUSSION

While the results of this study are incomplete, we anticipate the opportunity to compare findings at one U.S. institution with that from the Bailey, et al. (2015) study from Australia. This will be the first international comparison of factors influencing students choosing different modes of study. In addition, the findings will be useful by the University in planning and developing future programs to be delivered through online modes.

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AN INNOVATIVE INTERDISCIPLINARY APPROACH TO PROVIDING INTERNSHIPS FOR COLLEGE SENIORS

Kathy Fuller
California State University San Marcos, 333 S. Twin Oaks Valley Rd., San Marcos, CA 92096

ABSTRACT

The undergraduate Business and Human Development (HD)Departments at California State University San Marcos (CSUSM), are collaborating in an innovative interdisciplinary approach to supporting internships with local businesses in order to provide college seniors with experiences in the area of career development known as the "Senior Experience." Three local companies associated with serving the community in the area of healthcare or counseling, will hire a team of 5 college seniors (3 Business majors and 2 HD majors) to create a project for the company. The selected project will be agreed upon and supervised by both the company and university representatives from both departments. This paper will reflect on the literature base pertaining to creating a successful collaborative interdisciplinary internship for college seniors exploring possible career options.

KEYWORDS

Collaborative Internships, Career Development

1. INTRODUCTION

As study after study emphasizes the importance of supporting learning outside the confines of a classroom, one viable method is establishing internships. Internships in local companies provide students opportunities with actual experience within an organization, making students more employable.

The undergraduate Business Administration and Human Development (HD) departments at California State University, San Marcos (CSUSM) are collaborating in an innovative interdisciplinary approach to creating internships known as the "Senior Experience." Three local companies will each pay $1500 to CSUSM to hire a team of 5 college seniors to create a project for the company. These projects will be agreed upon by the company and the university. These rigorous and real world projects provide the opportunity for college seniors to act as consultants by actually applying the culmination of classroom. In addition, the collaborating businesses will gain with focused college seniors who provide a fresh perspective on the selected project. The three different projects will be in the area of "health" or "counseling". At the end of the semester, all teams participating in the Senior Experience will present their projects via a power point presentation. In addition, students will participate in a university hosted "Trade Show" to share their experiences and accomplishments with their assigned businesses. This reflection paper will focus on the development of this project.

2. BODY OF PAPER

Internships

There has been an increase in the number of students participating in internships from 3% of all college students in 1980 to 75% in 2012 (Hurst, et al. 2012). An internship is defined by the National Association of Colleges and Employers (NACE, 2015) to include the following: 1.) To be an extension of the classroom learning; 2.) To provide skills or knowledge to be applied to other employment settings; 3.) A specific beginning and end, with a job description and desired qualifications; 4.) The student has identified specific learning goals and objectives; 5.) Supervision by an individual trained and experienced in the field of endeavor is provided to the intern; 6.) Routine feedback is provided by the supervisor directly to the intern; 7.) Resources, equipment and facilities provided by the employer support the learning goals and objectives of the intern. In addition, academic internships involve the student, employer and the university (Daugherty, 2000). The work completed with the company must be related to the student's major and meet the provided criteria for hours worked, duties performed and the relation of these activities to studies, in order to receive any academic credit. These valuable internships provide opportunities for experiences in both the academic and the professional setting for college students. Providing services in a selected career area provides a direct understanding of what this particular career would be like on a day to day basis. For college seniors, this could be a life changing experience!

Partnerships

In order to support students participating in an internship, multiple partnerships are required between the university, the placement sites and the students. Frequent and effective communication between all partners involved is essential to support student interns in successfully completing the assigned project.

Another important aspect of this partnership lies within the area of mentoring. According to Johnson (2002), mentors influence the professional development of interns through teaching, advising and/or supervising both learning and performance outcomes. For the CSUSM Senior Experience, two faculty members and the site supervisor will all help mentor the students.

Feedback

Feedback will be provided to the interns by both the local business representative and the team's university supervisor. When considering the important criteria that need to be established and included in the feedback to interns, NACE (2015) found that business supervisors for interns wanted more clarity with the university expectations and more effective guidance on evaluating interns; more specific focus on creating an effective match between interns and their internship; and for the university to offer more career training experiences to support the development of professional behaviors in interns. These suggestions will be considered for guiding feedback from the business supervisors to the interns involved with the CSUSM project.

Promoting Intern Success and Beyond

A study conducted on job significance for interns indicated that the significance of specific task completion required by the intern, as well as the feedback provided on how well the task was completed, was indicated as being most significant for interns (D'Abate, Youndt & Wenzel, 2009). The CSUSM project will support students in approved goal and objective completion which will be mentored by both faculty.

Other aspects of the work environment that were found to be significant in the experiences of interns consisted of learning opportunities, supervisor support and organization satisfaction (D'Abate, Youndt & Wenzel, 2009). In addition to these considerations of student needs, collaborating with a selected team of students also provides an effective route for the company to identify prospective employees.

3. CONCLUSION

According to NACE (2015), college graduates with internship experience are much more likely to receive a job offer (approximately 57% in 2013), as well as a higher starting salary than students without internship experience. To turn an internship into a job, Adams (2015) recommends that a student select an internship that requires substantial work; act professionally; network; ask questions; set goals; volunteer; and follow up with the business after the internship is completed. Using previously conducted empirical studies as a basis, it is the goal of the CSUSM Collaborative Senior Project to prepare, support and assist university seniors in successfully attaining the career of their dreams.

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FOSTERING 21ST CENTURY SKILLS THROUGH GAME DESIGN AND DEVELOPMENT

Gregory P. Garvey
Quinnipiac University, Hamden, CT, USA

ABSTRACT

This reflection paper argues that the design and development of digital games teach essential 21st century skills. Intrinsic to application and game development is design thinking. Design thinking requires iterative development, which demands creativity, critical thinking and problem solving. Students are engaged through learning by doing in both concrete and at the same time in abstract thinking. Application and game design requires systems thinking that gives context and meaning to narrative and story telling. A deep understanding of information, media (visual, auditory and performative) and technology coupled to mathematical skills is a prerequisite to success in this domain. Application and game development requires social intelligence and interpersonal skills for working in diverse teams where communication and collaboration is essential. Finally game design requires knowing oneself as a designer but also knowing and understanding perception, psychology and cognition of the user and the player.

KEYWORDS

Application, game design, 21st century skills, creativity, problem solving, cognition, story.

1. INTRODUCTION

The game design document is similar to an extensively researched term paper. It is an attempt to describe a proposed game, in its entirety and in detail before any work begins. Ken Wong, the lead designer for the iPhone game Monument Valley explains why game documents are not useful: “We find you need to make a game wrong at least two or three times before you find the right path. We took a lot of opportunity to design and explore, knowing that a lot of it would be thrown away.” The development of digital games is an iterative process that requires creativity, exploration of promising avenues, dead ends and a willingness to fail in order to make progress.

2. DESIGN THINKING

Design thinking is problem solving conditioned by learning by doing. Design begins with brainstorming and idea generation using free association where any idea is fair game. A second pass selects a subset of likely candidates. Ideas are captured as sketches and notes on paper or whiteboards making it possible to see where changes can be made and how variations can be generated by similarity, contrast or even systematic combinatorics. Iteration is a process of generation, trial and error. Errors point the way to success.

2.1 Digital Game Design Thinking

Games begin first with brainstorming out of which emerges a core concept often coupled to an activity or interaction. Once implemented in code this coupling becomes a game mechanic. However for every game mechanic the game designer must test and iterate to find the right balance between engagement, difficulty, ease of use and boredom while advancing both the storyline and the gameplay.

2.2 Learning by Doing

It is not enough to think of a game mechanic, it must be built so it can be tested. Building it requires analytical, mathematical and concrete thinking needed for programing. For example a character may have the property of health. Concrete thinking is required to determine the data type (floating point or integer) for data representation. There is a leap of abstraction with the creation of a variable to store the value. In a further abstraction a function can pass this variable to increment it or decrement it. This abstraction is taken a step further when it represents the “health” of a character in the game. As increasing levels of abstraction and representation are added in a game where the game becomes a simulation of a complex world with physics, autonomous characters and programed entities interacting with the player.

2.3 Game Design is a Team Sport

Game design and development requires game designers, programmers, writers, artists, sound designers, composers, content experts, human factor experts, cognitive psychologists, marketing specialists and legal experts. It is by definition a collaborative process that requires clarity of written and verbal communication. Effective teams require members that have highly developed social intelligence and interpersonal skills which fosters understanding of teammates and the audience of players of diverse backgrounds and gender.

2.4 Know Thyself

Game Design teaches essential life and career skills. Team members must set goals, manage workload while working collaboratively yet independently. Self-assessment, an open mind, curiosity and self-directed life long learning are essential. With career advancement comes the responsibility to mentor and lead others.

3. CONCLUSION

Learning Game Design prepares students with 21st Century innovation skills and abilities for a rapidly changing technological world. These include critical thinking and problem solving; systems thinking; learning how to make judgments and decisions. Creativity and innovative thinking is fostered by idea generation techniques as well as cultivating curiosity and openness to different perspectives. Team work means working effectively, collaboratively and creatively with others; having clear verbal and written communication skills; being respectful of difference in the workplace and welcoming of a diversity of gender, lifestyle and cultural backgrounds. Information, Media and Technology skills are of course prerequisite to the field; life and career skills (flexibility and adaptability; time management, self-directed learning) combined with accountability sets the stage for greater responsibility and success.

ACKNOWLEDGEMENT

This paper reflects lessons learned while directing the Bachelor of Arts in Game Design and Development at Quinnipiac University, in Hamden, Connecticut.

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DEVELOPMENT OF CRITICAL THINKING SELF-ASSESSMENT SYSTEM USING WEARABLE DEVICE

Yasushi Gotoh
Niigata University, 8050,Ikarashi2no-cho,Nishi-ku,Niigata City, Niigata, Japan

ABSTRACT

In this research the author defines critical thinking as skills and dispositions which enable one to solve problems logically and to attempt to reflect autonomously by means of meta-cognitive activities on one's own problem-solving processes. The author focuses on providing meta-cognitive knowledge to help with self-assessment. To develop students' critical thinking, it is important for students to be able to use critical thinking rubric and assess themselves. Critical thinking self-assessment system has three components, video recording system using a wearable device, critical thinking rubric and meta-cognitive activities.

KEYWORDS

Critical Thinking, Self-assessment, Wearable Device, Meta-cognitive Knowledge, Meta-cognitive activity

1. INTRODUCTION

To develop students' ability to work together to solve problems is an important factor in education.The ATCS21 Project proposed 21st century Skills as ways of thinking, tools for working, ways of working and ways of living in the world (ATCS21).Recently, research into the assessment and teaching of 21st century skills has forged ahead, and MOOC learning environments have also been provided (e.g. at the University of Melbourne).According to ATCS21, critical thinking is one aspect of ways of thinking. A number of researchers such as Dewey (1910), Glaser (1941), and Ennis (1985) define critical thinking as reflective and logical thinking. The Association of American Colleges and Universities（AACU） defines critical thinking as a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion. AACU also provides a rubric known as a value rubric as a critical thinking assessment tool. The critical thinking value rubric has five categories: explanation of issues, evidence (selecting and using information to investigate a point of view or conclusion), influence of context and assumption , student's position (perspective, thesis/hypothesis) and conclusions and related outcomes (implications and consequences).The value rubric is used to rank students' activities on four different levels. For instance, the highest level (capstone) in the evidence category is 'Information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis. Viewpoints of experts are questioned thoroughly'. On the contrary, the lowest level (benchmark) is 'Information is taken from source(s) without any interpretation/evaluation. Viewpoints of experts are taken as fact, without question. 'To develop their critical thinking, it is important for students to be able to use this rubric and assess themselves.

The author focuses on providing meta-cognitive knowledge to help with self-assessment. In this research the author defines critical thinking as skills and dispositions which enable one to solve problems logically and to attempt to reflect autonomously by means of meta-cognitive activities on one's own problem-solving processes. To provide information on meta-cognitive activities, a record of the learning process is required.

One approach for recording this information is using computer log data. Log data about students' activities such as browsing the web, writing comments, reading web pages and discussing with peers on the bulletin board system will provide useful information. These data have already been used with assessments such as PISA and the National Assessment of Information Utilization Ability in Japan (2015).

On the other hand, computing is merely one aspect of students' activities. Students also read books, write comments or memos, and hold discussions with peers and teachers. Furthermore, computer log data are of no direct use in students' meta-cognitive activities. To provide information needed for meta-cognitive activities, the entire record of the learning process is required. Students' video-recorded data would seem to be particularly useful in assisting their meta-cognitive activities. In addition, the author mentions individual differences among students. It has recently been discovered that there are differences among individuals with regard to critical thinking (Gotoh . Individual differences such as personality, disposition toward critical thinking and self-efficacy will be discussed).

2. METHOD

Elementary school children, junior high school students, senior high school students and university students took part in this study. The material selected was cooperative problem solving, such as integrated studies and the knowledge constructive jigsaw method. Elementary school children at an elementary school attached to Niigata University gathered information about how to promote Niigata City and proposed a promotion plan. Niigata University students took part in the knowledge constructive jigsaw method and discussed their own career design from the point of view of technical / functional competence, general managerial competence, autonomy / independence, security / stability, entrepreneurial creativity, service / dedication to a cause and pure challenge.

2.1 Learning Environment

This system has three components of which the first is a video recording system using a wearable device. To record the entire learning process, a wearable device such as Google Glass or Sony Wearable Glass is used. A lesson protocol was developed using the recorded video. Using these data, the researcher extracted samples that meet the requirements of the rubric described below.

2.2 Critical Thinking Rubric

The second component is the critical thinking rubric. As already mentioned, previous research exists on the critical thinking rubric (Griffin, et.al 2012, Beyer 1985, Miyake 2014, VALUE project). The critical thinking rubric was used as a tool to enable students to carry out self-assessment and reflection. It is important for students to be able fully to understand and use the critical thinking rubric. For this reason, the critical thinking rubric was modified to suit each school level. For instance, the university rubric has four levels: capstone, upper milestone, lower milestone and benchmark similar to the VALUE Rubric. In contrast some elementary school rubrics have only two levels.

2.3 Meta-cognitive Activities

The third component consists of meta-cognitive activities. The integrated study project consists of several small units. At the end of each small unit the author requested students to reflect on their learning from the point of view of their own critical thinking performance. To assist these activities, students' watch a video that meets the requirements of the critical thinking rubric. The video of the sample extracted by the researcher undoubtedly helps students with their self-assessment. After watching the video, students assessed their own learning using the critical thinking rubric. At the university level, samples were displayed in which information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis and viewpoints of experts are questioned thoroughly. Students and teachers discussed points in the samples of students' activities where students showed excellence. Discussion provides a viewpoint from which students are able to assess their own learning activities. Students also become aware of their strengths and weaknesses.

3. EXPECTED RESULT

A pilot study was started at Niigata University and at the elementary school attached to Niigata University. At the elementary level, It was found that some children felt that self-assessment without any video recording was difficult. A wearable device seems to be useful because these devices provide a natural angle and clear sound. At the university level, these devices provide supportive information to evaluate students' activities. In terms of evidence, one of the critical thinking categories, the upper milestone was: 'Information is taken from source(s) with enough interpretation/evaluation to develop a coherent analysis or synthesis and viewpoints of experts are subject to questioning' whereas the lower milestone was: 'Information is taken from source(s) with some interpretation/evaluation, but not enough to develop a coherent analysis or synthesis. Viewpoints of experts are taken as mostly fact, with little questioning'.

A movie of the learning process recorded by a wearable device will provide useful information to enable a more precise understanding of the differences in these levels. Meta-cognitive activities and reflection will enable students to attain a deeper level of self-assessment. Differences among individuals are also taken into consideration. In particular, the difference in the problem solving process between those who are highly disposed towards critical thinking and those who are not, is not yet known. Using a critical thinking disposition scale the author extracted two types of students and compared problem- solving process, meta-cognitive activities and relfection and self-assessment between these two types.

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