15th International Conference

Mobile Learning 2019

11-13 April

Utrecht, The Netherlands

Edited by
Inmaculada Arnedillo Sánchez
Pedro Isaías
Pascal Ravesteijn
Guido Ongena

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15th INTERNATIONAL CONFERENCE

MOBILE LEARNING 2019

PROCEEDINGS OF THE 15th INTERNATIONAL CONFERENCE

MOBILE LEARNING 2019

UTRECHT, THE NETHERLANDS

11 - 13 APRIL, 2019

Organised by

Co-organised by

Edited by Inmaculada Arnedillo Sánchez, Pedro Isaías, Pascal Ravesteijn and Guido Ongena

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FOREWORD

These proceedings contain the papers and posters of the 15th International Conference on Mobile Learning 2019, which was organised by the International Association for Development of the Information Society and co-organised by the University of Applied Sciences, in Utrecht, The Netherlands, 11 - 13 April 2019.

The Mobile Learning 2019 Conference seeks to provide a forum for the presentation and discussion of mobile learning research which illustrate developments in the field. In particular, but not exclusively, we aim to explore the theme of mobile learning under the following topics:

- Learning analytics and mobile learning
- Cloud computing and mobile learning
- Pedagogical approaches, models and theories for mLearning
- mLearning in and across formal and informal settings
- Strategies and challenges for integrating mLearning in broader educational scenarios
- User Studies in mLearning
- Learner mobility and transitions afforded by mlearning
- Socio-cultural context and implications of mLearning
- Mobile social media and user generated content
- Enabling mLearning technologies, applications and uses
- Evaluation and assessment of mLearning
- Research methods, ethics and implementation of mLearning
- Innovative mLearning approaches
- Tools, technologies and platforms for mLearning
- mlearning: where to next and how?

The Mobile Learning 2019 Conference received 90 submissions from more than 23 countries. Each submission has been anonymously reviewed by an average of 4 independent reviewers, to ensure that accepted submissions were of a high standard. Out of the papers submitted, 15 received blind referee ratings that signified acceptability for publication as full papers (acceptance rate of 17%). A few more papers were accepted as short papers, reflection papers and posters. An extended version of the best papers will be published in the IADIS International Journal on WWW/Internet (ISSN: 1645-7641).

Besides the papers' presentations, the conference also features a keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Katrin Tiidenberg, Associate Professor, Tallinn University, Estonia, for accepting our invitation as keynote speaker.

The conference also includes one workshop entitled "Designing Mobile inquiry-based Learning Activities: Learners' Agency and Technological Affordances" presented by Dr. Esther Tan and Prof. Dr. Christian Glahn from Delft University of Technology, The Netherlands and one corporate showcase by Ray Levy from CLL Language Centres, Belgium.

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 everybody has enjoyed Utrecht and their time with colleagues from all over the world, and we invite you all to next edition of the International Mobile Learning Conference in 2020.

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Utrecht, The Netherlands
April 2019

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KEYNOTE LECTURE

MAKING SENSE OF SOCIAL MEDIA – YOUNG PEOPLE'S PRACTICES AND EXPLANATIONS

by Katrin Tiidenberg, Associate Professor,
Tallinn University, Estonia

Abstract

How do young people use social media, and how do they make sense of it? This talk will explore what I consider the more interesting recent trends in use practices, dialogue with prevalent discourses regarding technology, and discuss how young people reconcile the possible discrepancies between their own experiences and popular claims about the effects social media has on their wellbeing.

I will explore young people's social media use via a model of "4 Ps." These are – Practices (what are they doing); Platforms, (where are they doing it); Procedures (how are they doing it) and Purposes (the reasons they have for doing what they do). I will then interpret and contextualize young people's practices and experiences via two broad themes. First, the grand societal narratives about technology, especially the narratives of addiction, progress and 'digital nativeness.' And second, the phenomenon of attention, in particular attention as an individual capacity, versus as a coveted resource within an economy-like system. Finally, I will briefly touch upon the ethical and political implications of how young people use and make sense of social media.

WORKSHOP

DESIGNING MOBILE INQUIRY-BASED LEARNING ACTIVITIES: LEARNERS' AGENCY AND TECHNOLOGICAL AFFORDANCES

by Dr. Esther Tan
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Research Fellow, Leiden-Delft-Erasmus, Centre for Education and Learning (LDE-CEL), Delft University of Technology, Netherlands
Prof. Dr. Marcus Specht
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Abstract

Recent discourse and research studies on mobile learning showed increasing awareness of the complexity of mobile learning in the digital age. Notwithstanding mobile devices, Web 2.0 and Web 3.0 technologies have greatly empowered learners and educators to overcome the constraints of conventional education, such as time, space, location and to learn on the move. However, balancing technological dependency and learner autonomy remains an area of contention in designing meaningful mobile learning activities. Hence, this interactive and participatory workshop aims to bring together researchers and practitioners working on this issue to share their experience and to engage in facilitated activities and discussions on designing mobile learning activities that effectively balance learners' agency with mobile technology. Additionally, this workshop also provides a platform for unsolved challenges and future research directions on smart technology and smart learning spaces in the context of mobile learning, laying the groundwork for joint research efforts.

CORPORATE SHOWCASE

VISIAGORA BY CLL LANGUAGE CENTRES: AN INNOVATIVE DISTANCE LEARNING EXPERIENCE AND PEDAGOGICAL APPROACH IN A VIRTUAL CLASSROOM

by Ray Levy
CLL Language Centres, Belgium

Abstract

Providing an innovative solution for distance language learning is nowadays very challenging. The distance teachers are most of the time left alone to set up their classes and teaching material whereas learners are struggling to keep motivation at a high level.
After 2 years of research and experimentation, CLL Language Centres (associated to the Catholic University of Louvain-la-Neuve in Belgium) developed and launched an innovative solution, Visiagora, where classes are based on a communicative approach and are built up around a pedagogical structure of 30 minutes in a virtual classroom: learners benefit of the experience of a short but intense one-on-one class with the features of a physical classroom but are taking their language course from the comfort of their home or office. As a result, the learning experience and motivation is increased and the foreign language acquisition becomes more efficient.
This paper goes through the innovative and communicative pedagogical approach and structure of our 30-mn classes: they are composed of 7 phases (introduction, lesson overview, comprehension activity, consolidation activity, presentation activity, production activity and delay correction & summary). It also develops the features of our virtual classroom and whiteboard, which enable the learners and teachers to benefit from all the features of a physical classroom.
To conclude, the learning and teaching experiences from the perspective of learners and teachers are presented.

Full Papers

IMPROVING COLLABORATION IN BLENDED LEARNING ENVIRONMENTS THROUGH DIFFERENTIATED ACTIVITIES AND MOBILE-ASSISTED LANGUAGE LEARNING TOOLS

Ajda Osifo
Zayed University, UAE

ABSTRACT

Recent trends in higher education have initiated an increase in the attention given to the quality of teaching offered to the students, and significant changes in student populations since 2000, such as increasing social diversity (Biggs & Tang, 2011), have required educators to relook at their teaching and instructional practices. As diversity in higher education increases and accelerating technology adoption impacts on teaching, improving the quality of the instructive-educational process becomes fundamental based on understanding, observing, and re-evaluating the differences amongst our students. At the higher education level, our students are even more diverse than K-12 students due to their academic experiences and professional interests. Our learners differ not only culturally or linguistically, but also in their cognitive abilities, learning preferences, background knowledge, and have various levels of strengths and weaknesses in the area of multiple intelligences; hence a rethinking of the structure and management of the classroom, modifying curricula and maximizing classroom interactions are necessary. Differentiated activities together with Web 2.0 tools and mobile-assisted language learning applications can enhance collaborative learning where learners actively participate in groups to explore a topic or discuss to finalize a project. Differentiation or academically responsive instruction concentrates on teaching strategies that provide students with multiple pathways in the teaching and learning process to meet their needs. Mobile-assisted language learning (MALL) is a subarea of mobile learning in which integration of new mobile technologies into teaching and language learning has been a primary focus, and numerous mobile applications and online Web 2.0 tools have been developed to support academic English language learning, including reading, listening, writing, speaking, functional grammar and vocabulary. Web 2.0 refers to a huge array of web-based tools such as blogs, wikis, folksonomies, social networking sites and content-sharing sites which can offer numerous instructional opportunities like active engagement, personalized learning and innovation, and can empower and enable learners to participate in a variety of ways. This qualitative study explored the integration of MALL applications and Web 2.0 tools in differentiated EAP classes and sought to understand how they can assist in improving collaboration of EAP students to achieve higher levels of cognitive learning in higher education in UAE. The findings suggest that the usage of MALL apps and Web 2.0 tools in differentiated EAP classes in higher education assist students in terms of feedback, motivation, collaboration, pace, multi-modality and research skills; gives them an opportunity to choose the activity and the type of assessment that corresponds to their needs and abilities.

KEYWORDS

Collaboration, Mobile Language Learning, Differentiation

1. INTRODUCTION

Preparing students for the future is the core mission of higher education institutions (NMC Horizon Report, 2017). Over the past two decades, higher education in many countries has expanded as the number of students has increased significantly, access to education has improved and the student body has diversified (Henard & Leprince-Ringuet, 2008). As higher education continues to move away from traditional lessons toward more multifaceted interactions, educators are also expected to employ technology-based tools and mobile learning pedagogies. In blended learning environments, where a combination of delivery methods including face-to-face instruction and asynchronous/asynchronous technologies are used, higher education is well positioned to implement mobile technology into the classroom to address various learning styles of different students and to provide personalized learning experiences (West, 2013).

Differentiated instruction together with MALL and Web 2.0 tools have the potential to reach more diverse students in academic English language classes in higher education. The current qualitative research study in the form of action research, explored the integration of MALL applications and Web 2.0 tools in differentiated EAP classes and how they can assist in improving collaboration of EAP students in higher education in UAE. As there is a significant need to develop evidence for utilizing MALL apps and Web 2.0 technologies in classes to serve a diverse student population, action research methodology in this study offers a critical examination of a teacher's self-practices. One application of this study is to better meet the needs of diverse students in our classrooms by investigating the effect of integrating new technologies in our instructional design, which will lead to changed practices. In addition, as further research needs to be conducted at the higher education level to better understand differentiated instruction (Tulbure, 2011; Koutselini, 2008), this study, although limited, provides insights on utilizing it in EAP tertiary classes, thereby promoting the differentiated instruction approach.

2. BODY OF PAPER

In the United Arab Emirates (UAE), public and private universities are becoming more engaged with the new educational technologies as they attempt to get international accreditation. There have been governmental efforts to create structures for complete programs to include new mobile-enhanced delivery models that target specific student populations and can increase access to education. The landscape of higher education in United Arab Emirates (UAE) today includes the incorporation of Web 2.0 technologies and MALL tools into learning and teaching processes for more effective practices and strategies to redefine the task of learning. Although both governmental and higher education efforts have resulted in large-scale initiatives to integrate educational technologies in relevant curricula, firstly, students in the classrooms are diverse. Thus, the specific needs of the targeted student populations have to be accommodated. At present, there is a shortage in studies addressing diversity of students and their academic English language education, especially in a relatively more conservative Middle East region. Secondly, students entering foundational academic English language programs in the UAE universities are unfamiliar with active learning and frequently have problems adapting to the new setting (Rugh, 2002). They often lack the skills needed to learn actively such as critical thinking and problem solving skills, research skills, creativity and independent learning skills which may leave them unmotivated and discouraged. Consequently, there is a strong need for an effective teaching approach that educators can utilize to reach all students in their classrooms, and also evaluate academic readiness, learning progress and other educational needs of students.

According to Prud'homme et al. (2006), the term "differentiation" is labelled in various ways when a corpus analysis is done, such as "differentiated classroom", "differentiated instructional design", "adaptive education", "adaptive teaching", "mixed-ability grouping", "individual differences", "diversity in education", "cultural diversity" and "aptitude". They further state that the concept of differentiation is complex as theorists do not always agree on its nature. For example, it may mean to be "a tool, an attitude or a teacher's impact, an approach, a system of beliefs or a philosophy, a strategy for curriculum adaptation, an organizational strategy, a process for change in practices or a model for class management" (p.135). For the purposes of this research study, differentiation is seen as defined by Stradling and Saunders (1993): "the process of matching learning targets, tasks, activities, resources and learning support to individual learners' needs, styles and rates of learning" (p.129). It involves flexible learning activities experienced within meaningful situations adapted to the students' level, as opposed to traditional, rigid methods.

Although there are plurality of theoretical perspectives on differentiated instruction, it is commonly perceived as part of the socio-constructivist paradigm of learning which emphasizes the active participation of students in the learning process where construction of knowledge emerges due to the interactions of students with one another, their teachers, physical space and arrangement, and educational materials (Tomlinson, 1999; Subban, 2006). This study is grounded in the socially constructed ontology and rests on an epistemology that recognizes multiple realities. Knowledge is actively constructed within social interactions. Figure 1 shows an overview of the theoretical framework for this study.

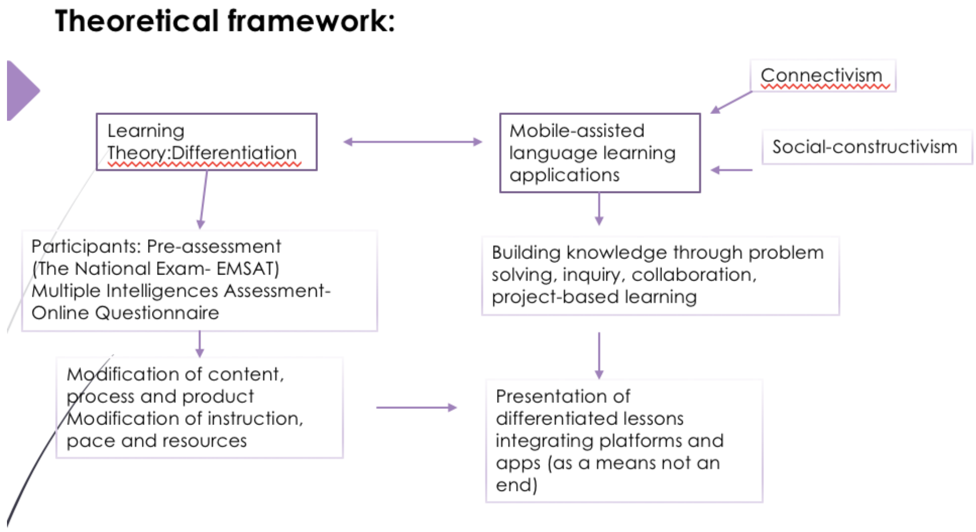

Figure 1. Overview of the Theoretical Framework

This study was conducted at a federal government university, where English is the medium of education, and classes are segregated. In the UAE, women are currently being encouraged to pursue higher education and then enter the workforce. Abdulla and Ridge (2011) observed that in 2011, 70% of students in higher education were female which illustrates that more females than men have taken up the opportunity of free education in UAE. The participants were 30 female Emirati students in the foundation program, all of whom spoke Arabic as a first language, and who did not meet the language entrance requirement for baccalaureate study and entered the academic English course. The female Emirati students in classes are diverse in terms of their cultural background, communities they belong to, educational background, and resilience and adaptability.

2.1 Data Collection Methods

The key question guiding this research study is “How can MALL applications and Web 2.0 tools assist EAP students in differentiated lessons in UAE higher education?”. To answer this question, the action research design facilitated the gathering of qualitative data through an online multiple intelligences questionnaire, a paper-based questionnaire and semi-structured student interviews. Firstly, an online multiple intelligences questionnaire which was designed by Armstrong (2009) was conducted as part of a class activity, and was used to determine students’ intelligence strengths and preferences. This information was important for arranging students into appropriate groups for differentiated lessons. Students were observed by the teacher for a period of 9 weeks and by the time the differentiated lessons were presented, the teacher could cater the differentiated lessons to the interests of the students to improve collaboration and provided them with options at varying levels of difficulty. These lessons included differentiated activities in four skill areas which are listening, speaking, reading and writing, and are scaffolded, including problem-solving tasks where students had to find information through research and shared it with their peers in order to build up an understanding of a real-world problem, and projects where students were encouraged to become content generators and reflect on their own learning. After the completion of both differentiated lessons, participants were given a paper-based questionnaire with ten questions which included closed and open-ended questions. Questions included MALL apps and Web 2.0 tools which were used during the presentation of differentiated lessons, such as Keynote, Padlet, Hemingway writing app and QR codes. Figure 2 shows examples of differentiated activities that were a part of the two separate differentiated lessons. All activities that took place incorporated various MALL apps and Web 2.0 tools as part of the intervention.

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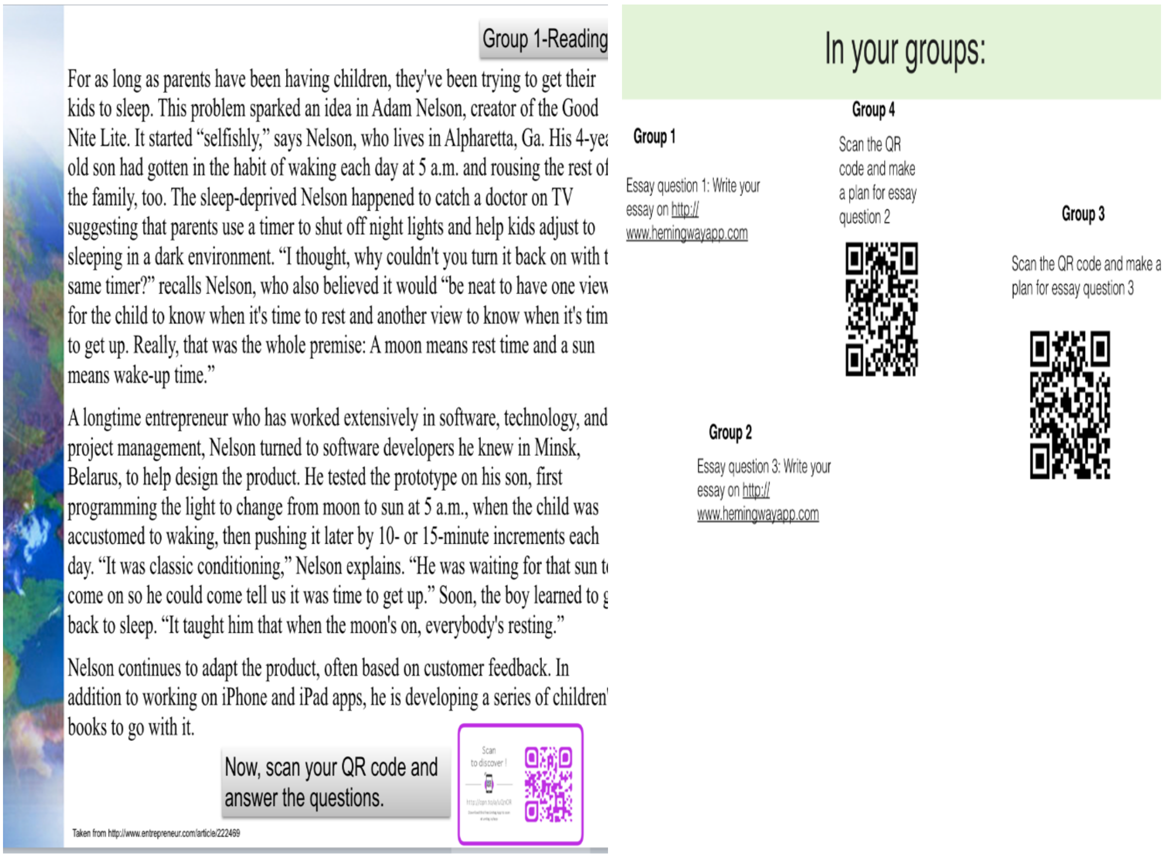

Figure 2. Examples of Differentiated Activities

2.2 Data Analysis and Results

As flexible grouping is essential in differentiated lessons, the online multiple intelligences questionnaire was used as pre-assessment data to group students in classes, however, students moved in and out of groups depending on the activities. As Gregory & Kuzmich (2004) suggest students were grouped according to their interests, their multiple intelligences, thinking skills and abilities for class activities.

The data analyzed from the paper-based questionnaire is used to reflect on the educational practice of the researcher and shape the following iterations in the next cycle. Table 1 provides the common themes in open-ended responses in the paper-based questionnaire:

Table 1. Common themes in open-ended responses in the paper-based questionnaire

Question No	Common Themes in Open-ended Responses	No of Responses Applied to the Theme	Examples of Participant Responses
4	• a) learning from each other • b) better motivation	10 4	a) I try to check the meaning of new words and communicate with others using it. b) I like when I have a Keynote because I like doing many different activities and learning new words.
5	• pace	5	It gives me time to read in my group. For example, it helps me to read the text and have a plan before we start.
6	• a) motivation • b) access to multi-modal texts	6 4	a) I want to do it again and it was fun. a) It's good because all groups have a responsibility to plan and present. a) I like it but not too often. b) Taking a photo and seeing a website or a picture helps me. b) It will help us to find different activities and if we have same activities for all groups it is boring.
7	• a) fun • b) collaboration	8 4	a) It will help me to have many ideas from others and it's easy and exciting. b) I like to use it again to put a box for problems and solutions after talking to my group. b) Yes, sure because we should share our ideas and this will help us in our exams.
8	• a) enabling research • b) improving organization skills	4 3	a) I believe apps are an easy way to search and it already have the activities. a) Using an app and dividing class into groups is easy to get information. b) I use Keynote for everything, because its help me to organize and plan and do well.
9	• a) providing feedback • b) personalization	11 6	a) It is the best; it makes me focus and look where my mistakes are. b) It really help me to know my mistake, like if there are colors I know I have a mistake in the sentence. b) I can write my ideas and others can write their ideas at the same time, so we can all see everything. It's fun and sometimes difficult.
10	• preferences	17	It is better to read a book and answer the question in notebook. Traditional study methods are boring. I will feel confused when I need to find information.

Table 2 outlines the themes, number of references and corresponding data samples of the interviews:

Table 2. Themes, number of references and corresponding data samples of the interviews

Theme	Number of references	Sample Corresponding Data
MALL apps and Web 2.0 tools giving feedback	8	[…] They give us "it's wrong word". […] It tells us what's wrong.. where the wrong word or the wrong space is. Hemingway app is good for us for writing, because we learn our mistakes for writing. And we see what we need in a paragraph. It helped us organize our essay and also brainstorm ideas. Hemingway writing app makes me crazy. I see all the different colors and I get frustrated with my mistakes.
Student learning preferences	6	[…] especially keynote because it has a lot of information and we do it in groups. I save the keynotes and when I review work, and if I missed some vocab, I just review keynotes. That helps me.
MALL apps and Web 2.0 tools supporting conversation and collaboration	5	[…] actually I like that, because we.. chatting.. we.. as group you know.. I think that's help me to write about things and search about the information.. I like different groups and different activities, because I think we didn't waste our time to get information for that you know. Each group .. together information you know.. that helped us.
Variety of assessment options	4	I like that we do what we like to present our work. We can present doing many things like creating slides and talking over it.

Although the UAE context of learning is quite conservative, when asked whether mobile learning apps and Web 2.0 tools should be used in the academic English classes, twenty-two out of thirty female Emirati students reported that they would like it. As expected, all participants owned a MacOS laptop, an iPad and a Smartphone reflecting the uniqueness of the region and the government's support for mobile initiatives in education. Also, students' replies to the second closed-ended question showed that most of them preferred using MALL apps and Web 2.0 tools for learning activities while a third of the students wished to use them "sometimes" and only two students preferred using "no" MALL apps and Web 2.o tools. Participants stated in their responses to question four that following a Keynote airdropped to them by the teacher with all lesson activities in it was helpful to learn and remember the content. Their responses included "…easy for us to remember the vocabulary", "The activities for my group were in it and it was fun", and "After the lesson, I tried to communicate with others using the vocabulary in the Keynote". This was reflected in the common themes in open-ended responses in the paper-based questionnaire such as "learning from each other", "fun" and "collaboration".

The responses to question five showed that the majority of the participants particularly found having differentiated activities useful for their learning. These activities seemed to have helped their learning by enabling multiple entry points to introduce new content and activating student interest through "multi-modal texts". "…help me to brainstorm for new ideas with my group and put some plan before start" and "I could take my time with my group to find out key ideas in reading" are two out of the twenty-one positive student responses. Questions six, seven and nine focused on the MALL apps and Web 2.0 tools used during the differentiated lessons and the themes "providing feedback" and "personalization" were often mentioned by the participants. However, according to one of the participants "…it is sometimes difficult to see what the colors mean and hard to correct mistakes". This shows that although providing feedback is an essential feature of a language learning app, it should not be time-consuming and confusing for the students. While many students may be more skilled with the use of apps and tools, there are still students who struggle with these technologies and ongoing support, scaffolding and choices need to be given to all students.

Data collected from the semi-structured interviews also identified "giving feedback" and "collaboration" as two ways to assist EAP students in their learning in higher education classes. MALL apps and Web 2.0 tools in differentiated classes work positively on many levels such as improving motivation and concentration (Lee, Han & Lee, 2009) which lead to enjoyment, relaxation, information acquiring and better time management.

While the participants noted in the collected data that using MALL apps and Web 2.0 tools may be challenging, the majority of participants also believed that the overall experience helped them enhance particular skills such as conversational skills, research and organization skills, and they enjoyed greater convenience in regards to having mobile learning assessment options.

3. CONCLUSION

With the points stated, it is important that educators ensure effective use of educational technologies by providing students options and giving them the freedom of choice, while making students feel more comfortable in their abilities. Providing mentoring, training and support to students will enable them to practice 21st century skills including communication, collaboration, and content creation.

Throughout the course of this study, several factors were identified that may have caused limitations to the outcomes of the study. The first limitation is on the number of participants. There are thirty participants in this study which is due to time constraints as the study took place nearing the end of the fifteen-week semester, and this number does not reflect the EAP language teaching practice at the foundation program completely. The presentation of two separate differentiated lessons occurred in weeks nine and eleven during a semester of fifteen weeks, and were completed in two to three days, which was followed by interviews with five participants. This number should be expanded to a higher number for a more accurate result as the participation of a bigger population could be better generalized. Likewise, gender was another limitation that could have impacted the results of the study. Since the research was conducted on a group of female students who were in two separate classes, perhaps including male students in the study would have given varied results. Moreover, students' motivation might have represented a possible limitation and as most of them were already repeating the course, they felt responsible for their learning and results, which may have affected their responses to the open-ended questions in the paper-based questionnaire. Finally, from the researcher's perspective, preparation time for the differentiated lessons which included a variety of activities was an important factor which was burdensome to the researcher who needed to be timely with data collection and analysis.

In regards to the recommendations, the results of this study shed light on several suggestions for further research:

i) There is a necessity to consider differentiating instruction and including MALL apps and Web 2.0 tools in EAP classes in higher education as meeting the learning needs of academically diverse students and raising student achievement are the priority in today's higher education classrooms. The themes from this research revealed that implementing differentiated instruction including MALL apps and Web 2.0 tools can instill a new excitement for learning to all students as it can provide enrichment opportunities to further accelerate students' EAP learning. Thus, there is a need to investigate the utilization of differentiated instruction with MALL apps and Web 2.0 tools in all four skill areas of English language for teaching and learning. Also, more studies on ways to include MALL apps and Web 2.0 tools in collaborative learning are encouraged.

ii) There is a need to create more Personal Learning Environments (PLNs) and professional development opportunities for teachers since they provide teachers with a common goal to collaborate on how to best differentiate instruction and ways to incorporate MALL apps and Web 2.0 tools. Thus, further research in this area would benefit higher education institutions and provide a clear understanding of the concept.

iii) This research study focused on collecting qualitative data through the means of a paper-based questionnaire and semi-structured interviews. It included the presentation of two differentiated lessons that occurred in two separate weeks of a semester. It is highly recommended that further studies be conducted in UAE in other contexts that adopt a mixed-method design in order to collect data on more participants, including their classroom experience and their language learning. Also, there is a definite need for further studies with a population of male learners to investigate their perceptions of differentiated lessons with MALL apps and Web 2.0 tools.

The results of this study indicate that the usage of MALL apps and Web 2.0 tools in differentiated EAP classes in higher education assist students in terms of feedback, motivation, collaboration, pace, multi-modality and research skills, and gives them an opportunity to choose the activity and assessment for themselves that corresponds to their needs and abilities. The task of creating differentiated learning pathways for students that integrate MALL apps and Web 2.0 tools is a challenging aim and as McLoughlin and Lee (2010) suggest it requires "not only the espousal of appropriate teaching approaches, but also awareness of the learner experience, and the importance of valuing learners' pre-existing skills" (p.38). Thus, there is a fundamental need for future research to be conducted on EAP students' classroom experience and their language learning in differentiated lessons that integrate MALL applications and Web 2.0 tools in UAE higher education. The research study concludes that the introduction of differentiated instruction using MALL apps and Web 2.0 tools into the educational process contributes not only to a deeper assimilation of knowledge, but also to the formation of motivation and self-esteem of students.

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IMPLEMENTATION OF ELECTRONIC TEXTBOOKS IN SECONDARY SCHOOLS: WHAT TEACHERS NEED

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ABSTRACT

E-textbooks are gaining momentum in the education systems and are used for teaching and learning. Teachers are often reluctant to accept and use these technologies in the classroom, despite the numerous advantages thereof. In environments where the use of e-textbooks are mandatory, such reluctance often manifests as using the software in a superficial way and job dissatisfaction. The objective of this study is to determine the needs of teachers when implementing e-textbooks. An interpretive case study was conducted at a secondary school in South Africa. 'Interviews were conducted with 14 teachers. The findings were used to enhance an existing 'needs of using e-textbooks perception scale'. Apart from the usability and functionality features of e-textbooks, this study highlights the need of teachers for 1) adequate and timely training, 2) having no learners in their classrooms without a tablet or mobile device, 3) the ability to choose the textbooks themselves, and 4) the need to communicate their requests regarding the software and functionalities with the service provider.

KEYWORDS

Mobile Learning, E-textbooks, Tablet PC, Teachers' Needs

1. INTRODUCTION

The problem identified was that teachers are often reluctant to use e-textbooks in their classrooms as another method of presenting learning material to their learners. E-textbooks nowadays are available for use by learners and teachers in classrooms. However, it appears that teachers who know little about technology are not willing to use technology (in this case e-textbooks) in classrooms (Wang, Hung, Hsieh, Tsai and Lin, 2012). Sometimes teachers feel that they were not consulted in the decision to implement technology in the classroom. For example, Weilbach and Matthee (2015) report that teachers felt that the decision to use e-textbooks was not theirs.

Teachers could be unwilling to use these e-textbooks as they are comfortable with using traditional textbooks. Other reasons for this resistance include lack of proper infrastructure such as hardware and software (Buabeng-Andoh, 2012), not having the required training on how to use e-textbooks, limited time to assess the e-textbooks and produce good learning material and the unavailability of funds from schools to buy e-textbooks (Johnson & Buck, 2014).

E-textbooks are a recent intervention in South African schools and are being introduced in a number of schools in South Africa (ITWeb, 2012). In addition, many South African schools are now adding Tablet PCs in their classrooms and this will affect learners as well as teachers (South Africa.Info, 2013). However, teachers are reluctant to adapt their current teaching methods and do not necessarily want to embrace the technology (Weilbach & Matthee, 2015). Eicker-Nel and Matthee (2014) investigated "the adoption of tablet based e-textbooks in a South African private school". They found that the learners found that the tablets and e-textbooks were advantageous because of lighter backpacks, having everything in one place, and no excuses of forgotten printed textbooks. However, they emphasized the importance of proper infrastructure and teachers needing to acquire new teaching skills. Lin, Liu and Kinshuk (2015) investigated "teachers' needs when using e-textbooks in teaching". They suggested a number of needs pertaining to the textbook itself (discussed in more detail in section 2.4 below). From the studies mentioned above, it seems that there are more aspects to consider apart from the functionalities of the textbook itself.

This study aimed, through a qualitative detailed investigation, to add to the study of Lin, Liu and Kinshuk (2015) by identifying the needs of teachers regarding the use of tablet-based e-textbooks in classroom. The researchers used the UTAUT model of Venkatesh, Morris, Davis & Davis (2003) to guide the interviews with focus on the constructs performance expectancy, effort expectancy, social influence and lastly facilitating conditions. The constructs 'Facilitating conditions' specifically, shed light on additional needs of teachers. The research question is therefore: What are the needs of teachers regarding the implementation of e-textbooks in the classroom?

This study focused on a specific e-textbook platform on tablet PCs in one particular private school in South Africa. This paper contributes to mobile learning by providing an understanding of what teachers need when using e-textbooks in the classroom. The needs identified can be used as guidelines by principals, teachers and service providers when the school(s) introduces e-textbooks as a teaching tool that both learners and teachers use daily.

2. LITERATURE

According to De Luna (2015), there is a transition in the publishing industry due to e-textbook technology's impact on education worldwide. Gu, Wu and Xu (2015) wrote that devices such as tablet PC, smartphones, e-book readers and iPads are rapidly dominating education systems worldwide. Book publishers have recognized the adoption of these devices and are now offering digital format textbooks called electronic books or e-textbooks (Rockinson-Szapkiw, Courduff, Carter and Bennett, 2013). Similarly, to printed textbooks, e-textbooks contain materials that are used in the classroom.

This sections discusses the previous researches that were done that focused on defining e-textbooks, identifying its advantages and disadvantages in education setting, technology acceptance in schools and the needs assessments that can help teachers implement e-textbooks in classrooms.

2.1 E-textbooks and their Advantages and Disadvantages

Embong, Noor, Hashim, Ali and Shaari (2012) defines e-textbooks as any published materials such as books or journals which can be read using a digital device such as mobile phones or tablets and are not in the form of hardcopy. E-textbooks enable learners to access printed textbook in an interactive way (Al-Mashaqbeh, 2015). Patel and Morreale (2014) wrote that even though electronic books provide these features and opportunities, they might not be used due to the users not knowing how to navigate and utilize them.

The advantages of electronic books include easier delivery and cheaper purchase. Back-up and storage are simpler with e-textbooks. Another advantage of electronic books is that they are cheaper than the printed textbooks (Patel & Morreale, 2014). Some studies show that students and teachers still prefer printed textbooks rather than electronic books (Dobler, 2015).

A disadvantage that Embong, et al. (2012) pointed out was that even though there are a number of devices that can be used to read e-textbooks, some provide limitations to the users. Other limitations and disadvantages suggested by Mehdipour & Zerehkafi (2013) are that some devices do not have sufficient storage space to store the number of e-textbooks that the user wants or requires and some classrooms do not have enough power outlets. They further emphasize that training is vital to teachers before and when using e-textbooks in classrooms. Furthermore, even when training is provided to teachers, some may still need more training; meanwhile, they cannot use e-textbooks to teach in class.

2.2 Teachers Acceptance of Technology and E-textbooks in Education

There are factors that influence the acceptance and rejection of using technology in classrooms by teachers, and these factors include teachers' attitude, beliefs and feelings (Alfahad, 2012). Buabeng-Andoh (2012) and Koksal, Yaman and Saka (2016) identified factors that they think prevent teachers from integrating technology in their classrooms. These factors are the teachers' attitude towards technology, their gender and age, technical support factors, accessibility and computer competency.

According to Alfahad (2012), these factors are divided into two categories, which are internal factors and external factors. Alfahad (2012) and Aflalo (2014) wrote that some of the internal factors that influence technology's acceptance and use include perceptions, fears and beliefs of teachers. In short, these factors are the way teachers judge themselves when it comes to introducing something new to their teaching processes and the confidence they have once they have finished the training courses (learning how to use the technology introduced in school for teaching) (Alfahad, 2012; Blackwell, Lauricella, Wartella and Robb, 2013). Hence, if the teacher feels that they have acquired enough knowledge about the technology and they feel confident to use it, then they will integrate it into their teaching toolkits (Alfahad, 2012). However, it is better to introduce change to educators in small chunks so that they feel confident enough or encouraged to study the technology and therefore learn the whole thing and implement it (Alfahad, 2012).

The external factors that can influence the adoption of technology by teachers include gender and age of the teacher, the support that the school can offer to teachers and the size of the class (Alfahad, 2012) and teaching experience (Bataineh & Anderson, 2015; Park, Byun, Sim, Han & Baek, 2016). Furthermore, the lack of teacher's computer knowledge and use influences the use of information technology in teaching (Buabeng-Andoh, 2012). In any case, technology in education is an innovation and its success depends on the acceptance of it by teachers as well as their students (Ifenthaler & Schweinbenz, 2013).

A study by Ifenthaler and Schweinbenz (2013) considered teachers' perspectives regarding the acceptance of the tablet PC for teaching in classroom, using the UTAUT model. They pointed out that teachers and students play a vital role in the success of tablet PC integration. The research approach that they used was qualitative research. They used the UTAUT model. They made use of all four constructs of the model which are performance expectancy, effort expectancy, social influence and facilitating conditions and added behaviour intention as well as use behaviour from the TAM.

The interview questions they asked the teachers were in-line with the UTAUT model and the teachers' attitude towards tablet PC. What they found on the performance expectancy construct was that a small number of teachers believed that tablet PCs might enhance "learning and instruction". Although they have seen tablet PC's potential, they did not have any idea how they could implement it as a teaching method. Age and gender played a role in their study (as part of the facilitating conditions construct).

Moving closer to e-textbooks, Eicker-Nel and Matthee (2014) investigated "the adoption of tablet based e-textbooks in a South African private school" using Activity theory. The data collection method they used was interviews using an interpretive case study. Their sample consisted of learners and teachers from the same grade (Grade 10) and the same school in South Africa.

They found that the learners considered tablets and e-textbooks as advantageous: tablets were light in weight, easy to use compared to printed textbooks, and easy to access due to being stored in one place, unlike when they forgot a printed textbook at home. Even though there were some advantages that tablets and e-textbooks brought, there were problems experienced by both learners and teachers. These problems included too many files and applications in different locations in the tablets, making it difficult to access some at the same time, tablets charging problems, difficulties when moving from one page to the next and trouble reading from the tablets. In the conclusion to their study, they wrote that there were a few things required when e-textbooks are introduced, which can also influence the adoption of e-textbooks. These are infrastructure that can provide e-textbook platforms and teachers needing to acquire new teaching skills.

Similar to the study by Ifenthaler and Schweinbenz (2013), this study employs the UTAUT theory (explained in the next section) to guide the study.

2.3 Unified Theory of Acceptance and use of Technology (UTAUT) Model

The purpose of the UTAUT model is to define the intentions of the user to utilise technology and extend the behavioural usage of technology (Alshehri, Drew and AlGhamdi, 2012). UTAUT consists of four important constructs. They are: performance expectancy, effort expectancy, social influence and lastly facilitating conditions (Alshehri et al., 2012). According to Alshehri et al. (2012), these constructs are used to determine behaviour and usage intentions. The other four constructs are used to influence the impact of the first construct (Alshehri et al., 2012). These other constructs are gender, age, experience and voluntariness of use (Alshehri et al., 2012).

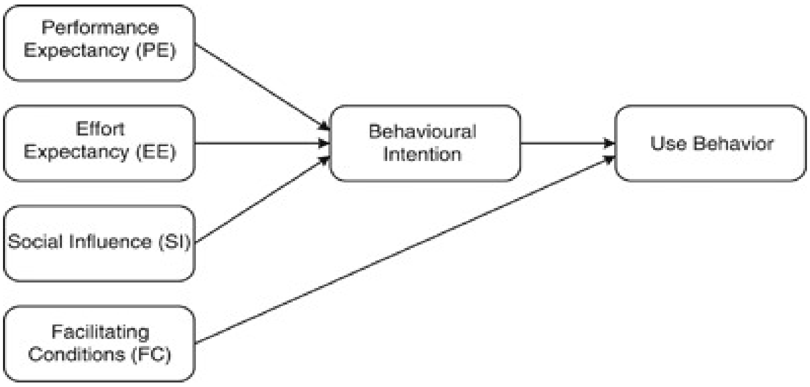

Figure 1. Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

The four main constructs are defined as follows (Alshehri et al., 2012; Williams, Rana & Dwivedi, 2015):

- Performance expectancy, which "is the degree to which an individual believes that using the system will help him or her to attain gains in job performance".
- Effort expectancy, which "is the degree of ease associated with use of the system".
- Social influence, which "is the degree to which an individual perceives that important others believe he or she should use the new system".
- Facilitating conditions, which "is the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system".

2.4 E-textbooks Needs Assessment Instrument

Lin, Liu and Kinshuk (2015) constructed the "needs of using e-textbooks perception scale" that would assist teachers in implementing and using e-textbooks in schools. Their study involved 415 teachers from 22 schools responding to a questionnaire and they interviewed five teachers who were known to be experts in the field of using technology in school. Out of the 415, only 378 participants' responses were usable for the study. They used a quantitative research approach.

Their work established three "needs of using e-textbooks perception scale" which are "to support teaching activities, to support reading and presentation and to support learning activities". They explained the first need of teachers as functions such as pushing of resources, giving quizzes, and the ability to update content when using e-textbooks. The second need was described as the need to provide teachers e-textbooks that have, to name a few, hyperlinks and functionality to change fonts and size. The last need was explained as the need to highlight information on the e-textbooks and "provide parent management interface".

According to their study, this "needs of using e-textbooks perception scale" were not based on or affected by gender and age. However, the level at which teachers teaches played a role in two of the three needs categories namely "needs of using e-textbooks perception scale" and "support teaching activities and support reading and presentation".

3. METHODOLOGY

This is a qualitative research study. The reason for using this method was that it allows the researchers to conduct a case study with the use of interviews to help determine and understand in-depth the teacher's perceptions with regard to the use of e-textbooks in classrooms for teaching purposes. There are several methods used in qualitative research and they are grounded theory, case study and action research (Myers, 2013). A case study methodology was chosen to be suitable for this study. The objective of a case study is to "illustrate a principle or a particular point that the instructor wishes to make" (Myers, 2009).

A sample is defined as "a subset of a population selected for measurement, observation or questioning, to provide statistical information about the population" (Boundless, n.d). The population for this study consisted of only the teachers who are using the e-textbooks for teaching purposes in the classroom. The participants in this study were 14 secondary-level school teachers at a school in Gauteng. Of the 14 participants, there were 10 male teachers and 4 female teachers, with various levels of teaching and e-textbooks experience. The school that interviews were conducted at is a private school and it has grade RR up to grade 12. Secondary school is from grade 8 to grade 12.

Recently a private company (EduX) launched a tablet PC based e-textbook platform at specific schools in South Africa. Its purpose is not to change the traditional learning process which it states is an environment in which the teacher is in control. It supports a blended learning process whereby traditional teaching is mixed with electronic learning. It provided tablet PCs, e-textbooks, tablets applications and storage to learners and teachers. It also provided the school with miEbooks application which is an e-textbook reader. The application provides a number of activities that both teachers and learners can use for learning. The functions are 1) the teachers can push homework, classwork, assessments, tests and notes to learners' resource library, 2) teachers can check learners' participation when using e-textbooks, 3) they can also download videos and push them to learners' resource library, 4) mark assignment and tests and 5) within an e-book, the user (teacher and learner) can highlight or underline information and make notes.

Interviews were used for data gathering. Myers (2013) wrote that the understanding of social context of people in terms of their "roles and situations" can be obtained with the use of interviews. The researchers made use of the semi-structured interview method, the reasons being that it allows the researchers to go through pre-determined questions and add other questions as the interview proceeds (Myers, 2013). It also allows the interviewee to pose questions to the interviewer, creating a conversation between the two and the questions asked by the interviewer can be open-ended. The only personal data that the researchers asked participants were their gender, age, years of experience and subject they taught. Each interview lasted for approximately 20 minutes. Most of interview questions were based on the constructs of the UTAUT model as shown in Figure 1 above. The interviews were all face-to-face and responses received were text-based data transcribed from 12 recorded and two unrecorded interviews.

The qualitative data analysis technique that was used is thematic content analysis. Braun and Clark (2006) define thematic content analysis as "a method for identifying, analyzing and reporting patterns within data". Alhojailan (2012), Moldavska and Welo (2017) and Mayring (2014) stated that there are two types of thematic content analysis, that is, deductive and inductive analyses. A deductive approach is a process of testing an existing theory that was used and tests if the theory can produce the appropriate resulting different situations (Alhojailan, 2012). He further defines the inductive approach as it does not follow any theory and that at the beginning of a research study observations have to be collected and there is no theory that is used to create questions for the study. This study focused on the deductive approach since the constructs of the UTAUT model were used to analyze the data.

4. FINDINGS

From the interviews analyzed, the fourth construct of the UTUAT model which is facilitating condition identified three themes through thematic contact analyses. The themes are Tools, Training and Support (from colleagues and from technicians). Facilitating Conditions was used to investigate the things that teachers need so that they can accept and use e-textbooks in the classroom. Literature findings identified three needs which were found from a study by Lin, et al. (2015). The needs they identified are detailed in Section 2.4 above. From the interviews findings, the needs were identified from answers that were related to infrastructure and training. The infrastructure in this study is software and hardware that the learners and teachers use daily when using e-textbooks. When it comes to software, there are different operating systems that are used and among them there is one that performs better than others. Therefore, the school needs to look at what works better and use that. Regarding hardware, for teachers the devices such as laptops, projectors and tablet PCs are available but the problem is when a learner does not have the device, it disrupts the use of e-textbooks.

Furthermore, there were three needs that were identified from the literature findings and another four found from the interviews. Some of these needs were identified by the themes found under this construct, which are Tools, Training and Support. The tools that they are using, which are laptops, tablet PCs and overhead projectors, according to participants are good tools for using e-textbooks in the classroom. Training seemed to be a problem, as some participants mentioned that they never had training when they joined the school; therefore, they are learning in classrooms as they use e-textbooks and tablet PCs and they struggled in the beginning to use e-textbooks. However, over time when they used them frequently and got training from their peers, it became easier for them to use the technologies. Furthermore, there was a complaint from some of the respondents that the training they receive from EduX is sometimes excessive and therefore they struggle to grasp what was taught; thus, they will not implement what they were taught. Therefore, the **first** need that was identified was the need for appropriate training before using the e-textbooks.

The **second** need that the researchers identified from the interviews analysis was the need for accessible devices for all learners. Some participants mentioned that there are several learners without tablet PCs and that this affects the use of e-textbooks in the classroom and outside the classroom. They mentioned that there are a few reasons as to why some learners do not have tablet PCs and these reasons are that the tablet PC got lost, got damaged, or even got stolen. Some parents are unable to replace the e-textbooks immediately which affects learners' progress.

The **third** need identified from the interviews was the need to be able to choose the e-textbook that teachers wanted to use for their specific subject. One of the participants mentioned that they are unable to choose the e-textbooks they would like to use. This statement is supported by the response from a teacher from the Lin, et al. (2015) study. At the time of conducting this study, EduX had an agreement with only selected publishers, resulting in having only certain textbooks available. It also implies that some of the e-textbooks might not be good to use for certain subjects.

A tablet PC has limited space for storing applications and other forms of information. One participant mentioned that there are some functionalities for which they do not have access to on the EduX platforms. Access to these functionalities would assist them in performing certain functions without relying on the EduX personnel to assist them. He further gave an example of the functionality which he would like the teachers to have namely permission to remove old resources that they no longer use. Furthermore, he elaborated that it was communicated to EduX that there are old videos that were still on the devices that they had requested to be deleted. This implies that teachers do not have all the permissions they may need to do certain things. The information that cannot be deleted on devices takes up space for other new resources to be loaded. The need for access to all the functions that teachers need was identified as the **fourth** need. The findings from this construct influence Use Behaviour in a positive way. The tables below show a comparison of the findings from the needs assessment perception scale and the findings from this study.

The NUEPS (Needs of using e-textbooks perception scale) is given below in table 1.

Table 1. Needs of using e-textbooks perception scale

NUEPS	Description
Supporting teaching Activities	Teachers need to be provided with the functions such as pushing of resources, giving quizzes, and the ability to update content when using e-textbooks. Another function that they need is the ability to share group learning outputs as well.
Supporting features and functions of Reading and Presenting	The need to provide teachers e-textbooks that have, to name a few, hyperlinks, to turn a page functionality to change fonts and size.
Learning Activities and Parent Interaction	The need to highlight information on the e-textbooks and "provide parent management interface".

Table 2. Needs of using e-textbooks identified in this study

NUEPS	Description
The need for training.	Teachers need to be provided with adequate and timely training.
The need to accessible device.	Having no learners in their classrooms without a tablet or mobile device.
The ability to choose the textbooks themselves.	The need to recommend, advice and choose the e-textbooks that they think will be good for the subjects they teach.
The need to communicate their requests regarding the software and functionalities with the service provider.	Teachers needs to be given an opportunity to voice out their needs and requirements before the implementation of e-textbooks.

In conclusion, many studies considered the implementation and use of e-textbooks at different levels of the education system. Moreover, they have been introduced in different countries, whether developed or developing countries. This study contributes towards existing research on e-textbook adoption by enhancing the NUEPS of Lin et al (2015). The NUEPS focuses on functionalities needed from textbooks in the learning and teaching process, whereas this study shows that needs pertaining to the learning environment of such an intervention cannot be ignored. Learning environment in this context refers to the enablers such as training, infrastructure, support and teacher control. The needs identified from both the literature and interviews findings can be helpful and if applied when e-textbooks are introduced in schools the integration of e-textbooks can yield positive results.

5. CONCLUSION

This paper provided some understanding as to what teachers go through during the introduction and implementation of e-textbooks in the classroom as a teaching tool. The needs identified in this paper can be helpful to schools and teachers during the implementation of e-textbooks. This paper can be extended to public schools and be useful for educators who are looking for tools for the classroom, for students and for continuing education and teachers with little technology experience.

There were some limitations to the study. These limitations were solely experienced during data collection. The first limitation was that the data were obtained from only one school. The researchers chose one school from many schools that are in South Africa in the province called Gauteng because the chosen school had already implemented e-textbooks and tablet PCs and both learners and teachers were using them. A better representation of teachers' views would have been obtained if more schools were involved.

Another limitation was the number of teachers who participated in the interviews. Only 14 teachers who were already using e-textbooks in the classroom from secondary level participated in the study and they were not chosen based on gender, age, experience or the subject they taught. The last limitation was the time that the researchers were allowed to conduct the interviews. The researchers were given lunch time to interview as many participants as they could and on average they managed to interview two teachers per day. Each interview lasted for approximately 20 minutes.

Apart from the usability and functionality features of e-textbooks, this study highlights the need of teachers for 1) adequate and timely training, 2) having no learners in their classrooms without a tablet or mobile device, 3) the ability to choose the textbooks themselves, and 4) the need to communicate their requests regarding the software and functionalities with the service provider. One of the biggest challenges identified by the teachers is the distraction of learners that use social media platforms during lessons.

If these needs are not addressed it can negatively impact the acceptance of e-textbooks on tablet PCs in the classroom by teachers. In general, though it seems that, apart from the functionalities of the e-textbook, by providing support, training and a good IT infrastructure, by allowing choices and interaction with the service provider, teachers will start finding e-textbooks a useful teaching tool.

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EDUCATIONAL MOBILE AUGMENTED REALITY EDUPARK GAME: DOES IT IMPROVE STUDENTS LEARNING?

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ABSTRACT

Mobile devices are being intensively used by the Portuguese youth in their daily life, but not in school activities. Despite this gap, research shows that technology can promote student learning in non-high education contexts. This paper comprises a survey study where mobile learning is analyzed through the eyes of 244 students attending the 2nd or 3rd Cycles of Basic Education (CBE). The acknowledged advantages and difficulties of the use of mobile devices for learning, as well as the educational value and usability of a specific mobile learning strategy, using the EduPARK app and game, were analyzed. Results revealed that most students owned a mobile device and were able to use them to learn. They had a positive perspective regarding mobile learning and valued the advantages of being easy to find up-to-date information, motivating for learning and easy to carry along. Nevertheless, students acknowledged difficulties in the use of mobile devices to learn, such as requiring an internet connection, its slowness, not being allowed to use mobile devices in schools as they facilitate access to distractions. The EduPARK game achieved an average Educational Value Scale of 83.8 and an average System Usability Scale of 80.2, indicating its high educational value and usability for students. This paper presents empirical evidence regarding the effectiveness of the integration of mobile game-based AR approaches in 2nd and 3rd CBE to promote students learning. It also includes an example of excellent interdisciplinary educational materials that comprises a very useful tool for teachers and students to explore scientific knowledge by accessing appealing information on biological and historical references of a local urban park.

KEYWORDS

Mobile Learning, Augmented Reality, Outdoor Activities, Game-Based Learning, Authentic Learning, Basic Education

1. INTRODUCTION

Mobile devices are being intensively used by the Portuguese youth in their daily life; however, these devices are seldom used in school activities, as they are still perceived as disruptors of learning and their use is frequently forbidden during instructional time (Liu et al., 2014). The gap between the use of mobile devices inside and outside schools can lead to students' disengagement with learning activities, thus, impacting negatively their academic success (Reyes et al., 2012).

Research has shown that mobile learning can promote student learning in non-high education contexts, with few published studies with neutral or negative results (Chee et al., 2017; Liu et al., 2014). Frequently, the literature reported student gains of increased attention, motivation, and development of key competencies (Martí & Mon, 2018; Sung et al., 2016).

The EduPARK (http://edupark.web.ua.pt/) is a research and development project with the aim to generate and implement original, attractive and interdisciplinary teaching strategies. The project employed a design-based research approach to create an interactive application with augmented reality (RA) for Android devices, with a set of educational learning games and integrating geocaching principles (Pombo et al., 2017b; Pombo & Marques, 2018). The final version of the EduPARK app is available in the Google Play Store (edupark.web.ua.pt/app) for Android devices, not requiring internet connection after download.

The app was developed for students and teachers from primary to higher education to be explored in a specific informal outdoor learning context, thus promoting an active, contextual and authentic learning (Herrington & Parker, 2013). Besides the educational community, local residents and visiting tourists can also use the app in an lifelong learning approach.

One of the EduPARK's innovative aspects relates with the fact that the promoted learning methodology combines a technology that is familiar to students with locations they see as their own. Thus, this methodology moves learning out of the classrooms and into the spaces of the students's community, such as their local urban park - the Infante D. Pedro Park, in Aveiro (Portugal). It is a large green area, with diverse fauna and flora, and even a reasonable sized lake with mallard ducks and amphibian species that deserves to be explored, in order to provide community education valuing conservative modes, to raise awareness about the importance of biodiversity and to promote the need for everyone to adopt more sustainable lifestyles to support healthy ecosystems (Pombo et al., 2017a).

The purpose of this paper is to present a survey study that analyzes mobile learning through students' opinion regarding the use of mobile devices for learning, including their advantages and difficulties, as well as the educational value of a specific mobile learning strategy, reified in the EduPARK game, after an experience of exploring it in formal and non-formal educational contexts. The educational value was analyzed concerning: (a) learning value; (b) intrinsic motivation; (c) engagement; (d) authentic learning; (e) lifelong learning; and (f) conservation and sustainability habits. Additionally, the app's usability is also studied as it can influence the exploration of the game.

The remaining paper presents: i) a theoretical framework of the study; ii) a contextualization regarding the EduPARK app and game; iii) methodological options; iv) results and discussion in the light of literature; and v) main conclusions, including suggestions of future work.

2. THEORETICAL FRAMEWORK

The use of technology to learn is not a new strategy. With the pervasiveness of mobile devices, their use in sustaining learning, either intentionally or not, was unavoidable. So, using, e.g., smartphones or tablets to support social and/or content interactions to learn, across physical locations and educational contexts, has been referred to as mobile learning (Crompton et al., 2017). Among its affordances are i) the small size and light weight of devices that allow easily carrying them to different places (Sung et al., 2016) and extending learning beyond the traditional classroom environment (Liu et al., 2014); ii) the interactivity with others and with media content (Burden & Maher, 2014); and iii) the panoply of contextual and situated learning activities they can provision, trough the proliferation of diverse hardware and applications (Parsons, 2014). Moreover, mobile learning research has shown that the use of this technology can promote student learning in K-12 educational contexts, with few published studies with neutral or negative results (Chee et al., 2017; Crompton et al., 2017; Liu et al., 2014). Frequently reported student gains are increased attention, motivation, and development of key competencies, as well as improved classroom climate (Martí & Mon, 2018; Sung et al., 2016). Though, the literature recognizes as limitations for mobile learning: i) the small screen size; ii) the processing limitations in connectivity and in computing (Liu et al., 2014); as well as iii) the possibility of disruption, cheating, cyberbullying and accessing inappropriate content on the Internet (Pedro et al., 2018). Additionally, mobile learning may entrench digital divides regarding technology access, technological skills and learning competencies (Parsons, 2014) and it requires high preparation from teachers (Sung et al., 2016).

The dissemination of mobile devices has supported the access of the general public to Augmented Reality (AR) technologies. These allow overlapping virtual elements, such as 3D models, with real objects of the physical world, in real-time, producing a new experience (Dunleavy & Dede, 2014). Those virtual elements can be triggered by real-world image recognition or by the user's location. AR has potential to increase learning performance, as it can make boring content more enjoyable and can be used to provide immediate feedback and support autonomous learning (Akçayır & Akçayır, 2017).

The literature has a growing number of studies combining mobile technologies and game-based learning (GBL). This approach refers to the promotion of knowledge and skills acquisition through the use of games (Qian & Clark, 2016) and has the potential to increase learner motivation, self-directedness, and social and inquiry skills (Giannakas et al., 2018), particularly if it activates prior knowledge and offers instant feedback (Ketelhut & Schifter, 2011). Mobile educational games can provide opportunities to meaningfully engage students in learning of relevant educational content (Liu et al., 2014); however, this teaching methodology requires a carefull balance of the play and the learning outcomes (Giannakas et al., 2018) or it is not likely to be effective (Sung et al., 2016). The EduPARK is using geocaching principles to enhance the gameplay experience for the app users, by finding hidden treasures to promote curiosity, a powerful intrinsic motivator.

Both mobile devices and AR technologies can provide authentic learning experiences. These technologies can situate the learner in a realistic physical and social context and scaffold learning processes (Dunleavy & Dede, 2014). Authentic learning builds on constructivist learning theories, particularly on situated learning, and includes features such as providing an authentic learning context and collaborative construction of knowledge (Herrington & Parker, 2013), giving students an active role in learning as they experience and use information in ways that are grounded in reality, instead on memorizing facts in abstract situations.

3. THE AUGMENTED REALITY EDUPARK PROJECT, APP & GAME

EduPARK (http://edupark.web.ua.pt) integrates a multidisciplinary team that involves researchers from the University of Aveiro (Portugal) comprising three areas: Education, Biology and Computer Science. The main relevance is its innovation in terms of outdoor learning strategies, in formal, informal and non-formal contexts, articulating curriculum contents with game challenges and with technology. The partnership with the City Council of Aveiro allowed the installation of 32 plant identification plaques in the Infante D. Pedro Park that give access to AR information developed by the project team.

The project organizes regular activities for students and visitors, as well as teacher training, to collect systematic data to better understand the educational value of mobile learning in outdoor settings. With this strategy, learning moves beyond traditional classroom environments to nature spaces that students can physically explore at the same time they make connections with curricular contents. To date, EduPARK has involved about 900 students from primary to higher education, 200 teachers and lots of tourists.

The EduPARK app (Figure 1) can be used autonomously, and at any time, promoting authentic learning so that visitors can enjoy a healthy walk while learning. The mobile app, for Android devices, was developed using Unity 5, a popular cross-platform game engine, since Vuforia is currently the most widely adopted platform for AR technology (Unity Technologies, 2017).

The EduPARK app has two main modes: i) explore freely mode, with no specific game or associated trajectory, and ii) game mode that includes interdisciplinary educational guides, or quiz games developed for specific audiences, from basic to higher education, but also for tourists/public in general. The last one is available both in Portuguese and in English to reach also foreign visitors. The school level guides were developed in articulation with the curriculum directives for specific audience and include subjects as Biology, Maths, History, etc. The AR markers are: i) in plaques, installed in the park for that purpose (see Figure 2A); or ii) in tiles (see Figure 2B), already existing in the park. The AR information overlays on top of a real-time camera feed of a feature within the park, augmenting the reality, and it can include images, audios, videos, schemes, or 3D models, such as 3D plant leaves. The AR integrated in the plaques includes information about plant species, such as leaf, flower, fruit, origin, ecology and curiosities about the species; the AR integrated on tiles is about historical and regional issues with interest for the general public (Figure 2).

There are a set of features that make the EduPARK game particularly effective in promoting learning. In what concerns pedagogical affordances, the game is grounded in the constructivist theories of authentic and contextualized learning. As such, it takes advantage of the context as facilitator of learning, as it prompts the players to observe several park elements to answer correctly the questions. For instance, the game invites the players to observe their surroundings and identify the musical instrument represented at the top of the park bandstand. It is also a game premise to have the learner assuming an active role in his/her learning process of interacting with the game resources, close environment and other team members. Additionally, the EduPARK team purposely developed the game to promote interdisciplinary learning, so it includes questions that, e.g., prompt the players to interpret the ‘not drinking water’ signal and answer in English, which is a foreign language for Portuguese children. The game also includes questions that prompt the players to acknowledge and respect the biodiversity, such as the one that suggest listening to the sound of a bird that inhabits the park.

Figure 1. EduPARK app: A) initial screen with language options (Portuguese or English), profile setting and different modes of app use; B) multiple-choice question; C) treasure hunt challenge; and D) final screen with game results

Figure 2. The EduPARK app triggering AR content: A) about plant species, using identifying plaques with AR image markers; B) about regional issues, using historical tiles as markers; C) virtual treasure displaying on the mobile screen

The EduPARK game also presents gaming affordances, such as a diverse gameplay experience. The players are asked to find specific locations in the park, to analyze the app contents (both AR triggered by plaques and by historical tiles, videos, audios, images or even the park map) and to answer quiz-questions with no time constrains. Additionally, players are also prompting to look for hidden virtual caches or treasures, but with a time limit, thus, sustaining a different game experience. Moreover, the popular treasure hunt (Laine, 2018) reifies the geocaching principles. Players are presented with challenges and riddles that require knowledge about the park (see Figure 1C) to find a specific virtual chest with bananas (see Figure 2C), having five minutes to find it. The longer the time players need to find each treasure, the less bananas they collect. Looking for hidden treasures can arouse curiosity, which is an intrinsic motivator and keeps the player engaged in learning during the game, hence, curiosity can result in improved learning and performance (Laine, 2018). The accumulated bananas can be used for help with the following quiz-questions.

4. METHODOLOGY

The EduPARK project aims to study how playing a game, supported by an interactive mobile AR app in an outdoor context may promote learning and motivation for learning, among other affective gains. The present paper gives continuity to previous works (Pombo et al., in press) and reports a survey focused on the opinion of students attending the 2nd and 3rd CBE in what concerns the use of mobile devices for learning, including their advantages and difficulties, as well as the EduPARK app educational value and usability.

Empirical data was gathered throughout the first year of app use in 15 outreach activities organized by the project involving schools and other educational entities. A total of 244 children participated in groups, both in formal and non-formal educational contexts.

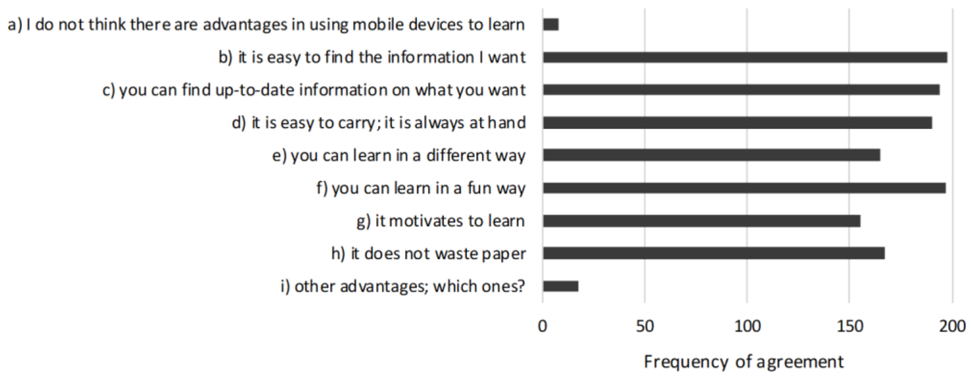
Data collection included a questionnaire survey applied right after the game activity, which comprises four sections, with multi-choice closed questions in a Likert scale. One section collected basic demographic data, as age and gender, students' profile as mobile devices users and their opinion on mobile learning advantages and disadvantages. Other section is about the interest regarding the activity of playing the EduPARK game in the park. Another section refers to the Educational Value Scale (EVS), and the last one is based on the System Usability Scale (SUS) (Brooke, 1996; Martins et al., 2015). As to data analysis, individual SUS scores and EVS score were computed according to Brooke (1996), with values varying from 0 to 100. In the present study, SUS scores were interpreted according to Sauro (2011) and to Bangor et al. (2009). The remaining data were analyzed through descriptive statistics. These sets of data were triangulated to provide a more comprehensive knowledge of students' opinion regarding mobile learning. This analysis will be presented in the next section.

5. RESULTS AND DISCUSSION

Students' age ranged from 10 to 16 years-old, being 48.4% of boys and 51.6% of girls. At the time of the activity, children were attending grade five to nine in the Portuguese Education System: 63.2% in grade five; 5.4% in grade six; 2.2% in grade seven; 27.4% in grade eight and 1.8% in grade nine. Grade five and grade eight were considered particularly suitable for learning in an urban park. This tendency can be associated with the National Curriculum for these years, as it prescribes learning related to the environment protection, ecosystems, biodiversity, etc.

Most students (85.8%) referred owning an Android mobile device, smartphone or tablet, and claimed they use mobile devices to learn either frequently (18.8%) or sometimes (67.8%). The remaining students (13.4%) mentioned they do not use mobile devices to learn at all. Most of children were already quite familiar with mobile devices and considered they were able to employ these technologies for learning. These results seem to support the literature that highlights the mobile devices proliferation (Chee, Yahaya, Ibrahim & Hasan, 2017), especially in what concerns school aged children.

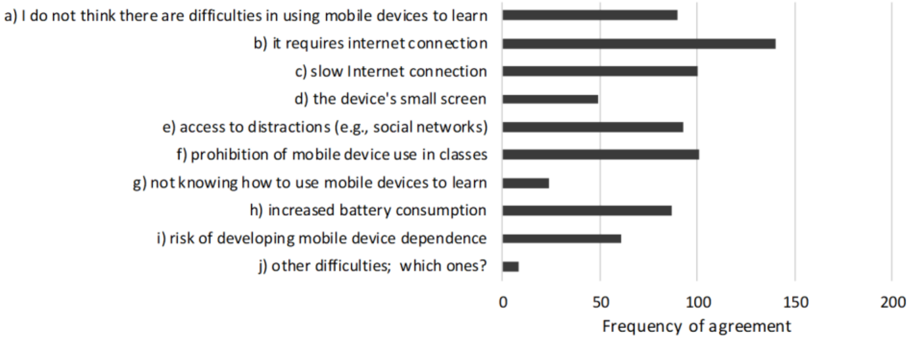
Students indicated a positive perspective regarding mobile learning, and Graphic 1 shows the agreement with each advantage sentence.



Graphic 1. Students' Opinion about Advantages in using Mobile Devices to Learn

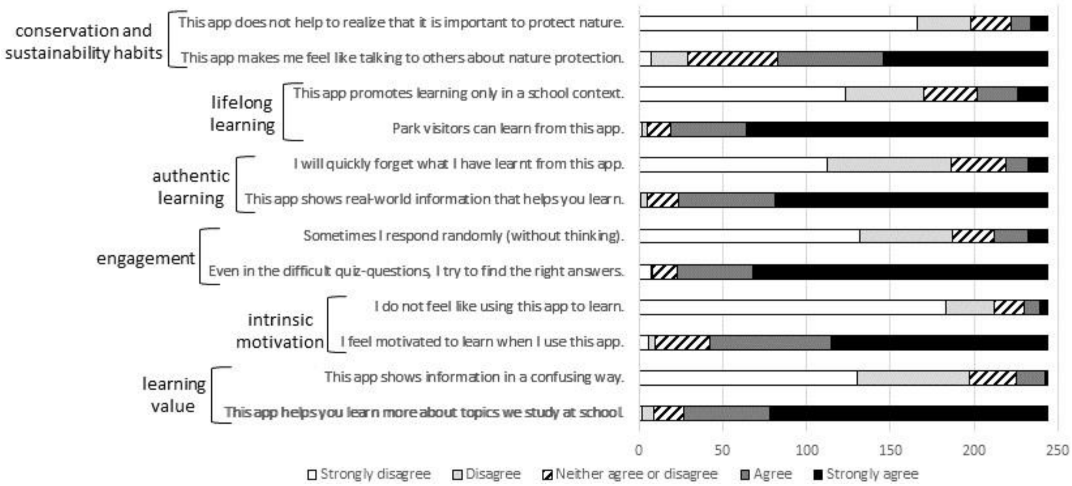
All sentences achieved a frequency of at least 150. Only 3.3% students did not recognize any advantage in mobile learning. Among the most acknowledged advantages are 'it is easy to find the information I want' (81.1%), 'you can learn in a fun way' (80.7%), and 'you can find up-to-date information on what you want' (79.5%). Moreover, 7.4% students added new advantages, such as the shortened time of information search when compared with other methods, not polluting the environment with the printers' tonners, the fun they have when using mobile devices or even not being bored studying with the books.

Regarding the difficulties of mobile learning, Graphic 2 shows that 36.9% students did not recognize any difficulties in the use of mobile devices to learn. The most mentioned difficulties are the requirement of internet connection (57.4%) and its slowness (41.0%), and the prohibition of using mobile devices in schools (41.4%). The EduPARK project approach contributes to reduce all these constrains, as: i) the game supporting app was conceived for offline use, not requiring internet connection, so its slowness is not an issue; ii) promotes teachers' support in the use of mobile devices to learn; and iii) reduces students' use of other mobile devices software, as they are engaged with the game in the park (Pombo et al., 2017b). Finally, 3.3% students added new difficulties, such as one cannot always find what one is looking for, not understanding the vocabulary, or even the risk of dropping the mobile device and losing it. Almost all students (94.3%) considered the EduPARK activity interesting (27.9%) or very interesting (66.4%).



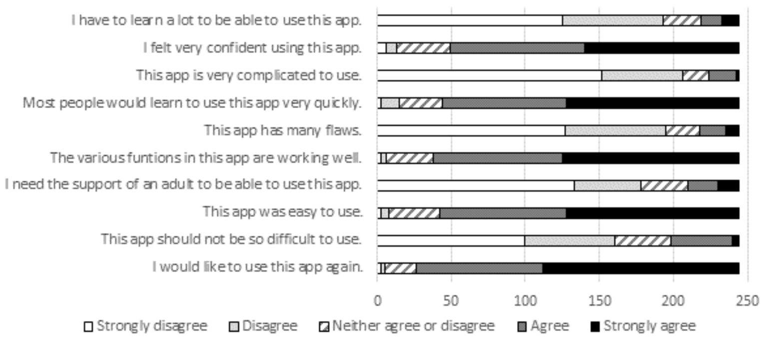
Graphic 2. Students' Opinion about Difficulties in using Mobile Devices to Learn

Graphic 3 summarizes children's opinion regarding the educational value of the EduPARK game. Their perception was positive, as, e.g., 90.2% students (strongly) agreed with the statement 'This app shows real-world information that helps you learn' and 86.9% (strongly) disagreed with the statement 'I do not feel like using this app to learn'. EVS score values ranged from 37.5 to 100, with an average of 83.8, which seems to be a high value, although more studies are needed to sustain that claim. The results seem to reveal that the EduPARK game has educational value for 2nd and 3rd CBE students.



Graphic 3. Second and third CBE students' opinion regarding the educational value of the EduPARK app

Regarding the indicators of learning value, 80.7% students (strongly) disagreed with the statement 'This app shows information in a confusing way' that assesses negatively the app's learning value. Similarly, opposite results can be found regarding the positive value attribution sentence. Similar results can be found for the remaining indicators. Graphic 4 summarizes children's opinion regarding the usability of the EduPARK app.



Graphic 4. 2nd and 3rd CBE Students' Opinion Regarding the Usability of the EduPARK app

Students' perception was positive, as, e.g., 82.8% students agreed or strongly agreed with the statement 'This app was easy to use' and 65.6% disagreed or strongly disagreed with the statement 'This app should not be so difficult to use'. SUS score values ranged from 30.0 to 100, with an average of 80.2, which is an higher value than the average SUS value (68) computed by Sauro (2011). Moreover, according to the classification of Bangor et al. (2009), the EduPARK app achieved a good-excellent usability for 2nd and 3rd CBE students.

6. CONCLUSION

The EduPARK project developed an innovative interactive mobile AR game to promote authentic interdisciplinary learning in a specific urban park being a resource with potential impact in schools, local community and tourism sector. This work reports the results of the EduPARK app and game implementation with 244 Basic Education students in outdoor activities organized by the project. The focus is students' opinion regarding mobile learning, as well as the educational value and usability of the app and game.

The results point to students' positive perspective regarding mobile learning in a population that owns personal mobile devices and claim to be able to use them for learning. Moreover, students valued mobile devices advantages of being easy to find up-to-date information, being motivating for learning and being easy to carry. Nevertheless, students acknowledged difficulties in the use of mobile devices to learn, such as needing an internet connection, its slowness, not being allowed to use mobile devices in schools. and the fact that they give access to distractions.

The EduPARK game achieved an average EVS of 83.8, indicating its high educational value. Additionally, it achieved an average SUS of 80.2, which comprises a good-excellent usability (Bangor et al., 2009), indicating that it is easy to use and promotes authentic learning in this target-public. Resources that combine this set of innovative features - such as being mobile, designed for outdoor use (namely in urban parks), with contextualized contents, supporting game-based geocaching activities and with AR contents - can be easy to use and may promote learning. These features (Akçayır & Akçayır, 2017; Burden & Maher, 2014; Martí & Mon, 2018; Qian & Clark, 2016; Sung et al., 2016) can be successfully integrated in methodologies to teach, in an authentic way, interdisciplinary and contextualized issues to Basic Education students in informal settings of their communities, such as urban parks.

This paper is a contribution to the literature on mobile game-based AR learning, as it includes empirical evidence regarding the effectiveness of the integration of new technologies in 2nd and 3rd CBE to promote students learning. It also bears the report of an example of excellent interdisciplinary educational materials – the learning game – that comprises a very useful tool for teachers and students to explore scientific knowledge by accessing appealing information on biological and historical references of a local urban park.

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WHAT FACTORS MATTER MOST FOR MOBILE LEARNING ADOPTION?

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ABSTRACT

This study investigates the interaction among factors affecting the effectiveness and consistency of frameworks for adoption and sustainable use of mobile learning. The research was designed according to a mixed-methods paradigm, including a literature review and a systematic review. A total of 362 factors were identified in the literature review of 75 studies. Twenty-five studies were included in the systematic review. The findings derive a five-discrete-dimension cluster that matter the most in isolation and as an orchestrate scenario: technological resources; digital literacy; pedagogical, behaviour, attitudes and ethics; and leadership. The findings could be useful to any schools which are thinking about introducing or amplifying mobile learning in their curriculum in order to prioritize and manage strategic initiatives.

KEYWORDS

Mobile Learning, Technology Integration, Leadership, Educational Strategies

1. INTRODUCTION

1.1 Theoretical Framework

The twenty-first century has brought a technological revolution which is continuously evolving toward powerful mobile and handled devices as well as intelligent software applications which are improving on our quality of lives (Fullan 2013, Camilleri 2016).

This digitization of the world is unstoppable, and this era is demanding digital talent. According to a 2016 Mckinsey study, “How to scale personalized learning”, 22% of jobs are in vacancy because companies don’t find the right candidates with the required skills. Tallinn, Estonia, held the first EU Digital Summit on September 2017. The summit brought together EU heads of state. It was a platform that launched high-level discussions on further plans for digital innovation with the aim of keeping Europe ahead of the technological curve. Since 2005, the European Commission’s science Knowledge service, launched the Joint Research Canter (JRC), research on Learning and Skills for the Digital Era, with the aim to provide evidence-based policy support to the European Commission and the Member States on harnessing the potential of digital technologies to innovate education and training practices. Digital competency is included in the most relevant 21st-century skills models: enGauge 21st-century skills: Literacy in the Digital Age; Framework for 21st-Century Learning and Nurturing our Young for the Future: Competencies for the 21st-Century (Adell, et al., 2013).

Affordability and usability are progressing worldwide at stunning speed. According to OECD quarterly broadband penetration report, mobile broadband penetration reached 97% penetration rate in the third quarter of 2016. Worldwide mobile subscriptions reached 7.5 billion, (Ewaldsson, 2016).. Mobile devices penetration’s levels will continue growing and BYOD model seems likely to become the norm (Johnson et al., 2013).

A vast literature has proven multiple mobile learning positive benefits and impacts and has been recognized as one of the most influential technologies for education (Chee, et al., 2017; Crompton & Burke, 2018; Hwang & Wu, 2014; Liu et al., 2014; Mahdi, 2018; Pimmer et al., 2016; Sung et al., 2016; Virtanen et al., 2018; Wu, et al., 2012; Zheng, Li, Tian, & Cui, Panpan, 2018; Islam & Grünlund 2016).

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Frameworks to implement mobile learning have been developed focus on technology, content and pedagogical aspects, the purposes of which mainly were: designing and develop tools, analysis tools, evaluation tools and guiding tools (Ada, 2018; Al-Hunaiyyan, Bimba, Idris, & Al-Sharhan, 2017; Crompton, 2017; Hwang, 2014; Kearney, Schuck, Burden, & Aubusson, 2012; Koole, 2009; Lim Abdullah, Hussin, Asra, & Zakaria, 2013; Ng & Nicholas, 2013; Nordin, Embi, & Yunus, 2010; Park, 2011; Rikala, 2015; Veerabhadram, de Beer, & Conradie, 2012). However, adoption and sustainable use of mobile learning haven't unleashed its potential. Education remains steadfast and a considerable number of schools' reality is still quite analogical. The pedagogical use of this powerful learning methodology has not been maximized (Voogt, Knezek, Cox, Knezek, & Brummelhuis, 2013; Vahtivuori-Hänninen & Kynäslahti 2012; (Alrasheedi & Capretz, 2015; Kopcha, 2012, Rikala, 2015; Nikolopoulou & Gialamas, 2016; Stevenson, Hedberg, O'Sullivan, & Howe, 2015). Moreover, when technology integration occurs, sustainability and efficiency use are challenges of mobile learning adoption (Keengwe, 2007; Sutton & DeSantis, 2016; Hannah Oakman, 2016; Keengwe, Onchwari, & Wachira, 2008).

Educational management has successfully adopted countless management tools, particularly those oriented towards strategic management processes. Mobile learning adoption has been considered as a strategic process that could be managed using management tools (Kettunen, 2007; Wong, 2005; Ng & Nicholas, 2013).

Critical factors are crucial in the organization's strategies, Michel Porter, (1996). "Critical factors can be viewed as those activities and constituents that must be addressed in order to ensure its successful accomplishment and acceptance by the various stakeholders "(Goyal, Purohit, & Bhagat, 2010, p.2). Managing factors affecting strategic management is part of the process and shape the efficiency and consistency (Glueck, Business policy and strategic management, 1980; Mintzberg, 1995; Porter, 1996).

1.2 Purpose of the Study

The objective of this study is to identify and evaluate the critical factors that shaped the adoption and sustainable use of mobile learning. Identifying the main factors influencing the mobile learning and how can enhance or impede effective adoption and sustainable use. Thus, the research question to be answered in this paper is: Which factors determine the success of mobile learning adoption and sustainable use?. The two specific research questions driving this study are.

(1) What are the key success factors in integrating mobile learning within education?
(2) How key factors affecting mobile learning can be grouped in a communal hierarchical taxonomy?

2. RESEARCH DESIGN

Explanatory sequential design (Creswell 2012) was used to direct different methods and mixed collection data tools were employed with the objective to triangulate and validate research and prove evidence. Table 1 illustrates the research design.

Table 1. Research Design

Research pursued	Research objective	Sample/ Participants	Data collection method
Explanatory	Develop an initial understanding of key factors affecting mobile learning adoption. RQ1. What are the key success factors in integrating mobile learning within education?	N= 75 studies N= 362 Factors identified	Literature review
Explanatory	To collect evidence regarding the cause-and-effect of the most common barriers and enablers of mobile learning. Identify the main categories grouping factors affecting mobile learning adoption in secondary schools. Gather information needed to design the expert judgment. RQ2 How key factors affecting mobile learning can be grouped in a communal hierarchical taxonomy?	N= 27 studies	Systematic review

Search literature was based in concept-centric (Okoli & Schabram, 2010; Webster & Watson, 2002). For literature reviews conducted in relation to education, the Web of Science database has been recommended by several previous studies (Fu & Hwang, 2018). With the objective to identify the main factors affecting mobile learning adoption, both mobile learning and strategic management critical factors were included in the research. The expressions ("mobile learning" OR "ubiquitous learning" OR "blended learning" OR "M-learning" OR "B-learning" OR "mobile devices" OR "strategic management" OR "strategic process" OR "strategic planning") AND ("factors") were used. The research process initially yielded 242 publications. Results were filtered by timespan between 2008 and 2018, resulting in 203 studies. A total of 75 studies were selected based on titles and reading its abstract and keywords revised, refined and article grouping was adjusted and summarize in a meta-data and concept matrix.

A systematic review (Hemingway & Brereton, 2009) approach was performed in this study to answer the second research question directing this study with the goals of providing an impartial synthesis, summarize and generalize the relevant knowledge, trends as well as to identify the main categories.

Based on the prior literature review research, the following inclusion and exclusion criteria were applied: categorization or grouping was among the key variables of the study and studies must have been published between 2008 and 2019. A total of 35 full-texts were identified as eligible for the review and were comprehensively analysed by two of them. Finally, 27 studies were included in the systematic review. Figure 1 shows the data search and collection process. The 27 studies included in this analysis are identified with an asterisk in the bibiliography.

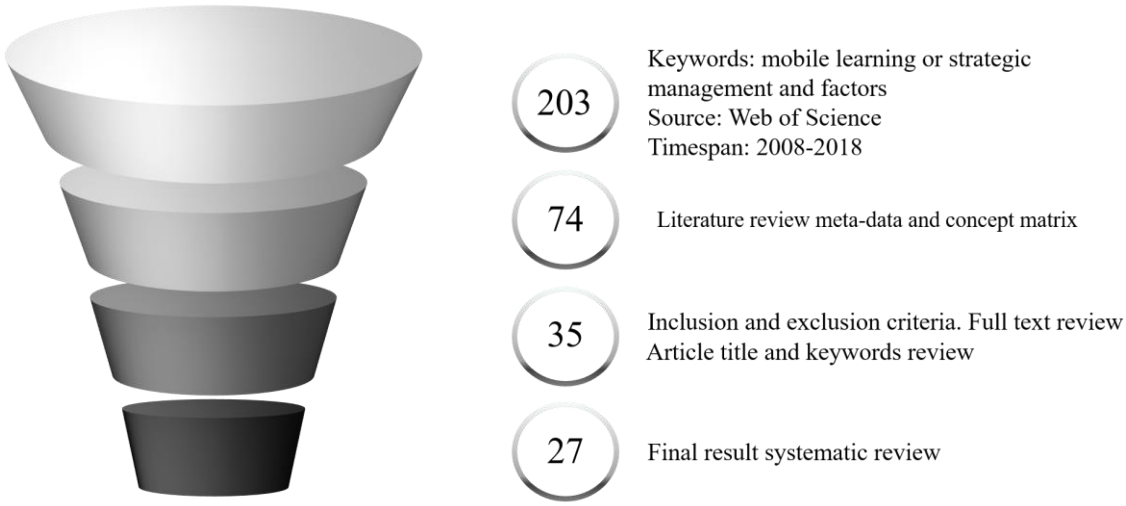

Figure 1. Diagram of the systematic review search process

3. RESULTS

3.1 Factors Affecting Mobile Learning Adoption

There are numerous mobile learning definitions, most of them highlight the core characteristics such as mobility, ubiquity, interaction, learner-centred approach, formative assessment, collaborative sharing and personalization (Osman, El-Hussein, and Cronje, 2010; Crompton, Muilenburg and Berge,2013; Peng et al. 2009; Peters 2009; Cochrane & Bateman, 2010; Teoh, 2011 Jahnke and Kumar 2014; Alrasheedi & Capretz, 2015; Thinley et al. 2014; Cochrane et al. 2013, Kean et al. 2013). For the purposes of this study, we will define mobile learning as the art of using mobile technologies to empower and enhance learning experiences (Rikala, 2016).

Literature highlights isolated recurrent factors affecting strategic management, and mobile learning. Most of the studies analysed were focused on the perceived performance or learning outcomes. A significant number of the studies analysed were focused on students' or teachers' perceptions. Based on the literature review of 75 studies, 362 different factors have been identified. The most cited factor is communication cited in 10 studies, followed by leadership, highlighted in 6 studies, assimilation with curriculum and institutional support were cited in five and four studies respectively.

3.2 Taxonomies of Factors Affecting Mobile Learning Adoption

There is significantly consistence amount grouping the factors affecting strategic management in two big categories. On one hand, **hard factors**, including those impacting company performances in a way that companies can reasonably handle, manage and measure. This category includes factors such as technological resources, company's structure, managerial skills, strategy and organization. Some authors call this group hard factors. Hard elements are easier to define or identify and management can directly influence them (Peters & Waterman, 1982). Other frameworks call this category performance factors (Dewar et al., 2011). Other studies group in a similar way called this category independent variables (Humaidi, Anuar, & Azzah Said, 2017). Some frameworks identify this category as hard or institutional factors (Li, et al., 2008).

On the other hand, **soft factors,** this second category includes the factors affecting the company's soul, culture and organizational behaviour.in their three main areas: individual, group and organization. This category has often been identified as soft factors. "Soft" elements can be more difficult to describe and are less tangible and more influenced by culture (Peters & Waterman, 2012). Other studies identify this category as health (Dewar, et al., 2011). Other studies group in a similar way called this category dependent variables (Humaidi, Anuar, & Azzah Said, 2017). This category has also been identified as soft or people-oriented (Li, et al., 2008). Table 2 summarizes the categories of factors affecting strategic management.

Table 2. Categories of factors affecting strategic management process: frameworks and studies

Category	Study working	Framework	Study
Hard	Hard	7 S framework	Peters & Waterman (1982)
	Hard	8 S framework	Higgings (2005)
	Performance	5 As framework	Dewar et al. (2011)
	Independent	Knowledge Project Management Performance Assessment	Humaidi, Anuar & Azzah Said (2017)
	Hard	A framework of strategy implementation research	Li, Guohui & Martin, (2008)
Soft	Soft	7 S framework	Peters & Waterman (1982)
	Soft	A framework of strategy implementation research	Li, Guohui & Martin, (2008)
	Soft	8 S framework	Higgings (2005)
	Health	5 As framework	Dewar et al. (2011)
	Dependent	Knowledge Project Management Performance Assessment	Humaidi, Anuar & Azzah Said (2017)

Featured in the book by former McKinsey consultants Thomas J. Peters and Robert H. Waterman, Mc Kinsey developed a management framework that maps a constellation of interrelated factors that influence an organization's ability to change. The McKinsey "7S" framework involves seven interdependent factors which are categorized as either "hard" or "soft" elements. "Hard" elements are easier to define or identify and management can directly influence them: Strategy, Structure and Systems. "Soft" elements, are more difficult to describe, and are less tangible and more influenced by culture: Shared values, Skills, Style and Staff. This framework that has persisted over the years according to McKinsey Quarterly report, March 2008. In 2005, Higgins adapted the framework and sets up an *"8S"* framework of strategy implementation, including strategy and purposes structure, resources, shared values, style, staff, systems and processes, and strategic performance.

Li, Guohui and Eppler (2008), identified nine recurring factors affecting strategy implementation. They divided those nine factors into three categories; soft, hard and mixed factors. Soft factors (or people-oriented factors) include the people or executors of the strategy; communication; relationship with different business units; consensus; tactics and commitment to the strategy. Strategy formulation factor is considered a mixed factor containing hard and soft elements (Li, et al., 2008).

The McKinsey "5As" framework, 2011, highlights health as well as performance as the key to sustaining excellence. The framework is based on a structured process characterized as "5As": aspire, assess, architect, act and advance. For each stage, there are frameworks for performance and health that enable leaders to manage both with the same rigour and discipline. Performance five stages are related to strategic objectives, capacity platform, the portfolio of initiatives, delivery model and continuous improvement, in terms of health, the five stages are health essentials, the discovery process, influence model, change the engine and central leadership (Dewar, et al., 2011).

Humaidi, Anuar and Azzah, developed a conceptual framework grouping factors affecting project management. The framework draws on the bases of T.M. Qureshi. A. S. Warraich and S.T. Hijazi, 2009, included six independent variables (leadership, staff, policy & strategy, partnership & resources, project life-cycle management process and key performance indicators) and one dependent variable (project management performance). They added knowledge as a factor that can cause management performance. The framework was named Knowledge Project Management Performance Assessment (KPMPA) (Humaidi, et al., 2017).

Most of the 27 studies analysed in the systematic review applied a specific model to test user attitude and intention to adopt new technologies. Several models have been identified, including: the theory of reasoned action (TRA) (Fishbein and Ajzen 1975), the technology acceptance model (TAM) (Davis 1989), the theory of planned behaviour (TPB) (Ajzen 1991), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis & Davis, 2003).

Among the different models, TAM appears to be one of the most used in the studies included in this research. Technology Acceptance Model (TAM) (Davis, 1989) consists of five main elements: perceived usefulness, perceived ease of use, attitude toward using, behavioural intention and actual system use. Perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance"; and perceived ease of use defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989). Both of them are impacted by external variables. Technology Acceptance Model is shown in Figure 2.

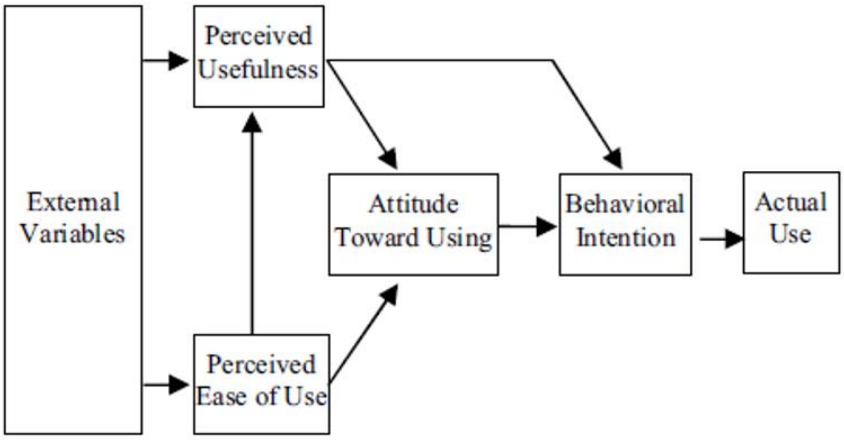

Figure 2. Diagram of the systematic review search process

A parallel can be made here with the main categories of factors affecting strategic management analysed above. Variables impacting perceived ease to use are those affecting "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989).

Based on strategic management factors classification described above (hard and soft); TAM theory classification (perceived easy to use and perceived usefulness); and Teoh (2011) and Alrashedi et al. (2015) studies; five categories were used to analyse the 27 studies included in the systematic review. Three categories of factors (technological resources, pedagogical and digital literacy) derived from hard factors and factors affecting the perception of easy to use. The other two categories (Behaviours, attitudes and ethics; and leadership) were considered soft factors or factors affecting the perception of usefulness in TAM theory. Table 3 shows the five categories of factors affecting mobile learning adoption and the number of mentions in the 27 studies included in this systematic review.

Table 3. Dimension and Categories of factors affecting mobile learning adoption

Dimension	Category	Recurrence in the systematic review
Hard		**72**
	Technological resources	17
	Pedagogical	39
	Digital literacy	16
Soft		**52**
	Behaviours, attitudes and ethics	23
	Leadership	29
	Total general	124

The first category is related to **technological resources**, it includes factors such as technological infrastructure, navigation, internet connexion, mobile tools, level of integration, technical support, student-device ratio or hardware. Other names with which this category is identified are: technological factors (Olafsen, 2005; Goyal, Purohit, & Bhagat, 2010; Mahdi, 2017; Sharples 2013; Hao, Dennen, & Mei, 2017); hard factors (Dublin, 2004); non-human factors (Spector, 2013) and technological infrastructures (Tay, Liam & Lim 2013).

The Second category encompasses **pedagogical factors** such as classroom integration, adaptability of the course, assessment, availability of content and software, critical thinking, develop thinking, time management, recognition of informal learning, define target learner groups for m-Learning; teaching preparation, solving problems, design approach, gamification, virtual environments, or customization. Most authors call this category pedagogical factors, pedagogical integration, learning-related or learner's requirement (Graf & Caines, 2004; Olivier, 2005; Goyal, Purohit, & Bhagat, 2010; Cochrane and Bateman, 2010; UNESCO, 2011; Johnson, 2011; Yoo, Han, & Huang, 2012; Mahdi, 2017; Hao, Dennen, & Mei, 2017; Ekberg & Gao, 2017).

A third category refers to educational community's mobile learning skills or **digital literacy**, to this category belong the following factors: teacher's digital knowledge, training, student's knowledge, teacher's and student's digital competency, teacher's practices and digital assessment knowledge. Some studies called this category of digital literacy (Johnson et al. 2011; Goyal, Purohit, & Bhagat, 2010). Tay, Liam, and Lim (2013) called this dimension of professional development. Yeap et al. (2016) referred to this category as "instructor readiness". Hargreaves and Fullan (2012) emphasize teacher's role in the use of technology for professional learning. Training has pointed out as a crucial factor (Abu Al-Zur & Qablan, 2011; Al Sharija, James & Waters, 2012).

The fourth category integrates human-related factors, focus on individual **behaviours, attitudes and ethics.** Often labelled as soft or human factors category (Dublin, 2004; Spector, 2013; Hao, Dennen, & Mei (2017), named this category personal and social factors. Yoo, Han, & Huang (2012), called motivational factors it also includes behaviours and attitudes, teacher's attitudes are decisive in the successful integration of m-learning in teaching. The resistance to change factors represents a significant portion of this category (Spector, 2013; Mercader, 2018).

The fifth category integrates human-related factors, affecting organization and groups, highlighting **leadership** as the most cited. In educational management, the importance of articulating organizational values is widely acknowledged. Tay, Liam, and Lim (2013) referred to this category as school leadership, Ekberg & Shang (2017) named support from school leadership. Ekberg & Gao, (2017) in their framework place a variable called school leadership.

4. CONCLUSIONS

The purpose of this study was to conduct an analysis of the factors that affect most mobile learning adoption. The study had employed two different research methods to gather evidence of the main categories of factors. A total of 362 different factors were found. Factors affecting mobile learning adoption were grouped based on two dimensions: hard and soft. Hard dimension relates to categories of factors that impacting learning performances in a way that institutions can reasonably handle, manage and measure. This dimension includes three categories: technological resources, digital literacy and pedagogical factors. The second dimension is soft and represents the categories of factors affecting the institution's soul and people's attitudes. Two categories derivate from this dimension: behaviours, attitudes and ethics; and leadership.

Future studies might confirm the proposed classification as well as prioritize the different categories and factors.

The findings could be useful to any schools which are thinking about introducing or amplifying mobile learning in their curriculum in order to prioritize and manage strategic initiatives.

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MOBILE LEARNING AND HEALTH EDUCATION: HOW STUDENTS OF BIOMEDICAL LABORATORY SCIENCES USE THEIR MOBILE DEVICES?

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ABSTRACT

Mobile Learning (M-learning) is an emerging area of distance education that takes advantage of the ubiquitous power of mobile devices, enabling the teaching and learning process by increasing access to information and supporting different types of learning. This article is part of a larger study, exploratory and descriptive, in which the use of mobile devices as a mediation tool in the teaching and learning process in a Portuguese higher school of health was analyzed. The instrument of data collection was a survey, which, in this case, 634 students responded to, with the aim of describing their use of mobile devices in learning contexts. From the data analysis, we perceive that the students mostly acquired their first mobile device at the age of 10 years old. Of these 98% use the Smartphone, mobile phone and tablet every day, and these mobile devices are of the following brands: Samsung (33%), Apple (15%), and Nokia (10%). The Android operating system prevails (70%) over iOS (15%). The features of the mobile devices most used by the students were SMS, alarm clock, and Internet access, with percentages of use greater than or equal to 90%. The importance attributed to the Apps for study and learning is indifferent or rejected for 72% of students. We can conclude, on account of our results, that the participants have, according to our perspective, the two conditions necessary to engage in mobile learning, namely: (i) positive perceptions about mobile devices, essentially in their ability to provide pedagogical advantages; (ii) owning a mobile device, meaning it is possible to implement a Bring your OWN device (BYOD) strategy.

KEYWORDS

M-learning, Mobile Devices, Students, Higher Education

1. INTRODUCTION

During 2010 the European Commission launched the Europe 2020 strategy, to guide the development of technological skills in order to carry out the economic and social objectives of the European Community in the long term. The European Digital Agenda, as part of this program, arises from the relevance of technologies, specifically the Internet, as a tool to obtain sustainable benefits. On the other hand, the Bologna Process has been requiring a major change in the pedagogical model of teaching and learning in higher education, due to the fact that it focuses on the acquisition of skills by the students and not on the mere accumulation of knowledge.

Technologically assisted learning environments are seen as fundamental support for reshaping education and can foster a more effective approach to constructive educational philosophies (Ferreira and Andrade, 2011; Sakhaei, Motaarefi, Zinalpoor and Sadagheyani, 2017; Sharpe, Beetham and Freitas, 2010).

It is clear that the current means of communication - open, social and participatory - offer great potential for transforming learning and teaching, by providing students and teachers with a range of options for communicating, collaborating and connecting – e.g. from an extensive peer network to processes of seeking information, the case of e-learning and consequently m-learning.

With regard to m-learning, Traxler (2005) considers it as an evolution of e-learning, giving importance not only to the technical characteristics and portability of mobile devices, but also to their pedagogical possibilities and advantages. He has defined it as: "any educational provision where the sole or dominant technologies are handheld or palmtop devices" (p. 262). Later, different actors and factors in the conceptualization process of m-learning continued to emerge (Traxler, 2007), which determine the perceptions and expectations, including in its evolutionary process towards the future (Traxler, 2009). Moreover, Traxler (2009) proposes a synthesis of the attributes of mobile learning as follows: it is penetrating and omnipresent; changes the nature of work; creates new forms of commerce; navigate through bite-size; is versatile in mobility; is a mobile hardware platform; is a "noisy" phenomenon; is a promoter of social change. In addition to these, m-learning, perceived as the learning process that occurs supported by the use of mobile devices, has as fundamental characteristic the portability of the devices and the mobility of the individuals, who may be physically and geographically distant from each other, or not, when in formal education physical spaces, such as the classroom. Thus, m-learning was further defined as the connected, interactive and personalized use of portable devices in classrooms, collaborative learning, fieldwork, counseling and student guidance (cf. Bastos, Bauer, Cardoso, Cornelius, Mertes and Shanks, 2018; Traxler, 2011). This definition means that mobile learning may include the following technological options: smartphones, tablets, game consoles, iPods, and wireless infrastructures.

M-learning is expanding in primary and secondary education centers, as well as in higher education, with most educational institutions being aware that change is omnipresent in the lives of students, which is why it is constantly analyzed to incorporate it into their practices (Cahill, 2011). Although m-learning is innovative, technically feasible, incorporates pedagogical advantages, and currently has visibility and increasing importance in Higher Education (El-Hussein and Cronje, 2010; Traxler, 2007), it may eventually have no possibility of large-scale institutional implementation in the near future (Traxler, 2010). For m-learning in higher education to become a successful, it is important to address the social, cultural, and organizational factors involved. These can be formal and explicit, or informal and tacit, and can vary enormously across and within institutions (Traxler, 2009). In fact, higher education institutions present different disciplines with their own cultures and specific concerns, often strongly influenced by the professional practice of the "outside world" (Traxler, 2009). Adding to this problem, most of the work developed in an environment of m-learning in the universities is still in the pilot test phase, which points to considerable difficulties in the support and development of this new teaching methodologies.

Although there is a strong interest in using mobile devices to promote learning and teaching, there also seems to be a split between the promise and the reality of the use in education of this type of technology. Likewise, there is little consistency in the evidence that education has undergone drastic changes with the introduction of these devices in the classroom. This paradox, between the potential use and the actual use of technology, is known as the main object of research in an area of study that has been developed in recent years (Conole and Koskinen, 2012). Research into the design of mobile-mediated learning seeks to better understand this mismatch (Krull and Duart, 2017; Sølvberg and Rismark, 2012). Therefore, we felt the need to contribute to a study, specifically intended to reflect on the implementation of m-learning strategies in a Portuguese Polytechnic Higher Education, namely in the Lisbon Higher School of Health.

With regard to the Polytechnic Institutes in Portugal, implementing measures against info-exclusion should be considered, as it plays a fundamental role in the development of the Information Society. Almost all of them have Internet connections, allowing students to access the information they need not only on campus but also outside the campus, for instance, in their homes, through Virtual Private Network (VPN) connections. As a consequence, e-learning presents itself as a learning methodology, applied through a learning management system (that enables, for example, the administration of formative events supported by a Web technology). On the other hand, several studies carried out in the last decade, both in formal and informal contexts, report a good acceptance of the mobile technologies by the students (Cardoso and Bastos, 2018; Attwell, 2007; Kuimova, Burleigh, Uzunboylu and Bazhenov, 2018; Kukulska-Hulme, 2009; Montrieux, Vanderlinde, Schellens and De Marez, 2015; Traxler, 2010; Waycott, 2004), in collaborative learning, in fieldwork and in student mentoring (Traxler, 2005). It was in this digital environment, and based on the literature review on the role that mobile technologies can have in the individual and collaborative construction of knowledge and its educational effects, that emerged our research theme. In this text, we will focus on the part of that research, aimed at studying how the students of biomedical laboratory sciences, of the Lisbon Higher School of Health (of the Polytechnic Institute of Lisbon, Portugal), use their mobile devices.

2. METHODOLOGICAL OPTIONS

2.1 Participants

This is a descriptive and exploratory study, so there was no formal calculation of sample size, and as such, it followed a non-probabilistic sampling process for convenience. Consequently, from the 1300 students who made up the faculty of the School of Health on the year 2015 responded to the survey 634. The age range ranged from 18 to 45 years, with a mean of 20.78.

2.2 Study Design and Procedure

As already mentioned, a descriptive and exploratory study was developed. First, it was necessary to ask the President of the Lisbon Higher School of Health for permission to carry out the research, namely the implementation of a survey. The main ethical problem in this study was the collection of potentially identifiable data. The necessary data were obtained only after informed consent of the students, to whom we explained the purpose and use of their data, after having reiterated that their participation in this survey was voluntary, ensuring full confidentiality of personal information. The informed consent took place in an online format, and from the moment of acceptance, the survey was immediately made available, which could be answered at once, or saved at a certain point and later completed. The survey had an estimated time of 10 minutes for its completion. The informed consent and inquiry were sent through a mailing list of students provided by the academic services of the Lisbon Higher School of Health. With regard to the development, access and monitoring of the survey, we worked with the Vanderbilt University's REDCap version 5.7.1 Software (https://www.project-redcap.org/). The data were later exported to the IBM SPSS software, so as to perform the statistical analysis.

2.3 Data Collection

In order to collect the data, a survey of 43 questions was conceived and implemented, consisting of five sections:

1. Sociodemographic characterization;
2. Characterization of the mobile device;
3. Dynamics on the use of mobile devices;
4. Perceptions on the use of mobile devices in an educational context;
5. Practices on the use of mobile devices in an educational context.

The first section allowed to obtain the sociodemographic characterization of the students participating in the research; in the other sections, it was possible to know the functionalities of the most used mobile devices and their valuation by the students in the learning process. Thus, the main goals of the survey can be summarized as indicated:

1. To demographically characterize the participants;
2. To identify the user profile of mobile devices;
3. To know the practices and perceptions of the students on the use of mobile devices in a formal educational context.

2.4 Statistical Methods

With regard to data analysis, we defined the level of variables that emerged from the survey. These were essentially nominal and ordinal variables. Bearing in mind the framework of variables, we used two types of statistical analysis, namely univariate and bivariate (Pestana and Gageiro, 2008).

Considering the univariate analysis, we used the descriptive statistics to describe the phenomena under study, based on the following measures:

a) Measures of central tendency: Average; Mode; Median; Average trimmed;

b) Measures of dispersion: Data amplitude; Minimum and maximum value; Standard deviation; Variance; Interquartile range;

c) Distribution measures: Kurtosis; Skewness.

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3. RESULTS

The results obtained on the daily use of the Mobile Device (MD) by students were analyzed in two contexts: school and non-school. With regard to the characterization of MD used by students in a non-school context, we conclude that:

• 98% of students said to have Smartphones, tablets and mobile phones;
• As far as the MD brand is concerned, Samsung prevailed (33%) over Apple (15%) and Nokia (10%);
• The two most widespread operating systems were Android (70%) and iOS (15%).

Regarding the MD user profile, the students participating in our survey showed the following general characteristics:

• having acquired the first device with a mean age of 11.12;
• having indicated that they most frequently write, indistinctly, on paper and mobile device (27.6%).

The MD functionalities used by students in a non-school context can be grouped according to the relative frequency. Thus, the first grouping with frequencies between 90% and 100% relates to the following functionalities: "SMS"; "Internet"; "Alarm Clock". The second grouping with percentages included between 80% and 90% comprises: "Social Networks"; “Calendar”; “Record/Play Pictures”. The three grouping with frequencies between 60% and 80% consists of the following functionalities: “Calculator”; “Voice Call”; “email”; “Games”. Finally, the last grouping, with frequencies under 60%, corresponds to the functionalities: "Record/Play Video”; “Record/Play Audio”; “MMS"; "Stopwatch"; "Radio” (Figure 1).

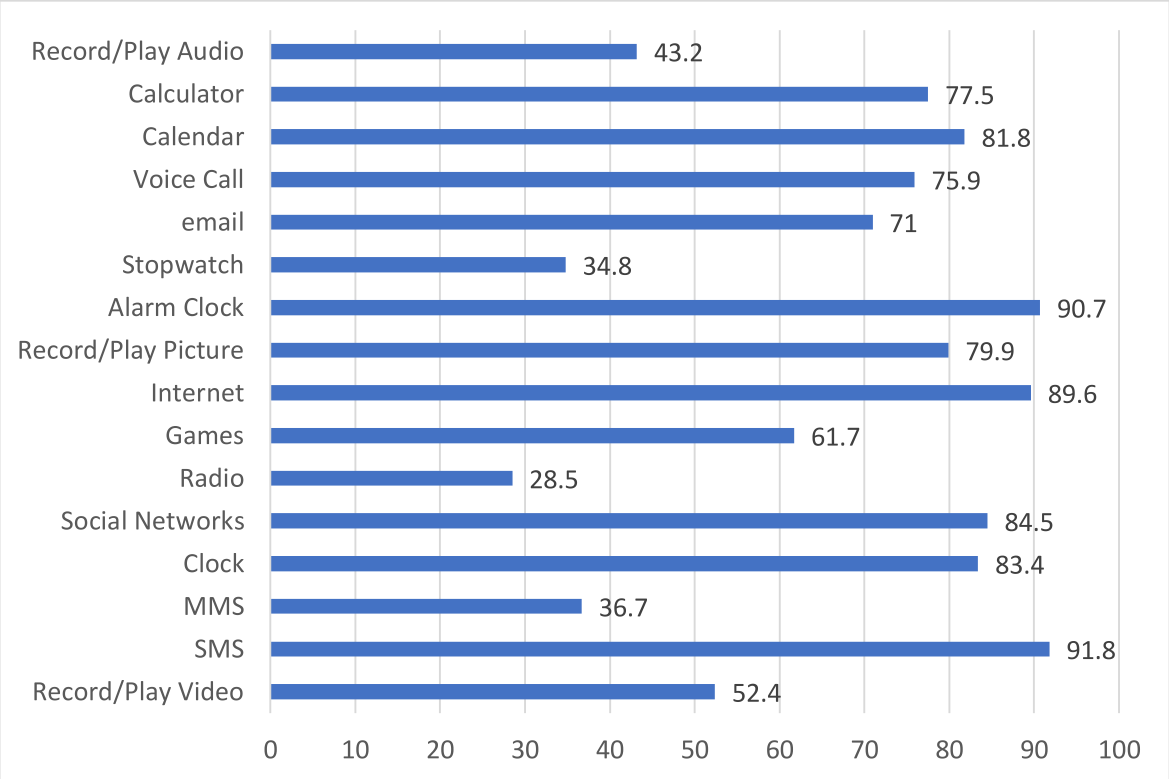

Figure 1. The MD functionalities used by students in a non-school context

Moving now to the analysis of the students’ practices and perceptions on the use of MD in a school context (e.g. learning in the classroom), we can point out the following results:

• The most used MD was the Smartphone (45%), followed by mobile phones (26%) and Tablets (24.1%), with the remaining values attributed to computers or no MD;

• Concerning the use of the multimedia and communication features of the mobile devices, students essentially use SMS (56%) and email (44%);

• Per day, 15.5% of students use their MD for over two hours for their learning assignments. Associated with this frequency, it is also verified that 84.4% of the students nearly don't use their mobile devices to present their educational contents (below one hour per day);

• Students usually don't use mobile devices in laboratory or practical classes (45.5%), neither in the internship seminars (50.6%);

• From the different perceptions on the use of mobile devices, students agreed that mobile devices are useful in the classroom (24.7%), present pedagogical advantages (74.3%), and are real information instruments (98%). However, despite the positive aspects stated, only 47.5% of the students agreed that the mobile devices in the classroom should be used; 46.2% of the students mentioned preferring to use them outside the classroom.

Another important fact is the perception that students have about the distraction (66.3%) that is attributed to mobile devices during the teaching and learning process. Besides, students stated they could imagine some situation where teachers can teach better (38%) and students learn better (51%) through a MD. However, the relevance of mobile applications (apps) to the teaching activity was considered low by 31.9% of the students, and high by only 27.5% of them (cf. Figure 2).

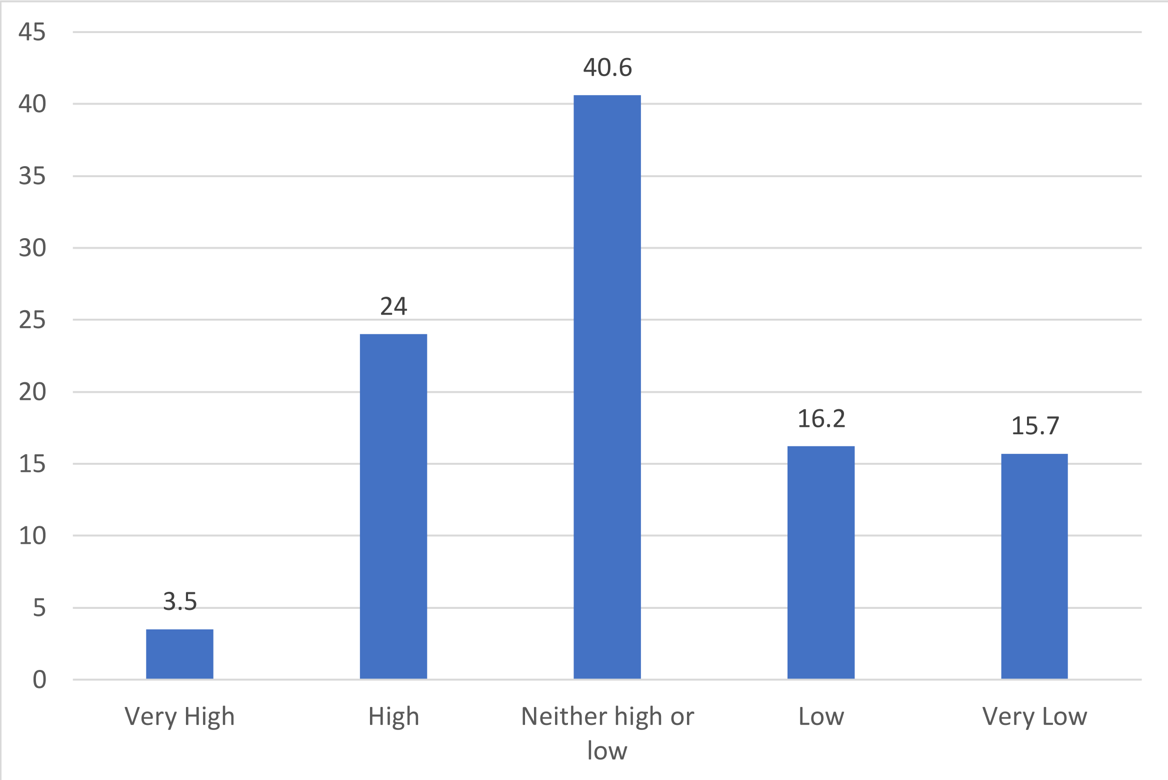

Figure 2. The relevance attributed by the students to apps for the teaching-learning process

From the analysis of the results, we can concluded that the students who answered to our survey use mobile devices as a learning tool very seldom, and only for the purposes of supporting individual (24%) or group work (20.2%), and clarifying doubts with teachers (7.9%) or classmates (4.9%).

4. DISCUSSION AND CONCLUSION

All the students who participated in our study acknowledged to have mobile devices, namely, most of them, Smartphones, and with the Android Operating System. These data are aligned with those presented in the literature (where results are also very close to 100%). On the other hand, we should not forget that the penetration rate of mobile devices in the global market with the Android Operating System in the fourth quarter of 2014, according to International Data Corporation (IDC), was of 76%, followed by iOS with 19.7% (IDC, n.d.). Comparatively, the results obtained in our study show a slight decrease of 6% for the Android operating system, and about 4% in iOS. This difference may be partly due to the size of our sample.

As far as the e-learning implementation policies in Higher Education Institutions are concerned, it is important to consider the difficulties these institutions face, namely with regard to how education technology is used and whether or not it enables e-learning in Higher Education environments. In this respect, we must not forget, on the one hand, that there are differences between the learning technologies, determined by the official bodies, and the way students use the technologies outside the classroom. On the other hand, it is necessary to understand how to combine the effectiveness of the new technologies used to promote collaborative learning processes with the development of a higher order reasoning.

Our results demonstrate that participants have, according to our perspective, the two necessary conditions to become involved in mobile learning activities. The first condition is that students have shown positive perceptions about mobile devices, essentially on their ability to provide pedagogical advantages. The second condition *sine qua non* is that all participants have a mobile device, and there is no need to adopt a Bring Your Own Device (BYOD) strategy. This strategy may not be easy to implement: an example of this is a quantitative cross-sectional observational study that was carried out at a Dutch University. In this study, students did not seem very enthusiastic about taking their mobile devices to class, choosing instead to leave them at home, thus compromising the University's strategy, despite the didactic advantages that it could have (Kobus et al., 2013).

In addition to the having a mobile device, it is important, as recognized before, to have a positive perception about m-learning, but not only by the students. It is also essential that teachers have a positive perception about m-learning, as is the case e.g. of one of our studies (Cardoso and Abreu, 2015) or as described in a prior research that aimed to evaluate the self-efficacy of a nursing faculty in the use of mobile technology, in the teaching and learning process in contexts of education and clinical practice (Kenny et al., 2012).

Another very important aspect to consider is the political action on the part of the Institutions of Higher Education (IHE) that should act in two fronts. The first of these is that IHE should promote online or mixed training offers, to remain competitive (cf. in the Portuguese context e.g. Peres, 2018; Peres and Mesquita, 2014). In this respect, a proposal to implement e-learning in the traditional universities of the United States of America has been presented, taking into account the concept of educational change, based on three fundamental issues: (a) Program content; (b) How to sell programmatic content within the educational community; (c) How to make a permanent assessment of its effectiveness (Cahill, 2011). The second line of political action to be considered by Higher Education Institutions is to meet the need for content open, i.e. the open educational resources repositories of Institutions in Higher Education should continue to adapt their characteristics, so that the content, the creation and publication of, the access to, and the use and reuse of learning objects can be made available from mobile devices. This action, of democratizing open content, is reflected for instance in the Horizon reports of 2004 and 2010, which referred respectively to learning objects and open content, foreseeing its short-term impact due to the current free content on the Internet that can be accessed from mobile devices (Tabuenca et al., 2012).

The importance of technology in the current and incoming generations of students, their direct implication in the classroom, combined with their potential in the learning process, is crucial to achieve academic excellence, and also to create an environment of disruption, promoter of research and innovation. Technology is not simply seen as an additive for these students, instead it is critical for them to organize and guide their own learning. Hence, technology provides, for example, a variety of interaction and communication opportunities and guarantees them the flexibility that allows them to take control in their own learning process. These generations have been and are being educated in an environment filled with (new) technologies. However, the use in learning of these technologies, and namely the mobile devices, occurs simultaneously with their use in other social and entertainment activities. And so, further research questions emerge, challenging the integration of m-learning in (health) education, to which we intend to address so as to contribute to innovative and innovating approaches, in the teaching and learning of the biomedical laboratory sciences.

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STUDENTS' PERCEPTION TOWARDS PROGRAM VISUALIZATION ON SMARTPHONE - CASE OF SUNLAB INITIAL INVESTIGATION

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ABSTRACT

Effectiveness of program visualization tools in teaching and learning programming is well documented. However most of program visualization tools are desktop applications, this study aims at investigating students' perception of program visualization on Android smartphones. Study result shows that program visualization using smartphones can arouse students' enthusiasm in learning programming especially when they can write program to interact with their environment. Students were interested in writing small programs to interact with smartphone sensors and perform trivial functions like sounding an alarm whenever a phone enters a school football pitch.

KEYWORDS

m-Learning, e-Learning, Program Visualization, Computational Skills, Teaching Programming

1. INTRODUCTION

Computational thinking is nowadays a vital skill in our daily life. In addition to reading, writing, and arithmetic skills computational thinking is seen as necessary and important skills in this digital age. Computer programming is an effective and most applicable way of teaching computational thinking. However, computer programming is difficult to master. Therefore, different teaching methods and tools have been developed to help students master computer programming concepts. According to Serafini's vision learning programming on an adequate level of abstraction is a very effective didactic approach to Computational Thinking (Serafini, 2011). Program Visualization (PV) tools are promising programming teaching tools in early stages of the learning path of a programmer. PV tools can engage students in viewing animation, creating animations, responding to questions and changing inputs.

Urquiza-Fuentes and Velázquez-Iturbide surveyed 24 experiments of evaluating program visualization and algorithm animation systems. Their results show that learning can be improved with PVs in different ways depending on engagement level. Improvements in knowledge acquisition were detected in 75% of the experiments at any engagement level (Urquiza-Fuentes, et. al., 2009). Moreover, improvements in attitude towards either material or subject matters were detected. Finally, it was found that programming skills of students were improved. Despite of the importance of PV in teaching and learning computational skills there are few studies on the effectiveness of PV using smartphones. In this paper, we present finding on the students' perception of program visualization on smartphones using SunLab and make several contributions to future works on PV on smartphones. This paper is the extended work of the paper "dynamic program visualization on Android smartphones for novice Java programmers" (Kumalija, E. et. Al. 2018).

2. RELATED WORK

There are different approaches that have been adopted to utilize the potential of mobile phone to students studying programming. These approaches include delivering education content, introduction to programming where students learn directly by developing smartphone applications and using the smartphone to write programs that will be run on smartphones (John M.S. & Ran, M. 2015). Moreover, there are mobile platforms for learning programming on smartphones like mobProg a mobile-based application that provides students with a smartphone-based platform for learning Java programming (Hashim, A. 2007) and Microsoft TouhDevelop a programming environment intended to enable anyone to use a phone to program the phone using scripts for their windows-based smartphones (Athreya, B. Et al. 2012). Despite wide availability of smartphones, there are few studies that attempts to include PV in mobile devices for teaching programming.

In teaching programming there are several studies on smartphones to visualize program or algorithms in web-based format. Example, a collection of algorithm visualizations of various classical and non-classical algorithms presented in a unified and interactive web-based visualization (Halim et. al. ,2012). mJeliot provides support for students to interact with Jeliot via their mobile phones (Pears et.al., 2011). These tools do not support students to create their own programs and visualize them. Improvement is made in SunLab to enable students to write their own programs, compile, and execute their programs using smartphone. In addition to that students can interact with their environment using the sensors embedded on their mobile phones.

3. SUNLAB, A PROGRAM VISUALIZATION TOOL ON ANDROID SMARTPHONE

SunLab is a dynamic program visualization tool developed to help novice programmers to learn programming concepts using Android smartphones. The initial concept was a dynamic program visualization tool for novice Java programmers (Kumalija, E. et. Al. 2018). This tool was changed from Java programming to pseudo programs so that to focus on learning the programming concepts, not the language syntax.

SunLab supports dynamic visualization for sequential instruction execution, variable declaration, and assignment, Expression Evaluation, data input, message output, selection, loop and function calls. SunLab key features are language independent, visualization control, visual tracing of statement execution and ability to interact with the environment through smartphone embedded sensors.

3.1 SunLab Program Visualization

The diagrams below show SunLab editor panel and program visualization panel.

Figure 1. SunLab editor panel

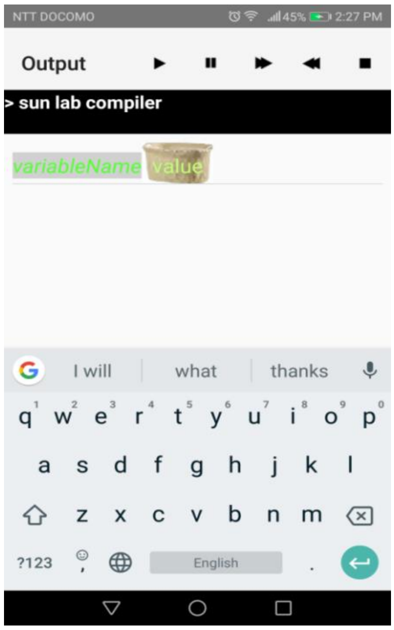

Figure 2. SunLab editor panel

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In every statement execution a graphical presentation of variable changes and output is generated. Students can control the animation speed by using control buttons on top of the animation window.

Sequence of instruction execution is animated by highlighting with pale dark blue color the instruction number of the current instruction (see instruction number 10 in figure 1 above). The console of traditional compilers is retained where user can enter input to the program and output of the program as shown in figure 3 below. Understanding variables and role of variables is the most important part in understanding programming. SunLab provides variables visualization.

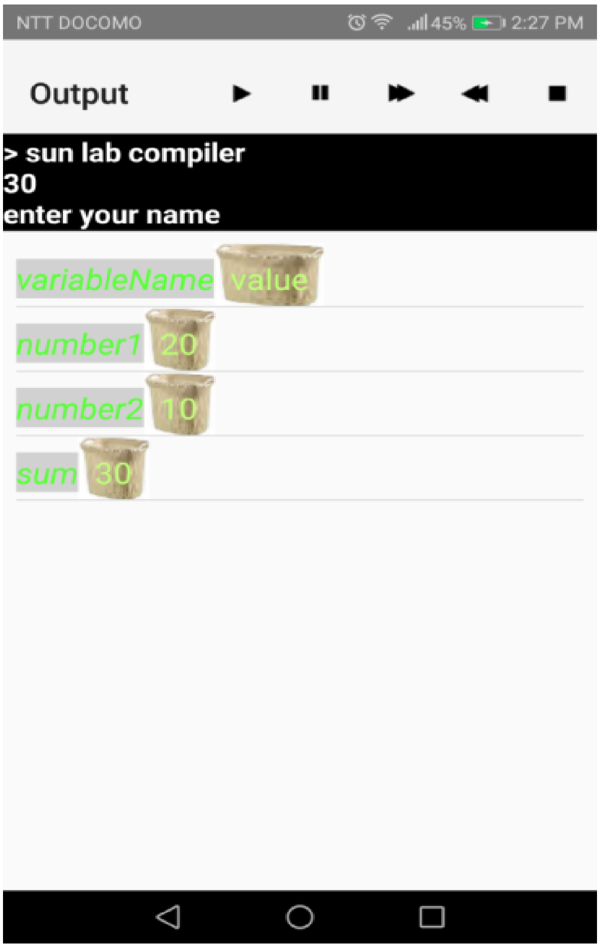

Figure 3. Variables and Role of Variables Visualization

In computer programming, a **variable** is a storage location (identified by a memory address) paired with an associated symbolic name (an *identifier*), which contains a data item that may take on more than one value during the runtime of a program. In SunLab a variable is visualized as a basket containing a value as shown in figure 3 above. The value on changes as the variable value changes during runtime of the program. More variables appear as they are referenced and disappear as they are no longer referenced for students to easily understand the role of variables.

Every programming language has built in functions to help programmers with common tasks like data input, data output, and mathematical functions. SunLab has built-in functions to help users create applications with less effort. These functions support user input, printing output to console, taking a picture using a camera, playing music and getting values from sensors embedded in a smartphone. Moreover, SunLab has functions for putting a flash on and for performing basic mathematical functions.

4. RESEARCH DESIGN

Lower secondary school students at Kokirie secondary school in Tanzania were recruited for initial investigation. The criteria for recruitment were: - the student should have taken a class on introduction to computer programming, student should have permission to use a smartphone and bring a smartphone to school from home. Thirty-one students in lower secondary school volunteered for the study, among these 31 students 18 were girls and 13 were boys. The age distribution of participants was between 14 years old to 17 years old. Students used different versions of Android OS and smartphones.

Recruited students were introduced to SunLab application features for 2 hours every day in one week. This introduction took place at school, then after they were given one week to use the SunLab out of school time. After one week of using the application, students' feedback on usage of SunLab application was collected through interview with participants. The focus of data collected was frequency of use, ease of use of the editor, visibility of animations, preference of built in functions and if it helps to understand the programming concepts. Furthermore, students were asked to showcase applications they have written.

5. RESULTS AND DISCUSSION

5.1 Continuance Intention to Use

When a user uses the application once and does not use it again, it is the sign that the user did not like the application. Students were asked how many days in the week they used the application at least once in a day. 19% used the application in less than days, 32% used the application in less than 4 days, while 49% used the application in 5 to 7 days.

The high number of students who used and reused the application signifies that students were interested in using the application.

5.2 Usability of the Text Editor

The text editor for programming is an important component of the SunLab system. It is important to know how users perceive how easy or difficult is to use the text editor.

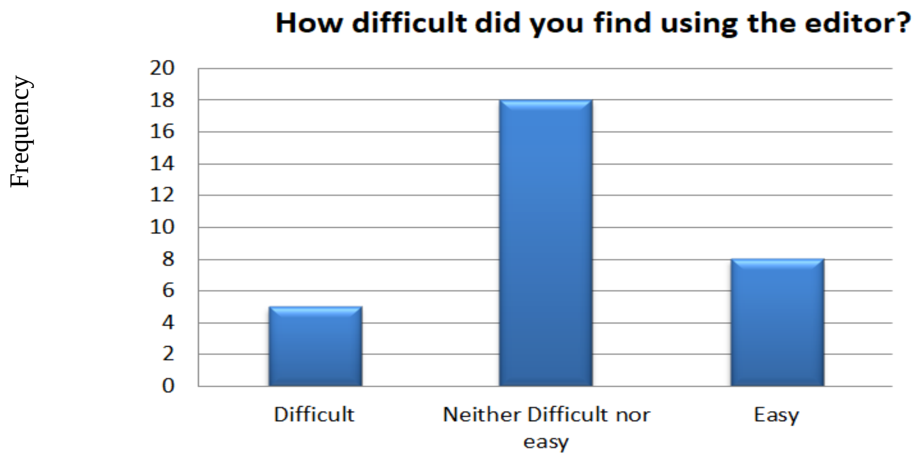

Figure 4. Editor Usability

Generally, users were satisfied with the usage of the editor, out of 31 participants 18 participants found that it is neither difficult nor easy to use the editor. However, 16 participants expressed their concerns on the difficult on using special keys on the virtual keyboard.

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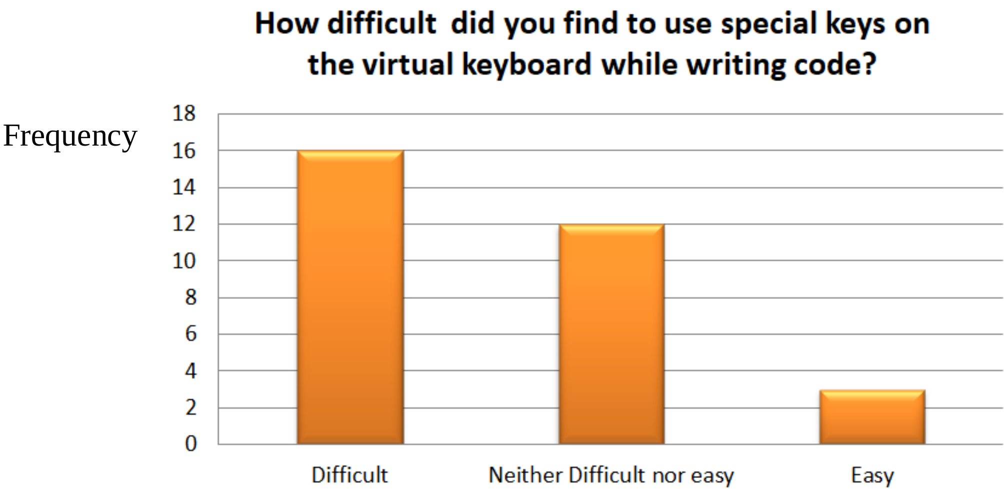

Figure 5. Response on Usability of Special Keys

Using special key was found difficult because it is not common to use special keys in the android users, it is very rare for someone to use special key like {or >> in daily usage of smartphone. Sometimes students were required to go three levels down to get the key. The key suggestion bar was helpful but it was new to students.

5.3 Animation Visibility

Students were asked on the visibility of animations. Visibility of animations was intended to measure how students perceived the easiness to see and understand the graphical execution of the program.

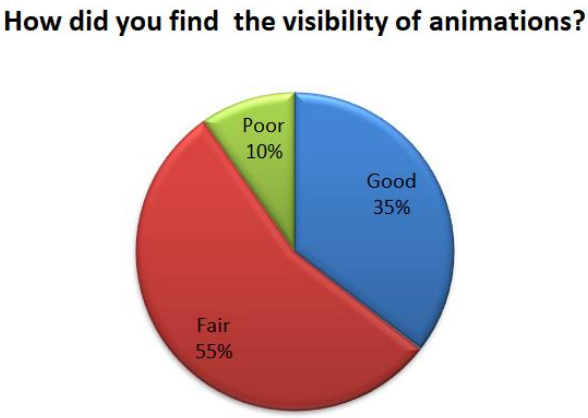

Figure 6. Animation Visibility

In this question, 35% responded positively that the visibility of animations is good and 55% response towards visibility of animations was neutral. These are generally promising results considering the screen size of the smartphones. However this area needs improvement.

5.4 Function Preferences

In any programming language exists pre-defined functions for common programming tasks like input, output and mathematical functions that users can use without the need to re-invent the wheel. SunLab is no exception. It contains pre-defined functions (inline functions) that users can use. These pre-defined are to help users with common programming tasks. Moreover, in Sunlab these functions help users to program and interact with different smartphone embedded devices like camera, GPS etc.

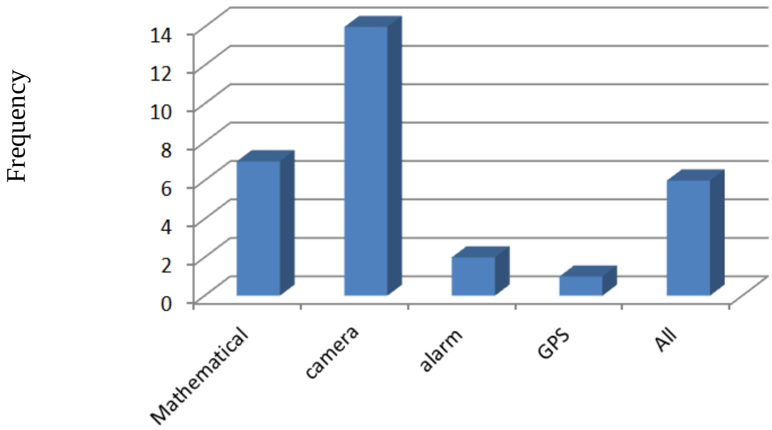

Figure 7. Built-in Functions Preferences

The histogram above shows the preferences of students on SunLab inline function. Most students expressed interest in camera functions, mathematical functions being the second in preference. The camera preference is attributed to daily usage of camera by these students so they were curious how they can program and control the camera from their code. The GPS functions were less preferred, the reason being complicated to make any useful information from the data received from GPS functions and the mathematics involved in the processing of data to get desired result which was a heavy cognitive load for this level of students.

5.5 Help in Understanding Programming Concepts

The core objective of developing SunLab application is to help students understand programming concepts easily and acquire computational thinking skills. Students were asked if using SunLab helped them to understand programming concepts. Students were asked if this application helped them to understand expression evaluation, variables and arrays, if-else, while loop and functions. Program visualization was provided for these programming constructs.

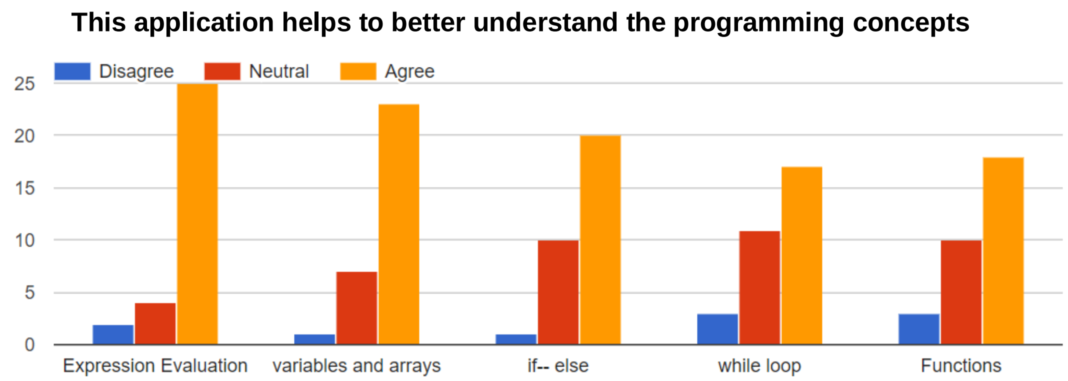

Figure 8. Help in Understanding Programming Concepts

The above histogram shows the response of students. Most of the students agreed that this application helped them to understand programming concepts better than before. However very few were neutral and some students said it did not help them.

5.6 Applications Developed Using SunLab

Every student was told to write any application he/she can write using SunLab and showcase that application at the end of one week. Students wrote very trivial applications like application to add two numbers, application to show usage of looping function. Using built-in functions students wrote programs to take picture using camera and sounding alarm.

One interesting application was developed by two students in collaboration. They developed an application that sounds an alarm whenever they are out of the school's football pitch. During presentation they said their application can be used to alert them when they go to play so that they will not go very far from their village, the issue that their parents insists every day.

6. CONCLUSION

In this initial investigation, it was observed that mobile devices are potential teaching and learning tool in lower secondary schools. Mobile phones are widely available at home. Hence they can be used as tools for students for after school study activities.

Students participated in this study learned mathematical and computational ideas (such as variables, conditionals, loops and functions), they are also learnt strategies for solving problems, designing projects, and communicating ideas. Using SunLab application also stimulated their creativity thinking, by thinking what they can do more with smartphones and computers in general. These skills are useful not just for computer scientists but for everyone, regardless of age, background, interests, or occupation.

Programming using mobile phones can be a viable solution to schools with financial and environment constraints for setting a computer laboratory. There is no upfront cost for schools to set a computer lab and the school does not need to be connected to electricity supply or have electricity generator. Collaboration between school and parents can enable students to learn computational and programming skills during after school hours using parents' smartphones.

Currently, SunLab is designed for writing basic programs. Later it can be extended to support programming Android components like views so that to enable students to write Graphical user Interface android applications using their mobile phones. Moreover, the inline function to interact with devices like camera, accelerometer, GPS, and flashlight can be improved.

This research proved the concept that smartphone can be used in classrooms to teach programming. However, there are challenges like editor usability. It is okay to write small programs using mobile editor but the task becomes tedious when the program has many lines of code. It is challenging to visualize variables when users declare long variable names due to small screen size of smartphones. Long-term evaluation of the Sunlab application is recommended to assess its' effectiveness in improving the performance of students in semester by comparing it with students taught using a traditional computer laboratory.

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FINDINGS FROM A MOBILE TABLET PROJECT IMPLEMENTATION IN RURAL SOUTH AFRICA

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ABSTRACT

The purpose of this paper is provide evidence of how the selected teachers at 24 schools in 7 provinces in South Africa reacted to questions pertaining to the extent of their prior training, attitudes towards technology, perceived self-confidence in integrating ICTs and finally using ICTs on a daily basis. The project is known as the Information Communications Technology for Education (ICT4E) project, funded by the Department of Rural Development and Land Reform (DRDLR) in South Africa, where teachers were trained in seven of the nine provinces in South Africa over a period of a year and a half to integrate mobile technology to support their teaching and learning at 24 schools. This project involved 197 teachers and 6895 learners. The methodology that was applied is a sequential explanatory mixed method approach where data was collected using firstly a survey (baseline survey), followed by one-to-one interviews. Data was analyzed using descriptive statistics (quantitative data) as well as coding through Nvivo (quantitative data). The main results indicated that more females (65.5%) than males were involved. Teachers mostly received training on the basics of computers in Education and are mainly using word processors for their work purposes. The average age of the teachers are 43 years and their mother tongue is mostly Setswana (21%). In general, they indicated a positive attitude towards getting training to use the mobile tablets but they did worry about their competence and knowledge in resolving technical issues if these may occur with the tablets. A high percentage indicated they use social media (96%) and 92% indicated that their schools have banned the use of a mobile phone. 95.4% of teachers felt comfortable to use a tablet to enhance their teaching and learning and they can teach in more effective ways (98%). The teachers were convinced (2%) that the mobile device will assist the learners to learn more.

KEYWORDS

Teacher's Perception, Mobile Tablets, Teacher Professional Development, Rural Schools, Attitude and Experience in Mobile Technology

1. INTRODUCTION

In February 2016, the Council of Science and Industrial Research (CSIR) in Pretoria, South Africa, signed a Project Specific Agreement with the Department of Rural Development and Land Reform (DRDLR) for implementing the DRDLR ICT for Education Project (ICT4E) over a period of three years. The aim is to integrate mobile technology into schools to facilitate improvement to the quality of teaching and learning, the scope of the DRDLR ICT4E Project covers(Botha & Herselman, 2018) amongst other things a focus on providing Teacher Professional Development through accredited training materials.

For the purpose of this paper the focus will be on baseline survey that was applied prior to the teacher training in order to understand their level of computer literacy, their experience with using and applying ICTs in the classrooms (if at all), and their attitude towards using mobile tablets. What they used a mobile phone mostly for was also assessed. The baseline provided an overview and a basic understanding of the teacher's responses on different concepts related to ICT integration in education.

Schools and more specifically rural schools in South Africa are battling to try and implement the White Paper on e-education (Department of Basic Education, 2004), especially at organizational level (Kotzé, Van der Westhuizen & Barnard, 2017; Vandeyar, 2010). This is mainly the case as the translation of national policies to provincial policy still needs to be determined coupled with contextual issues.

Research question of this paper is: *What evidence can be provided on teacher's perceptions of using mobile technology in their classrooms before given training on using the devices?*

The focus is specifically on rural schools in resource constrained environments as these schools are influenced by other dimensions than urban schools. These schools face more challenges when implementing mobile technology, like the lack of internet access, lack of funding, geographical location and electricity. These schools are also sometimes referred to as resource constrained as access to basic resources are a challenge. According to Botha and Herselman (2016) a resource constrained context where rural schools are found is regarded as a place where low income communities reside and bandwidth is also a challenge. Other constraints in this type of context can include cultural issues and people are usually not familiar with or have an anxiety to use technology. Power and connectivity are also sometimes non-existing (Adukaite, van Zyl, Er & Cantoni, 2017).

2. TEACHER SKILLS AND COMPETENCE TO USE TECHNOLOGY

To invest in the training of teachers, is regarded as much more important than to invest in technology (Vosloo, 2010). Teachers are increasingly expected to have skills to apply technology to support learning (Botha, Herselman, Musgrave & Jaeschke, 2017). This requires teachers to take advantage of the power of emerging technology to design and deliver education to promote learners' understanding of concepts and to develop learners' digital literacy. Investing time and money to improve teachers, and teaching, is viewed by members of School Governing Bodies (SGBs) as pivotal (Botha *et al.*, 2017). For this to happen teachers have to be trained to apply and develop content of a digital nature and to use technology in their specific subject areas (Ekanayake & Wishart, 2014).

Teacher support improves practice (Botha & Herselman, 2015). Lack of adequate and ongoing school support influences the acceptance and adoption of mobile devices in teaching (Chiu & Churchill, 2016).

Teachers also have individual, and collective, responsibility for their own professional development. Teachers have to take charge of their own self-development by identifying areas in which they need to develop and to seize opportunities that are available to them through various forums such as the South African Council for Teachers (SACE), which is the teachers' own professional body, and the Integrated Quality Management System (IQMS)(Department of Basic Education, 2007).

The White Paper on e-education (Department of Education, 2004), was the first example of how the South African government envisaged the use of ICT should be applied in education in 2004. ICT was regarded as a resource for whole school development to improve productivity, management and administration; curriculum integration and delivery, communication and teacher and learner collaboration (Mabila, Van Biljon & Herselman, 2017). When ICTs are implemented in schools, it can support literacy skills but also allow for teachers to change their thinking, values, emotions (especially anxiety) and attitudes regarding the integration of mobile devices into teaching (Chiu & Churchill, 2016).

There are numerous examples of mobile technology integration projects to support teaching in South Africa (d'Aiglepierre, Aubert & Loiret, 2017; UNICEF, 2017; Meyer, Marais & Dlamini, 2016; Smore, 2016; Kukulska-Hulme, 2007; Thornton & Houser, 2005). There are also educational platforms available in SA to support teaching and learning like Thutong (Department of Basic Education, 2012). Other platforms supporting mobile integration in schools are hosted by organizations like Mindset Learn and digital classrooms of Vodacom (Mabila et al., 2017). Projects that are supporting mobile specifically in South Africa is the provincial government department projects such as the Gauteng and North-West tablet projects as well as subject specific projects such as the Teaching Biology and MoMaths projects (Kruger, 2015).

3. TEACHER'S BELIEFS AND ATTITUDES TO USE TECHNOLOGY IN THEIR CLASSROOMS

The beliefs, attitudes and anxiety levels of teachers when integrating mobile technology into their classrooms are important to consider (Blackwell, Sheridan, Instone, Schwartz & Kogan, 2009; Kim, Holmes & Mims, 2005). It is for teachers more important to experience how to use the technology and to know how to integrate it to support various teaching methods (Şad & Göktaş, 2014; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012). Therefore, it is necessary to develop programmes that support ICT literacy skills. Especially if strategies can be included to nurture the desired changes in teachers' thinking, values and attitudes and insights into how anxiety can be limited when integrating mobile devices into teaching (Chiu & Churchill, 2016; Teo, Lee & Chai, 2008).

Teachers need to be trained to effectively use educational learning applications to teach various curricula. Professional learning communities, which enable teachers to collaborate and share best practices and integrate 21st century skills into classroom practice, should also be supported (Mabila *et al.*, 2017; Haßler, Major & Hennessy, 2016). It is here where mentorship programmes, which provide support for implementation can be applied and assistance can be provided to teachers. Especially when they have to determine which applications to select to support their specific subject content (Kruger, 2015).

Even if there are concerns about the integration of technology into educational settings (Bates, Swennen & Jones, 2014), it is believed that with the support of adequate leadership and the potential of digital content to support teaching, these challenges can be counteracted (Terhoven & Fataar, 2018; Rikkerink, Verbeeten, Simons & Ritzen, 2016). Thoughtfulness, creativity and commitment to sustain specific action plans are required to successfully integrate technology to support teaching (Naiman, 2016). Successful integration of mobile technology to support collaborative learning has also been indicated by Fu and Hwang (2018) and explained by Hwang, Chu and Lai (2017) when a mobile learning project was conducted in Taiwan.

In order to eliminate poverty, reduce inequality and spur economic development, South Africa's National Development Plan (NDP) identifies education, training, life-long learning and innovation as key priorities(National Planning Commision, 2011). The four major features supported by the E-education policy framework for the use of ICT in teaching and learning are: equity, access to ICT infrastructure, capacity building and norms and standards (Mabila *et al.*, 2017). Education systems must change to facilitate mobile access to education and one of the most important changes is training teachers to prepare them for the mobile world (Ally, 2009). The infrastructure of a school is also important for teachers to motivate them to teach, as some schools, especially in rural areas of South Africa lack basic equipment like desks and many computer facilities at these schools are under-serviced and dysfunctional (Terhoven & Fataar, 2018). Better qualified teachers move to better equipped schools where there is adequate infrastructure, buildings, electricity, lavatories, learning materials and resources, as these factors directly affect teachers' and learners' performances (Ramorola, 2018) (Khumalo, Molepo & Mji, 2015). In a recent report of the OECD (OECD, 2018) it was indicated that Education has a vital role to play in developing the knowledge, skills, attitudes and values that enable people to contribute to and benefit from an inclusive and sustainable future. Learning to form clear and purposeful goals, work with others with different perspectives, find untapped opportunities and identify multiple solutions to big problems will be essential in the coming years.

The challenges of the educational school system in South Africa should be underestimated as conditions in which teachers work are complex due to the pervasive legacies of South Africa's history (Ramorola, 2018). The subsequent changes in policies and implementation that have occurred since the dawn of democracy in 1994, did result in different education departments (Mabila *et al.*, 2017).

Efforts have been made to rationalise the education system into a single national system, and teachers have had to cope with the changes amid other challenges, as new curricula have been introduced (Terhoven & Fataar, 2018). Teachers therefore face many challenges in schools in South Africa (Ramorola, 2018).

Based on these challenges of rural schools, the DRDLR has decided to invest in these communities throughout South Africa by providing infrastructure and training to teachers to use the infrastructure (mobile tablets, servers and learner tablets). Before the project could commence it was important to determine where the pre-selected teachers are regarding their digital literacy skills, their attitude as well as experience with technology integration in classrooms. This knowledge informed the development of the specific training modules that was provided by the University of the Free State or UFS (they won the tender to train).

4. TEACHER PROFESSIONAL DEVELOPMENT IN ICT4E PROJECT

The CSIR was given the mandate by the DRDLR to develop a baseline survey as part of the monitoring and evaluation from the initiation of the DRDLR ICT4E project. The DRDLR selected the schools and 10 teachers from each school. Therefore, a total of 240 teachers were initially enrolled to take part in TPD. Each teacher received a pre-loaded (apps and training material) mobile tablet (Android) for the training and use in schools to support their teaching and learning. The TPD training commenced in the afternoons, for four (4) hours after school hours. TPD training is divided into six separate sessions of two consecutive days each. The teachers are expected to do *Reflective Journals 1 – 3* to be submitted during Session 2 (visit 2), session 4 and after session 5 but before session 6 (the 3rd one will not be marked but teachers need to hand it in to be competent). The teacher will complete and hand in *2 assignments* – and hand them in at session 3 and session 5. This information was part of the baseline survey and communicated to all teachers and principals involved by both the CSIR and UFS before training started.

TPD involves accredited training by University of the Free State (UFS), where teachers have enrolled as students at the UFS and received student numbers. Teachers are expected to commit themselves to attend at least 90% of the training sessions. These teachers also receive homework and are assessed in order to qualify to receive the accredited certificate in TPD for Digital Mobile Learning Certificate, if they meet all the required criteria. Successful participants may then apply for recognition of prior learning for advanced standing/credit transfer towards the introduction to the ICT module as part of the Advanced Certificates in Teaching offered by the UFS. The way teachers are accredited and trained also involved gamification elements and this motivated them all to attend these sessions amidst other challenges (time, new curriculum and large classes).

5. METHODOLOGY

A sequential, explanatory mixed methods approach was followed where the use of both the qualitative and quantitative research methods in a singular study is applied (Creswell & Clark, 2017). In this paper, this method was applied to collect and analyses data. Integration of the two forms of data provided a more robust understanding of the research problem than a singular approach would have done (Creswell & Poth, 2017). Out of the six types of mixed methods designs observed by Creswell and Clark (2017), this study used the sequential explanatory design (Quan followed by Qual). In qualitative data analysis, the overall inferences and meaning of data are considered to be more important than the meaning of its parts (Creswell, Hanson, Clark Plano & Morales, 2007). Quantitative data (from the survey), on the other hand, is analyzed using statistical and mathematical techniques in order to observe specific variables in a data set (Mouton, 2006). The thematic analysis of qualitative data (from one-to-one interviews was carried out using the Nvivo software version 11 (NVIVO, 2017). The data analysis for the quantitative phase of the survey was conducted using the SPSS version 24. The data analysis consisted of both descriptive and inferential statistics (Cronbach's alpha and t-tests).

Triangulation of both the qualitative and quantitative data will be used to establish reliability and validity of the components of the model. Triangulation is done to ensure that the research design is strengthened and also to increase the ability to interpret the findings. Using more than one data method allows the finding from one method to be corroborated or questioned by comparison with data from another method.

The baseline survey covered five areas: Demographics, prior training of the teachers**,** the ICTs that teachers use mostly on a day-to-day basis, information about the attitude of teachers towards using technology in their classrooms and finally teachers self confidence level to integrate technology into their classroom. The interviews also focused on the same five areas in order to determine more information directly from the teachers to support the survey data.

6. RESULTS

From the 240 teachers who started as part of this project only 197 teachers from all the 24 schools in the 7 provinces completed the baseline questionnaire. The baseline was done by the Monitoring and Evaluation team of the CSIR (all could speak the specific mother tongue languages of a specific area). Every teacher involved were assisted if any questions were raised or if there was any misinterpretation of specific questions. More primary than secondary schools were involved. Ethical approval was received to conduct this assessment and thus each teacher completed an informed consent form which outlined that all information will be confidential.

A summary of the results is reflected below:

Section A covered the demographics and revealed the following results:

A third (34.5%) of the participants was male and 65.5% female; the ages ranged from 22 to 64 years and the average age of the group of teachers was 43 years; three-quarters of the teachers (74%) had a Bachelor's or higher degree; a quarter of the teachers lived in the Northern Cape; and the five languages spoken by teachers represented the most were SeTswana (21%), Afrikaans (20%), isiXhosa (16%), isiZulu (15%), Sepedi (14%). The provinces where the schools were situated consisted of Limpopo, Gauteng, Free State, Northern Cape, North West, Eastern Cape and Kwa- Zulu Natal. Mphumalanga and Western Cape were not involved.

This data was also confirmed during the interviews.

Section B covered prior training of the teachers and revealed the following results (Figure 1):

Most of the teachers (82%) did receive basic introduction to computer training. The use of word processors were also recorded at 67%. Low percentages were found regarding their knowledge on technical supporting themselves when problems occur (18%), as well as knowledge of ICT leadership and managing ICTs in schools (9%).

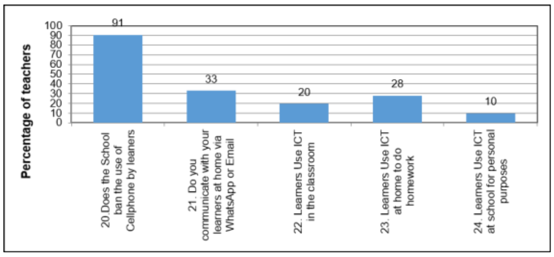

Figure 1. Prior experience of teachers on ICT Training

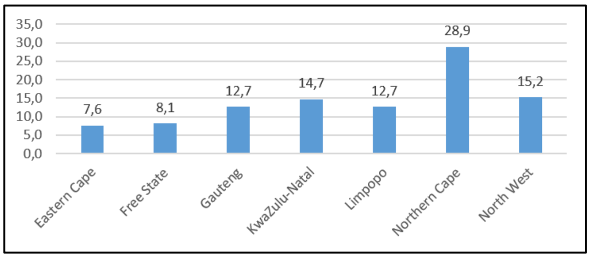

Figure 2. ICTs teachers mostly use of a daily basis

A stepwise multiple regression analysis was performed to evaluate the contributions of the different items in the battery of items to the scale on exposure to prior training. At step 1 of the analysis 'Basic Usage of ICTs in Education' entered into the regression equation and was significantly related to the scale on 'exposure to prior training', $F(1,195) = 215.49$, $p < .000$. The multiple correlation coefficient was 0.73, indicating approximately 52.5% of the variance of the scale: 'exposure to prior training' could be accounted for by 'Basic Usage of ICTs in Education' (Adjusted $R^2 = 0.525$, $p < .001$).

Section C covered the ICTs that teachers use mostly on a day-to-day basis and revealed the following results (Figure 2):

- 92% access social networking platforms from their own mobile phones and not from computers at school or at home
- 75% do email also via their mobile phones whilst 21% do this form a computer at home
- 63% do mobile banking using their mobile phones
- Mobile phones are mostly used for taking photos (98%) and video recordings (88%) and accessing Apps (87%)
- Typing exam papers (52%) and recording marks (74%) and school administrative tasks (69%) are mostly done at computers at schools.
- When involving learners via ICT at schools 90.6% indicated that schools ban the use of mobile phones by learners at schools.

Section D provided information about the attitude of teachers towards using technology in their classrooms:

95.4% of teachers felt comfortable to use a tablet to enhance their teaching and learning and they can teach in more effective ways (98%); 50.3% indicated that they will not be able to fix anything if something goes wrong on their tablets; 95% were excited to use a tablets in their classrooms and 98% indicated that the tablets is a valuable tool for a teachers to use in their classrooms and it will change the way they teach (98.9%); The tablet will change the way their learners learn in class (98.2%) and learners will find it easy to use (92%).

Section E covered the teachers self confidence level to integrate technology into their classroom and the following graph indicates that they are very confident:

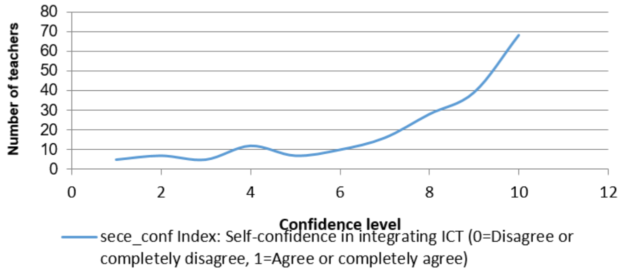

Figure 3. Teacher's self confidence levels regarding ICT use

Most teachers also indicated that they will need support to select appropriate technology or software to support them in teaching with the tablets and that they can learn quickly to adapt to new technology (49%) but 60% felt that their digital literacy levels mostly bad when it comes to technical skills to solve problems.

The sixth scale or indicator represents the teachers' responses on a Likert rating scale of 1 to 10 to the statement: "I think my level of digital literacy is…". Descriptive statistics on the scales are provided in Table 1.

Table 1. Descriptive statistics of the developed scales

Scale/ Indicator	N	Minimum	Maximum	Mean	Std. Deviation
Prior training	197	-1.16192	2.80758	.000	1.000
Attitudes towards training	157	-3.57226	1.80231	.000	1.000
Self-confidence in integrating ICT	175	-3.66327	1.84529	.000	1.000
Digital literacy and ICT acceptance	190	-3.22269	2.78879	.000	1.000
I think my level of digital literacy is:	195	-2.46686	2.69942	.000	1.000
Attributes of ICT acceptance in teaching	176	-2.58021	2.01293	.000	1.000
Valid N (listwise)	140				

It is evident that most of them had a basic understanding in using ICTs in Education but they have not integrated these ICTs into their classrooms yet. As more than half (53%) of the teachers completely agreed that the tablet computer is a valuable tool for educators and 49% completely agreed that tablet computers will change the way they teach, one will then determine if this was the case during the post baseline assessment.

Another significance is the attitude of the teachers towards technology. In the interviews it was revealed that themes on assistance of the tablets to teachers and their learners were very strong. The following are a few qualitative feedbacks: 'The use of the tablet computer as a learning tool excites me'; 'The tablet computer helps me to teach in more effective ways', 'The tablet computer can help my learners to learn because it allows them to express their thinking in better and different ways'; and 'The tablet can assist my learners to understand concepts in more effective ways'. I expect to find ICT useful in my teaching work'; 'Using ICT will enable me to exercise my teaching work easier'; 'Using ICT will enable me to positively teach more learners'; 'I intend to continue using ICT for my teaching rather than discontinue using it'; 'My intentions are to continue using ICT for teaching rather than traditional teaching'; 'ICT use for teaching is clear and understandable'.

The post baseline assessment will therefore be used, to determine what the real impact of the project after training of the 6 training sessions have had on teacher's digital literacy levels, their adoption of technology to make it part of their teaching and learning and finally on their overall perception and motivation to use the technology in future. The feedback on whether teachers have formed communities of practices amongst themselves and between various schools, will also be important to determine as this will also provide input into the impact of this project on the various communities in the various clusters. Based on this project the total no of learners who were affected is 6895 (Boys = 3346 Girls = 3549).

7. CONCLUSION

The results provided by the teachers before commencing training on how to use and integrate mobile technology into their classrooms revealed that they feel challenges regarding solving technical difficulties. The baseline indicated that almost two-thirds (63%) of them were not able to solve their own technical problems, while 57% of the teachers believed that they did not have good ICT skills. More than half (52%) of the teachers did not know a lot about different technologies. The advantages were that the teachers did had prior exposure to basic introduction to computers and some word processing knowledge. They are also positive about what difference the use of the mobile technology can have for both themselves and their learners.

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iLEAP: A HUMAN-AI TEAMING BASED MOBILE LANGUAGE LEARNING SOLUTION FOR DUAL LANGUAGE LEARNERS IN EARLY AND SPECIAL EDUCATIONS

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ABSTRACT

In this research paper, we present an AR- and AI-based mobile learning tool that provides: 1.) automatic and accurate intelligibility analysis at various levels: letter, word, phrase and sentences, 2.) immediate feedback and multimodal coaching on how to correct pronunciation, and 3.) evidence-based dynamic training curriculum tailored to each individual's learning patterns and needs, e.g., retention of corrected pronunciation and typical pronunciation errors. The use of visible and interactive virtual expert technology capable of intuitive AR-based interactions will greatly increase student's acceptance and retention of a virtual coach. In school or at home, it will readily resemble an expert reading specialist to effectively guide and assist a student in practicing reading and speaking by him-/herself independently, which is particularly important for dual language learners (DLL) whose first language (L1) is not English as many of their parents don't speak English fluently and cannot offer the necessary help. Our human-AI teaming based solution overcomes the shortfall of conventional computer-based language learning tools and serve as a supportive and team-based learning platform that is critical for optimizing the learning outcomes.

KEYWORDS

Dual Language Learners, Mobile Learning, Human-AI Teaming, Language Intelligibility Assessment, Mobile Cloud Computing

1. INTRODUCTION

Learning English just like any other language can be equally challenging to dual language learners, both young and adults (Krasnova and Bulgakova, 2014). Dual language learners (DLL) whose first language (L1) is not English need many opportunities to speak and read English (L2) to achieve the English language proficiency needed for academic success, social and emotional competencies. Many schools offer programs during school time that assist such children in developing language proficiency. But those programs may not be enough due to restriction of time and staffing.

In this research, we have developed a mobile solution – iLeap, enabled by the latest artificial intelligence technologies, such as Machine Learning and Automatic Speech Recognition, that will support DLLs of young age. The iLeap learning tool offers them the option to practice accurate pronunciation with a virtual reading specialist and receive immediate feedback and instruction on how to correct pronunciation even when a native speaker is not available to assist. It will serve as a virtual assistant at school for the reading specialist since these students may require personalized attention which instructor cannot ensure due to limitation of staffing and practice time. Moreover, it helps address their biggest challenge in language learning - to extend the language practice and learning in school to home, as many of their parents don't speak English fluently and cannot offer the necessary help at home.

1.1 Background of Study

There are many learning apps already available, either web-based or on mobile platform, for Dual Language Learners that provide personalized language training (Heil, et al, 2016). Some of these applications use Flash cards, animation-based games (e.g. match words with pictures) to keep the learners engaged. They motivate the kids to memorize the vocabulary, but they hardly help in developing communication skills. There are some popular applications like Babbel, Duolingo that use translation and dictation to emulate traditional language classes. Learners read text, listen to videos and then interpret and answer questions. But most of these applications have a focus of improving vocabulary and writing skills than speaking and accurate pronunciation. The applications provide no tools to assess speaking skills and quality of pronunciation which is critical for student's practices (Neri, et al, 2003). Thus, there is a need of application that could assess the pronunciation of new learners, provide instant feedback on mispronounced words, pinpointing the mistake at the corresponding phonemes, and then be able to provide both audio and visual instructions on how to correct the pronunciation.

1.2 System Features of Proposed Solution

Our primary goal of this project is to support dual language learners for independent language learning. To achieve this goal, we identify the following key capabilities and features necessary for supporting effective pronunciation training/learning.

1.2.1 Emphasis on Reading and Pronunciation Skills

The iLEAP system insists on developing the reading and pronunciation skills of the learners. The learners work on various books reading sessions through the app and the system assess their performance in real time. Books are suggested to the learner intelligently based on the profile data. The application leverages speech recognition API provided by Google Cloud Speech services.

1.2.2 Intelligibility Assessment, Feedback and Phoneme Level Correction

The assessment of the performance is done in real-time. Learner gets to know immediately if he/she mispronounced any word. We make use of Android usability features Text highlighting, clickable spans to make the application easy and intuitive to use. The mispronounced word is compared with original word further at phoneme level. For this work, we have used the set of 39 distinct phonemes from CMU (CMU-Sphinx project). On summary view, when word playback is requested, only the phonemes that diverged on the recognized word from original word are uttered, with help of visual animation that show lip movements required to accurately pronounce that specific phoneme. For instance, if learner pronounce "LIFT" for original word "LEFT",

- Both words will be compared at phoneme level as:

  L EH F T → *L IH F T*
- The server returns mismatching phoneme "EH"
- The app will playback sound for "EH" with corresponding animation followed by utterance of original word "LEFT"

The accurate analysis of learner speech makes it possible to provide instant feedback on what he/she did not observe otherwise. Instant feedback plays a crucial role in learning. It helps the learner clearly know the adjustment needed. Furthermore, it helps the learner to know whether he/she achieved the goal or not. Evaluation system of language learning may also help the trainer to develop training courses that concentrate better on identified weakness and provide highly personalized learning experience. The feedback of our language learning application provides the advantages of both Constructivist and Behavioristic theories of language learning. The application acts as a virtual facilitator by providing instant feedback that emulates constructivism. Further, it implements behaviorism by identifying errors pertaining to intelligibility and guiding the learner to practice on specific pronunciations (Heil, et al, 2016).

1.2.3 User Profiling and Learning Retention Assessment

The content server in the cloud also maintains user profile. After completion of each session, the app sends performance data (e.g., list of mispronounced words) during that session, which is updated by the server in database. This enables the cloud server to generate different insights into user profile, like most frequent mispronounced words, typical phonemes that the learner may have difficulty to pronounce, retention of learning over time, i.e., whether the learner's pronunciation improved for certain word. The scope of data collection and server-side capabilities can be conveniently extended as needed due to the use of cloud-based approach, once the basic framework is available. Thus, we may also enhance both app and the server in future for many other insights in user profile.

2. SYSTEM OVERVIEW

The iLEAP application focuses on the usability of the application, keeping a specific audience in mind: young kids of 4 - 8 age group. Hence the mobile application incorporates simple and intuitive ways to provide performance assessment on the reading session instantaneously.

2.1 System Architecture

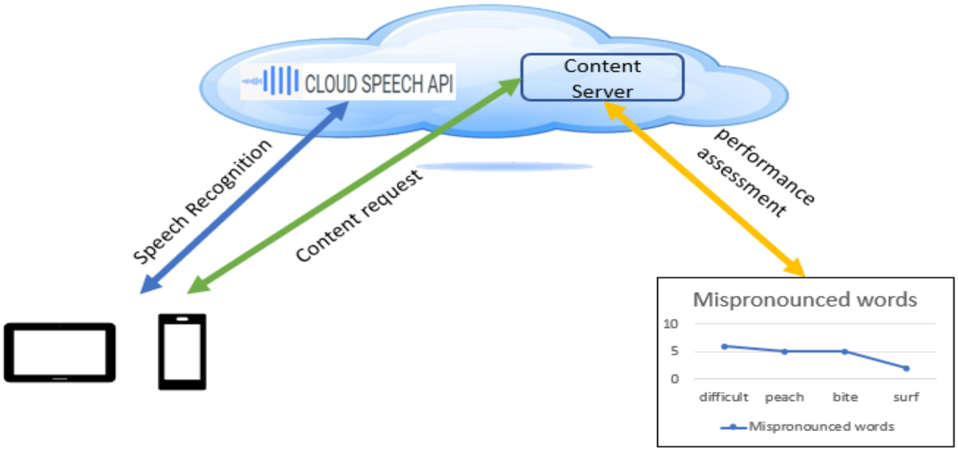

Figure 1. Overview of iLEAP System Architecture

Figure 1 illustrates the iLEAP system architecture. The application can be deployed on mobile device or tablet. The user is authenticated with content server and then the books that fits the authenticated account profile can be listed on the device. The title selected by the user will then be retrieved from server and the text content is displayed on the device. When learner starts reading the book, speech recognition service of android app captures audio stream and sends the audio data to Google cloud Server for recognition. When the recognition result is received from the cloud server, the recognized text is compared with source text from the book for word by word comparison. The learner will be given instantly the feedback of his/her intelligibility in speaking the language in terms of highlighted text as the reading progress –

- Green highlight indicates the word pronunciation was accurate
- Yellow highlight indicates the word was mispronounced

These mis-pronounced words can be rehearsed when the session ends. The content server also provides retention tracking. All the mispronounced words are updated in the database for learner's profile. This data can be used to perform analytics on the learner's profile and evaluate the user performance. The analytics may provide insights like words that learner persistently fails to read, or individual phoneme in different words that the student face most difficulty in pronouncing accurately. It may also provide pattern of retention in the learning; whether the learner improved on certain word that he/she faced difficulty in the beginning.

2.2 Components and Enabling Technologies

2.2.1 Speech Recognition

iLEAP uses Google Cloud Speech Streaming API to recognize AUDIO input. Streaming API enables it to perform speech recognition of continuous audio stream in real-time. Google cloud services provides gRPC stub for Android/Java platform. We implement speech recognition service using the gRPC stub APIs. For accounting purpose, the gRPC client stub needs authentication token in order to validate the account for the use of speech recognition service. Currently this service is available worldwide at $1.44 per hour, which is significantly lower when compared to hiring a personal language coach or tutor.

2.2.2 Content and Profiling Server

The contents for reading session are dynamically retrieved from the content server instance that is deployed on cloud for 24/7 availability. In our project, Amazon cloud service is used and the Content server is implemented in Flask/Python with MySQL as backend database. This server provides RESTful APIs such that android app will be able to request reading content, request phoneme level comparison of words, update user profile in MySQL database for mispronounced words or get analytics on user profile for reading patterns.

2.2.3 User Interface

The user interface of the prototype is the most critical part of any learning apps designed for children at young age, it has to be as simple as possible with the intention to avoid distraction due to unnecessarily complicated operations. Thus, in iLeap, most of the interactions are through intuitive components, such as buttons, layouts and views carry symbols that handily describe the objective of the interface. On completion of a reading session, it automatically summarizes all the mispronounced words from the session along with phoneme level intelligibility feedback, such that the system utters only individual phoneme that was mis-pronounced in case of homonyms. The coaching system simultaneously highlights correct way of lip gestures required to pronounce the phoneme accurately using visual animations through Emoji or Animoji.

2.2.4 Intelligibility Assessment

Speech intelligibility assessment is a complex process that may vary significantly from one human evaluator to another. In this research, we propose and adopt a more objective assessment methodology by determining the intelligibility based on outcome of speech recognition (Liu, et al, 2006). Following speech recognition, the assessment process is completed by an accurate comparison between speech-recognized spoken text and the original text. For instance, we need to compare the two texts to find the incorrect words that the learner spoke. Then, based on the result from the comparison, the learner will be given feedback of his/her intelligibility in speaking the language.

To identify the similarity/dissimilarity between two texts, we need to measure the distance between them. This can be achieved using various minimum distance finding algorithm, such as Levenshtein Distance, Hamming Distance, Longest Common Substring Distance and Jaro-Winkler Distance (Cohen, Ravikumar and Fienberg, 2003). In this research, we compare the recognized spoken text and the original text word-by-word using the Levenshtein algorithm. It calculates the minimum numbers of change, including deletion (Missed), insertion (Removed), and substitutions (Replaced), required to transform one string to the other. The time complexity of this algorithm is O (n*m), where n and m are the lengths of the two sentences being compared. The memory space complexity is O (n*m) because it memorizes in matrix. This could be a concerning factor considering we have to compare the sentence incrementally every time with speech recognized text if the sentence is uttered in multiple parts with pauses. However, it becomes less a concern nowadays as most of today's mobile devices can provide enough computing power and memory space for its operation, even for long sentences.

In Table 1, we illustrate the comparison between 2 sentences using the Levenshtein algorithm. For instance, the comparison between "five little monkeys jumping on the bed" and "five little monkey jumping the bad" computes similarity score of 71.

Table 1. Assessment through Levenshtein Algorithm

		five	little	monkey	jumping	the	bad
	0	1	2	3	4	5	6
five	1	0	1	2	3	4	5
little	2	1	0	1	2	3	4
monkeys	3	2	1	1	2	3	4
jumping	4	3	2	2	1	2	3
on	5	4	3	3	2	2	3
the	6	5	4	4	3	2	3
bed	7	6	5	5	4	3	3

3. EXPERIMENTAL RESULTS

The prototype has been developed to illustrate and evaluate the effectiveness of the mobile app enabled language learning. The following results provide validation for our approach.

3.1 User Interface

Once the app is launched on the device, user lands on login page as shown in Figure 2. The authentication process verifies user profile on the backend server. After authenticating the learner, the application lists book titles that are relevant to learner's profile. The profile level is derived at the server side based on learner's age and how he progresses through various reading sessions. Server maintains books in generic hierarchical structure so that random titles can be displayed to the learner in order to expose them to new content/vocabulary and avoid repetition.

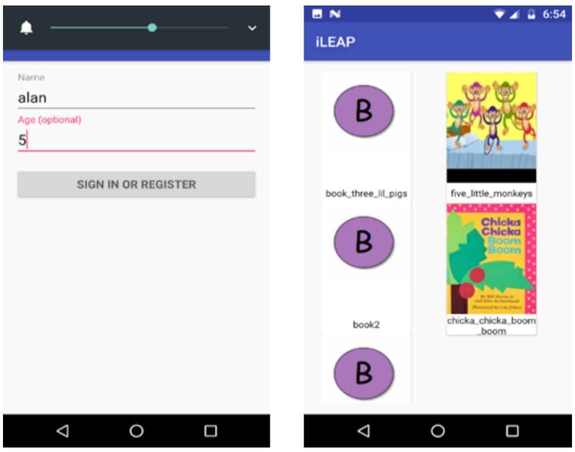

Figure 2. Launch the App

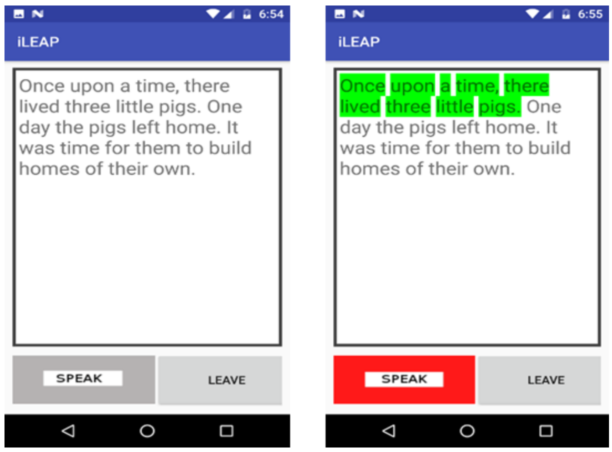

Figure 3. Reading progress without errors

3.2 Reading Progress with Accurate Pronunciation

When a book is selected by learner for reading, the contents are displayed as plain text. Once the audio recording is enabled with a button click, speech recognition results are matched with the original text in the background and text is instantly highlighted with appropriate color spans. As illustrated in Figure 3, if the recognized text matches with source text, the green background span highlights the portion of matched text.

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3.3 Reading Progress with Dissimilarity Detection

If any word is mispronounced during the session, intelligibility assessment algorithm returns dissimilarity with original text. This dissimilarity is highlighted with yellow background on original text. The highlight also enables clickable interface on the word so that learner can click on the word to hear out correct pronunciation of the word using Android Text-To-Speech API. As illustrated in the Figure 4, when “left” was mispronounced as “lift”, the intelligibility assessment detects the mismatch between recognized text and the text is highlighted accordingly.

Figure 4. Reading Progress Errors

3.4 Session Review and Correction Coaching

At the end of the session, all dissimilar words are displayed for practice as shown in Figure 5. The dissimilarity is mapped at phoneme level such animation shows lip movement for the missing phoneme. As shown in the figure, learner pronounced “lift” for “left”, the missing phoneme was identified as “EH”. The animation mimics lip movements to pronounce “EH”, along with Text-To-Speech utterance of the phoneme and entire word. The learner can practice again with the word that he/she failed to pronounce properly as shown in Figure 6. The mic button interface enables speech recognizer to accept audio input for speech-to-text translation. Intelligibility assessment feedback for the re-attempted word is also available in terms of background color of the mic button.

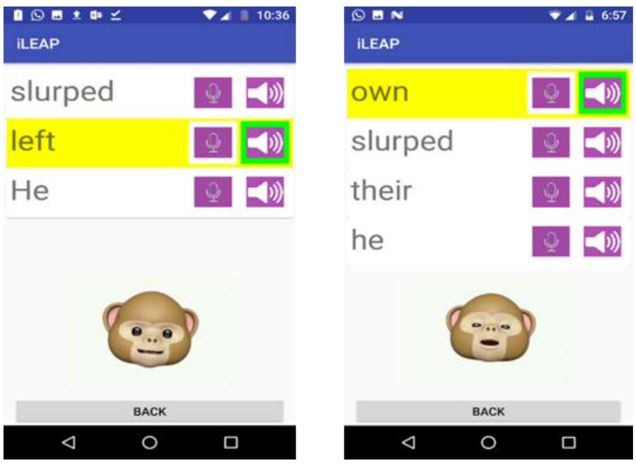

Figure 5. Correction Coaching

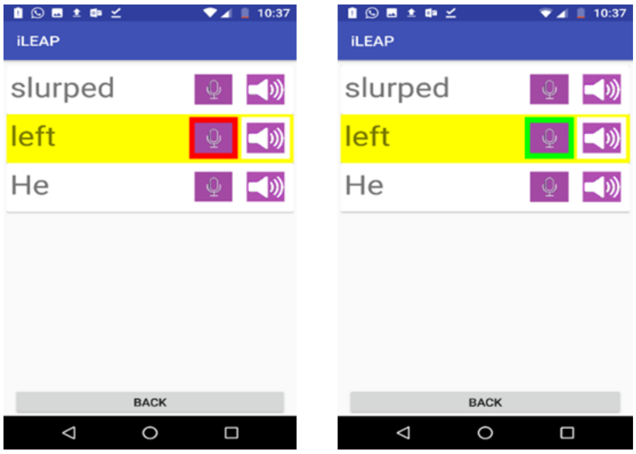

Figure 6. Correction Practice

3.5 Analysis of Retention Based on Learner's Profile Data

The backend server implements a comprehensive database to store profile data for each student. The tables retain information such as frequency count of mispronounced words, frequency count of phonemes that found to be mismatching in recognized words. The analysis results can be displayed to show the student's typical pronunciation errors at word and phoneme levels as illustrated in Figure 7. It can assist the classroom learning by providing the accurate and comprehensive list of assessment data to instructors. It is also used as evidence by iLEAP to automatically build dynamic training curriculum tailored to everyone's learning patterns and needs based on his/her typical pronunciation errors, e.g., by recommending books that have the same words or words with the same phonemes.

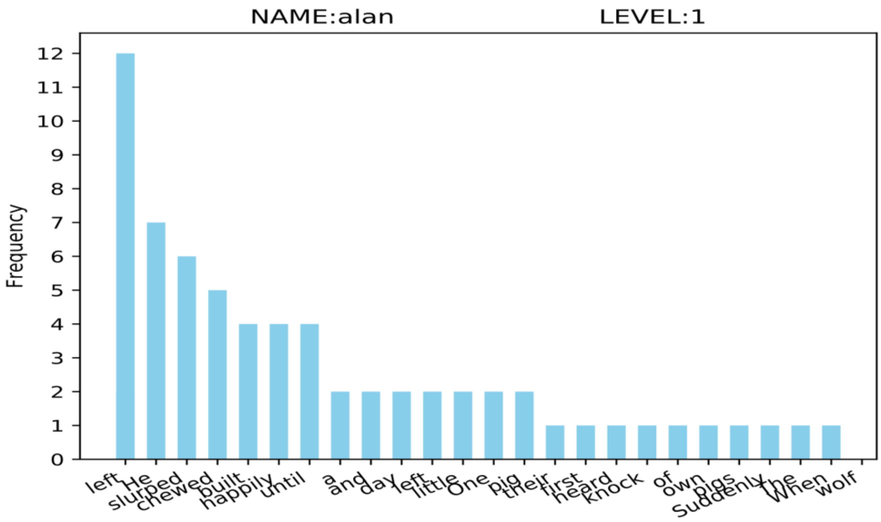

Figure 7. Performance Analysis, e.g., Frequency Count of Mispronounced Words

Furthermore, for individual word, iLEAP can also find pattern of retention, which can provide evidence that learner improved on the word over time as illustrated in Figure 8.

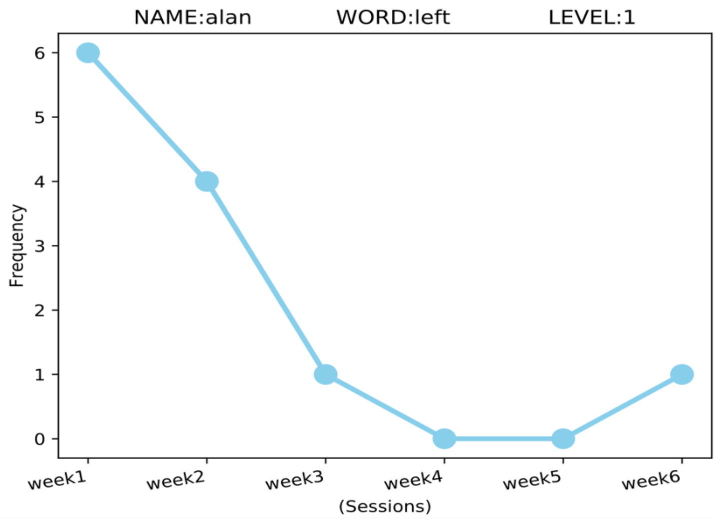

Figure 8. Performance Tracking, e.g., Retention of Corrected Pronunciation

4. CONCLUSION

The prototype iLEAP solution confirms that advanced technologies in speech recognition, AI and AR and mobile cloud computing can be leveraged to build a learning system for dual language learners. The system can provide a low cost, highly available and personalized tutoring with focus on reading and pronunciation skills of a learner who is attempting to learn English. Our experimental results demonstrate that the system is not only capable of providing immediate intelligibility assessment, but also tracking the learner's experience, which in long term can aid in improving the retention of the learning.

Even though the current system capabilities of iLEAP prototype are limited in terms of analyzing an individual's typical and atypical learning patterns, moving forward in future we could enhance backend system with No-SQL server, implement better analytics and profiling code that can generate a more detailed insight on learner's performance and trends in retention capabilities. Depending of those patterns, the system may better recommend a specific book that contains contents with a balance of learning new words and the retention of corrected words in a more engaging and supportive learning environment for young dual language learners.

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EVALUATING THE IMPACT OF THE COMPONENTS OF A MOBILE BEHAVIOR CHANGE INTERVENTION TO SUPPORT CRITICAL THINKING IN RESEARCH PROJECTS

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ABSTRACT

This paper presents a study which aims to provide an understanding of the impact of using the components of a digital mobile-based behavior change intervention (mBCI) to support critical thinking skills during university student research projects. The digital behavior change interventions are tools and techniques designed to induce behavior change and provide continuous support and tailored advice for willing learners through web and mobile platforms. We investigated the impact and the usability of the designed tools by analyzing self-reflections and the users on the digital mobile-based behavior change intervention components. An instrument was used to examine the differences in the self-perceived improvement of critical thinking between the intervention group and the control group before and after working on real research projects for two months. The results of comparing post surveys for the independent samples showed that the intervention group had a statistically significant perceived improvement in critical thinking than the control group. The findings indicated encouraging and positive feedback on the use of mobile intervention components to promote critical thinking when supervising research projects.

KEYWORDS

Critical Thinking, Digital Intervention, Mobile Learning

1. INTRODUCTION

Critical thinking is an essential tool for students to be able to reasonably analyze, understand and evaluate arguments in their research projects (Carpi et al., 2017; Yilmaz and Keser, 2016). Research projects are research-based tasks that enable learners to study a specific problem by examining the possible solutions to be supported with reliable evidence (Devi et al., 2017). Students are usually supervised throughout their research projects. According to Ismail et al. (2017) and Clear et al. (2014), traditional face-to-face meetings are commonly used to facilitate communication between students and their supervisors. Technology has been used to partly overcome the communication barriers of time and place (Seifi et al., 2014). Critical thinking, however, is important to be individually supported in research projects and individually tailored to students' levels of critical thinking (Brew and Mantai 2017; Duron et al., 2006). Delivering scalable critical thinking content with relevant advice to students during their research projects through technical tools must be compatible with the nature of critical thinking (Haghparast et al., 2014). It is necessary to design appropriate tools to assist both students and supervisors to enrich the individual learning experience when critical thinking is considered. A few research gaps have been identified in using technology in critical thinking, and these deficiencies could be the cause of the lack of critical thinking. First, there are inconsistencies in definitions to comprehensively cover critical thinking, not only as a skill but also as a lifelong behavior that requires sufficient time to accumulate (Al-Mubaid and Bettayeb, 2017; Paul and Elder, 2013). Second, there has also been little research in dealing with critical thinking and research projects together as relatively associated tasks (Brew and Mantai 2017; Yilmaz and Keser, 2016). Finally, there is a lack of well-tested suitable tools to help academic supervisors, who may lack the technical knowledge to create mobile or web-based interventions to evaluate students' progress and behavior in critical thinking. In fact, the available tools provide mostly manual settings;

once they are developed, they are relatively fixed and inflexible, unable for large-scale reuse or iteratively collect randomized data (Swart, 2017; Seifi et al., 2014).

We suggest that using digital mobile behavioral change intervention (mBCI) methods could provide a convenient technical tool to assist students to develop critical thinking and research skills. As argued by Wai et al. (2018) and Saade (2012), associating critical thinking with behavior provides an insight into the potential success of linking mobile devices to learners with fewer restrictions in time and place. Smart-phones that provide interventions could help students improve their critical thinking behaviors during their research work (Asiri et al., 2017; Wilde and Zaluska, 2016). This research will study the impact of using a mobile application, subdivided down to its components, to encourage behavioral changes to improve critical thinking for third-year students in their research projects before and after the intervention. The identified mobile components used in this study are: 1) activities and training for leaners to understand critical thinking, 2) tasks for practicing critical thinking, 3) a basic information page about the research project of the learner, 4) short questionnaires to examine the progress of critical thinking, 5) goals and plans settings, 6) notifications for nudges and triggers to keep learners engaged in the mobile intervention, 7) inquiries by the learners, and lastly 8) providing answers and feedback by the researcher to support critical thinking. The components were identified based on a literature review and previous interviews with supervisors and academics; published recently by the same authors of this paper. The existing LifeGuide Toolbox software, co-designed by the authors, has the potential to be successful in designing mobile intervention components to promote critical thinking. The LifeGuide Toolbox software package consists of an authoring tool that enables intervention builders with minimal programming background to easily create mobile interventions with the mentioned components. As a result, the tool could be widely used by many researchers to provide them with the data that they need about students' behaviors regarding their critical thinking in research projects. The suggestions provided by the components of the mobile intervention, provide students with relevant information and regular advice to improve their behaviors toward their critical thinking during their research projects.

2. BACKGROUND

Within the context of mobile learning, smartphones are suggested to offer superior online learning content because of their unique personalization features, flexibility, connectedness, and portability (Wai et al., 2018). Mobile technology is one of the most important innovations affecting almost everything in our lives, from personal interaction and social communication to education and work. Critical thinking, from this perspective, is also an essential daily activity that could be encouraged by mobile technology (Asiri et al., 2017). Attaching critical thinking to the daily use of mobile devices could help students monitor decision-making, change behaviors, acquire intervention support, and track thinking patterns through their diaries, reminders and goals at any time and from anywhere. Several attempts have been made to use mobile technology to promote learning and thinking skills in different educational settings. For instance, Alnuaim et al. (2014) examined the impact of a contextual mobile learning application to improve students' design thinking through collaboration between learners. Similarly, Wong (2013) designed and used a mobile critique platform that enables and motivates designers to co-design with each other and criticize each other's work. However, generally the results of using mobile technology to improve critical thinking for students indicated that students still have low levels of critical thinking ability, as addressed by Yilmaz and Keser (2016). Moreover, mobile technology has not been used to promote critical thinking in the context of research projects by enabling supervisors with less programming background to use tested flexible tools to create and deliver reusable digital mobile-based interventions to their students. These deficiencies were resolved in the current study.

2.1 Digital Behavior Change Interventions (DBCIs)

Digital behavior change interventions are techniques used to provide continuous tailored advice for learners wishing to improve their behavior through web and mobile platforms (Yardley et al. 2016). Digital intervention has been used in health education fields to facilitate communication between doctors and patients. Data generated from the web-based or mobile-based tools can be studied by evaluating how both experts and users interact with the system, when and how the information is delivered to the users, and by identifying behaviors patterns (Hargood et al. 2014). As mentioned earlier, the features in the LifeGuide Toolbox software are suitable for study because they flexibly provide cross-platform applications for critical thinking cases. The software contains several components that can be broken down for this study such as designing activities, tasks, short quizzes, planner, goal setting, sending notifications, and receiving questions from intervention users. According to Lustria et al. (2013), a digital behavior change intervention involves three main interacting participants, as illustrated in Fig. 1. First, the intervention developers (i.e. programmers) provide the necessary tools for digital interactions between intervention experts and users through web or mobile platforms. Second, the intervention experts (i.e. researchers) who may lack sufficient programming skills but may still design digital interventions for their users. Third, the intervention users who are the targets of intervention from the experts, may then pass data back to the experts by using the mobile-based or web-based intervention that then permits an iterative improvement of the intervention.

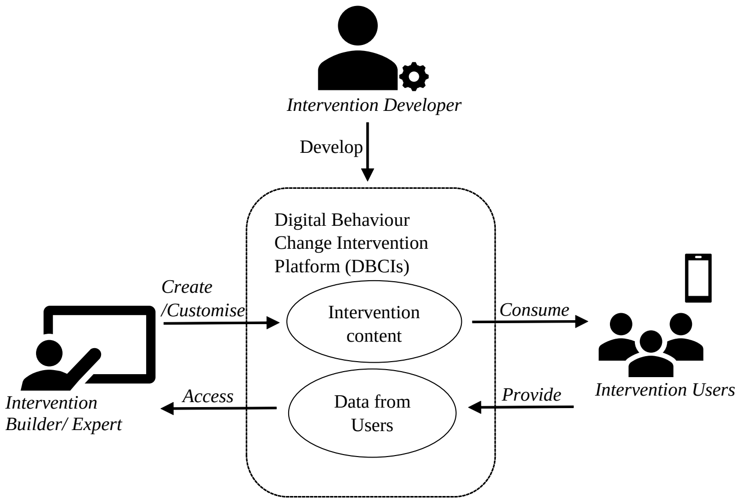

Figure 1. Main Actors in Digital Behavior Change Interventions (DBCIs)

The use of DBCI systems in blended educational contexts can influence higher education in a variety of ways. Firstly, for students, the systems can influence their approaches to learning and may stimulate communication with their educators or with each other. Secondly, for educators, DBCIs may assist the development and selection of online resources and change traditional teaching practices. Thirdly, for institutions and researchers, DBCIs can provide large data sets that can be analyzed to investigate more deeply the processes of learning and learner behavior.

3. METHODOLOGY

The study aims to examine the impact of using a mobile application-based behavior change intervention on students' critical thinking in the context of research projects. A mixed method approach was used to collect qualitative and quantitative data from participants. The participants were third-year undergraduate students from the Electronics and Computer Science (ECS) program at the university, who were invited to participate by using the university's 3rd year ECS email list. Sixty students who agreed to participate were divided randomly into two equal groups; a control group and the group that used the mobile application-based intervention for two months. Differences in critical thinking skills before and after the experiment between the two groups were explored.

3.1 Procedure

As shown in (Table 1), a validated instrument was used as a pre- and post-survey tool, which was designed by the authors of this paper, to measure critical thinking in research projects in the context of digital behavior change intervention. The instrument was inspired by the Paul-Elder critical thinking framework, which consists of two sections; the Intellectual Standards' statements, and the statements for the Elements of Thought

(Paul and Elder, 2013). The participants were asked to self-reflect on their critical thinking skills using the instrument based on those statements from the Likert scale: No = 1, Sometimes = 2, Not sure = 3, Usually = 4, and Always = 5 using the online iSurvey website forms before and after the experiment. Text boxes were left empty for adding explanations or comments by participants at the end of the pre- and post-online surveys.

Table 1. An Instrument to Assess Critical Thinking in Research Projects for DBCI Context

Intellectual Standards	Elements of Thought
Clarity: When I write reports or essays, I express my thinking clearly in different ways and with multiple supporting examples. ***Accuracy***: I support my arguments by making sure that all information is correct and free from errors based on the reliable resources. ***Precision***: In writing, my words and data used are specifically exact and no more details could be added to explain what I mean. ***Significance***: I essentially focus in my research work on the most important ideas and crucial facts that would help to make a meaningful point. ***Relevance***: In the literature review, everything included is important, that each part makes a difference and accordingly I connect my arguments to any reliable relevant information. ***Depth***: My arguments are thorough by tending to explore the complexities in the research questions which are addressed profoundly in my answers. ***Breadth***: I consider additional perspectives and different viewpoints when I think or write in my research work to look at the problem from various ways. ***Logic***: My arguments are reasonable that the thinking is consistent, and the conclusions follow from the evidence where things make sense step-by-step. ***Fairness***: My arguments are balanced, objective and free from hidden biases by considering both positive and negative outcomes.	***Purpose***: I think purposefully when I set my research objectives by trying to answer what the main goal of my work is and why it is important. ***Questions***: I use my research questions as a guidance for my thinking to figure out how to solve the research problems. ***Information***: The information I use is correct, accurate and relevant to the purpose and to the questions or issues I am addressing. ***Inferences***: The inferences and conclusions I make logically follow from the evidence with no more or less than what is implied in the situation. ***Concepts***: I justifiably use concepts, ideas, theories, laws, principles, or hypotheses in thinking to make sense of things in my research work. ***Assumptions***: In assumptions, which are the beliefs I take for granted subconsciously or unconsciously, I make sure that they are justified by sound evidence. ***Point of view***: In my research work, I understand the limitations of my point of view and I fully consider other relevant reasonable viewpoints. ***Implications***: I am aware that the implications of my claims logically follow from other claims or truths, where implications follow from thoughts and consequences follow from actions.

Once students completed the pre-online survey, another email was sent to invite the intervention group to continue participating in the mobile intervention experiment for two months by downloading a mobile application from the AppStore or Google Play based on their phone's operating systems. The mobile application-based behavior change intervention (Figure 2) was created by the LifeGuide Toolbox software for this experiment. The components of the mobile application are designed to enable users to interact with the content of the intervention. The intervention components used in this experiment are broken down into 1) activities and training for users to understand critical thinking, 2) tasks for users to practice critical thinking, 3) a basic information page about the research project of the users, 4) short questionnaires to examine the progress of critical thinking, 5) goals and plans settings, 6) notifications for nudges and triggers to keep users engaged in the mobile intervention, 7) inquiries by the users, and lastly 8) providing answers and feedback by the researcher to support critical thinking. The content of the critical thinking activities and tasks were formed from two recent books (Cottrell, 2017; Paul and Elder, 2013). During the experiment, participants in the intervention group received mobile notifications from the researcher. The types of notification vary based on the intervention needed to be supported. The intervention components were mapped into the Intellectual Standards and the Elements of Thought to understand which components contributed to enhance certain skills in critical thinking. Collecting data about approximately how much time spent in each component, along with the texts with responses to those components was a way of assessing the impact of the mobile intervention in this research. After finishing the two-month experiment, participants from both groups filled out the post-online survey to examine the differences between the two groups in critical thinking.

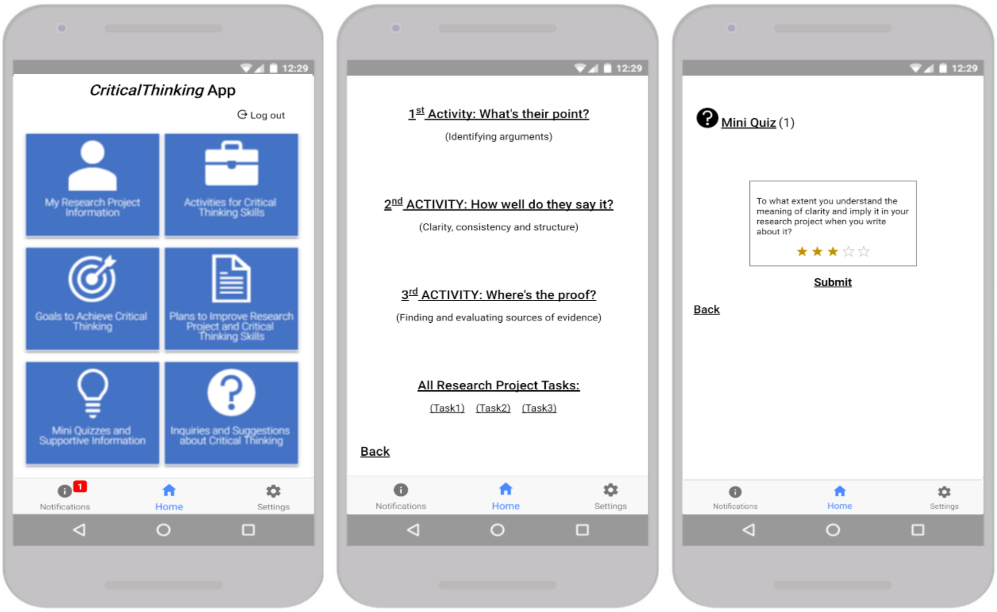

Figure 2. Home Page, Activity Page and Short Quizzes Page in The Mobile Application-based Intervention

3.2 Data Analysis

Two main factors in the analysis were used to examine the impact of the components of the digital behavior change intervention on participants' critical thinking and research skills. First, analyzing the data from the pre, post and SUS (Usability of the System) surveys provides evidence for perceived improvements, if any, in the critical thinking Standards and the Elements of thought for both groups and to examine usability. The SUS test consists of ten questions with five response options from strongly agree to strongly disagree, which provides a reliable tool for measuring the system usability (Brooke, 1996). Second, analyzing the data from log files for the mobile application was used to study the correlation between critical thinking improvement and time spent in the mobile application, usage patterns and the level of engagement affected by the mobile notification.

4. RESULTS AND FINDINGS

Sixty participants completed both the before and after-online surveys from both intervention and control groups; thirty participants for each group. The results of independent t-tests for comparing between mean values between the two groups in the pre-surveys showed that there were no statistically significant differences (with $p < 0.05$) in the Intellectual Standards or the Elements of Thought before the experiment was carried out, with participants from both groups having equivalent perceived levels of critical thinking skills in research projects. However, a paired t-test comparing the post-experimental surveys showed that both groups had significantly improved their critical thinking skills, indicating an increase in some Standards and some Elements regardless of intervention. Table.1 shows the results of a paired t-test that compares mean values for the pre- and post-experimental surveys within the same participants for the control group. There were statistically significant differences after the experiment (with $p < 0.05$) in the Intellectual Standards: *Relevance* and *Logic* and in the Elements of Thought: *Questions* and *Information*. Similarly, for the intervention group, as shown in Table 2, the paired t-test showed that there were statistically significant differences after the experiment in the Intellectual Standards: *Clarity*, *Relevance*, *Breadth*, and *Logic* and in the Elements of Thought: *Questions*, *Information* and *Point of View*.

Table 2. Paired Samples Test for Pre and Post Surveys: Control Group

Intellectual Standards and Elements of Thought	Paired Differences					t-test	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Clarity	-.266	.980	.178	-.632	.099	-1.490	29	.147
Accuracy	-.066	.739	.135	-.342	.209	-.494	29	.625
Precision	.200	.610	.111	-.027	.427	1.795	29	.083
Relevance	-.700	1.441	.263	-1.238	-.161	-2.659	29	**.013**
Significance	-.400	1.404	.256	-.924	.124	-1.560	29	.130
Depth	.066	.739	.135	-.209	.342	.494	29	.625
Breadth	-.133	1.455	.265	-.676	.410	-.502	29	.620
Logic	-.466	1.195	.218	-.913	-.020	-2.138	29	**.041**
Fairness	-.333	.994	.181	-.704	.037	-1.836	29	.077
Purpose	-.033	.764	.139	-.318	.252	-.239	29	.813
Questions	-.433	1.135	.207	-.857	-.009	-2.091	29	**.045**
Information	-.433	1.040	.189	-.821	-.044	-2.282	29	**.030**
Inferences	-.266	1.048	.191	-.658	.124	-1.393	29	.174
Concepts	-.066	1.172	.214	-.504	.371	-.311	29	.758
Assumptions	-.300	1.489	.271	-.856	.256	-1.104	29	.279
Point of view	.000	.787	.143	-.294	.294	.000	29	1.00
Implications	-.100	.994	.181	-.471	.271	-.551	29	.586

Table 3. Paired Samples Test for Pre and Post Surveys: Intervention Group

Intellectual Standards and Elements of Thought	Paired Differences					t-test	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Clarity	-.800	1.517	.277	-1.366	-.233	-2.887	29	**.007**
Accuracy	-.233	1.040	.189	-.621	.155	-1.229	29	.229
Precision	.200	1.730	.315	-.446	.846	.633	29	.532
Relevance	-.733	1.638	.299	-1.345	-.121	-2.451	29	**.021**
Significance	-.466	1.525	.278	-1.036	.102	-1.676	29	.105
Depth	-.266	1.529	.279	-.837	.304	-.955	29	.348
Breadth	-.300	.702	.128	-.562	-.037	-2.340	29	**.026**
Logic	-.800	1.186	.216	-1.242	-.357	-3.694	29	**.001**
Fairness	-.200	1.471	.268	-.749	.349	-.744	29	.463
Purpose	-.166	.949	.173	-.521	.188	-.961	29	.344
Questions	-.600	1.191	.217	-1.045	-.154	-2.757	29	**.010**
Information	-.533	1.357	.247	-1.040	-.026	-2.151	29	**.040**
Inferences	-.366	1.629	.297	-.974	.241	-1.233	29	.228
Concepts	.066	1.779	.324	-.597	.731	.205	29	.839
Assumptions	.100	1.539	.281	-.474	.674	.356	29	.725
Point of view	-.666	1.124	.205	-1.086	-.246	-3.247	29	**.003**
Implications	.066	1.080	.197	-.336	.470	.338	29	.738

It was also necessary to use the independent t-test to identify the significance of the perceived improvement in participants' critical thinking skills between the two groups after the experiment (i.e. comparing only the post surveys for both groups). The results of independent t-tests for comparing mean values of the post surveys between the two groups showed that there were statistically significant differences (with $p < 0.05$) for the intervention group only in the Intellectual Standards: *Clarity* and in the Elements of Thought*: Point of View*, after the experiment was carried out. Thus, participants in the intervention groups had self-reported that they had improved in one Intellectual Standard and in one of the Elements of Thought. The data from the two-month mobile intervention from the thirty students in the intervention group were also analyzed. In general, there was a modest estimated correlation (with 0.65) between the total time spent on the mobile application and the total scores of the post-survey for each participant. However, there no correlation was found between time spent in a certain intervention component and its mapped Standards or Elements. As illustrated in Fig. 3, participants spent more time reading the content than typing in the mobile application. The results for the engagement with the mobile intervention showed that the amount of time spent in the mobile intervention by all participants varied depending on the specific intervention components: project information (66 minutes), first activity (136 minutes), second activity (96 minutes), third activity (115 minutes), first task (82 minutes), second task (97 minutes), third task (69 minutes), short quizzes (45 minutes), goals and plans (19 minutes), inquiries and answers (49 minutes), and feedback (92 minutes). The weekly notifications (feedback and reminders) by regularly nudging participants to participate helped to keep them engaged with the mobile application to practice critical thinking in research projects.

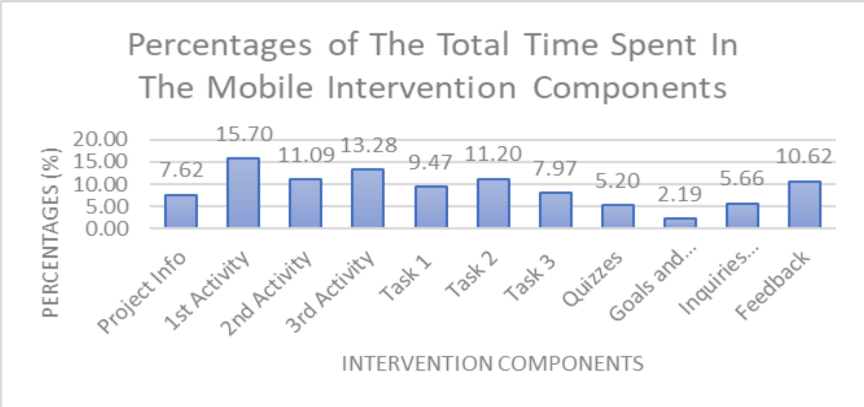

Figure 3. Engagement with the Mobile Intervention Components

Lastly, the usability of the mobile application as measured by the total mean of SUS scores for the current research was 77.3, is above the average score of 75.24 (Bangor et al., 2008) of usability in the area of mobile and web interfaces. This indicated that the mobile application-based intervention is useful and easy to use based on the calculated overall average of SUS scores.

5. DISCUSSION, CONCLUSIONS AND FUTURE WORK

In this study, the mobile behavior change intervention helped show perceived improvement in some critical thinking Standards and Elements for the participants who used the mobile components in the context of their research projects. The mobile intervention has effectively drawn students' attention into critical thinking while working on their research projects. However, the experiment took place during only the first two months of the students' research projects. This might be the reason for the improvement in some but not all Standards and Elements of critical thinking. The overall results indicated that students still need support in their critical thinking when working in research projects as reported in the literature as well by Al-Mubaid and Bettayeb (2017) and Asiri et al. (2017). As a limitation, the researcher was a replacement for the supervisors to support students' critical thinking with the feedback and answers for the students inquires during the experiment. This occurred because of the limited time and busy schedules for the academics in supervision during the semester. This may have introduced inaccuracies in outcomes. In future work, further assessment by experts and academics will be carried on for the qualitative data gathered from this experiment. More evaluation of the mobile log files to understand the effect of the mobile intervention components on the improvement in certain Standards and Elements of the critical thinking will be undertaken. To conclude, engaging with these mobile components helped students understand, practice, reflect and use critical thinking skills in their research projects. The mobile application with its components was deemed by participants to be practical, useful and easy to use.

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DEVELOPMENT AND DESIGN OF A COMPOUND VERB AR LEARNING SYSTEM EMPLOYING IMAGE SCHEMAS

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ABSTRACT

Recently, the number of learners of Japanese as a foreign language (JFL) has been increasing. In Japanese language acquisition, compound verbs (verbs that are composed of two verbs, e.g., *tobikomu* 'jump into') are frequently used in daily life; these present difficulties, including unclarity of combination and opacity of meaning. Matsuda (2001) proposed an image schema that applies core theory to Japanese compound verbs and the application of image schemas to Japanese language education. However, since image schemas are composed of simple diagrams and arrows and are highly sophisticated due to being intended for linguists, it has been suggested that they are not easy for JFL learners to understand (Tagawa and Yuizono, 2016). In this paper, we designed and developed a compound verb AR learning system with core theory and image schemas. Moreover, we discussed Japanese compound verbs acquisition, the image schema of compound verbs as well as the application of AR in learning, and also explained the design and development of the system based on problems in compound verb acquisition.

KEYWORDS

Augmented Reality, Compound Verbs, Image Schema, Mobile Learning, Japanese Acquisition

1. INTRODUCTION

In recent years, the number of learners of Japanese as a foreign language (JFL) has increased. According to the Survey Report on Japanese-Language Education Abroad by the Japan Foundation (2017), it was found that the number of Japanese learners had increased significantly from 1979 to 2015. Compound verbs are an important learning item in Japanese acquisition; they are formed from two single verbs, e.g., *tobikomu* ('jump into', *tobu* and *komu* are simple verbs). As they are frequently used in daily life, in many cases, it is necessary to understand their meanings.

However, it is difficult for JFL learners to master them even if they reach an advanced level (Matsuda, 2002). The difficulties include the unclarity of combination and opacity of meaning. Specifically, unclarity of combination means that the combination order of two single verbs and the existence of a compound verb are uncertain (Sano, 2005). That is to say, JFL learners do not know which two verbs can form a compound verb or the sequence of the two single verbs, and thus it is difficult for them to remember compound verbs. Moreover, opacity means that the meaning of a compound verb cannot be inferred from its two single verbs, because the meaning of a compound verb is not always the combination of the meanings of the single verbs (Chen, 2007). Therefore, learners cannot simply infer the meaning of compound verbs. Furthermore, it has also been pointed out that it is hard to distinguish the differences in meaning between single verbs and compound verbs (Matsuda, 2000). For example, the single verb *yobu* 'call' and the compound verb *yobikakeru* 'call on' are easily misinterpreted as having the same meaning, though *yobikakeru* has a distinct meaning from *yobu*.

Matsuda (2002) applied a cognitive semantic method to explain the various complex meanings of Japanese compound verbs and suggested an "image schema," which is an image of the knowledge structure abstracted from perceptual and motor activities. While an image schema can help JFL learners to understand the meaning of a compound verb through a single image, it is not easy for them to understand, because an image schema is simply composed of abstract diagrams and arrows (Tagawa and Yuizono, 2016). Hence, it

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might be concluded that it is undesirable to directly apply an image schema for JFL learners to learn compound verbs. On the other hand, employing augmented reality (AR) technology can effectively teach concepts that are difficult to understand by displaying virtual visual information in the real world as an innovative educational tool. Thus, we designed and developed a compound verb mobile learning system.

The system employed 3D animations to express the meanings of single verbs and compound verbs via augmented reality (AR), based on core theory and an image schema. In this system, learners learn the meaning of the single verbs first and then the compound verbs through combinations of verb cards (see Figure 1). In this way, the meanings of compound verbs and single verbs can be distinguished, and the system can also determine whether the combination is correct.

In this paper, the authors present image schemas of Japanese compound verbs, the augmented reality for learning them, and the system design and implementation.

Figure 1. Verb card of tobu (kanji and hiragana of the verb)

2. IMAGE SCHEMAS OF JAPANESE COMPOUND VERBS

Cognitive scientists have made proposals to illustrate the process of abstraction from specific sensorimotor experiences to abstract concepts. There are many linguists and psychologists (such as Lakoff and Langacker) in the field of linguistics in cognitive science. This field is called cognitive linguistics (CL). Its purpose is to explore the model or connection of linguistics structures with human embodied experience, conceptual knowledge, and the communicative function of discourse (Gibbs, 2006). The image schema is a crucial concept in cognitive linguists. It is a structured representation of various experiences based on our bodily orientations, movements, and interaction. For example, the image schema for the preposition *in* is a schema of a container to indicate that something contains something.

Image schemas are used pedagogically. For example, in Benjamin's (2012) study, learners of English as a Foreign Language (EFL) used their own imagination to draw image schemas of the phrasal verbs. The results of this approach show that confusion regarding phrasal verb usage was reduced as a result of drawing and collecting image schemas, suggesting that the attempt to teach phrasal verbs emphasizing conceptualization via an image schema is valuable.

There is a "core theory" developed from image schemas. Bolinger (1977) argued that if the form of a word is different, the meaning is different, and the meaning is common if the form is the same. Based on this, Tanaka and Matsumoto (1997) suggested a "core theory" that assumes a schema covering the whole ambiguous sense, and argued that an ambiguous usage can be explained by focusing on and converting core schemas. Core means a context-independent and overarching meaning. Hence, we are allowed to adjust the core via context, whereby the polysemy of vocabulary arises. Although the core theory was originally proposed to support Japanese learners of EFL for the polysemous verbs of English, Matsuda (2001) proposed the application of Tanaka's core schema to Japanese compound verbs and the use of image schemas in Japanese language education. For example, the single verb *tobu* 'skip' is represented by the movement of the arc in Figure 2, and the single verb *komu* 'enter' refers to movement to the inside, as indicated by the arrow in Figure 3. The compound verb *tobikomu* in Figure 4 overlaps the images in Figure 2 and Figure 3, and thus represents the meaning 'jump in'. In this way, the image schema of a compound verb can be comprehensively comprehended through a single image, opening a new possibility for aiding vocabulary acquisition. However, the image schema is composed of simple diagrams and arrows and is highly sophisticated due to its use by linguists. Therefore, rather than presenting an image schema directly to a learner, it is believed that presenting visual glosses would result in a better learning effect (Sato, 2016).

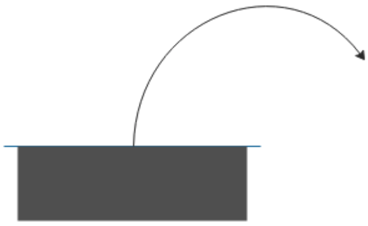

Figure 2. Image schema of 'tobu'

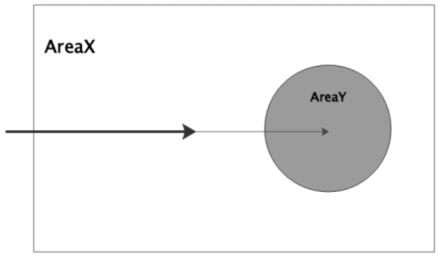

Figure 3. Image schema of 'komu'(A type)

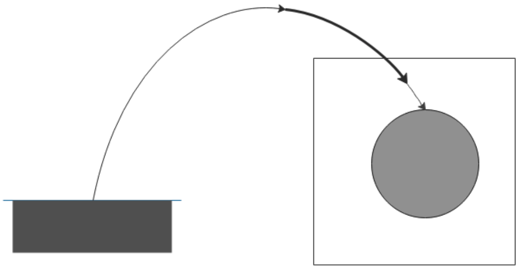

Figure 4. Image schema of 'tobikomu'

3. AUGMENTED REALITY FOR LEARNING

Recently, various learning environment designs have become possible with the spread of mobile devices such as smartphones. Augmented reality (AR) is one graphic technology for which learners need no special equipment and through which they can experience the content easily and efficiently. AR is defined as a simultaneous combination of the real world and virtual objects (Ibanez et al., 2016; Sin and Zaman, 2010). By applying AR, abstract concepts and complicated problems can be effectively taught (Walczak et al., 2006). There are several other advantages. For example, as it does not require a specialized device, its cost is cheaper than VR, and visualization, simulation, and interaction with virtual objects become possible. With these advantages, it is possible to provide new educational tools, showing that AR technology has the potential to greatly improve educational outcomes (Chiu et al., 2015).

AR is generally categorized as comprising location-based and image-based systems. Location-based AR systems use data relating to the location of the mobile device via a GPS or Wi-Fi based positioning system. The user can also move while using the mobile device in the actual environment. The information created by the computer depends on the location of the user. Image-based AR systems focus on image recognition techniques used to determine the proper location of virtual content relative to physical objects in a real environment. Since AR has advantages such as portability and low cost, it is applied to various fields such as ubiquitous learning (Dede, 2011) and cognition (Specht et al., 2011).

Language learning environment research using the graphic technology represented by AR has also been carried out. Mashiro et al. (2011) created an English vocabulary learning support system by using AR markers corresponding to the letters of the alphabet to arrange them. In Japanese language learning, Maekawa et al. (2015) proposed a learning system for the Japanese phonograms by arranging two to three

AR markers written in hiragana. AR can be used to improve present learning methods by annotating audio, text, and 3D images to objects in real environments.

In order to solve the problem of compound verb acquisition, we designed and developed a compound verb AR learning system based on core theory and image schemas.

4. SYSTEM DESIGN AND IMPLEMENTATION

This study focuses on an image-based AR using physical object tracking in smartphones. That is, the learner scans the card with the verb in the smartphone application, and the corresponding meaning animation is displayed on the card through the screen. In the study of the AR phonogram learning system above (Maekawa et al., 2015), the learners' impression was that it was easy to imagine characters and reading by relating AR animation to characters and reading. Thus, in this study, the animation is displayed on the text; that is to say, learners can also touch the text while grasping the meaning, so it is expected that the system can also promote familiarity with verb characteristics.

4.1 The System and Compound Verb Acquisition Problems

The following design was applied to the problems of compound verb acquisition.

4.1.1 Unclarity of Verb Combinations

In order to deal with the lack of clarity regarding compound verb combination, we designed a function named the combination judgment function to present the correct and incorrect order in verb combinations. When the learner combines the two cards for single verbs V1 and V2, the system determines whether the card order is correct or not (the order of verbs, whether this compound verb exists or not). If it is incorrect, the system presents the message, "The combination of compound verbs is incorrect." On the other hand, if it is correct, an animation of the compound verb's meaning is displayed.

4.1.2 Opacity of Compound Verb Meanings

The meaning of a verb is represented by a visual gloss of 3D animation created according to the image schema (see Figure 5, Figure 6, and Figure 7) in the system. In particular, the display of compound verbs was designed based on the V1 + V2 strategy (Matsuda, 2004), which seeks to convey an understanding of the meaning of compound verbs by combining single verbs V1 and V2 after understanding the meanings of V1 and V2. In addition, as shown in Figure 8, learners first learn the meanings of the single verbs V1 and V2 and then learn the meaning of compound verbs by combining the cards for single verbs. Therefore, it is possible to understand the semantic distinction between single verbs and compound verbs via the above function. Moreover, it is possible to infer the meaning based on the context because it is based on the image schema.

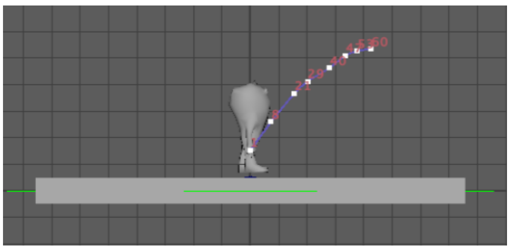

Figure 5. The motion track of the *tobu* animation

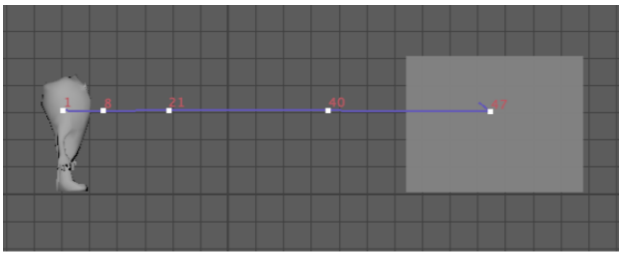

Figure 6. The motion track of the *komu* animation

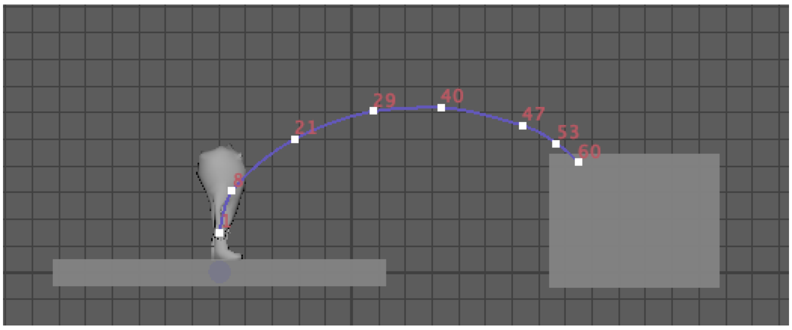

Figure 7. The motion track of the *tobikomu* animation

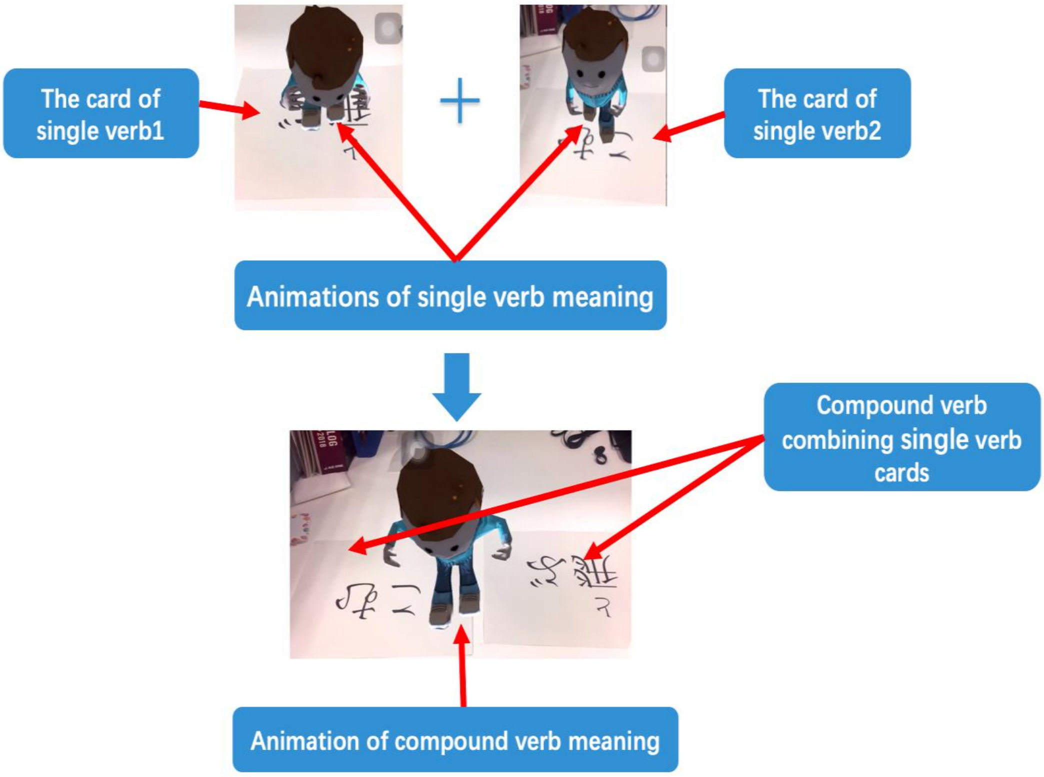

Figure 8. Screenshots of the verb combination

4.2 Outline of the System

In this study, the development language was C#. The animations of verbs were made with Maya based on the image schemas proposed by such studies as Matsuda (2004). Since iOS and Android are utilized as operating systems for smartphones commonly used in daily life, we employed a software development supporting multiplatform: Unity. Developed applications can be implemented on iOS and Android devices. Figure 9 is a configuration diagram of the system. It can be seen that the system recognizes the verb card using the Vuforia plugin. Figure 9 also shows that there are three main functions of the system, which will be described in detail below.

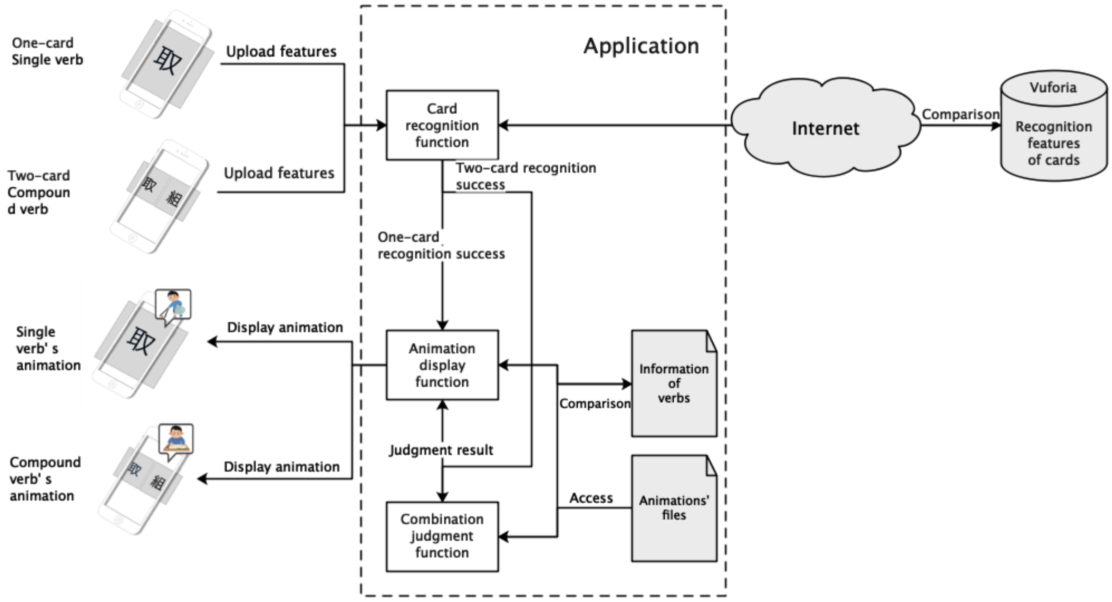

Figure 9. System configuration diagram

Figure 10 shows a flowchart of the system's function. It consists mainly of three functions.

4.2.1 Card recognition Function

The card recognition function recognizes the verb card on the camera screen and judges whether the verb card is present. The number of cards is also judged. The recognition features consist of Japanese verb characters and their readings. Recognition is made by comparing them with the recognition features uploaded to Vuforia.

4.2.2 Animation Display Function

When the card is recognized, the system is moved to the animation display function, in which the animation of the single verb or compound verb is displayed according to the number of cards. As long as the corresponding cards appear in the camera, the animation will continue to play. The animation and cards are not separated; rather, the animation displays on the cards. Moreover, the animation is not simply the animation of image schema. In the system, we use an avatar instead of a moving object and the motion trajectories of the avatar instead of arrows in the image schema (see Figure 5, Figure 6, and Figure 7). The results of one study (Sato, 2016) show that there is no significant difference between the learning effects of animated glosses and pictorial glosses in learning polysemous words. The authors believe that the learning effect of this function should be verified in future studies.

4.2.3 Combination Judgment Function

The combination judgment function judges the correctness of the combination of two cards. After the card recognition function recognizes two cards, this function will be triggered. The system will judge the order of the card combination and whether the combined verb exists. The existence of the compound verb is judged by the verb information file preset in the application.

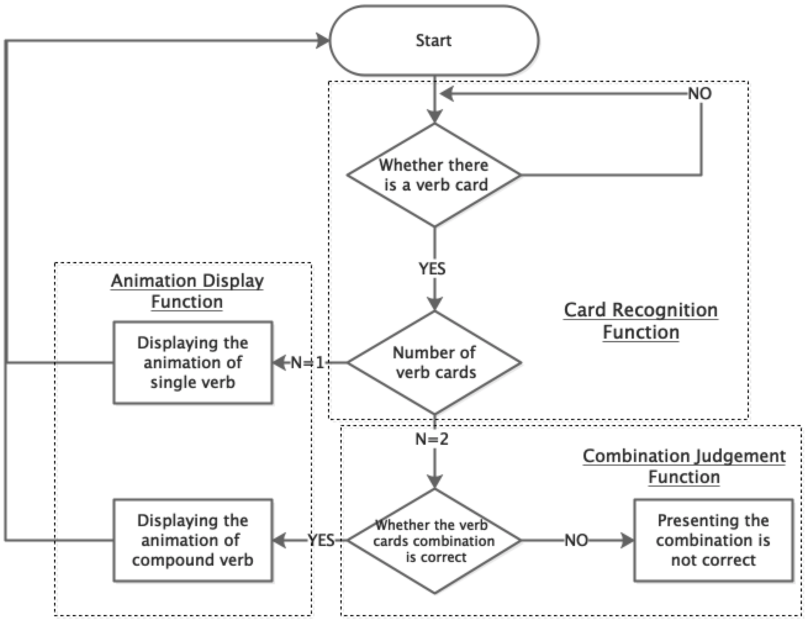

Figure 10. Flowchart of the functions

5. CONCLUSION AND FUTURE WORK

In the present study, we discussed the acquisition of Japanese compound verbs, image schemas for compound verbs, and the application of AR in learning, and explained the design and development of the system.

In future work, we will clarify the effect on learning compound verbs of this system. Furthermore, we will examine the differences in the learning effect due to literal explanations, visual glosses of the AR animation, and pictorial glosses of image schemas.

ACKNOWLEDGEMENT

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EXPLORING THE SOCIAL LEARNING VALUE ENABLED BY AFFORDANCES OF THE FOOD FOR US MOBILE APPLICATION: THE STORY OF A SOUTH AFRICAN FOOD REDISTRIBUTION APP

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ABSTRACT

This paper reviews the research undertaken in a social learning and innovation project focusing on food surplus redistribution, via a mobile application project called ‘Food for Us'. This initiative was pilot tested in two study sites, namely Worcester, Western Cape and the Raymond Mhlaba municipality, Eastern Cape in South Africa. In South Africa, one-third of the food produced for consumption is wasted, whilst 26% of all households’ experience hunger. Food surplus occurs in many contexts, including communities of emerging small-scale farmers, many of which aren't able to find markets for their products resulting in wastage. In a time of mobile technology expansion, the wide infiltration of internet-enabled smartphones into diverse communities has increased dramatically with the uptake of mobile applications being a key area of interest amongst environmental educators. The Food for Us application project aims to address the challenges of food insecurity and market access for small-scale farmers by creating an innovative technological solution in the form of a mobile application. The Food for Us mobile application and social learning research project aimed to investigate the social learning that was enabled within the communities of practice that utilized and interacted with the Food for Us mobile application. The Food for Us mobile application aimed to reduce on-farm food surplus by providing a tool on which small-scale farmer could find alternative markets for their unsold produce. This paper will look at the key findings that emerged out of the first phase of the project including the important social learning findings; instances of boundary crossing and intergenerational learning and network building, as well as the recommendations that have emerged that surround the need to develop strong social networked systems around technological innovative solutions to promote the realization of transformative value.

KEYWORDS

Informal Mobile Learning, Social Learning, Small-scale Farming, Transforming Food Systems, Market Transformation

1. UNDERSTANDING THE FOOD WASTE / FOOD SECURITY PARADOX AND THE NEED FOR THE FOOD FOR US APPLICATION

Food waste has become a major global and national concern, with one-third of all produce grown for human consumption being wasted, often ending up in landfills (FAO 2011). This excessive food waste is juxtaposed against a backdrop of mass malnutrition and hunger in many developing counties. According to the 2014 Food and Agriculture Organization (FAO) statistics yearbook, 24,8 % of people in Africa are undernourished (FAO, 2014), yet it is believed that up to 37% or 120 -170kg /year per capita of food is wasted in sub-Saharan Africa (Sheahan & Barrett, 2017). While South Africa produces enough food for its 53 million citizens, roughly 26% of South African households are food insecure (von Bormann, 2017). This wastage predominantly occurs in the agricultural production part of the agricultural value chain with 2.7 million tons of good food lost a year (Oelofse, 2015).

The research on food waste in South African food systems is very limited, with even less being conducted on the presence of food waste in the rural farming communities (Pereira, 2014). Khapayi and Celliers (2016) and Mpandeli and Maponya (2014) note that one of the key challenges that hinder small scale emerging farmer’s development in South Africa is their lack of participation in appropriate local markets, therefore, resulting in wasted produce and resources. In a study conducted in King William’s Town in the Eastern Cape, South Africa, it was found that 55% of the small-scale emerging farmers had no access to market information, therefore no exposure to new markets, prices, or information regarding produce supply and demand (Khapayi & Celliers, 2016). Many farmers complained that their produce would be spoiled due to the lack of markets in close proximity (Khapayi & Celliers, 2016).

This issue of food waste and lack in market access is occurring in a time of increased use of and a surge in ownership of Internet-enabled mobile phones in the postmillennial decade (Donner, Gitau, and Marsden 2011). Donner et al. (2011) argue that a mobile phone's portability, flexibility and ability to be personalized has the potential to increase productivity and agency within the global south, offering great opportunities for services to reach critical masses (Brown et al. 2003). In a recent national survey, 53% of households had at least one member who had access to the Internet with more than a third of this, (33,7%) being through mobile devices (Statistics South Africa, 2016). According to the Mobile Economy Sub-Saharan Africa 2017 report, there were 420 million unique mobile subscriptions, which translated into 43% mobile subscription penetration in Sub-Saharan Africa (GSMA 2017). Of these unique mobile subscriptions, a quarter is smartphone connections which enable the mobile phone user to access the internet (GSMA 2017). With the surge in internet use on internet-enabled mobile phones (smartphones), there has been an increase in the use of Application-Based Mobile Services, commonly known as mobile apps (Opera 2016). According to the 2016 State of the Mobile Web Report, South Africa is the leading African country in terms of application use with one-third of the population using applications regularly (Opera 2016). Aker and Mbiti (2010) note that recent app developments are designed to make life easier and more efficient (Aker & Mbiti, 2010). Yet not much is known about the social learning associated with the uptake and use of these applications.

The Food for Us project, funded by the United Nations Environmental Programme (UNEP) under the 10-year framework of programs (10-YFP) One Planet initiative, aimed to trial a mobile application as a solution to divert surplus food to feed an alternative market whilst also looking to transform market access and strengthen the development of local circular economies via social learning. As such, the Food for Us project also aims to encourage the establishment of a community of learning around food waste and technological innovation to strengthen the research in these fields within the small-scale farming context (Jenkin, 2016). This paper looks at the type of social learning that emerged from the affordances of the Food for Us mobile application and the Food for Us support systems and makes recommendations on how social learning can be improved.

2. FOOD FOR US FOOD REDISTRIBUTION APPLICATION PILOT

The first phase of the Food for Us project ran over an 18-month period with the Food for Us application being trialed in two case study sites, Worcester, in the Western Cape province and Raymond Mhlaba Municipality in the Eastern Cape province of South Africa (Food for Us 2018a). This paper will be discussing the findings that emerged out of the Raymond Mhlaba, Eastern Cape case study.

The Raymond Mhlaba Municipality is a rural municipality within the Eastern Cape Province of South Africa. This municipality is a predominantly rural municipality with 72% of the population living in rural villages and on smallholder farms (Raymond Mhlaba Municipality 2017). The municipality has a high unemployment rate (87 %) (Raymond Mhlaba Municipality 2017) and high poverty rate with 64.7 % of the population living in poverty (ECSECC 2017). The local government has highlighted the need to create jobs with potential being recognized in the local farming sector (Raymond Mhlaba Municipality 2017). It was within this context that we introduced the Food for Us application as an innovative project to assist in the empowerment of local farmers and the development of more connected supply chains.

The project started with a set of introductory workshops (August 2017) inviting a diverse set of stakeholders (farmers, retailers, government representatives amongst others) in the two case study sites to be part of a collaborative application designing process. The first version of the application, built off the suggestions that were made at the workshops, was made available to trial participants in mid-September 2017. The introduction of the Food for Us application was coupled with important training workshops that were run in both study sites to assist users on how to download, register and use the new application. In conjunction with the training, a support WhatsApp group was developed for the Eastern Cape case study to provide a support platform for users to discuss challenges, to navigate solutions and communicate with diverse stakeholders about available and demanded produce.

Within the Eastern Cape case study, the Food for Us project partnered with a similar social learning research project situated in the area, Amanzi for Food (Pesanayi, 2018). The Food for Us project was incorporated into the Amanzi for Food Training of Trainers course, which enabled the Food for Us project to reach more people and be exposed to more comments and suggestion. The Food for Us application was workshopped on three occasions within the Amanzi for Food course which was held in November 2017, February 2018 and May 2018.

The final intervention that occurred in the Eastern Cape case study was the #MatchMaking event, which took place in April 2018. This event invited local farmers and buyers in the community to come together for a day of networking and discussion between the members of the local supply chain. The event provided an opportunity for local buyers, sellers and intermediary stakeholders to network, build partnerships and come together to discuss supply chain challenges and potential solutions.

The first phase of the Food for Us project ended with a dissemination event, which was held at the Sustainability Institute in Stellenbosch, Western Cape. This event invited a diversity of stakeholders from the South African food system and food waste fields to join together to open discussion about innovative solutions (Food for Us 2018b). The dissemination event provided a space for the Food for Us project findings, from the Western Cape and Eastern Cape case study, to be presented and discussed therefore opening a platform for discussion and collaboration on how to address food waste in the current South African context (Food for Us 2018b).

A number of data sources was used to understanding how the Food for Us application value creation, and Food for Us social networked support systems and social learning were used within the Eastern Cape case study. The pilot trials included the trialing of 40 users use of the Food for Us application, 20 in the Western Cape province case study and 20 in the Eastern Cape Case study. The trial users included a mix of small-scale farmers, small-scale buyers, restaurant owners, and intermediaries' organization (who assist in the connecting of farmers and buyers). The data that was collected from the willing volunteer trial participants included;

1. **Application metadata** collected from the backend of the Food for Us application recording the activity on the application,
2. **Baseline survey** collected at the beginning of the project to get an understanding of the background of the trial participants, (23 collected in Eastern Cape case study)
3. **Value creation semi-structured interviews** to understand the experiences and value created, or lack thereof experienced by the several users, (6 value creation interviews)
4. **WhatsApp group conversations** and interactions around the Food for Us project, including reporting of issues challenges and opportunities,
5. **Workshop** discussions and observation
6. **Final Survey** conducted at the end of the project as a way to understand the type of value enabled and determine whether expectation was met and how best to learn from the project. (16 collected in the Eastern Cape Case study)

Through the data collected we identified the affordances that emerged from the Food for Us application and the Food for Us networked social learning processes. Simply put, an affordance is described as an action possibility (Turner 2005) however Doering, Miller, and Veletsianos (2002) explain that it is important to emphasize the relationship that exists between the user and artifact as the perception of an affordance, applied affordance and realization of the affordance all are interlinked and dependent on one another. In this paper, we look at the types of affordances of the application and the networked support systems and how these affordances enabled social learning.

3. RESULTS

3.1 Using the Value Creation Framework

The social learning that emerged from the Food for Us project was analyzed through the use of Wenger, Trayner and de Laats (2011) Value Creation Framework. The Value Creation Framework provides a framework to understand the social learning that occurs within and between communities of practice (Cop) through understanding social learning as a series of value creation cycles that exist between the grounded, people's current experiences, and the aspirational narrative of a community or individual, what people hope to achieve through a social learning/ shared practice processes (Wenger, Trayner, and de Laat 2011). Wenger, Trayner and de Laat (2011) define 5 types of value; immediate, potential, applied, realized and reframing. These value cycles can exists independently but most often interlink and interact with one another to develop a value creation narrative which records the cycles of value that emerge over time (Wenger, Trayner, and de Laat 2011).

The framework acts as a methodological tool, guiding researchers on the type of indicators to look for, and an analytic tool, which assist the user to map the value across five value cycles (Wenger, Trayner, & de Laat, 2011). The strength of Wenger, Trayner and de Laat's framework is that provides a structured way to understand the information shared, therefore, understanding the different value created while not removing it from its context (de Laat, Schreurs, and Nijland 2014).

In the results discussed below, I discuss the different cycles of value that were enabled by the use of the Food for Us application and the networked social learning processes that accompanied it.

3.2 Limited Value Realization from the use of the Mobile Application Alone

The Food for Us application was used by the 20 users that made by the Food for Us pilot trial. The application was opened up to anyone else how would like to be part of the project, however, these use and experience of the project were not tracked. In total the Raymond Mhalaba Food for Us pilot had 25 sellers of produce, 11 buyers of produce and 7 researchers registered on the Food for Us application. Over the duration of the project, ending in May 2018, 31 produce uploads were made from the registered participants. The uploads included a variety of livestock, spinach, potatoes, and other local produce. Of the 31 uploads, there was only one transaction made between the sellers and buyers on the application. The key perceived and applied affordances of the Food for Us application can be seen in Table 1 below.

Table 1. Table showing the perceived and applied affordances of the Food for Us application

Perceived Affordances		Applied Affordances
Bring local farmers into the local supply chain to produce for local retailers:	> Increased access to more buyers > Increased access to more local farmers > Increased communication within local supply	> Increased interaction with mobile technology > Increase local audience for farmers to advertise to > Buyers exposed to a number of local producers. > The information required for selling the products was simplified > Users able to be buyer or seller of produce
Improve logistics of the local trade – Transport/packaging	> Reduce distance driven and share transportation costs > Recording of data about the Farmers produce > Improve immediacy of the supply chain > Price Comparison Tool for buyers > Improved price for Farmers > Market Information > Improve Quality of the produce > Reduce wasted resources (water, seed, fertilizer, fuel etc.)	

The two over-arching perceived affordances where that the users perceived that the Food for Us application would enable them to (1) bring local farmers into the local supply chain and (2) improve the logistics of local trade allowing for a more efficient, economical and waste-free local supply system. The applied affordances included, (1) increased interaction with mobile technology, (2) increased local advertising, (3) increased exposure to local farmers, (4) simplified market information and lastly (5) users able to be both buyers and sellers of produce through the application. These affordances enabled value to be created which has been summarized in table 2 below.

Table 2. Table summarizing the value created through the use of the Food for Us application

Immediate	Potential	Applied	Realized	Reframing
Excitement	Improve mobile Use Skills	Download the application	Increased mobile use confidence	Using technology as an agri-business tool
Exposure to new ideas	Build connections	Advertise produce on the application	Exposure to local produce	
	Share market information	Search for demanded produce		
		View Public Wall		

As one can see from table 2 above, the majority of the value emerged as potential value and applied value, with little, realized and reframing value emerging from the applied affordances.

The immediate value that emerged included excitement and enthusiasm. There was much interest and excitement that developed out of the introduction of the Food for Us application with most of the users showing immediate enthusiasm about being part of the application trial. The second immediate value that emerged was exposure to new ideas, which included ideas of using mobile technology to increase a farmers market, as well engaging in ideas around food waste and wasted resources and how to address these challenges.

The potential value that emerged developed out of the excitement that surfaced as an immediate value. The potential value that emerged included; (1) improved skills around the use of mobile technology, (2) develop connections, and (3) share market information. Users improved their perceived ability to engage with mobile applications, which plays an important part in enabling action and therefore the development of further value creation cycles. Through engaging with the produce upload adverts on the application; users have started to connect with unknown farmers and buyers, therefore developing their social network further increasing the potential to further work with new people. Finally, the use of the Food for Us application shared information through allowing the uploads to be viewed by all who had the application, this provided farmers with some idea of what was being produced and sold and at what price. The potential value provided a foundation from which the applied value could draw on.

The applied value that emerged from the use of the application included all the actions that were taken including the users downloading the application (43 in total in the Eastern Cape case study), uploading of produce from the farmers (31 uploads in the Eastern Cape), searching the application for demanded produce and the viewing of the public wall[1].

Not all of the applied actions where successful in their pursuit of the over-arching aspiration narrative (this being the shared aim of the project - to reduce on-farm food waste and wasted resources while increasing market access and assisting with the strengthening of local circular economies). The realized value that emerged included the increased confidence of users to use their mobile phones and applications. This was recorded in many of the value creation interviews where people explained that they felt they were more confident to use their phone in different ways that they had not engaged in before. The second realized value was that a number of the buyers explained that they were exposed to farmers whom they had not known prior to the Food for Us project. Unfortunately, there was only one transaction out of 31 uploads made on the application therefore not warranting the transacting of local produce on the application a success.

The final cycle of value is the reframing value that emerged through the duration of the project. Wenger, Trayner and de Laat (2011) explain reframing value as the transformation capital that emerges where the participants of the community start to reimagine success based on the previous cycles of value. The reframing value that emerged was that the trial users started to reframe how they imagined using technology as an effective tool for furthering their agricultural or consumer businesses. Through improving their skills (potential), applying their skills in the use of the application (applied) and becoming more confident in mobile technology use (realized), the users started to re-imagine what mobile technology could do for them.

As one can see there was value that emerged out of the use of the Food for Us application alone, however, this value was inhibited through a number of challenges including the inconsistent stability of the application, users access to compatible technology and the complex process of the application, to name just a few. Therefore, value creation from the direct use of Food for Us application was not fully realized to meet the expectations set out by the Food for Us project.

3.3 Rich Value Creation enabled by the Networked Social Learning Processes that accompanied the Introduction of the Food for Us Application

As described above, there were a number of networked social learning processes that accompanied the introduction of the Food for Us application in the Raymond Mhlaba case study. These included the Food for Us WhatsApp group, the application training workshops, the Food for Us workshops within the Amanzi for Food course, the #MatchMaking event and the continuous research interaction. These networked social

[1] The public wall was a feature of the Food for Us application which provides a space for event notifications, recipe sharing and other miscellaneous to be recorded and shared with all the application users.

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learning processes evolved as the project went on, changing to accommodate and support the Food for Us users to get the most out of the application as they could. As was found with the Food for Us application, there were many perceived and applied affordances that emerged out of the networked social learning processes as well. These affordances can be seen in table 3 below;

Table 3. Showing the perceived and applied affordances of the various networked social learning processes that accompanied the introduction of the Food for Us application

Perceived Affordances		**Applied Affordances**	
Improve Logistics	> Create a consistent supply of locally produced food > Platform to discuss demanded produce	**Network Building:**	> Link Consumers to local producers > Search for demanded produce
Developing farmers skills	> Business skills and recording of data > Local Pricing of produce	**Grow the Food for Us community**	> Enable local trading of produce > Food for Us Community developed > Bring the youth into the local supply chain
Partnership	> Networking opportunity for buyers and sellers of produce. > Bringing new partners into conversation	**Communication**	> Communication between users (Producers and consumers) > Communication between the users and app developers
Partnership Opportunity to strengthen local businesses	> Networking opportunity between the buyers and sellers of produce. > Bringing new people into the conversation > Market Access > Incentivize farmers > Reduce the transaction costs of users	**Knowledge Sharing**	> Recognize Food waste > The shift toward organic crops and sustainable farming practices
		Support Platform	> Technical difficulties > Experimenting with the application > Support New users > Collaborative Troubleshooting
		Collaboration	> Negotiation of how the app will be used > Supportive feedback loops > Shared interest and Ownership of the project
		Building Confidence:	> Building Business and Marketing skills > Learn about IT
		Strengthen Local Supply Chain:	> Communication > Building a circular economy > Build a joint vision for local supply chain > Healthy competition > Enable local trade

The number and complexity of affordances that is enabled by the networked social learning processes are much more extensive than those of the Food for Us application. However, it is important to note that here we are comparing the affordances of one tool within a multitude of social activities and workshops. The applied affordances allowed for actions that were instrumental in enabling value creation. The afforded communication between the trial participants (afforded by the Food for Us WhatsApp group) and the afforded building of relationships and extension of networks (afforded by the #MatchMaking event, Training Workshops and Amanzi for Food Training of Trainers courses) enabled large amounts of value to be created as described in table 4 showing the value creation enabled by the networked social learning networks.

The value that emerged from the social learning support structures created a much richer and multi-leveled value for the Food for Us project. The most important value that emerged was the strengthening of the local supply chain through the development and opening up of social networks (realized value). Farmers who had not been part of existing farming networks were introduced into the network (such as youth co-operative members). There were instances of inter-generational learning where older members of the farming community shared knowledge accumulated through years of practical experience with the young farmers and newcomers There was also sharing of knowledge from the youth members who assisted elder Food for Us trial participants with downloading and utilizing the Food for Us application (potential value). There was also increased discussion between the different stakeholders within the local supply chain, therefore, enabling boundary crossing between different communities of practice (such as the small scale farmers and the local buying community). This intergenerational knowledge sharing and cross-community of practice boundary knowledge sharing was enabled by the support systems through their affordances to enable relationship building (potential value), building connections (potential value), encourage new channels of communication (applied value) and build a strong and supportive community (realized value) around the shared idea of strengthening a circular local supply chain.

Table 4. The value creation that emerged from the networked social learning processes that accompanied the introduction of the Food for Us application

Immediate	Potential	Applied	Realized	Reframing
Excitement	Network & Relationship Building	Increased communication	Strengthening of local supply chain	Using technology as an agri-business tool
Exposure to new ideas	Data Base	Community Support	Transacting of local produce	Definition of food waste in rural areas
Build Contacts	Sense of Community	Collaborative Troubleshooting	Improved application	Bring youth into the local supply chain
	Building Skills	Supportive Feedback loops	Ownership of the project	Importance of strong social networks
	WhatsApp Group	Marketing and trading of produce	Increased confidence in Mobile Use	
	Knowledge Sharing	Recognize Food waste		
		Interest in Sustainable Farming		

The networked social learning systems also enabled improved use of the Food for Us application through enabling the users to encourage one another with supportive messages (applied value) on the WhatsApp group. The WhatsApp group invited all those who were part of the trial to be part of the WhatsApp group. The WhatsApp group also included the technical liaison for the Food for Us application and Food for Us trial managers. This enabled direct contact between the application users and the application technical team, which allowed for application errors to be reported and advised upon immediately (applied value). Through collaborative efforts, users and the technical liaisons were able to collectively identify a common error and report it to the coding team so that software issues were timeously solved (realized value). These supportive feedback loops enabled the coding team to develop a more stable and user-friendly application by the end of the 18-month project period.

As explained above, there was very limited transacting of produce that occurred on the Food for Us application itself, however, this was not the case in the networked social learning processes. According to the final survey data, there was between 15 – 20 transactions made outside of the Food for Us application which was enabled by the Food for Us project. Many users explained that they would view the produce that was available on the Food for Us application and then contact the farmer outside of the application as a matter of convenience. This prompted the research team to try and understand why users did not feel comfortable communicating through the application and instead used familiar communicating channels such as calling or using WhatsApp. We realized that in future research, it is important to understand the technology use culture of the application audience, therefore understanding how the users engage and utilize mobile technology, so as to allow for contextualized application functionalities that speak to the used culture.

The technical support on the Food for Us WhatsApp group, the training workshops and #MatchMaking event also enabled users to develop their skills in terms of using mobile technology. Not only did the training workshops show users the specifics of the Food for Us application, but also explored how to use email and social networking software (such as WhatsApp) to build social networks to develop one's business further. This emerged as one of the major cycles of reframing value that emerged from the Food for Us project, as users started to re-imagine how they could use technology, understanding that technology could act as an important tool to build social networks and encourage communication and collaboration in and across communities of practice.

The networked social learning processes, which supported the implementation of the Food for Us application in the Raymond Mhlaba community, enabled multiple levels of value creation within the project landscape, showing the importance of investing in social learning and network building in social systems of uptake and use around mobile application design and use.

4. CONCLUSION

In conclusion, as can be seen from the results summarized above, there was much learning that emerged from the Food for Us pilot project. Through the value creation analysis, it becomes clear that technical innovations on their own do not change situations. As Mc Namara (2003) explains, “ICTs enable change; they do not create it” (Mcnamara 2003, 6). What emerged, as a successful component of the project was the strong, networked social learning support structures that enabled connections, discussion and collaboration between the Food for Us trial users.

There were a number of limitations to the project, the key one being the length of the project. The 18-month period was too short to achieve a full understanding of the type of value created by the application and the networked-social learning processes over time. In future research, we recommend that such a project be conducted over a longer time frame with more time allocated to the development and refinement of the application.

Going forward, we are hoping to continue this research and explore what value is created through this project over a second phase of the Food for Us project. We hope to explore how best to support sustainable social innovation in multi-stakeholder partnerships through developing sustainable business models, and expanding the connections between buyers and sellers in local learning and transaction networks, as site for uptake and use of the mobile technology, where associated social learning potential can also be maximized.

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THE EXPANSION OF THE CLASSROOM THROUGH MOBILE IMMERSIVE LEARNING

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ABSTRACT

In this article we describe how mobile devices enable immersive learning experiences. Expensive Head Mounted Displays (HMDs) are a thing of the past, as even inexpensive alternatives in combination with a smartphone make it possible to immerse oneself in virtual worlds. Learners then take these worlds as realistic, which can lead to cognitively and physically behaving as in real life. Immersive learning then may contribute to the dissolution of space and time and to more authentic learning experiences. The limitations of spatial classrooms can thus be broken down and expanded more and more, in the K-12 classroom as well as in higher education.

KEYWORDS

Virtual Reality, Augmented Reality, Mobile Immersive Learning, Authentic Learning

1. INTRODUCTION

"*What killed the mobile learning dream*" asks Traxler (2016) in his eponymous article. For him the potential of mobile devices for teaching and learning has not yet become reality in education. Rather, traditional pedagogical approaches are used, and educational content is prepared to fit on a small screen. This criticism is reminiscent of early definitions of mobile learning, as the technological perspective was in the foreground. Quinn (2000), for example, recognized mobile learning just as learning "on" or "through" mobile computers whereas for Kukulska-Hulme (2005) the physical mobility provided by handiness made a difference to other educational technologies. The potential of mobile learning goes far beyond these technological perspectives, including the possibility to offer authentic and collaborative learning environments (Cook & Santos, 2016), create learning tasks like designing multimedia artefacts (Arnedillo-Sanchez & Tangney, 2006; Stevenson, Länsitie, Kogler, & Bauer, 2015), bridge indoor and outdoor classroom activities (Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009) and access to explorative as well as gamified problem-based learning scenarios (Klopfer & Sheldon, 2010; Squire & Jan, 2007). When we talk about mobile learning, we have to take a second aspect of learning into account: informal learning. Kids, adolescents and adults are living in an increasingly digital, hence connected world, which also leads to a more mobile lifestyle. Tourists discover cities with Google Maps, backpackers book their room on the way from one destination to the next and history lovers explore monuments in Prague and Pisa through Augmented Reality (Duguleana, Florin, Postelnicu, Brondi, & Carrozzino, 2016; Kysela & Štorková, 2015). Based on these changing processes Sharples et al. (2009) define mobile learning as a personal and public "*exploration and conversation across multiple contexts, amongst people and interactive technologies*" (Sharples et al., 2009, p. 237). While informal learning is characterized as a time and space independent process which basically takes place outside the classroom, formal education is defined by fixed physical spaces and given lesson times (Kearney, Schuck, Burden, & Aubusson, 2012). Here, Traxler (2009) recognizes one of the greatest potentials of mobile learning: the dissolution of space and time.

In the course of time, many different media and technologies have been used to develop this potential. First, we will describe classical approaches that have already attempted to expand the physical learning space. Here the factor of authenticity must always be taken into consideration and to what extent a medium makes authentic learning experiences possible.

Building on this, we will then outline new technologies and teaching methods that gradually increase authenticity and try to dissolve the constant space.

Finally, with mobile immersive learning, we will present a promising possibility that can currently set new standards both in the field of authentic learning experiences and in the expansion of the learning space.

2. NON-IMMVERSIVE EDUCATIONAL TECHNOLOGIES

For a long time, pictures have been the window to the world outside of the classroom. The static images make authentic experience possible only to a limited extent, which is why they were replaced in a next step by moving images. The use of videos has a long tradition in education. The time when videocassettes or DVDs have been used in classrooms all over the world is over. Now, all sorts of films with educational purposes are available on online platforms' (Buchner, 2018). For our learners YouTube (web and application) is among the most important educational tools (Hart, 2018). Teachers can use video clips for virtual field trips, visiting Machu Picchu, the African desert or the European Parliament can become reality and this possibility can bring new learning spaces into the everyday classroom (Koumi, 2006). Also the demonstration of dangerous experiments, the revival of long past historical events or the exchange with experts via Skype are possible benefits (Hansch, Hillers, McConachie, Newman, & Schmidt, 2015). Videos can also expand the temporal component, e.g. when used for a flipped classroom setting. This way students are able to watch the video at home anytime, anywhere and at their own pace (Arnold-Garza, 2014; Bergmann & Sams, 2012).

The problem with videos is that learners follow a given structure and, apart from the classic navigation options, have little influence on what is shown. Furthermore, videos depict the world only in 2D, which does not correspond to our real perception of life.

3. AUGMENTED LEARNING

Mixing real environments with digital representations is known as augmented reality (AR) (Azuma, 1997). AR can be realized through every mobile device with a camera, an existing internet connection and an AR application (Yuen, Yaoyuneyong, & Johnson, 2011). Visualizing the invisible and seeing the world around us in new ways as well as interacting with this world are the main benefits of AR (Klopfer & Sheldon, 2010; Sotiriou & Bogner, 2008). Interaction in this case means the possibility to zoom in and out, watch a 3D model from every perspective and manipulate the depicted digital representations. In class augmented learning for example means that students are engaged into an interactive trip to ancient Egypt. The start-up Areeka has realized this with a magic book including 3D animations that allows students to explore the building process of the pyramids, discover the function of a shadoof or deal with a pharaoh's mask in detail. This book can also be used at home, in the free time or it can be shown to parents or grandparents. Outside the classroom AR allows the reconstruction of historical monuments, which are only preserved in fragments. Figure 1 shows a roman archway overlaid with a digital representation of it.

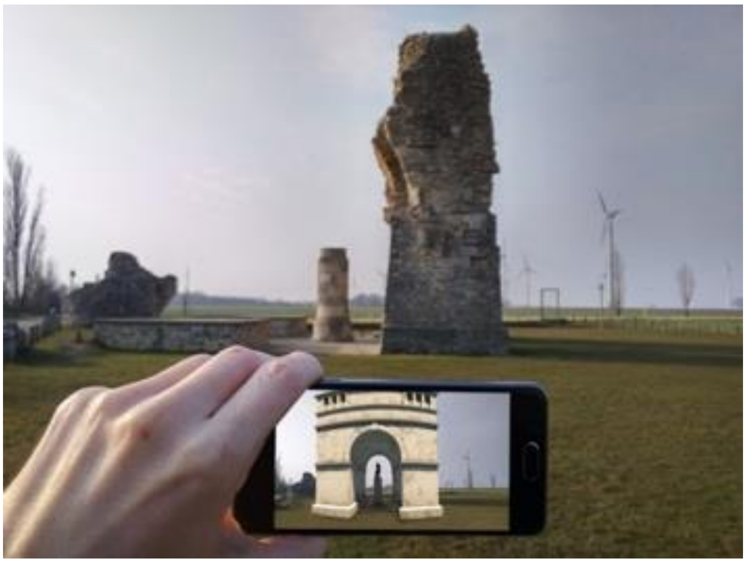

Figure 1. AR in the former roman city Carnuntum, used by permission of the publisher, © by 7reasons

In informal learning, AR is widespread. Museums, cultural heritages and tourism boards use AR to find new ways to engage and excite their visitors (Ceynowa, 2012; Kysela & Štorková, 2015; Ryffel et al., 2017). AR can support both, the extension of time and space by bringing the past to life and through the augmentation of places. Learners then experience totally new worlds just through the lens of their smartphone. A traditional auditorium can be transformed into an interactive laboratory with AR, or a football field into a polluted lake (Squire & Jan, 2007; Squire & Klopfer, 2007). Learning with AR can be perceived as very authentic and situated but the feeling of really being in another space is still missing (Dunleavy & Dede, 2014).

4. MOBILE IMMERSIVE LEARNING

Immersion is the feeling of being totally present in a computer-generated world. We know such worlds today as virtual environments (VE) and virtual reality (VR). VE like the social virtual world *Second Life* allows users to fully engage with a digitally created 3D environment. In contrast to VR, for this experience, no special glasses or head-mounted displays (HMD) are necessary. (de Freitas, Rebolledo-Mendez, Liarokapis, Magoulas, & Poulovassilis, 2010). Social interactions, control above one's own behavior and the possibility to generate a virtual-self (= Avatar) support the feeling of being totally present in such worlds. If the virtual world is then not only seen as an objective virtual illusion, but as a subjective psychological sense of being in a virtual world, Slater and Wilbur (1997) speak of presence.

Slater et al. (2006) showed that the feeling of presence can be caused via VR. The authors replicated the famous *Milgram Experiment* and found strong evidence that the participants experienced the treatment as real. With these findings, a door may have opened for more social investigations that are not feasible in real life due to ethical or other considerations. Other studies linked VR with emotions, empathy and of course learning (Dede, 2009; Riva et al., 2007; Shin, 2018). First experiments also showed that people who learned with VR can recall information better compared to a non-VR learning group (Krokos, Plaisant, & Varshney, 2018). So, the potentials of immersive learning are there and have already been used in different domains. For language learning Barreira et al. (2012) and Chen (2016) are to be mentioned here, for history education Minocha, Tudor, and Tilling (2017) and for the K-12 classroom Merchant, Goetz, Cifuentes, Keeney-Kennicutt, and Davis (2014) provide an overview. As already outlined, VR glasses for schools are not yet affordable due to their high costs. A solution are newly developed technologies and applications that are available on every mobile device. This now makes mobile VR possible, which can also be used by teachers in their classes (Cochrane, 2016). Many of these apps work with 360° videos which, when used correctly, can also create the feeling of immersion (Aitamurto et al., 2018). One recommendation is the use of headphones, so that the sound of the virtual world can also be perceived. The second one concerns the

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immersion in VR and how this can be realized at a reasonable price in school. With Homido VR Glasses a technically up to date smartphone can be transformed into a VR-capable gadget. Figure 2 shows the Homido, which can easily be attached by means of a holder to mobile phones regardless of brand and size.

Figure 2. Homido Mini VR Glasses

Simple VR glasses can also be self-made, e.g. by using the manual of Google VR. For example, Google's cardboard can be built in interdisciplinary lessons and then used for virtual excursions in all subjects. Cochrane (2016) notes that by using Google VR Tour Creator, learners can also create VR content themselves. With the panorama function of each photo app, 360° images can also be created and then transformed into interactive VR environments, e.g. with the online platform Thinglink. We also recommend the CoSpaces Edu app, which allows teachers and learners to build virtual 3D worlds.

The combination of mobile devices and immersive learning worlds now enables mobile immersive learning. Teachers can bring distant or even inaccessible places into the classroom as real authentic experiences. The learning room can be extended without limits, neither spatially nor temporally. In contrast to the seamless learning approach (Looi et al., 2010), photo stories, video documentations or multimedia presentations can now be made not only from the local environment, but also from the visited places. If the theme African Savannah is treated, the children travel there virtually and can capture the vegetation and wildlife there with the photo function. Time also suddenly becomes an influenceable factor. Virtual time travel enables the authentic experience of historical and political events, which can then be reflected upon and discussed in a different way. Such realistic encounters are becoming increasingly important, because the generation of contemporary witnesses to World War II is slowly but surely dying out.

Social learning and exchange are possible through mobile immersive learning when visiting a virtual lecture in Harvard it will be possible to talk to the other students, ask questions to the professor and take part in the discussion related to the lesson topic.

Research-based learning can also be strengthened with the help of mobile immersive learning. Young people can investigate the question of whether life on Mars is possible. But what does it look like there? What do we know about this planet? With the Google Expedition App, it is also possible to visit the surface of the red planet and these questions can be pursued in a completely different way.

5. CONCLUSION AND FURTHER RESEARCH

Teachers have always tried to create authentic learning experiences for their learners. Media have been and still are able to make a major contribution to this goal by opening the classroom. Pictures and videos have dominated this opening for a long time, until the development of mobile devices with the power of computers opened up completely new possibilities. Augmented Reality was only the next logical step, which has already provided more authenticity. The space factor can also acquire completely new meanings via AR, for example, when the school courtyard mutates into a medieval marketplace. The currently strongest degree of authenticity can be achieved with immersive technologies such as VR. The times when only head-mounted displays allowed immersive experiences are over. With cheap or self-made VR glasses and a mobile device, mobile immersive learning experiences can be realized and used in all fields of education. However, one thing is clear: virtual experiences are not intended to replace real ones, but only to supplement them.

These additions can then perhaps ensure that mobile learning becomes again, what Traxler understands by it: a dissolution of space and time with the consideration of new didactic innovations.

It should also be noted at this point that AR and VR applications are still prone to errors. Learning with these technologies is often considered more difficult compared to traditional media. The problem of attention tunneling can occur as well as dizziness, so-called motion (or simulation) sickness or negative feedback due to the restricted field of vision (Dunleavy & Dede, 2014; Rupp et al., 2016; Schuemie, van der Straaten, Krijn, & van der Mast, 2001; Tang, Owen, Biocca, & Mou, 2003)

Future research must now clarify whether the experience of immersion can actually lead to better or different learning outcomes and how the mentioned challenges can be overcome. What criteria are needed to create authentic situations? Can we then promote pro-social behavior in and with them? Which skills can be trained and how? Moreover, how do immersive learning spaces affect our social behavior in reality?

These and similar questions must be taken up by different scientific fields in the coming years in order to be able to define the conditions for successful mobile immersive learning more closely.

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MOBILE LEARNING AND THE FORMATION OF DIGITAL LITERACY IN A KNOWLEDGE SOCIETY

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ABSTRACT

The present article aims to show the emergence of digital technologies in university education as a way for the formation of digital literacy in the contemporary knowledge society. The article analyzes the changes, which occur in university education creating prerequisites for mobile learning. Special attention paid to distance learning, where teachers and learners use digital communication technologies and interactive learning tools.
Methodology is based on qualitative methods, under the national project "*Digital Media Literacy in the context of "Knowledge Society": state and challenges", №* КП–06–Н25/4*, 2018,* funded by National Science Fund – Bulgaria. The respondents - lecturers and students assessed digital skills and environment in university education.
The main conclusions are that more efforts needed to improve the approaches to mobile learning, to create Internet security and to take into account the interests of learners.

KEYWORDS

Digitization, Mobile Learning, Digital literacy, Digital Competencies, Distance Education

1. INTRODUCTION

Public processes are characterized by an ongoing "digitization". This concept analyzes the interrelation between development of information technologies and communication, on the one hand, and transformations in culture and society on the other. The change in media consists of convergence between mobile communication technologies and the internet, which establish new communication networks and routines and become an integral part of life. The new environment requires the development of digital skills that enable effective use of ICT and information (Peicheva, Milenkova, 2017; Cartelli, 2013). Digitization, interactivity and virtuality are constantly opening up new possibilities and extending the boundaries of learning (Henriksen, 2011). Digital skills should be seen as directly related to the strengthening of information and communication technologies (ICT), which are a factor in access to wider and up-to-date knowledge, more effective and creative thinking, informed decision making in different problem situations. The integration of information and communication technologies into university teaching at all levels and in all areas of training requires the development of skills and competencies related to the knowledge and use of digital media. Very often mainly Internet is the basic source of information for preparing the classes and for the carrying out research tasks that are undertaken during different subjects at university; so the study processes, which take place in the institutions of both formal and non-formal education are closely linked with the digitization. The process itself of cooperation between media and education and the strengthening role of digital literacy as complementary educational processes is a subject of daily and systematic implementation and development in any particular educational situation.

Objectives of the present paper are: 1) To reveal mobile learning as an approach and real learning technology in modern education in the knowledge society. 2) To show the dimensions of the digitization in university learning. 3) To analyze the assessments and opinions of actors directly involved in educational processes.

2. BASIC CONSIDERATIONS

Digital technologies reflect the level of development of the material environment and conditions and stimulate their improvement and modernization. History of technology shows a striving for rapid and comprehensive access to knowledge stored on different media.

The creation of the Internet has expanded the boundaries of digitization, and the combination of the Internet with individual conditions for access to information after the invention of personal computers and electronic personal devices has given unlimited access to all kinds and volumes of information. This resulted in the formation of a computer-based communication area. In terms of online communication is established the possibility of feedback in all forms of communication - text, audio-visual, multimedia.

Digital technology has changed the relatively static, dominant linear pattern of communication into a dynamic, multilevel, demanding and content-making model. (Livingstone, 2004).

The Knowledge Society is based on digitization and represents the interrelation between individuals and the pervasive and all-round application of computer technologies.

Knowledge society means that every area of public life and personal development is based on the targeted application of knowledge. Furthermore, it suggests sustainability of individual and social space and time, which builds dynamic balance between people, their artificial creations and nature.

The concept of "knowledge society" gains popularity as part of the political discourse presented by the institutions of the European Union (EU) and influential international institutions such as the Organization for Economic Cooperation and Development (OECD) and the World Bank (WB). Knowledge is at the center of economic development policies and social growth. In this sense - investing in human capital through education and training, as well as investment in research and development began to be seen as a central factor for economic growth. This necessitates the need for the creation of policies in knowledge- creating sectors such as education and research (Kenway & al., 2006: 21).

The first policy document, which mentions "knowledge society" is the "European social policy - options for the Union". It speaks directly of the completion of the industrial era and of the revolution, which changed the economic processes (European Commission, 1993: 30). Another document is "Living and working in the information society: people first", published in 1996. Although "information society" is used as a key term, the text talks about a "learning society" to emphasize the concept of lifelong learning and it describes "knowledge society" as a more developed and complete version information society. "The information society will also be a knowledge society in which lifelong learning - in school, at home, in the workplace - will be paramount" (European Commission. 1996). An important document (also from 1996) is the annual report on the activities of EU research and technological development. In the document "knowledge society" is associated with: 1). The impact of new technologies on the organization of society. 2). Development of adequate policies with emphasis on scientific and educational policies. 3). The problem of social exclusion. All topics are dealt with in the discourse of employment, social cohesion and knowledge society (European Commission, 1996).

The latest policy documents of the European Commission in which the term "knowledge society" is central are the last two strategies for the development of the EU. The Lisbon Strategy (2000) sets ambitious goal to make the EU "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth and providing more and better jobs and social cohesion" (European Council, 2000). In "Europe 2020", one of the three main priorities is "smart growth and developing an economy based on knowledge and innovation" (European Commission 2010).

In the knowledge society everyday life offers saturation with information presented in all possible forms: texts, sounds, animations that are reproduced with massive customized means, and user activity determines its awareness. According to a survey by the National Statistical Institute (NSI) conducted at the end of 2017 https://www.mediapool.bg/32-ot-domakinstvata-u-nas-nyamat-dostap-do-internet-news272863.html , 67.3% of households in Bulgaria have access to the Internet and 63% have a desktop computer, laptop or tablet. The most active Internet users are young people aged 16-24, with 88.1% using computers or the internet every day. 90 % of university graduates surf regularly on global networks. Most often students use computers (95.6%) and 97.8% regularly surf.

These results have directed us to educational institutions, various approaches used, teaching and learning methods that are part of the mobile learning and are geared towards shaping digital skills so important in the modern world. The digitization of educational processes refers to any form of learning and teaching that is based on some kind of technology. Digital skills are an indicator of the development of society, the level of competence of the population, the readiness to accept new challenges in the context of social transformations.

Digital skills form an essential part of e-skills. There is a necessary minimum of digital skills that everyone must possess in order to be able to participate fully in society and in the work process. As the Internet is part of our daily life, most people have access to the internet to take advantage of on-line services, training, networking and information opportunities. The widespread use of digital technologies provides people with access to a large amount of information, which creates a need for a set of access, management, integration and evaluation skills.

The main goal of mobile learning is to improve not only the learning process but also the efficiency of the education system. The foundation of modern educational technologies is the integration of information and communication tools and achievements. What integrates digital technologies and education is enhanced interactivity, based on the concepts of *cooperative learning*, *collaborative learning*, *e-learning*, *in order to achieve digital literacy*. A basic characteristic of these processes and of mobile learning overall is the pursuit of achieving a certain *autonomy of the student*. That is why the attention of the specialists is focused on the theories of learning and their application in the teaching of different study subjects.

Mobile learning contributes to the application of the following approaches in education:

1) Learning in experience and through experience. What characterizes the educational technologies in the basis of which learning through experience and in experience is laid, is the creation of real-life situations. In this type of learning tasks close to the life ones have an important place. Specialists talk about so-called *authentic tasks*. Their solution allows the creation of such an educational environment in which the traditional roles of the teacher and the trainees change. Students acquire the material as an activity in the framework of role discourse situations where they improve their socio-cultural competencies (to fulfil certain social roles in a particular socio-cultural context). This type of learning offers opportunities to use the preliminary knowledge.

2) Problem-based learning is related to solving cognitive problems. In organizing it, the model of scientific knowledge is followed and it is being realized by the following stages:

a. *Identifying the general subject* by the lecturer, but it may also be formulated by the students. Its importance and relevance to the participants in the research is important.

b. *Decomposing the general topic* to micro-topics and each group chooses their micro-topic to work. This can be done through brainstorming and through a conceptual network (the key words and the logical connections between them).

c. Planning and implementing the research process.

d. Data collection and preparation of a report on the activity carried out.

e. Presentation of the development through a computer presentation.

f. Assessment of the presentation of each group by the other participants. Criteria discussed in advance, which are accepted by all participants, are used.

3) Global-oriented learning is a concept based on cross-curricular links. The cross-border nature of cognitive activities carried out by learners is a favourable prerequisite for improving their socio-cultural competences as well as the use of knowledge acquired on different subjects and aimed at achieving higher erudition.

Building on these approaches to education and its digitization, mobile learning contributes to the formation of Digital competences including:

- Competence assessment information and knowledge covering the skills needed to find digital content make a critical assessment of it and use it for various purposes - in work or entertainment (Carteli, 2006).
- Active Digital Competence - encompasses the skills for producing, validating, editing, enriching and updating digital content (Ilomäki, al., 2011).
- Fair and legal digital citizenship, this is the legitimate way to use copyrighted content (Eshet-Alkalai, 2009).
- Competence to use the right tools for human purposes: these are the technical skills to use different tools, e.g. mobile platforms and devices - to understand their potential and limitations. In addition to "computer skills", "ICT competences" (Aesaert et al., 2015) or "digital literacy" (Bawden, 2008).

Digital competency is described as a confident, critical and creative use of ICT to achieve goals related to work, employability, training, recreation, inclusion and / or participation in society (Ilomäki, al., 2011). Digital competences are seen as a crosscutting key competence enabling people to acquire other key competences such as language, math, learning skills or cultural awareness (Ferrari, Punie & Brecko, 2013).

Digital competence includes the following areas (Ilomäki, Al, 2011):

- Instrumental use of knowledge.
- Additional skills and knowledge for communication and collaboration, information management, training and problem solving and meaningful participation.
- Attitudes towards the use of strategic skills in intercultural, critical, creative, responsible and automated ways (ALA, 210).
- Culture competence, which covers the understanding of digital culture and to be able to work in a digital environment (Martin, 2006).

Digital competence is the ability to be in line with rapid ICT changes.

2.1 Empirical Framework

Methodology is related to several qualitative methods – three focus groups and six In-depth interviews with students and lecturers from South-West University (SWU), Bulgaria. The main topics discussed were: different digital tools used in the training process; mobile learning and its forms and degrees of application in the university environment, the digital literacy of the students.

Fieldwork has been done within the national project "*Digital Media Literacy in the context of "Knowledge Society": state and challenges", №* КП–06–Н25/4, *2018*, funded by National Science Fund - Bulgaria. The respondents discussed how students engaged in various kinds of online and offline activities, and how these skills can subsequently affect their specific skills and abilities. Special attention given to the question: whether students were able to find information about the tasks that the professors assigned to research and classes work. Do students think based on self-assessment that they have formed digital skills relating to finding information, communicating, creating content, and ensuring safety.

2.1.1 Results – Respondents' Views

The results show that students spend a lot of time on the Internet and social networks. Students have indicated that they use the Internet anywhere. They realistically assess their content-related skills, informational and formal skills. The importance of media and information literacy among young people has increased particularly strongly in the last few years when the media ecosystem was almost overwhelmed by fake news and hybrid media "wars".

According to the teachers, thanks to the digitization of training, the possibilities for organizing the pedagogical interaction here and now, regardless of time, space, the number of the participants in it, the subject of pedagogical communication, etc., expanded. As a new information reality, the digital learning environment creates the conditions for using e-mail, newsgroups, forums for project-based learning; interdisciplinary work.

Teachers share that the successful ICT integration implies the fulfilment of several important requirements: justified use of electronic communication - for example e-mail correspondence to establish contact between the participants; coordination of work between them so that all students would be included, discussing and editing the newsgroup texts, searching for information on the Internet, using multimedia.

Distance learning is another important platform based on digitization and can be used to implement, track and control the learning process; it allows the participation of large groups of people who may be at a distance from one another, to interact with each other in a three-dimensional environment.

Distance learning allows:

- Creating different types of training materials - modules, courses, exercises, tests, online exams, etc.
- Uploading and distribution of files - Word, Excel, PowerPoint, audio and video files.
- Setting group tasks and exercises.
- Tracking the learners' educational progress.
- Creating groups and joining of an unlimited number of users to them.

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Distance learning allows great mobility as well as maintaining activity, upgrading and continuous improvement of the learning process and student achievements as well as their participation in every element of the learning content.

In the focus groups which have been undertaken, students share their satisfaction that they can study without having to attend the university. They say they are remotely prepared by materials, studying uploaded lectures, solving tests, developing independent themes on research projects.

Students say they do not have the opportunity to attend systematically because they work or care for their families, and they think this is the way they can acquire a higher qualification. The lecturers say that in the SWU distance learning is widely used in the form of uploaded materials through the Blackboard platform.

Teachers believe that the implementation of any modern educational technology:

- is elaborated on a specific pedagogical topic or assignment and it is based on a certain methodological and philosophical position of the author;
- provides for a concrete result and mode of implementation, stages through which it is going, specific teaching methods to be used, digital technologies to be provided;
- applies the principles of differentiation and individualization, optimal realization of human and technical possibilities, use of dialogue, communication with trainees;
- suggests ways of evaluating and specific methods for this: criteria and specific indicators to measure results.

Students included in the focus groups shared they use various mobile devices to access the Internet and to surf online**.** These include computer, laptop, tablet, or smartphone of their own; they also have access to computers in the university classrooms and library. This is why they can be online regularly and for long periods.

They all indicated possessing operative skills to use the Internet, including the mobile Internet. These skills include: easily using the Internet, connecting to a Wi-Fi net; downloading applications for a mobile device; keeping track of, and updating, mobile applications; surfing on the Internet, downloading and uploading files; regulating the privacy settings for dealing with computer viruses and problems in the Internet; working with search engines, like Google and Bing

The surveyed students indicate they possessed systematic Internet skills for quick orientation in a given website, moving from one webpage to another, or easily finding a website they had visited before.

The respondents assessed themselves as having information-related Internet skills**,** such as: easily finding the information they need, easily examining search results and choosing which to check. They also read news and journals online, and were able to use different strategies for finding Information on the Internet.

Students were confident about their ability to judge whether a website was trustworthy or not; they could compare websites to decide which ones were truthful; they could evaluate the information found online.

Regarding "communication internet skills", the respondents declared they were confidently able to engage in online communication. They freely shared comments in blogs and social networks and were convinced sharing online was risk-free. They were more confident about, and better able to work with Facebook and Messenger than with Twitter and YouTube – perhaps because Twitter is less popular in Bulgaria among online users, while YouTube is mainly used to watch films and listen to music.

Creating content: regarding this skill, the surveyed students declared they could create and upload online content and could make changes in already created content. They stated they had little confidence they could personally create websites and preferred to turn to specialists for this. On the other hand, they knew how to share online video content, write comments on various contents, or create new products out of existing images, music, video.

According to lecturers (participants in the focus groups and in-depth interviews), in order for mobile learning to be effective, it is necessary to emphasize both the improvement of the digital environment of the teaching and learning process and the content side related to students' expectations and the demands of the labor market. Professors say that more effort needed to design on-line courses and lectures in order to provide better training.

Teachers say that the digitization of learning forms a series of skills and qualities that are important for the overall cognitive process and the formation of professional skills such as**:**

- Deeper Entry into the subject area: search, discovery, awareness and problem-solving skills; questioning skills;

- Targeting: Skills for gathering and understanding information; to develop critical and alternative thinking - to distinguish facts from opinions and assessments;
- Selection and Interpretation: Skills for Evidence, Metaphorical Thinking, Defining Concepts;
- Combining cognitive content: regrouping the learning material, decision-making skills, associative links, structuring and restructuring;
- Reflexive mechanisms: self-control skills.

Equally important are different social skills that students define as important in order for the training process to be effective: Group work skills; sense of responsibility and self-discipline; Decision-making skills, sense of belonging, risk assessment and risk management skills; Initiation, curiosity and creativity.

3. CONCLUSION

In summary, it can be said that digital technologies are widely used in training. Mobile learning has a different degree of application, and it also depends on digital possibilities as a technological environment and its maintenance in the relevant university environment. Computers and the Internet have steadily penetrated the everyday life of people. The digitization of society is ubiquitous and lasting (Bisht, & Radhakrishnan, 2013). Regular Internet users most often use the global network for communication: connecting with people, expressing themselves, gaining recognition for the created content. At the same time, the rapid pace of change in society and emerging new structures, the generation of new information flows are the basis of modernizing education models in line with digital technologies.

Mobile learning is a combination of successful digitization and the use of its capabilities, with the digital literacy of the students themselves. It creates prerequisites for being part of the global network, linked to the upgrading and dynamic flow of information, fast communication and easy access to various institutions.

The students at South-West University (SWU) and generally young people (18-38) spend much time online in the Internet and the social networks. They pointed out they used Internet everywhere. They made a realistic assessment of their skills in creating content and their informational and formal skills. They know how to create and upload online content and make changes in already created content. They feel confident they can create different kinds of content and online products, including confidence in their skills regarding privacy and knowledge about security equipment and personal data protection; however, they find they have yet more to learn in this field. Overall, their self-assessment is high, which indicates their good knowledge of the digital environment.

The participation of students in the modern digital environment includes access to computers, electronic resources, and other information products and services. It should be taken into account that the acquiring of digital skills for work in an interactive environment improves their efficiency with respect to creatively and innovatively pursuing education activity. Achieving greater effectiveness in training and acquiring knowledge involves the successful use of information and communication technologies, based on acquired skills for seeking and finding useful information and resources, as well as the capacity to analyze and combine the obtained information, to share and discuss different ideas and viewpoints, which they may comment on with their fellow students and teachers.

In this connection, based on the results of the survey presented, it may be said enabling adaptation to the challenges of digital society requires finding more effect pathways to engaging, encouraging, and motivating people to assimilate good theoretical and practical knowledge and skills for working with information and communication technologies. Hence, the efforts of people should generally be guided towards optimizing various ways of using ICT and interactive communication in their work; this may improve their capacity for critical thinking, effective communication and joint problem-solving.

The results of the survey presented indicate which specific skills should be the focus of greater effort in order to make the work of the teachers and the role of education more effective. Engaging young people in short-term or long-term courses could also contribute to their acquirement of important knowledge and qualities related to digital skills. One must not underestimate the conducting of seminars and lecture courses, the possibility of access to online tutorials, electronic textbooks and other means of enhancing digital competence; through these means, it is possible to develop extensive skills for seeking, identifying and critically assessing and using information, and for young people’s more independent and creative behaviour in a digital environment.

For the formation of digital culture, it is of great importance to saturate the work environment with computers, and to include the Internet in the specific responsibilities of those performing different activities. Digital literacy depends on the level of education, age and occupation of individuals. Young and educated people are prone to the formation of digital skills and literacy. The results showed that more efforts needed to improve the approaches to mobile learning, to create Internet security and to take into account the interests of learners.

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EXPLORING A LEADERBOARD ALTERNATIVE IN A GAMIFIED MOBILE APP FOR MUSIC LEARNING

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ABSTRACT

This paper describes the use of an Android app, PracticeCactus, to support independent piano practice in the context of one music teacher's private studio through a feature known as "Daily Practice Goal" (DPG) notifications. DPG notifications are positioned here as a type of alternative to a traditional leaderboard within a gamified learning environment. The DPG notifications were a means of gamifying independent practice, thereby facilitating social community support that is in contrast to the isolation and individualistic learning that is sometimes characteristic of independent musical instrument practice. Piano student participants, ages 10 through 15, made use of the mobile app for 20 weeks, and their usage patterns and experiences of the DPG notifications are explored here as a way of illuminating how social interactions may be supported and encouraged during independent practice between weekly lessons.

KEYWORDS

m-Learning, Music Education, Piano Practice, Social Interactions

1. INTRODUCTION

This paper describes the use of a mobile app to support independent piano practice in the context of one music teacher's private studio through a feature known as "Daily Practice Goal" (DPG) notifications. DPG notifications are positioned here as a type of alternative to a traditional leaderboard within a gamified learning environment. The DPG notifications were a means of gamifying independent practice, thereby facilitating social community support that is in contrast to the isolation and individualistic learning that is sometimes characteristic of independent musical instrument practice. Piano student participants, ages 10 through 15, made use of a mobile app known as PracticeCactus, and their usage patterns and experiences of the DPG notifications are explored here as a way of illuminating how musical skill development may be supported and encouraged during independent practice between weekly lessons. This specific consideration of DPG notifications is one part of a larger study that examined social interactions more broadly in the context of the PracticeCactus app.

In the context of studio music learning, practicing regularly between lessons is important for developing musical skills, confidence, and technical proficiency on an instrument (Bloom & Sosniak, 1985; Bonneville-Roussy & Bouffard, 2015; Ericsson, Krampe, & Tesch-Römer, 1993). Therefore, the importance of independent musical practice cannot be minimized. But music students often report that they sometimes find independent practice to be isolating, enigmatic, and boring (Ericsson et al., 1993; Jørgensen, 2000). During independent practice, students can become discouraged, forget what they are supposed to be practicing, and forget how to practice it (Jensen & Frimodt-Møller, 2015). Additionally, studio music teachers consistently report that students under-practice or practice ineffectively (McPherson & Renwick, 2001; Oare, 2012); this may be due to the lack of excitement inherent in independent practice, or it may be due to other factors, such as busy schedules or lack of parental support (Upitis, Abrami, Brook, & King, 2017). Since practice is necessary for developing skill, it is important to consider students' experiences of such practice.

One of the ways in which PracticeCactus was designed to mitigate against common problems with independent practice, and to facilitate social interactions, was to make independent practice visible and known. In other words, while the students in this particular piano studio likely knew that their colleagues were practicing, the app was designed to provided tangible evidence of this practice. One way to make musical practice visible would be to implement a leaderboard that showed students' accumulated number of practice minutes and listed students in order of who practiced most to who practiced least. However, the PracticeCactus app used an alternative approach to sharing practice in a leaderboard format for three reasons. First, research reporting the effects of leaderboards is often focused on whether students' motivation or achievement levels are somehow affected. In the context of this research study, this was not the main goal; rather, the idea of sharing practice was meant, primarily, to foster social interactions. Second, research reporting the effects of leaderboards is mixed. Research in workplace and higher education contexts shows that leaderboards have positive effects including facilitating more lofty goal setting, and motivating students to engage more frequently with the material to be learned (Fotaris, Mastoras, Leinfellner, & Rosunally, 2016; Landers, Bauer, & Callan, 2017). However, many studies in these same contexts reveal mixed results concerning leaderboards, with some participants expressing positive responses, and others finding the leaderboard to be a negative experience, and expressing their dislike and uneasiness (Domínguez et al., 2013). Leaderboards have been demonstrated to have an effect on performance in academic settings, either negatively or positively, depending on the individual perspective of each person vying for a position on the board (Christy & Fox, 2014; Domínguez, Saenz-de-navarrete, & Pagés, 2014). Therefore, due to the potential for negative reactions to a leaderboard, PracticeCactus was not designed with such a feature. A third reason not to incorporate a traditional leaderboard within PracticeCactus is that in a previous research study with music students of this age group (Birch & Woodruff, 2017), a traditional leaderboard was shown to frustrate and confuse some of the participants. Therefore, the risk of using a traditional leaderboard which depicted students in order of achievement was decided against. Erring on the side of caution, another form of sharing progress with the app was implemented, i.e. the DPG notification feature.

Investigating how a digital tool—and in particular, a mobile app—can support musical instrument practice is important because music students are already using their mobile devices to support them during independent practice, largely to look up YouTube videos as exemplars for their playing and to record their own playing in order to listen and reflect (Upitis, Brook, Abrami, & Varela, 2014). Therefore, an investigation into how an app specifically designed to enhance learning in the context of private music study is essential for informing current student practices, and for exploring an alternative to a traditional leaderboard for sharing student progress within a music learning community.

2. PRACTICECACTUS: A DESCRIPTION OF THE APP

The PracticeCactus mobile app was collaboratively designed by a group that included me, the researcher, a team of piano students, their parents, piano teachers, user-experience researchers, and computer programmers. The design methodology employed was participatory design, meaning that all stakeholders have a voice affecting the direction of the design and development of a solution to a design problem (Steen, 2013). As a result, the PracticeCactus app has three major functions that were designed to address the students' descriptions of independent practice as lonely and isolating. The design functions that mitigate against those negative descriptions are the technical supports for sharing practice, listening to practice, and quantifying practice. This paper will specifically report on the functionality of listening to practice and quantifying practice in the context of DPG notifications, and the resulting experiences of the piano students.

2.1 Listening to Practice

When the PracticeCactus app is active on a mobile device, through an embedded acoustic analysis module it automatically detects student piano. The student designers of the app insisted that they did not want this app to record their practice sessions so that the teacher might check in at any moment and hear their practice. The app does not track which songs are practiced, in which order, or for how long. Neither does the app assess whether a student plays correct rhythms or notes. Rather, it most simply counts up the number of minutes a student has practiced during each 24-hour period.

2.2 Quantifying Practice

Based on what it "hears," the app generates notifications on the Community page every time a student meets their self-determined goal of number of minutes of piano practice per day. Length of a piano-practice session, although an easily quantifiable measure that could be used to characterize a session, is not universally applicable to students of different ages and skill levels. An expected piano practice session length for a beginning student may be ten minutes, while an advanced student may be working toward an hour or more of practice each day. Therefore, the quantifiable measure of the Daily Practice Goal (DPG) was defined and used to make students' practice sessions tangible and shareable and to establish a common language in the PracticeCactus community that everyone could relate to and achieve. When a student in the study reached their DPG, the app automatically created a post, letting others know (See Figure 1). No information was revealed about the actual length of time of each student's Daily Practice Goal. The series of DPG posts about students meeting their daily goals, then, was not intended to invoke comparisons, but rather to provide a tangible picture of the efforts of individuals, thus highlighting those efforts and allowing them to become part of an interaction, as opposed to those efforts remaining as isolated experiences.

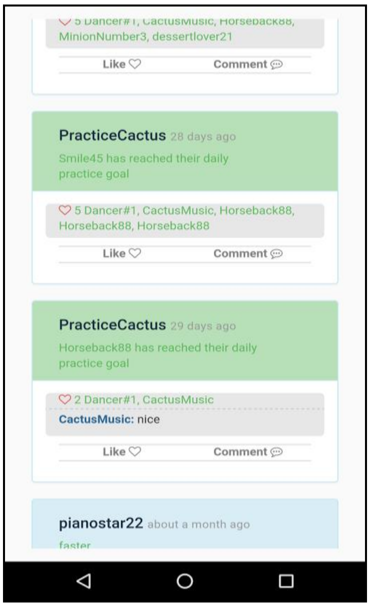

Figure 1. Screenshot of the app posting Daily Practice Goal (DPG) Achievements

3. THEORY

As a whole, the social sciences are largely in consensus on the perspective that society and culture are enacted through a series of social interactions (Regelski, 2016). Piaget's focus might be said to rest with society's influence on learners, while Vygotsky emphasizes culture as the context in which social interactions take place (Cole & Wertsch, 1996). Ultimately, social constructivism is concerned with what students learn and the process they undertake in order to do this learning (Cobb, 1994). The ideas of social constructivism are useful in the context of the current research study because, even though independent musical instrument practice is by nature done independently, the artifacts and experiences that are developed through social processes continue to support and influence learners, even when they are alone. So then, the social aspects of the process of learning operate not only when people are in a social setting.

4. METHOD

This paper describes a case study, as outlined by Stake (1995), in that the particularities and complexities of a single case exist as an opportunity to understand the activity within that case, which is an ideal approach in the context of the study of people and their behaviour (Yazan, 2015). The case was bounded by a length of 20 weeks and engaged 18 participants; there were nine males and nine females ranging in age from 10 to 15 years of age. Participants had played the piano for between three and twelve years and were studying at levels two through nine of the Conservatory Canada piano curriculum. These participants were invited to use the app in the context of their independent practice between weekly piano lessons with their teacher.

5. DATA COLLECTION AND ANALYSIS

Throughout the data collection period, as the researcher, my *modus operandi* was to be in the context where the students were (i.e., logged in regularly to the PracticeCactus app) to observe the students' behaviour and to make decisions, through analysis and synthesis, while maintaining an awareness of my own subjectivity (Stake, 1995). Within this study, the following four sources were used to collect data about the case: (a) interviews; (b) music-sharing sessions; (c) field notes; and, (d) student-created artefacts. Content analysis—that is, analyzing the content of interviews and observations, was conducted, whereby I, as the researcher, identified, coded, and categorized the key patterns within the data (Patton, 1990). Some of the data were winnowed in order to preserve the most relevant data (Morse, 2018; Wolcott, 1990).

6. RESULTS

6.1 Frequency and Patterns of Usage

Throughout the period of this 20-week study, 694 practice sessions were recorded by students. The students were not instructed as to how often they should use the app but were simply given a device and told how to create a PracticeCactus account. Some students used the app multiple times per week, whenever they practised, while others decided to use it only occasionally throughout the course of the study. Some students articulated that the app was useful to them by way of the embedded acoustic analysis module, insofar as it generated DPG notifications in the community. These students explained that they wanted the community, i.e. their piano-playing peers, to know they were practising.

6.2 Daily Practice Goal

Daily Practice Goal notifications were posted in the Community when students achieved a certain number of minutes of practice per day. In this way, students created an artefact in the PracticeCactus environment indirectly since the app automatically posted on their behalf. Throughout the research study, students reached their Daily Practice Goal (DPG) 81 times.

Reactions to seeing others reach their DPG included feeling reassured, motivated, and competitive, as well as feeling happy for and supportive of peers. As a student with the username pianoman10 recounted, for him, seeing a person reach their DPG made him feel happy for that person, but it did not really affect him too much, since he did not know if their practice goal was five minutes or five hours. "I care a little bit but probably not the same feeling as scoring a [hockey] goal because it's, like, a rush, you know, really happy but I'm still happy for that person." As described by hockeyman, seeing DPG notifications was reassuring, "because it would tell you that if other people can do it then you can do it too…So if you see other people doing it then you're like, oh, yeah! You can do it." As archer explained, it "motivated me to achieve my daily practice goal if I hadn't done so already, partially because I wanted that same feeling of satisfaction once I completed my goal and partially because I'm a pretty competitive person, so to see other people achieving their goals makes me want to achieve even greater."

Once DPG notifications were posted in the community, students had the opportunity to listen to those recordings and to respond by "liking" or adding a comment. One of the behaviours that almost all students engaged in was to "like" posts that appeared on the Community page of the app. When the app posted that someone received their Daily Practice Goal (DPG), these types of posts received a total of 70 "likes," or 35% of all the "likes" given in total. Perhaps not surprisingly, students "liked" others' posts and DPG notifications more often than they "liked" their own. Reasons students "liked" a post were to show appreciation, to support their peers' beliefs, values, hard work, and growth, and when they were unsure of what to say in a comment. Students agreed about positive encouragement; if they got "likes," or people gave them a compliment, then this helped them feel good and motivated them to keep practicing.

MinionNumber3, a 13-year-old male participant, made frequent use of DPG notifications as a springboard for introducing social interactions to the PracticeCactus environment, both through posting ironic comments and "liking" posts multiple times. He often created content or left comments that invited a response from others. Here are some examples of the comments he left on Daily Practice Goal notification posts, shown in Figure 2.

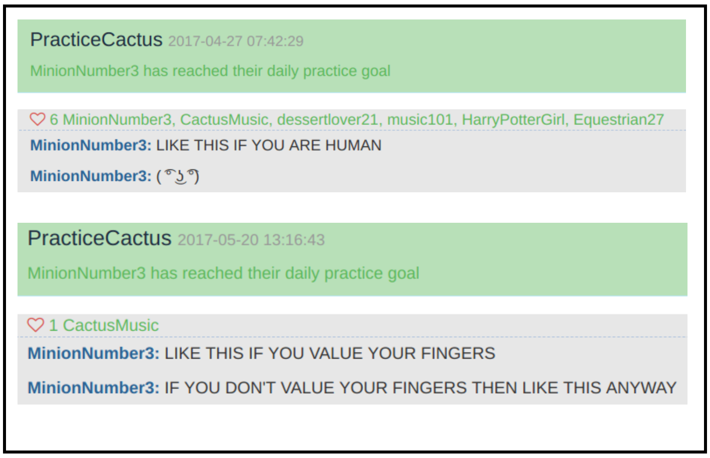

Figure 2. Screenshots of humorous comments posted by MinionNumber3

7. DISCUSSION

7.1 Frequency and Patterns of Usage

Throughout the 20-week period of the study, students chose to make use of the app at varying levels, with some using PracticeCactus frequently and others, infrequently. Students chose to use the app multiple times a week, once per week, or every few weeks. Since there was initially no direction given to students about how often they should use the app or how they should participate, this is an example of providing an opportunity for active music making completely on the participants' own terms in order to open, deepen, and widen the space for contributions (Camlin, 2014; Wegerif, 2012).

Reasons to share user-generated content in an online space are theorized by Waldron (2013b) as having a space for people to have discussions and to learn from the musical experiences of others who have similar interests. While a DPG post in itself is not a discussion, it presents an opportunity for a social interaction in that others may decide to read it, or additionally, to "like" or comment on it. Other recent work by Pak (2014) distinctly conceptualizes the idea of sharing in today's world, not necessarily in terms of reasons why people decide to share or not to share. Rather, since the terms "online" and "offline" are less and less meaningful now due to the ability to have constant access to connected devices, the more useful distinction becomes the choice between "shared" and "private." Thus, the question is not whether to go online and share or stay offline and decide not to share, but instead how to manage, store, and share one's personal data. As Pak (2014) explains, real meaning is found in how shared personal data connects to others' data and the value others find in your data. In the context of PracticeCactus, then, the sharing of their practice and others' responses to that practice functioned as opportunities for students to control their own expression of their personal data and to express that they found value in what had been shared.

7.2 Daily Practice Goal

The acoustic analysis module within the app that "listened" for piano playing allowed students to add meaningful signs to their learning environment in the form of Daily Practice Goal (DPG) postings (Gee, 2005). When the students reached their DPG and the app posted a notification for others to see, the students were adding content to the learning space. As the students described, seeing others reach their DPG was a type of reminder that allowed them to acknowledge that others were practising just as they were. The DPG notifications, then, were a group of signs in the community (Gee, 2005) that students engaged with through reading, "liking," and commenting on them. Thus, the posting of the DPG achievements allowed for individual practice sessions to result in a social interaction, i.e., to be "liked" or commented on by others. Even though not all DPG posts resulted in an explicit social interaction (i.e., not all of these posts received "likes" or comments), the students perceived that their peers "saw" that they were practising. Whereas their practice sessions were once private, they now became shared. Even without a direct social interaction, the DPG posts reinforced new relationships and participatory practices among the students in two ways. First, a new, shared practice was added to the students' repertoire of external signs within their learning context, i.e., students let each other know when they were practising. Second, one of their internal signs (i.e., practising their instrument) shifted from being an intangible sign that unified them primarily by assumption to a tangible and shared common sign that unified them based on direct knowledge of their affinity group habit of practising piano.

As explained, Daily Practice Goal posts were external signs created by users within the affinity space, although, admittedly, the app auto-posted these achievements and there was no explicit action required by the user. There was a specific action of practising the piano that triggered the post and thus indirectly added a sign into the affinity space. Where students did exercise direct control over DPG posts was through choosing and adjusting the number of minutes of piano practice that would trigger the achievement of their goal. This gave them control over the frequency of posts about them; students did, then, have the ability to manipulate the signs within the space (Gee, 2005).

8. CONCLUSION

Most music educators acknowledge that young music learners in the 21st century have unprecedented access to music. They have opportunities to engage even more deeply with music than simply just listening (Allsup, Westerlund, & Shieh, 2012; Jenkins, 2006; Tobias, 2014). Digital technology allows them to produce music and engage socially around music (Gee, 2010; Jenkins & Deuze, 2008; O'Hear & Sefton-Green, 2004). Traditional barriers of finances, technology, advanced knowledge of music theory, or access to professional producers, distributors, and recording labels, are no longer acting as such major barriers against creating and sharing music (McGrath, Chamberlain, & Benford, 2016; Partti, 2014). Music-sharing sites, as well as cloud-based storage services and mobile devices allow for music to be easily shared with an audience of any size (McGrath et al., 2016).

Mobile app developers can consider the features and design of the PracticeCactus app as a model of a technology designed to foster opportunities for students to interact with one another throughout the week between their music lessons and to provide students with increased independence in making decisions about their own music learning. Knowledge of this research study and the benefits to students of such learning may empower developers to intentionally avoid developing music-learning apps based on limited conceptualizations of music learning that reduce music learning to exercises in naming notes or identifying the correct piano keys. As explained by Scardamalia and Bereiter (2008), educational technology is seldom neutral, but, rather, through its available features usually facilitates some actions more readily than others and thus encourages those actions. As studio music teachers broaden their practice through the use of digital tools (Upitis, Abrami, & Boese, 2016; Upitis, Brook, Abrami, & Varela, 2014), they will need technologies to use with their students that facilitate and encourage meaningful music learning in socially and culturally relevant contexts. Along with this research, other studies about informal, online musical sharing spaces such as Mikseri (Partti & Karlsen, 2010) and the Banjo Hangout (Waldron, 2013a) can provide models for consideration. Studies focused on iSCORE and Cadenza also provide insight into the types of digital tools that students will engage with and that will promote music learning (Brook & Upitis, 2015; Upitis & Abrami, 2016). Informed with this knowledge, developers can engage in intentional design for connected music learning and ideally create apps that teachers will actually use with their students, perhaps on an ongoing basis.

Future research could usefully be design-based, wherein students have input regarding the features of PracticeCactus and inform a responsive developer team who can implement their suggestions in iterative stages. As new features are added or changed, students can provide direct feedback as to how changes have influenced their experience of learning. Studies such as this would provide more information to mobile app developers interested in creating apps for facilitating music learning. Knowing which features maximize opportunities for music learning and encourage students to use the app would inform their future development projects in ways that support both music students and teachers. Ultimately, app designs focused on facilitating social interactions in the context of music learning will prevent students from having to experience individual musical instrument practice as a lonely and isolated endeavour.

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INDIVIDUALIZATION WITH TABLETS IN THE CZECH REPUBLIC - SPECIAL PRIMARY SCHOOLS

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ABSTRACT

This paper summarizes the results of the completed and defended dissertation on the topic of Categorization of pupil work with tablets in a special elementary school in the Czech Republic. This work was a two-phase research. Qualitative research - a four-year structured observation of pupils at a special elementary school, where categorization was subsequently proposed. Quantitative research - this categorization was verified in 361 special pupils throughout the Czech Republic. The process of personalizing pupils with pupils in selected pupils categories was described. We present the most important findings from this dissertation.

KEYWORDS

Individualization, Mobile Touch Technology, iPad, Special Educational Needs, Primary School

1. INTRODUCTION

Since there is not enough information on the issue of using tablets in the instruction of pupils with special educational needs, this paper tries to address it. Moreover, in the Czech Republic there is no recommended working method or categorization of pupils which would help teachers use tablets in an appropriate manner (expected outcomes are not defined). It would help teachers divide pupils with special educational needs into categories, providing a springboard for the future use of tablets. Therefore, the following research problem was defined: *"Using mobile touch devices (tablets) to individualize the instruction of pupils with special educational needs"*. As it emerged from the research, foreign resources link the theme of mobile touch devices and primary school special (and similar) exclusively to iPad tablets. That is why we have decided to devote our iPad tablet to iOS operating systems as part of our dissertation project. The latter, working with a functional "assisted approach", becomes a very adequate tool in teaching pupils in a special school. For example, the results of the iPad support study for mothers and their preschool children show that the iPad-enabled assistive technologies in the settings / accessibility tab apply to pupils with SEN in numerous areas such as reading, writing, communication, day-to-day structure, etc. Aram & Bar-Arm, 2016; Batorowicz, Missiuna, & Pollock, 2012). The iPad in Education (2012) study adds that introducing the iPad into special education pupils is a step forward.

A field study in selected European countries concluded that the iPad, thanks to its ability to access, significantly supports individualized learning that was highlighted as a major benefit of pupils' work with this device. Above all, the ability to control the iPad only visually is highlighted in a case study from Belgium where the iPad controls a SEN pupil who cannot move the upper and lower limbs (SENnet, 2014). IPad access can be used in a variety of ways to suit individual pupils, including those who rely on fingertip control, other parts of the body (nose, joint finger flexion, etc.). Pupils thus control applications that do not require a precise touch and are able to work with the iPad (Flewitt, Kucirkova & Messer, 2014); making accessibility helping to increase the independence of pupils with mental disabilities and helping them acquire skills in the learning process (Flores, Musgrove, Renner, Hinton, Strozier, Franklin & Hill, 2012). The form of a combination of appealing sounds and visual ringtones that is triggered by a well-solved example positively enhances pupils' interest and motivation to work, especially pupils with Autistic Spectrum Disorders (Dohenyasa, Şimdi, Özcan, Çataltepe & Birkan, 2014) to successfully fulfill the curriculum (Kaur, 2017). Combined with effective pedagogy, work is a benefit to both educators themselves and pupils (Karney & Maher, 2013). Application Interactivity for iPad has clear benefits to support engagement with the potential to acquire new skills in other development areas (Camp, Stephenson & Cooper, 2016). Disabled pupils were able to test with applications that required less accurate touch, proving their emerging understanding of the cause and effect, and their involvement through implicit sensory motor learning and exploration (Kucirkova, Flewitt & Messer, 2014).

Digital touch technologies provide a unique advantage and opportunity for customization that traditional paper material cannot provide. The application can be either "closed" or "open". Both variants are interactive but only the second allows the user to modify or edit the content (Allen, Hartley & Cain, 2016). **Individualized learning** combines the advantages of individual work with group work (Valenta, Müller, 2003). Specific elements of individualisation can be, for example, the individual tasks of mass employment of all pupils, the assignment of homework, extended interpretation for some pupils, tutoring, respecting the individual style of pupil learning, non-classification of some pupil's manifestations (dyslektici), inclusion of silent work writing, reading), in practical activities, a greater share of work with visual material, etc. (Maňák, Švec, 2003). And for the inclusion of a tablet in this type of teaching (Johnson, 2013 b), one can then demonstrate another of the iPad's benefits **-** an easy way to organize teaching with selected apps that support the individuality of the pupil.

2. METHODOLOGY

In order for this kind of instruction to be realized, it was necessary to define categorization for the use of tablets (including the so-called expected outcomes, i.e. defining what a pupil in a particular category is able to achieve), which teachers could use to divide pupils into categories. The data necessary for proposing such categorization was collected through non-participant and structured observation in the education process, using **video recordings**, **pictures**, **text notes**, and **answers provided by** both the **pupils** (within their individual capabilities) **and participating special teachers** (the class teacher, the second teacher in the classroom). During this observation, particular attention was paid to the level of difficulty and self-sufficiency, respectively. We were interested to know how the pupils used the iPads. The pupil's individual diagnosis was not important. The research sample consisted of special elementary school pupils (the school was established pursuant to Paragraph 16 of Article 9 of the School Law). There were 21 pupils, who provided the basis for creating categorization (which is described in detail below). Instruction at this school is based on the current Framework Educational Program for Special Elementary School, Volumes I and II. The research was divided into two parts – qualitative and quantitative.

2.1 Determining the Level of Difficult of Tablet Use

The **level of difficulty** which the pupils could understand when using an iPad was monitored on several levels: *using a particular content-based application; using an iPad for creating one's own outcomes; operating an iPad – technical (turning it on/off); operating an iPad – hygienic (whether or not a pupil is able to keep their device clean and whether or not they even pay attention to it, etc.); using an application which allows the user to create multimedia content (e.g. a short film, a song, etc.); pupils' knowledge of what individual applications are used for and how they could use them; pupils' interest in particular applications*.
Analysis – since each pupil is unique, the "pupil – iPad – schoolwork" interaction with this touch device is not uniform. Taking each pupil's deficiencies into account, the instruction needs to be individualized in a way that enables a pupil with moderate mental retardation (and related disabilities) to reach their full potential (school outcome) with regard to the particular curriculum.

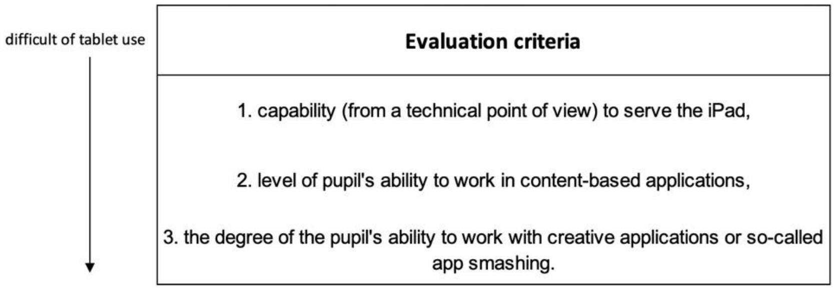

Figure 1. Established Criteria for "iPad Use Difficulty"

iPad use area starts at the most basic level "Operating an iPad", followed by "Use of content-based applications", i.e. applications that the teacher downloads and tells the pupil how to use them, with the pupils being able to use them immediately. The most difficult stage is the so-called *app smashing*, i.e. the process of using multiple applications to complete a task or a project – the pupil starts a task in one application, expands it in another application and completes it in a third application.

2.2 Determining the Degree of Self-Sufficiency when using an iPad

The following factors were considered when determining a degree of **self-sufficiency when using an iPad**: *if the pupils work alone; if they need to follow an instruction manual; if they work in groups; if they help one another; if they require the teacher's help; if so, in what way and to what degree the teacher helps them; if all the pupils are interested in using an iPad; if there is someone who is rejecting an iPad; does the same diagnosis predetermines the degree of self-sufficiency?*

Analysis – the research sample pupils were introduced to an iPad; were told how to use it, including charging the device and keeping it clean. During the academic year, the were taught how to use individual applications. During this instruction period the adequacy, repetition and "from simple to complex" principles were followed. Moreover, during this period the pupils were being observed by the teacher who took notes on each pupil's progress and then checked to see how it compared with the established criteria. The research sample was divided into 4 categories which reflected the degree of self-sufficiency when using an iPad.

Evaluation scale for criterion 1	can use iPad on their own	can use iPad with teacher's help	can use selected functions only with teacher's help	not interested
Evaluation scale for criterion 2	individual work	can use iPad with occasional help from teacher when all their disabilities are compensated for	can only use iPad with occasional help from teacher and assisted acces function on	is only slightly interested (visual/hearing interest) or completely rejects iPad
Evaluation scale for criterion 3	individual work with words of encouragement from teacher	works only with constatnt help (verbal and physical) from teacher	unable to use iPad	unable to use iPad/completely rejects iPad

degree of pupil's self-sufficiency when using an iPad →

Figure 2. Determining the Degree of Self-Sufficiency when using an iPad

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3. PROPOSING CATEGORIZATION FOR PUPIL'S USE OF TABLETS

The proposed categorization was based on the collected data. The first stage of the qualitative research (as part of a dissertation) took place from the first half of 2015 (spring) to June 2016. The observation was not scheduled and the researcher did not interfere with the teacher's work or influence the choice of topic of the class in which iPads were used. iPads were used in various subjects. At that time, the research sample pupils had already been using iPads for three years. Since the author of this research had actively participated in the project "iPad in instruction", the pupils were used to his presence in the classroom. This fact made observation easier as the pupils had already known the researcher and felt comfortable around him (i.e. no mediator was necessary). The fact that the author had already been familiar with the school environment and with how the pupils worked before the implementation of iPads proved beneficial. Moreover, the school management being open to testing new technology in instruction also played its part. This data collecting method was chosen because the author had unlimited time to complete the research. By the end of this research stage, the pupils had been using iPads for four years.

difficult of tablet use

iPad use area	1. category	2. category	3. category	4. category
1. capability (from a technical point of view) to serve the iPad	can use iPad on their own	can use iPad with teacher's help	can use selected functions only with teacher's help	not interested
2. level of pupil's ability to work in content-based applications	individual work	can use iPad with occasional help from teacher when all their disabilities are compensated for	can only use iPad with occasional help from teacher and assisted acces function on	is only slightly interested (visual/hearing interest) or completely rejects iPad
3. the degree of the pupil's ability to work with creative applications or so-called app smashing.	individual work with words of encouragement from teacher	works only with constatnt help (verbal and physical) from teacher	unable to use iPad	unable to use iPad/completely rejects iPad

degree of pupil's self-sufficiency when using an iPad

Figure 3. Categorization for Pupil's use of Tablets

4. VERIFYING THE PROPOSED CATEGORIZATION FOR PUPIL'S USE OF IPADS

Only special elementary school pupils (those with at least moderate mental retardation) participated in the verification process. Only pupils with this diagnosis can attend this type of school. In order for the proposed categorization to become functional (for a transient version to become a final version), it needed to be verified. Therefore, it was distributed to various special elementary schools in the Czech Republic. The target group consisted of special teachers who agreed to participate in the research. In order to give the teachers an idea about the individual areas of iPad use, the categorization of pupils included expected outcomes which the pupils of the original school should be able to achieve, i.e. the categorization was based on the 4-year experience of the 21 pupils from the Bruntál special elementary school. Special teachers used the information to divide their pupils into the individual categories. It should be stated that the pupils with limited mental ability could not fill out the questionnaire as they simply did not know whether or not an iPad helped them.

Therefore, it was the participating teachers who provided answers to these questions. The verification process had only one goal – to verify the proposed categorization. If, for some reason, the teachers were unable to place a large number of pupils into any of the categories, the "transient version" would have to be modified and then verified again. However, this situation did not occur (see below for statistical data). Moreover, it also needs to be stated that no hypotheses were established for the verification stage. The answers were processed and statistically evaluated (see tables and graphs below for details). The only condition was that pupils in the participating schools had been using iPads for at least one academic year prior to the research (that is how long it usually takes pupils to learn how to use the device).

The total number of pupils (recorded by the respondents) was 361. Therefore n=361. Since 361 pupils were enrolled for each category, we can assume that 1083 pupils were categorized for the whole category.

Category	Number of pupils	in %
1. category	194	18%
2. category	300	28%
3. category	340	31%
4. category	221	20%
not classified	28	3%

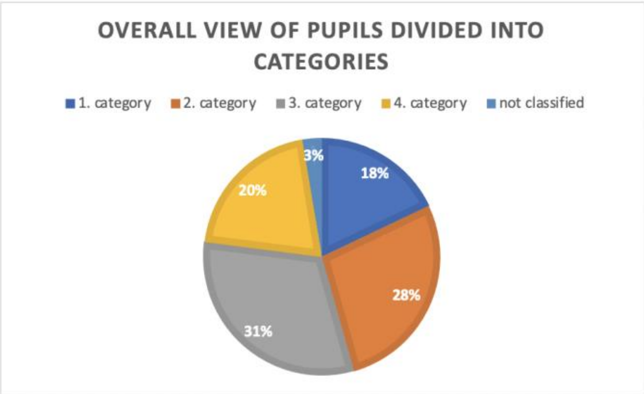

Figure 4. Overall View

The respondents' answers show that the proposed categorization for the use of iPads at special elementary school appears to be realistic. It can provide inspiration for teachers who are about to implement iPads into their instruction, giving them an idea of how their pupils can use iPads and what they are able to learn with their help. Since there are 1,446 pupils in Czech special elementary schools, we can proudly say that we worked with a sample consisting of 24.96% of those children (UIV, online, 2018).

5. DESCRIPTION OF INDIVIDUALIZATION PROCES IN SPECIAL ELEMENTARY SCHOOL WITH IPAD-BASED INSTRUCTION

5.1 Individualizing Instruction of Category 1 Pupil

Pupils in this category are able to use content-based applications on their own. Moreover, with occasional help from the teacher, the pupil is also able to use applications for the so-called app smashing. Since this pupil has a number of technical and content options, it is entirely up to the teacher which topic they choose to present. Therefore, pupils in this category are likely to achieve the learning objective.

Summary – Pupils in Category 1 individualize their work more or less on their own. The teacher becomes an observer. Only during the last stage, when the pupil needs to switch between applications and open content they created in the previous application, does the teacher provide words of encouragement. This pupil can operate an iPad, using a variety of applications and regular teaching aids. Usually it takes the pupil one class to complete the task at hand, completely fulfilling the stated objective. For this pupil the iPad is not as important as their own skills, which are developed to a certain degree.

5.2 Individualizing Instruction of Category 2 Pupil

The education process of a Category 2 pupil is only individualized when an iPad compensates for their disabilities. Most often it is motor disability which is a sign of moderate mental retardation. However, their disability is much worse than that of Category 1 pupils. Such compensation can be, for instance, in the form of a glove with only one finger – preventing accidental touching of the screen and allowing the pupil to place the entire palm on the iPad's screen. Another possibility is to enlarge the iPad's screen (and the icons) in order to make the use of the iPad more convenient for pupils with visual impairment. No other device is necessary to do so as the iPad already has this function.

Summary – Category 2 pupils' instruction is individualized with the teacher's verbal guidance, especially during more demanding tasks. These pupils can perform certain tasks on their own. However, the teacher should supervise their work and encourage and praise them. Compared to Category 1 pupils, these pupils can only work half the time. Therefore, the teacher should modify the tasks in order for the pupils to be able to fulfill the stated objective within a time limit. Even though the iPad is motivational, the pupil can become tired after a certain period of time. When individualizing this pupil's instruction, it is vital to make the iPad more accessible to them – the magnifying glass function, prevent accidental touching of the screen, changing the color of the screen, etc. This pupil's skills are at a secondary level. Compared to a regular computer or a laptop, an iPad is less demanding for these pupils in terms of graphomotor skills and eye-hand coordination.

5.3 Individualizing Instruction of Category 3 Pupil

Instruction of these pupils can be individualized, but not fully (as in the previous two categories). In order for Category 3 pupils to be able to use iPads, the Assisted access function needs to be on. This function reduces distractions, allowing the pupil to use the application selected by the teacher.

Summary – this pupil's knowledge and skills are not important. It is the Assisted access function that is vital as it allows the pupil to use the iPad even though they cannot operate it correctly. This function eliminates distractions and prevents accidental touching of the screen, allowing the pupil to complete the task at hand and thus fulfill the stated objective. Apart from eliminating distractions and anxiety, it also compensates for their lack of fine motor skills, allowing the pupils to be satisfied with their results.

5.4 Individualizing Instruction of Category 4 Pupil

Instruction of Category 4 pupils cannot be individualized through the use of iPads. The reasons are given in Case study 4.

Summary of the impact of iPads on individualization of instruction in the individual categories:

Table 1. Impact of iPads on Individualization – Summary

Pupil's level of self-sufficiency by category	Primary impact	Secondary impact
Category 1 (highest level)	Pupil's mental skills and abilities	- - -
Category 2	iPad accessibility	Pupil's mental skills and abilities
Category 3	Assisted access function	Pupil's mental skills and abilities
Category 4	- - -	- - -

Instruction can be individualized in Categories 1, 2 and 3.
Category 1 – iPad does not play a major role (as can be seen in the table).
Category 2 – iPad plays a major role – its accessibility.
Category 3 – iPad plays a major role – its function "Assisted access".
Category 4 – iPad cannot be used to individualize instruction.

6. CONCLUSION

This paper was aimed at individualization of instruction through the use of mobile touch devices, iPad tablets in particular. Considering that instruction at special elementary schools is mainly individual, we were interested in learning whether pupils with special educational needs could use tablets in an individualized manner, i.e. working at their own pace, be self-sufficient, fulfill the stated objective in allocated time. If it was possible, such instruction would be tailored to pupils' needs.

Nowadays, tablets are widely used at schools, leaving special teachers with no choice but to use the Internet to look for ways to incorporate them into the instruction of pupils with special educational needs. However, not all teachers are partial to this idea. And not all of those that are in favor of it are willing to use the trial and error method. That is why the presented research may be beneficial.

In order to be able to describe the individualization process, a classification table (and the method used to divide pupils) needed to be designed. Using the proposed criteria, the teachers could divide their pupils based on what they might be able to achieve using a tablet. Therefore, defining categorization for the use of tablets, which could serve as a guideline for teachers, was a necessity. This categorization was then verified. The final part of the paper was aimed at the individualization of instruction in all four categories.

The research showed that this particular tablet was widely used in special education as it can accommodate the needs of individuals with special educational needs, i.e. the Assisted access function. This function proved to be essential as it allowed pupils, who would otherwise not be able to concentrate on the task at hand, to use an iPad by eliminating distractions, limiting the functionality of the screen and thus enabling each pupil to participate in instruction. That is why the iPad was the main focus of the author's dissertation.

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Short Papers

FACTORS AFFECTING PARENTAL RESISTANCE TO THE USE OF SMARTPHONES FOR LEARNING PURPOSES AT SCHOOLS

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ABSTRACT

This study examined parental resistance to the use of smartphones in schools, the resistance factors underlying the parental resistance and other factors that predict this resistance. The data was collected from 220 parents who filled in an online questionnaire. The participants reported on their level of resistance to the use of smartphones in schools (no resistance, passive resistance, active resistance) and the resistance factors (pedagogic, social, environmental and economic factors) underlying this resistance. About two-thirds of the parents who participated in the study resisted to the use of smartphones in school, and more than half of them expressed active resistance to such use. The social resistance factor found to be the highest in the study, while the pedagogical resistance factor was the lowest. Nevertheless, both these factors, and the economic factor, were positive predictors of parental resistance level. The research sheds light on the phenomenon of parents' resistance to the use of smartphones in school learning, discuss the implication of this phenomenon on school policy and suggest practical solution for schools to overcome the parental resistance.

KEYWORDS

Smartphones, Parents, Resistance to Technology

1. INTRODUCTION

In recent years, with the rise in the number of smartphones owned by students, there is an ongoing debate between parents, educators and policymakers regarding the integration of smartphones into school learning processes. Smartphones offer a variety of learning applications and facilitate collaborative and accessible learning (Barrs, 2011; Meishar-Tal & Gross, 2014). However, despite this potential for empowering learning, many parents in Israel have expressed negative attitude towards the use of smartphones in schools. Parents have even appealed to the High Court of Justice to prevent their use in education, which eventually led to a ban on the use of these devices in schools (The Israeli Ministry of Education, 2016).

A variety of theoretical frameworks explains adoption and rejection of technologies. Among the well-known approaches are Technology Acceptance Model (Davis, 1989) and The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003). These theories explain rejection to technology as lack of acceptance, mainly in terms of "ease of use" and "usefulness". One the other hand, "Three Pillars of Technological Rejection" model, (Murthy and Mani, 2013) refers to resistance to technology as an independent phenomenon stemming from social, economic and environmental factors.

Moreover, resistance to the use technology in schools has been discussed extensively in the literature in regard to teachers' pedagogical attitudes (Hall & Hord, 1987) and even students' (Sung, Chang & Liu, 2016), but much less attention has been payed to the parental resistance. The parents' resistance to using Smartphones in schools could be understood in light of the fact that Internet use by children is usually associated with social dangers and risks such as bullying, racism and sexual harassment (Livingstone & Haddon, 2009). Use of smartphones by children is also associated with addiction and social loneliness (Bian & Leung, 2015; Genc, 2014). Parents are also concerned about the environmental risks (exposure to radiation) and high economic cost of using Smartphones by their children (Genc, 2014). Identifying the parental resistance factors, and which factors predict the parental actual resistance - may contribute to the understanding of this phenomenon and can serve policymakers in defining ways to overcome this resistance.

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2. METHOD

2.1 Participants

The participants included 220 Israeli parents, most of them mothers (89%). About half of the parents had a child studying in a middle school, and the rest had children in elementary and high schools. The majority of the participants' children (60%) studied in state-secular education, while 28% studied state-religious education, and the rest - in the ultra-orthodox schools. About 45% from the parents were non-religious, 28% traditional and the rest of them religious people. The level of income was also examined, 37% were average income, 28% below and 35% above the average income. Finally, 77% of the children have a smartphone.

2.2 Instruments and Procedure

The research was conducted within the quantitative paradigm through online questionnaires distributed among groups of parents via social networks. The questionnaire included the following measurements:

The actual parental resistance was examined as non-resistance, passive and active resistance, based on studies of resistance to change in general and about parental involvement (Fisher & Friedman, 2009; Oreg, 2006).

The resistance factors were measured by four resistance factors, three of the factors: social, environmental, economic - were based on the Three Pillars of Technological Rejection model (Murthy & Mani, 2013) and the pedagogical factor was based on the Concerns Based Adoption model (Hall & Hord, 1987). All the scales demonstrated good reliability: social (α=.87), economic (α=.83), environmental (α=.88) and pedagogical (α=.84).

The research questions were:
RQ1: What is the level of resistance to smartphone use among parents?
RQ2: What are the dominant resistance factors for using Smartphone in schools? (social, environmental, economic, and pedagogical)
RQ3: Are there differences between the resistance factors in each parental resistance group?
RQ4: Which of the factors predict the actual level of parental resistance?

3. RESULTS

3.1 The Actual Parental Resistance to the use of Smartphones in Learning

The resistance level to the use of smartphones at schools measured three parental resistance levels: non-resistance, passive and active resistance. The active resistance was rated as several resistance levels as shown in Figure 1.

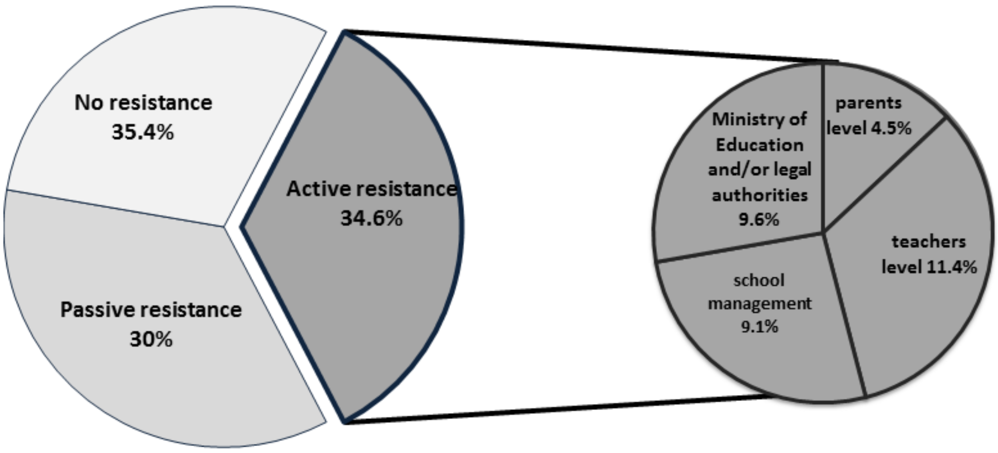

Figure 1. Distribution of parents' resistance to educational use of smartphones (n = 220)

As can be seen, 64.6% of parents resisted their children's use of a smartphone, 30% of them expressed passive resisted, while 34.6% expressed active resistance to the use.

3.2 The Dominant Resistance Factor to the use of Smartphones in Learning

In order to examine which factors between the four factors (social, environmental, economic and pedagogical) are most dominant and whether there are differences between these factors, analysis of variance with repeated measurements was conducted and a significant difference was found between the four groups $F(3,216) = 73.80$, $p = .000$, ${}_{p}\eta^2 = .232$. Table 1 presents descriptive statistics.

Table 1. Descriptive statistics for the resistance factors questionnaire (n = 220)

Variable	Mean (sd)	Median	Skewness (sd)	Range
Social resistance	3.57 (1.11)	3.75	-.489 (.164)	1.00-5.00
Economic resistance	3.45 (1.13)	3.50	-.257 (.164)	1.00-5.00
Environmental resistance	3.23 (1.16)	3.25	-.168 (.164)	1.00-5.00
Pedagogical resistance	2.83 (1.12)	2.80	.159 (.164)	1.00-5.00

Pairwise comparisons showed that the average of the pedagogical resistance factors (M=2.83) was significantly lower than the social resistance (M=3.57), environmental resistance (M=3.23) and economic resistance factors (M=3.45, *p*'s=.000). The social resistance was significantly higher than pedagogical and environmental factors, but no significant differences were found between them and the economic factors (p = .056). In addition, the environmental factors were significantly lower than the social rejection factors (p = .001).

3.3 The Differences between the Resistance Factors in each Resistance Group's Level

In order to examine the differences between the resistance factors among the parents in each resistance group, particularly to reveal the dominant factors in the active parental resistance, repeated measures ANOVA tests were conducted separately for each resistance level. Table 2 presents the results.

Table 2. Differences in resistance factors at different levels of actual parental resistance (n=220)

	Pedagogical resistance A	Society resistance B	Environmental resistance C	Economical resistance D	F	Pairwise comparisons: Bonferroni correction
Actual parental resistance	*M* (SD)	*M* (SD)	*M* (SD)	*M* (SD)		
Non-resistance (*n*=78)	1.86 (0.72)	2.64 (0.97)	2.25 (0.52)	2.78 (0.97)	*F* (3,231) = 41.81, ***p*=.000**, $_p\eta^2$=.352	C<B & D, A<B, C, D
Passive-resistance (*n*=66)	3.08 (0.88)	3.89 (0.80)	3.52 (0.91)	3.46 (1.07)	*F* (3,195) = 18.09, ***p*=.000**, $_p\eta^2$=.218	B>C & D, A<B, C, D
Active-resistance (*n*=76)	3.58 (0.92)	4.23 (0.82)	3.98 (0.89)	4.12 (0.93)	*F* (3,225) = 28.14, ***p*=.000,** $_p\eta^2$=.273	B>C, A<B, C, D

The pedagogical resistance factors were found to be the lowest at all parental resistance levels. In addition, for parents who reported non-resistance, the environmental resistance was low compared to social and economic factors. On the other hand, for passive and active resistance groups, social resistance overcame environmental resistance.

3.4 The Resistance Factors Predicting the Parents' Actual Level of Resistance

In order to examine the factors predicting the parents' actual level of resistance, two-steps regression analysis was performed. The first step included the demographic and socioeconomic variables, and explained 5.2% of the variance in the level of actual parental resistance. In the second step, the **resistance factors** explained additional 39.1% of the variance. Altogether these factors explained 44.3% of parental resistance level variance, *F* (10,209) =16.597, *p*=.000. Table 3 shows the regression result.

Table 3 Regression of resistance factors as predictors of parental resistance level

Variable	β	*t*	*p-value*
Step 1			
Parent gender	.010	.153	.879
Have smartphone (child)	-.106	-1.446	.150
Education stage	-.018	-.248	.805
Religiosity level	.134	1.929	**.055**
Education degree (parent)	-.064	-.878	.381
Income level	-.078	-1.072	.285
Step 2			
Parent gender	-.029	-.555	.580
Have smartphone (child)	-.025	-.430	.668
Education stage	-.006	-.106	.916
Religiosity level	.005	.096	.923
Education degree (parent)	-.005	-.085	.932
Income level	-.028	-.488	.626
Pedagogical resistance	.321	2.910	**.004**
Society resistance	.240	2.283	**.023**
Economy resistance	.183	1.545	.124
Environmental resistance	-.070	-.935	.351

As can been seen, in step 1, positive predictability was found for the *religiosity level* (borderline significance), so the higher the level of religiosity of a parent, the more he/she resists to using smartphones in schools. In step 2, among the four resistance factor, positive predictability was found only for the *pedagogica*l and the *social* resistance factors, while religiosity was not any more a significant predictor of actual parental resistance.

4. CONCLUSION

This study examined parental resistance to the use of smartphones in schools, the resistance factors underlying the parental resistance and the factors predicted the parental resistance level. About 65% of the parents who participated in this study resisted to the use of smartphones in school, and more than half of them expressed active resistance. The high rate of parents who résistance the use of smartphones in learning regardless of their personal differences indicates that the resistance to smartphone use among parents is a widespread phenomenon and requires examination of the factors affecting this resistance.

The findings indicated that social and economical factors were the highest among resistance factors while the pedagogical factor was the lowest. It could be explained in light of Bian & Leung (2015) study that reflected the parents' fear of exposure to inappropriate and harmful content on the Internet. The low level of pedagogical resistance may indicate that parents did not perceive the smartphone as a major resource of learning, they unaware of the pedagogic aspects of learning with smartphones. On the other hand, pedagogical and social factor significantly predicted high parental resistance level, indicate that parents, whose resistance was pedagogically or socially motivated, are those who will actually take their objections to the Ministry of Education and to court.

These findings indicate that active resistance and parental intervention in educational policy does not require a majority of active parents, even a minority can be enough to change the existing educational policy as long as there is an atmosphere of resistance among parents. We recommend that policymakers in the Israeli education system will act to increase awareness of the importance of integrating smartphones into learning among parents, while taking into account the pedagogic and social factors underlying the active resistance of parents.

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INNOVATIVE MOBILE LEARNING: A SCAN OF THE LITERATURE

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ABSTRACT

This paper summarises findings from an initial study completed as the first phase of the Erasmus+ KA2 research project: Designing and Evaluating Innovative Mobile Pedagogies (DEIMP). The purpose of the scoping study was to inform the design and development of a multi-purpose mobile app that will support educators and pre-service teachers in designing and evaluating creative and innovative mobile learning episodes for their students. This first component of the DEIMP study involved the conduct of a Systematic Literature Review to identify innovative and effective practices in m-Learning. A set of 57 articles were identified as reporting on innovative mobile practices and these were further assessed for their level of innovation. The study showed that innovation lies on a continuum from sustaining innovation to disruptive innovation and that disruptive innovation is infrequent.

KEYWORDS

Innovation, Mobile Learning, Systematic Literature Review, Disruption, Sustaining Innovation, Mobile Pedagogies

1. INTRODUCTION

This short paper reports on a Systematic Literature Review (SLR), which investigates whether and how mobile pedagogies are disrupting practice. It is a component of a large-scale EU Erasmus+ project, Developing and Evaluating Innovative Mobile Pedagogies (DEIMP), which aims to support school teachers and teacher educators to design and evaluate innovative, engaging and transformative mobile learning pedagogies that will improve student learning outcomes and encourage students to become effective learners in a digital age. The project involves an intensive professional learning aspect in which teachers are supported by research-based findings in their development of effective and innovative mobile pedagogies. «A starting point for this project was an analysis of the literature on mobile learning, to obtain a scan of the innovation and disruption that may already be occurring in school mobile pedagogies. This article discusses the SLR that provides this scan. Given the focus on innovation that is central to this SLR, we first discuss the understandings of innovation that underpinned this study.

1.1 What is Innovation?

The word 'innovation' is used liberally across the education literature, policies and reports (Moyle, 2010) to describe new ideas, products, approaches or processes (Fenwick, 2016). Innovations can be small or large-scale but need to go beyond superficial change to introduce new ideas or practices that are impactful and valuable to individuals or communities (Denning, 2004; Fenwick, 2016; Linfors & Hilmola, 2016). In an education context, for example, innovation could mean new curriculum, pedagogy or assessment solutions to improve student outcomes (Danaher, Gururajan & Hafeez-Baig, 2009). Interpretations of 'innovation', or the extent to which an idea or process is new or impactful will ultimately depend on one's perception and context (Caldwell, 2018). Tornatzky and Fleischer (1990) suggest that innovation needs to be impactful at least to the people or organisation carrying out the innovation.

There are two ends of the innovation 'spectrum'. At the more conservative end are 'sustaining innovations', described as an adaption of existing approaches (Christensen, Horn & Johnson, 2008; Fenwick, 2016) and a trade-off with established practices and paradigms (Christensen, 1997). Alternatively, at the radical end of the spectrum, 'disruptive' innovation is extremely different to the status quo and can initiate a paradigm shift (Christensen, 1997), transforming existing, dominant practices. In education, disruptive innovations create new practices, purposes and processes, (e.g. of learning), new relationships between students and teachers, and potentially a change in the nature of school and its relationship with the community: "…the innovation as a whole can be considered a 'disruption' to prevalent practices" (Law, 2008, p. 428). These new practices may demand reimagining of schooling.

Innovative digital pedagogical approaches, or what Law (2008) calls 'ICT-using pedagogical innovations', typically explore the use of learning technologies to support new strategies that might change or replace traditional teaching approaches. Hedberg (2006) advocates the use of innovative digital pedagogies that facilitate a shift towards constructivist pedagogical approaches adopting student-centred learning strategies. He argues that these approaches give students control over choice of learning topics and sequences and typically encompass emphasis on their creation, evaluation and synthesis processes. They support a shift from the learner as "a passive participant toward an active engaged constructor of their own experience" (p. 181). However, Law (2008) warns that innovative digital pedagogies do not depend on the technology but rather on the intended use of the technology and the educational context. More recently, a team at The Open University in UK has issued an annual report on 'new forms of teaching, learning and assessment for an interactive world' (Ferguson et al., 2017), focusing on "novel or changing theories and practices of teaching, learning and assessment for the modern technology-enabled world" (p. 6). The group defines digital pedagogical innovation as: "new pedagogies making use of technologies to go further, to open up new possibilities" (p. 8).

2. THE SYSTEMATIC LITERATURE REVIEW

With the above discussion in mind, we conducted a SLR to explore innovative mobile digital pedagogies in school education. A SLR comprises more than an ad hoc search of literature. Instead, it uses a set of criteria and a well-defined procedure to scan various databases for articles that fit the criteria. We initiated the SLR with a focus on the following overarching research question:

How does the use of mobile technologies support innovative teaching and learning practices for school-aged learners?

This then had two sub-questions:

1. What do innovative and disruptive mobile pedagogies for school-aged learners look like?
2. To what extent do innovative mobile pedagogies disrupt traditional structures and practices of teaching and learning for school-aged learners?

Three major search terms were derived for the SLR: 'mobile learning', 'innovation', and 'school-aged learners'. From these major search terms, synonyms and alternative terms were identified. For example, informed by the literature on digital pedagogical innovation, the 'innovation' component of the search string included words such as 'disrupt', 'renew', 'redefine', as well as phrases such as 'new practice', 'new teaching approach' and 'emerging learning strategy'. The search string was applied on a range of databases to ensure that relevant studies were not missed.

This initial search and selection process yielded 208 papers. A further selection process was then carried out which yielded 72 papers. This process involved pairs of researchers applying the following selection criteria to all 208 papers included in the search results: the paper had been published in English between 2010 – 2017; the SCImago journal ranking (SJR) of the paper was in the top two quartiles; the study targeted school-aged learners (5-18 years); the study adopted a rigorous methodology and compelling evidence was presented; the paper focused on innovative mobile pedagogies (as defined in the previous section) and pedagogical strategies and approaches were identified.

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If these criteria were not met, the paper was excluded. Issues related to the possible exclusion of papers were resolved through inter-researcher discussion at team meetings and any remaining questions were resolved by reading the full text of papers. We then set about a more finely grained selection process to identify the range of innovation shown in the papers. We removed papers that we felt, on a second reading, were not sufficiently disruptive to be included. At the conclusion of this process there were 57 papers selected as being suitable for inclusion in this SLR.

Our next step was to decide where on a continuum from sustaining to disruptive innovation each paper would lie. To decide this we used a scoring system based on the degree to which each paper met four criteria. These criteria were identified from our understandings of innovation as articulated in the discussion above. They were 1. Nature of task/activity; 2. The context of the learning (time, place); 3. Relationship between teacher and student (didactic, democratic, involving members of community); and finally, 4. Student agency. A table of scores was set up so that each criterion could be scored from 1 (low) to 3 (high). The team first scored nine papers collaboratively to ensure there was a shared understanding of each criterion. Each team member then independently scored a selection of papers and scores were statistically analysed for outliers. After discussion of the outliers, team members reviewed their original scores to seek greater consistency in understanding.

Each article was scored on each of the four factors. Each factor was scored 1 for low innovation, 2 for medium and 3 for high innovation or disruption, using the definitions of these described in section 1 of the article. Given that these 57 articles all displayed some innovation, they all scored at least one in each criteria. Therefore, the expected total score for each article across all four factors ranged from 4 to 12. We categorised the total scores for the articles as:

- Low: 4 - 6
- Medium 7-9
- High: 10-12.

In our final scoring, only 28 papers were identified as containing medium to high levels of disruptive innovation practices in the context of m-learning, with the remaining 29 papers focused on sustaining digital pedagogical innovations. Of these 28 papers, only three papers focused on practices that were assessed by the research team as demonstrating high levels of mobile pedagogical innovation, containing pedagogical elements that could potentially disrupt traditional practices. Figure 1 shows the position of each of the 57 papers on the continuum from low to high innovation.

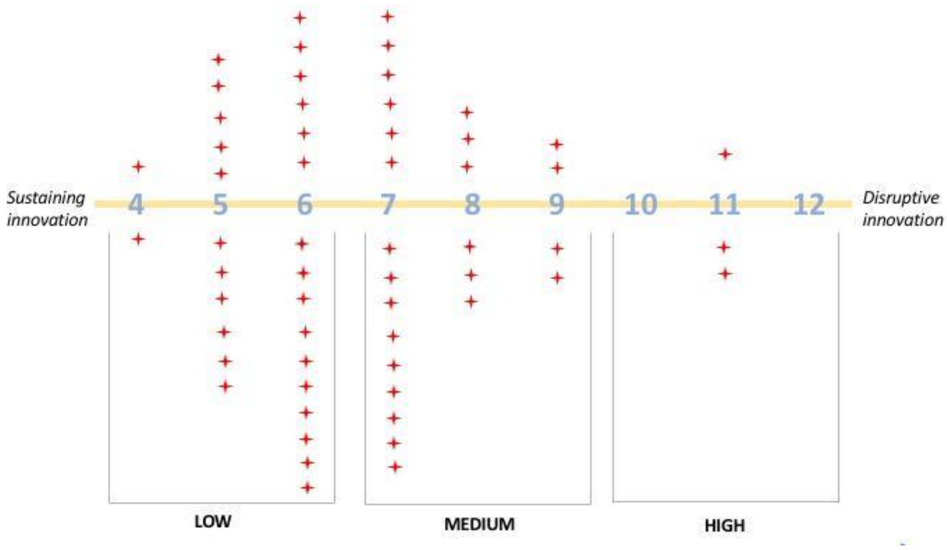

Figure 1. Innovation Spectrum - Breakdown of all 57 Papers According to Level of Disruption

The three categories can be described as follows:

- *Low level disruptions* (sustaining innovations): in these cases the innovation brought about through the mediation of mobile devices adapted existing practices or approaches to make them more effective or efficient, but not to radically change them.
- *Medium level disruption:* in these cases the innovation modified or added something new but this did not in itself fundamentally challenge or alter the underlying approaches, purposes or practices.
- *High level disruption* (disruptive innovations): in these cases the use of mobile technologies enabled learning to take place that would not otherwise be possible. It challenged and fundamentally altered existing approaches and practices such as the relationship between teachers and students or the nature of the curriculum.

The mean score for all 57 papers was just above 6 (6.3) sitting on the borderline between the low and medium innovation boundaries.

3. DISCUSSION

Of the four criteria used to rank the articles, student agency scored the highest (average 1.9 from 3) followed closely by task/activity (1.8). The other two criteria scored noticeably lower with context 1.4 and teacher/student relationship 1.3. In the most disruptive articles students had the freedom to determine the activity itself although in most cases high levels of student agency referred to how the activity was undertaken mediated by a mobile device. In many of these studies the task or activity was also designed in a deliberately flexible and thoughtful manner in order to maximise the affordances of mobile technologies such as their context aware capabilities or their ability to capture and share data spontaneously at any time or place. Despite the pervasive and ubiquitous capabilities of mobile technologies many of the 57 studies were located in relatively fixed and formal settings. Twenty five of the 57 studies were situated either in the classroom (19) alone or in the the school gardens (6) whilst 7 were located in a museum or heritage setting and 3 in an environmental setting such as an arboretum. Informal settings, such as the home or community, were rarely used as locations for these studies and relatively few of them crossed the boundaries between settings in what is often referred to as ‘seamless learning’(Toh, et al, 2013). Similarly most of the studies reported traditional, hierarchical relationships between the teacher and student with few examples of sharing responsibility, co-authorship or other characteristics of a more symmetrical relationship.

As a result of the SLR and the analysis we have now completed we are set to move into a second phase of the project which will see the creation of pedagogical design principles distilled from these 57 studies, enabling teachers to design and construct their own individual innovative mobile pedagogies. Twenty-one innovative principles have been identified to date and these are currently being piloted with teachers and mobile learning experts alike using a Best/Worse scenario survey technique. The results will be used to inform the development of a mobile learning app that will enable teachers to design, evaluate and share their innovative mobile learning scenarios within a network of like minded practitioners.

4. CONCLUSION

This first component of the DEIMP study is proving significant in a number of ways. Firstly, it is providing research-based examples of innovative mobile practices that will be useful for teachers who are seeking some illustrations of effective activities with mobiles. Secondly, the SLR analysis indicates that the most likely innovations are those that are feasible, and are sustaining or incremental in nature. Given the constraints of school systems and curricula, teachers are more likely to develop, adopt and adapt feasible innovations than those innovations that disrupt practices. School executives, policy developers and teacher educators need to bear these facts in mind and adjust expectations accordingly, if they wish to see more widespread innovation in mobile pedagogies.

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MOBILE ASSISTED THIRD SPACE (MATS) – WHAT IS THE POTENTIAL FOR M-LEARNING?

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ABSTRACT

This paper outlines the use of Third Space theory to support teaching and learning in the context of educational technologies such as m-learning. This research forms part of a wider project which seeks to better understand the potential of mobile learning and develop a framework for mobile assisted third spaces (MATS). The literature highlights several features of Third Space learning that can be clearly allied to the pedagogic principles outlined in m-learning pedagogy such as the iPAC Framework. The symbiotic nature of Third Space theory and mobile pedagogy is discussed and the potential of MATS to support mobile learning practices are explored.

KEYWORDS

Mobile Learning, Mobile Pedagogies, Mobile Pedagogical Framework (MPF), Third Space, Mobile Assisted Third Spaces (MATS)

1. INTRODUCTION

Mobile learning (m-learning) is rapidly establishing itself as a contemporary pedagogy increasing opportunities for innovation in a variety of educational contexts and practices (Burden & Kearney, 2017). Defined as pedagogy facilitated by portable devices which are ubiquitous, pervasive and offering a diverse range of capabilities (Kearney et al, 2015), m-Learning is situated as learning that untethers users from traditional concepts of time and space (Schuck & Maher, 2018). M-Learning has been criticized as an under theorized field of research, lacking in conceptual models and frameworks (Koole et al, 2018). Initial attempts to explore how Third Space theory informs the practice of m-Learning and may offer the potential for the development of the frameworks required by the field (Schuck et al, 2017). Third Space Theory's potential for m-learning is a largely under-researched and under-theorised domain of m-learning. This conceptual paper explores how this space might be constituted and is part of a wider study that seeks to develop a theoretical framework for thinking about Mobile Assisted Third Spaces (MATS).

2. BACKGROUND LITERATURE

2.1 What is Third Space

The concepts of space and place were explored extensively in the latter part of the twentieth century, particularly through the in the works of Soja (1996), Oldenburg (1989) and Bhabha (1994). Third Space theory has since sought to elicit deeper epistemological and ontological understandings in a wide range of disciplines, including education and the broader field of pedagogy. This development in spatial thinking has been used to formulate fresh ideas around the interplay of physical and virtual existences afforded through new technologies (see Lapp et al & 2014; EVolvi, 2017). Scholars have suggested that space should no longer be viewed as a container of individuals and activity, but rather as a process through which social relations and identities are produced and reproduced (Soja, 1996). The inauguration of Third Space concepts into the field of educational technology has built pace over the last decade (See Aaen & Dalsgaard & 2016; Lapp et al, 2014) and has more recently been linked with m-Learning practices (Schuck et al, 2017).

The study of Third Space theory acknowledges the role of physical location in defining space but also prioritizes the social dimensions that are integral to it (Bhabha, 1994; Soja, 1996; Oldenburg, 1989). These authors stress the importance of human interaction with both sentient and non-sentient elements in defining space. For example, Soja (1996) describes space as a mutually constituted construction between the physical and the social. He argues that physical elements can shape the social interactions within them but also this is a reciprocal relationship and social activities can also shape the physical space around it. Thus spatial thinking moves away from the notion of space as a container of activity or existence towards thinking of space as a process, born from the interplay of interactions and intersections within it (Soja, 1996). Similarly Bhabha's (1994) interpretation of Third Space discards thinking of spatial dimensions as being homogenous or contained, emphasising the cultural dimensions of space. He argues entities of space or time are never unitary and therefore manifestations of culture and discourse must exist between referential systems and beyond cultural borders. A further iteration of Third Space is offered by Oldenburg's 'The Great Good Place' (1989) in which he argues the importance of informal social spaces that bridge the first and second spaces of home and work. Third Places are neutral and inclusive, they facilitate social interactions in which knowledge is shared and new understandings are formed and are therefore crucial for community and society. These aspects of space have been increasingly applied to educational practices (See Gutierrez, 2008 & Flessner, 2014) and their emphasis on hybridity, rejection of binaries and time/space fluidity has been hailed as fundamentally important m-Learning characteristics (Schuck et al, 2017).

2.2 iPAC Theory and Third Space

The iPAC framework captures what its authors refer to as the signature pedagogies of m-learning (Kearney et al, 2012), (see Fig. 1 below). These include the constructs of Personalisation, Authenticity and Collaboration, along with each of their sub-constructs. At the heart of the iPAC framework are the concepts of time and space, which point heavily towards the concept of Third Space.

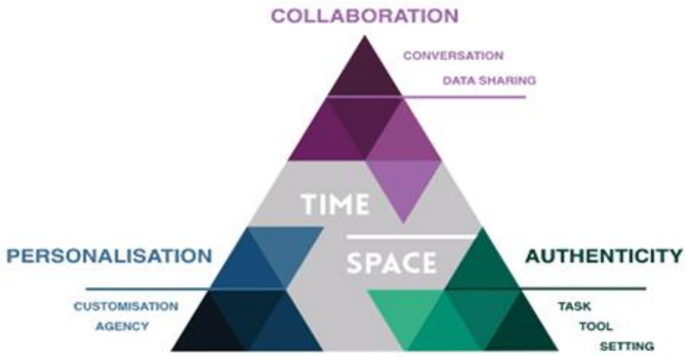

Figure1. iPac Framework, (Burden & Kearney 2017)

Drawing upon sociocultural perspectives (Burden & Kearney, 2017) the iPAC framework is analogous with Third Space concepts in several ways. Firstly, the central location of time/space as the epicentre of this framework emphasises the critical influence of context. The framework promotes the importance of innovative uses of temporal and spatial dimensions of learning as crucial to m-learning practice. Secondly, the inclusion of personalisation takes advantage of how learning is experienced individually; learners have an increased agency over how, when and where their learning can occur. Thirdly, Authentic aspects of m-Learning allow learning to happen in realistic contexts making it more transferable between the classroom space and real life spaces. Finally, the collaboration construct privileges the importance of hybrid discourses, interactions between diverse individuals and environments, which is emphasized as a key feature of m-Learning. All the features of m-learning described are apparent in third space pedagogy indicating their synergetic potential, this is explored in detail through this research.

2.3 Mobile Assisted Third Spaces (MATS)

The mutual constitution of m-Learning practices and Third Space is evident. There is a synergetic relationship between Third Space theory, mobile pedagogy and wider socio cultural pedagogies which is the central topic of this research. An initial review of the literature and several small scale pilot studies have generated an anterior framework for considering Mobile Assisted Third Spaces (MATS) in educational contexts (see-Figure 2).

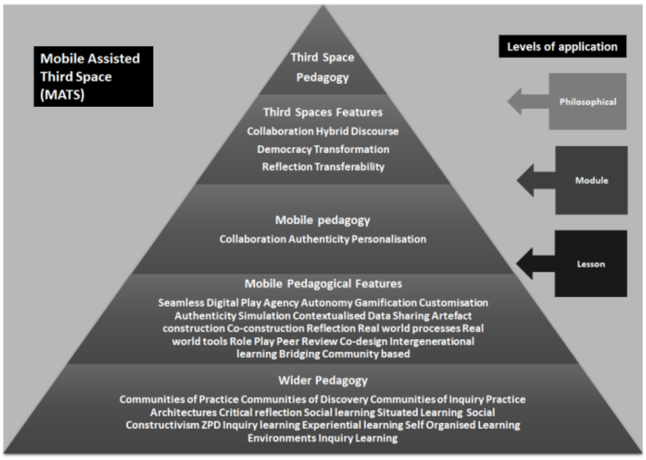

Figure 2. Mobile Assisted Third Spaces (MATS) diagram

The literature highlights a tiered application of Third Space theory as a teaching method. The application of Third Space concepts at the **macro** level identified a philosophical shift towards Third Space concepts (Flessner, 2014), at a **meso** level application was identified at the module/syllabus level (Idrus, 2015) and at the **micro** level application was within a lesson plan or specific activity (Aaen & Dalsgaard, 2016). It also demonstrates the existence of a hierarchical relationship between sociocultural pedagogy, mobile pedagogy and Third Space pedagogy. These facets of MATS have informed the development of this anterior framework. A brief discussion of the synergy between these pedagogical facets is offered during the next section.

3. INITIAL EVIDENCE FOR EDUCATION MATS FRAMEWORK

Ongoing case study research and review of literature in this field highlights several recurring features of Third Space theory for learning: Collaboration, Reflection, Democracy, Transferability, Hybrid discourse and Transformation. Through initial pilot studies analysing m-learning activities specifically using the iPAC framework, and evidence from wider research in m-learning practices the symbiotic nature of the two concepts is evident.

Collaboration allows for learning through social construction and corresponding theories such as Communities of Practice (Lave & Wenger, 1991) are therefore present in both Third Space learning and m-learning research. Aaen & Dalsgaard (2016) report findings of student led Facebook groups as a Third Space of school life, indicating a defined community structure through which a shared practice supports and enriches their experiences of school life; this demonstrates the synergetic relationship between these pedagogical aspects. Charitonos et al (2012) highlight how m-Learning practices extend the social spaces in which students/teachers can interact and therefore make learning more ubiquitous. Collaboration necessitates the interaction of two or more discourses, this interaction is used to create a new hybrid discourse which is built from new knowledge/ new understandings generating a hybrid language between collaborators. In order to operationalize the concept of Third Space, Kirkland (2010) calls for a pedagogical Third Space in teaching that synthesizes traditional school literacies with students' lived literacies. The ability for m-Learning to facilitate this is evident in Hwang et al (2011) where students co-construct concept maps in which they share and modify their ideas and visualise their knowledge representations.

Almost all of the studies using Third Space for learning explicate their adaptation of a Third Space as a reflective space. Reflection is explored as a key activity in Third Space learning for immigrant education (Dryness & Hurstig, 2016). Reflection around professional roles/ personal identities, cultural identities and the structure of society is widely purported as necessary within Third Spaces. The capability of m-Learning to enhance reflective practice is evident in Leinonen et al's (2016) evaluation of apps which showed increased engagement in reflective practice as different modes of participation were synchronously available.

Not surprisingly with the extensive use of collaboration and a reliance on the amalgamation of difference into hybrid discourses, Third Spaces are described as inherently democratic places. The work of Freire (1970), is used to explore the potential of Third Space concepts for greater social justice in education (Idrus, 2015). The opportunities afforded by m-Learning to promote the skills required to engage with others and contribute to the community is evident in Barak & Ziv's (2013) study of students designing interactive, location based artefacts. Many studies recognise the potential of Third Space to support transformational outcomes. Whether this be at a deep level of identity formation (Idrus, 2015) or increasing ability in specific content areas (Flessner, 2014). The transformational potential of m-Learning is made clear in Mintz's (2013) research where mobile technology is used to support behavioural and social development of students with ASD.

The ability of Third Space concepts to bridge the academic and non- academic world is also cited as a crucial feature amongst the articles reviewed. Studies such as Idrus (2015) provide strong examples as they utilise Third Space concepts to actively increase the relevancy and transferability of learning to wider contexts outside of the classroom. M-Learning's capacity to make learning more transferable is clear in Toh et al's (2017) study where students were able to traverse multiple contexts and interact with diverse resources to bridge science learning with the scientific concepts manifest in their everyday lives.

The similarities between m-Learning practices and Third Space learning are clear. Initial case study research in this area highlights evidence of MATS and their potential to support an innovative and even transformational approach to 21st Century learning. MATS offer opportunities to disrupt traditional teaching and learning practices and offer a more current and relevant pedagogy for the 21st Century. The development of MATS answers calls from the m-Learning community for increased theoretical frameworks in this field (Koole et al, 2018) and has the capability to support an unconventional revision of traditional time/space concepts which would initiate the changes in the roles, practices, curriculum and timetable required to fully exploit the opportunities of m-Learning (Schuck & Maher, 2018).

4. CONCLUSION

The symbiotic existence of m-Learning pedagogy and Third Space learning practices is evident. There is clear potential for mobile assisted Third Spaces (MATS) to support the development of contemporary educational praxis and offer an innovative framework for 21st Century learning. The future focus of this research is to empirically explore the affordances of MATS and refine a framework to support m-Learning pedagogy; these findings will be presented as part of this research paper presentation.

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LEARNING GAINS RELATED TO THE USE OF MOBILE RESOURCES FOR UNDERGRAD PHYSICS COURSES

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ABSTRACT

In this paper we present the results derived from a project aimed to study the *learning gains* obtained by undergrad engineering students that used two mobile learning resources (in video format). We conducted our study over a 6-year time interval applying *pre-test* and *post-test* instruments to both experimental groups (which used the mobile resources) and control groups (which did not). Our sample consisted of N = 793 students and we found that the experimental group obtained learning gains about 26% higher than those of the control group. We found this difference to be meaningful, with p-values around 0.022. Perception questionnaires applied to the control groups showed that most of the students consider that the use of mobile resources improved their concept-comprehension and helped them to develop their problem-solving skills.

KEYWORDS

Learning Gains, Physics, Student Perception, Educational Innovation

1. INTRODUCTION

The use of mobile technologies has changed the way we interact and communicate (Kukulska-Hulme, 2007; Ally and Tsinakos, 2014). Nowadays, it is very common for students to have access to different sources of knowledge on the Internet, in many cases in video format. One example may be the so called *YouTube channels*. Using video and multimedia resources in on-line systems is nowadays a *must* practice and turns out to be quite natural for current new-millennial students, from elementary school to undergrad and graduate studies. Gamification has also become a major trend in educational institutions and have a strong potential in years to come. One of the main advantages of using videos for instructional purposes is that the user can watch them anywhere, anytime, as many times as needed and can be paused if necessary in difficult or fast-paced parts of the video.

To the best of our knowledge, however, and despite the importance of using (mobile) videos for academic purposes, there has been little effort aimed to set a quasi-experimental environment where the effectiveness of using such online material can be assessed (Cochrane, 2014 and Cochrane & Narayan, 2016). On one hand, some authors have reported that the use of mobile learning (henceforth *mL*) resources have a positive impact on learning outcomes (Wu, et.al. 2012; Kearney, et.al. 2012; Merayo, et.al., 2015). However, on the other hand, some authors have pointed out the potential risk of using mobile devices, since they can easily become a distractor in the classroom (Robledo, 2012).

A decade ago, the Tecnológico de Monterrey launched a large-scale mobile learning model in which each new student was given a mobile device (back then it was a Blackberry) in order to deliberately incorporate the use of mobile resources (mainly in video-format) to deliver course content, both in high school and undergrad courses. Since then, our research group started an initiative aimed to design, implement and evaluate the impact that using mL resources may have in student outcomes. The contribution of this paper is then to share with the mL community our findings regarding this project. In Sec. 2 we comment on the general aspects of the mL resources design. In Sec. 3 we describe the methodology employed in this study, and in Sec. 4 we present our main results regarding the learning gains attained by students whom used the mL resources in their Physics courses (the Experimental group) as compared to those obtained by students whom did *not* used the resources (the Control group). We also summarize our findings regarding the general perception of the Experimental students about the use and benefits of using mL resources. Previous results have been reported by Robledo-Rella et al. 2010; Chirino et al. 2010; Robledo-Rella et al. 2011). Complementary and extended results to this paper are presented by Robledo-Rella et al. 2017.

2. DESIGN OF ML RESOURCES

As mention above, we designed several mL resources in video-format to be used in Physics I (Classical Mechanics) courses in our institution in order to cover the main themes of the course (from vectors in 3D to rotational dynamics). However, for this study we focused ourselves in only two main themes: *i)* Particle Dynamics (Newton's 2nd law and Free Body Diagram) and *ii)* Conservation of linear momentum. The design of these mL resources was carried out by professors of the Science Department with the support of instructional designers whom helped to guarantee that the final product videos were adequate and attractive to the students regarding *i)* aesthetic, *ii)* sound and graphics considerations, and *iii)* length and content displayed. Each video has a framing introduction, a brief description of the main concepts (the theory) and ends with a proposed exercise for the student (the practice) so to recap on what was just learned.

Our first resource was a 5-minute video showing the student how to build a Free Body Diagram (hereafter FBD) and how to apply Newton 2nd law to a block resting on an incline and being acted by an external force. Regarding the theme of Conservation of Linear Momentum (hereafter CLM) we designed two short videos, one explaining general aspects of linear momentum in everyday life and the other explaining the conditions for linear momentum conservation and the different types of collisions in 1D (this last video included measuring experimental cart-collisions in the lab). At the end of the video, the students are also asked to answer some summarizing questions. The CLM mL resources were later redesigned so to improve both visual and audio elements (Neri et al. 2016).

3. EXPERIMENTAL METHODOLOGY

As mentioned above, we implemented a pre-test/post-test methodology applied to Experimental and Control groups. The Experimental groups had access to the mL resources for about two weeks using their mobile devices (either smartphones or tablets), while the Control group was given similar material in a traditional way. In both cases, the professor gave her lectures as usual. In order to minimize the *professor-variable*, we guaranteed that the professor had, for any given semester, at least one Experimental group and one Control group. The selection of both the Experimental and Control groups were random before the start of the semester.

Both the FBD and CLM mL resources were applied from 2009-II to 2015-I terms. Table 1 below shows the number of students participating in the Experimental and Control groups, both for the FBD and CLM mL resources, respectively. We analyzed $N = 423$ student results for the FBD and $N = 370$ students for the CLM mL resource. Before analyzing our data we cleaned our sample due to misclassified students between the Control and Experimental groups (about 2% of the sample).

The pre-test and post-test were basically the same and were carefully designed so to measure the fulfillment of the leaning objectives stated in each mL resource. The pre-test was applied to the whole population *before* the Experimental groups had access to the mL resources. The post-test was also applied to the whole population *after* the Experimental group interacted with the mL resources, about 2-3 weeks after the pre-test was applied. In this way we were able to assign to each student a learning gain defined by: $G_i = Post_i - Pre_i$, where $Post_i$ and Pre_i are the post-test and pre-test grades of student i. The pre-test and post-test were applied to all students during class time in the classroom and each lasted about 15 – 20 minutes. Each test was graded in a 0 – 100 scale following a well-defined rubric.

In order to proceed with the analysis, we defined for each group its average learning gain as: $\langle G \rangle = (1/N) \Sigma G_i$, where N is the number of students in each section per semester.

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4. RESULTS AND DISCUSSION

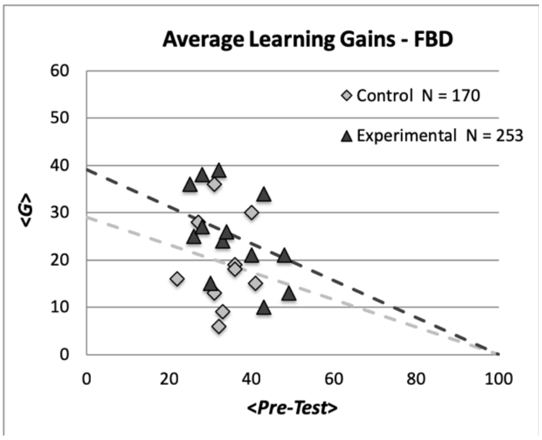
Our main results are summarized in Table 1 both for the FDB and CLM mL resources. We show the number of sections/semesters in which the measurements were taken, the number of students, the average pre-test, average post-test and average learning gain, both for the Experimental and Control groups. For the sake of clarity, we do not indicate the standard deviations of the pre-test and post-test, which were typically of about 15 points.

Table 1. Average pre-test, post-test and learning gains for the Experimental and Control groups for the FBD and CLM mL resources

	***N* sections**	***N* students**	**<*Pre*>**	**<*Post*>**	**<*G*>**
FDB Experimental	13	253	34	60	26
FBD Control	11	170	32	51	19
CLM Experimental	10	208	34	61	27
CLM Control	9	162	35	51	16

As can be seen form Table 1, the average pre-test is similar for the Experimental and Control groups, as expected, given that these groups were randomly chosen.

In order to help us to visualize the differences between the Experimental and Control groups, we show in Figure 1 the "Hake diagram" of the average learning gain <*G*> vs. the average pre-test <*Pre*> of each of the 24 sections considered for the FBD mL resource and the 19 sections considered for the CLM mL resource, respectively (Hake, 1988).



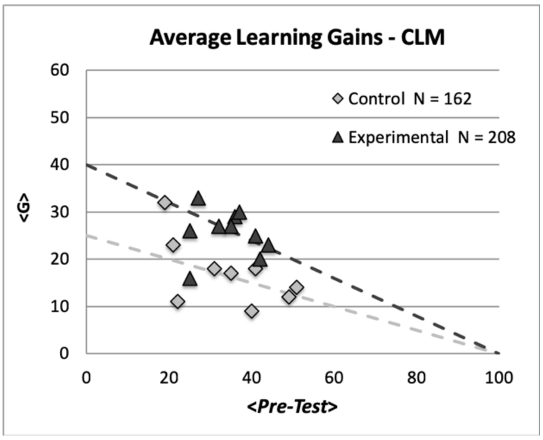


Figure 1. "Hake diagram" of average learning gain <*G*> vs. average pre-test <*Pre*> for each of the studied sections for the FBD and CLM mL resources, respectively

As can be seen from these plots, the Experimental sections tend to populate larger values of <*G*>, for a given pre-test, as compared to the Control sections.

We performed a *t*-test to the individual student learning gains (N_{FBD} = 423 and N_{CLM} = 370) in order to determine if the differences between the Experimental and Control groups were meaningful. For the FBD we found *p*-values of $p = 0.0022$, making the difference meaningful for this resource. However, for the CLM we found $p = 0.045$, which means that the difference is barely meaningful.

From Table 1, we can see that, for the FBD mL resource, the average learning gain for the Experimental group is about 7–8 points higher (in a 0 – 100 scale) than that for the Control group. For the CLM mL resource, this difference is up to 11 points.

Although it is not shown in Table 1, we found that, contrary to any reasonable expectation, some students within our sample got *negative* learning gains (that is $Post_i < Pre_i$). We found that the percentage of students with negative learning gains was about 3% smaller in the Experimental than in the Control groups.

As mentioned above, we also applied a perception questionnaire (with a 5-step Likert scale) to find out what was the overall student perception about the usefulness of the mL resources to enhance concept-understanding and the development of problem-solving skills. We collected N_P = 203 student responses and our main results are summarized in Table 2 below, where we have binned the answer in only three levels (Agreement, Neutral y Disagreement). As we can see, the use of mL resources has a positive approval among most of the students.

Table 2. Perception questionnaire main results (N_P = 203)

	Agreement	***Neutral***	***Disagreement***
mL helps to understand concepts	67%	23%	11%
mL promotes problem-solving skills	61%	23%	16%

5. CONCLUSIONS

We presented a self-consistent study spanning 6-years about the use of mobile learning resources and their impact in the learning process. In general, we found encouraging (and expected) results indicating that the use of video materials favored the learning process of Physics concepts as measured by means of a pre-test/post-test instrument, with increased learning gains by as much as 26%, being this a meaningful difference. It is worth mentioning that the general teaching methods used by the professors lecturing these Physics courses did not change substantially along this 6-year time span, so we consider that the observed differences in the learning gains between the Experimental and Control groups are mainly due to the use of the mL resources.

The use of mobile resources in education, in the form of short videos has still a strong acceptance among most students and should be considered for teachers when preparing their instructional design. Given the current wide acceptance and necessity in our daily lives of the use of smartphones, tablets, *the Cloud* and Web 2.0 services, it is expected that enforcing these channels of communication will continue to be a major educational feature. Therefore, we expect that the use of mobile devices related to gamification will certainly increase in the forthcoming years.

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TOOL SELECTION: LEARNING PICK-AND-PLACE OPERATIONS USING SMARTPHONE AR TECHNOLOGY

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ABSTRACT

This paper presents an ongoing development process for an experimental application that aims to train an inexperienced user to operate a mobile device and receive Augmented Reality (AR) guidelines for basic pick-and-place operations. The purpose of the presented work is to offer a learning environment for placing multiple physical tools in specific places, as indicated by various guideline notes. The current phase represents the 9'th experiment from a series of others (24) that are conducted in order to identify the proper specifications, challenges and development estimations for a training station (room) built for manufacturing industry workers. The application is developed from a gamified perspective allowing users to explore 2 different games. According to the rules of each game, the user advances to the next level if he manages to place each object in a corresponding placeholder until all the spaces from a 2X3 grid are occupied correctly. The process is timed and the user sees a custom countdown timer alongside with guiding messages and feedback. While most of technical challenges were successfully surpassed, the interaction together with the performance measuring are currently going through an improvement process meant to identify and assess the educational advantages offered by this type of solutions.

KEYWORDS

Mobile Application, Augmented Reality, Human Computer Interaction, Gamification

1. INTRODUCTION

As a relatively recent enhancement added to the virtual reality (VR) technology evolution, AR brings a totally different level of interaction. The applicability of AR is focused on a variety of areas, starting from most common ones like gaming, assistive e-health, e-learning, to other more complex use-cases like military applications, smart city, industry and many others as presented in (Marr from Forbes, 2018). In order to bring the power of AR closer to the user and contribute to far-reaching scenarios, the most important factor is to combine AR with various other technologies that offer flexibility and mobility while allowing multiple ways of exploring AR visualizations as presented by (Aaltonen and Lehikoinen, 2006).

The current paper presents an ongoing progress of an experimental application that uses AR capabilities of modern smartphones. The application (currently in alpha version) requires a smartphone with an Android operating system and AR support in order to use the detection and display features of the device for educational and training purposes. The presented test scenario uses a gamified experience in order to guide the user to recognize and place correctly several common bricolage tools into specific indicated placeholders. The guided toolbox is part of a series of experiments that will be used in the development of a self-configuring and dynamic industrial training module to overcome the current industry workforce challenges. Every experiment has a sole purpose of identifying the challenges behind a specific type of user interaction. The current use-case aims to understand how fast human workers can execute easy indications received through an AR-enabled mobile device in order to correctly execute dynamic pick-and place instructions.

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2. EXPERIMENTAL APPROACH

2.1 Scenario Description

The scene setup configuration was inspired by the medical use-cases where there are several tools on different tables and the actors (doctors or nurses) are operating with them. Also, the mixed reality environment design has taken into consideration the conclusions described in (Antoniou et al, 2017).

In this particular use-case (tool selection), the user is directed to pick a correct tool from a tool library (tool table). All the objects from the tool library were scanned before with Vuforia Object Scanner and a database stores the Object Data. There is a direct one to one correspondence between the tool library (software) and the tool table (physical object). Once an object is upheld, it has to be placed in the indicated spot on the placeholder table. The placeholder table is a physical table that has a one to one direct correspondence with a digital AR matrix (2X3) so that the system can process real time object tracking operations.

All the user actions are sequential, pre-established and without completing a certain task, the user cannot proceed further in the process. The placeholder has 6 boxes, as displayed in Figure 1, each one of them represented by a colorful pattern, very different one from another in order to favor the precision of the solution at this stage.

Figure 1. Placeholder table with 6 boxes as displayed on the working table
View from the top. Camera shot.

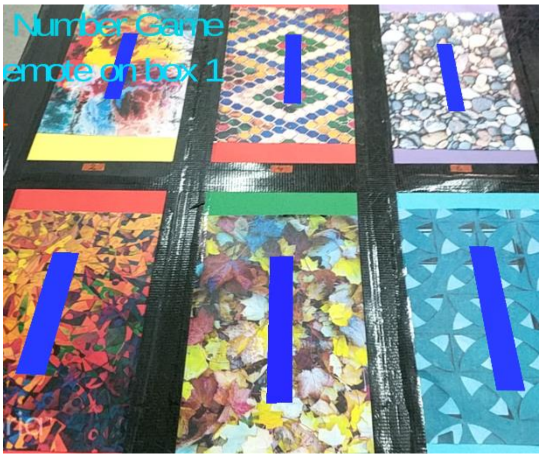

Figure 2. Placeholder table with 6 boxes and blue band strips for object placing direction.
View from the Android device screenshot

For guiding the correct tool placement, each box contains a colorful band strip (permanent AR object) that shows the correct direction for placing a tool. Without the proper tool direction, for some cases (marked with black stripes), even if the object would be placed in the right box the result would be considered incorrect. The color of the strip was chosen to be dark blue because of the big contrast with the background. The strip placement is affected by the distance and the tilting angle of the smartphone and it was one of the first signs of correct mapping, similar with the stabilizing methods described in (Andreasson, 2017). The empty placeholder with the blue direction strips are displayed in Figure 2.

2.2 Gamified Experience

In order to build a gamified experience, the whole process was designed around 2 available games:

- the game of numbers: the rule is to place an object in a placeholder that's indicated by a number (object x to box n mapping). The boxes are numbered in natural order.
- the game of colours: the rule is to place an object in a placeholder that's indicated by a color (object x to color c mapping). This game requires more attention since the placeholder images are very colorful, there is no order of the colors and multiple boxes can have the same color;

For both games, each attempt is presented like a challenge against time with a countdown timer displayed directly from the beginning. In case a user doesn't put all the tools in the indicated boxes, after 120 seconds the game is interrupted. Every time a user makes a move, no mather if the move was correct or not, relevant instructions and feedback messages are displayed in order to guide him for the next step until he manages to place all the objects, as shown in Figures 3 and 4.

Figure 3. Completed board with all the 6 tools placed correctly and within the 120 seconds timeframe

Figure 4. Incomplete board, the 120 seconds have passed and not all the tools are in the correct position

2.3 Scenes

Unity allows the creation of multi scene applications. Each scene can have its own isolated environment that can contain components of several types. A scene can contain basic elements like buttons, pop-up messages and virtual objects, or more complex ones like animations and manipulations. As described in (Kim et al, 2014), this particular feature allowed us to split the application in two scenes: START (only with basic elements) and GAME (mostly with complex elements).

The START scene as displayed in Figure 5, has elements from the interface that are visible on the phone's screen while running the application. In this scene a menu is displayed which has 3 native buttons and displays messages depending on what button you press. Through the menu the user can select what type of game they want to play.

The GAME scene, as displayed in Figure 6, represents the game's environment and has interface elements, buttons and text messages Vuforia-specific elements, that allows the use of virtual reality, AR Camera functions that operate with the scanned objects (Object Target) and the recorded images (Image Target).

Figure 5. Start Scene as Displayed in the Unity View

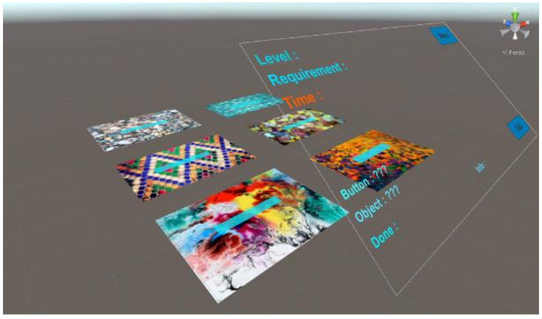

Figure 6. Game Scene as Displayed in the Unity View

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3. EARLY PERFORMANCE ANALYSIS

During the development process, the application performance was tested on several devices in different environments and their performance was rated below as displayed in Table 1.

Table 1. Performance Rating for Devices used during the Development Process

Device Name	Camera Resolution (mp)	Operating System	Rating (1-5)
LG Nexus 5X	12	Android 8.0	4
Samsung Galaxy J3 2016	8	Android 5.1	3
ZTE Blade V8	13+2 (dual)	Android: 7.0	5
Xiaomi Redmi Note 5	12+5 (dual)	Android: 8.1	4
Google Pixel XL	12	Android 9.0	5

The testing stage also concluded that there are 3 main factors that influence the overall performance:

- lens camera quality (not the resolution) - device feature - directly impacts detection speed;
- reflection of light - environment feature - multiple tests were conducted in several different rooms and when the artificial light was very strong the objects were glossy, and the detection precision decreased drastically;
- complexity of the item - object feature - at this stage, in order to increase the accuracy of scanned objects we decided to use only the items that have a large number of Vuforia Object Scanner Points (more than 100). A surface scan for a drilling machine is shown in Figure 7.

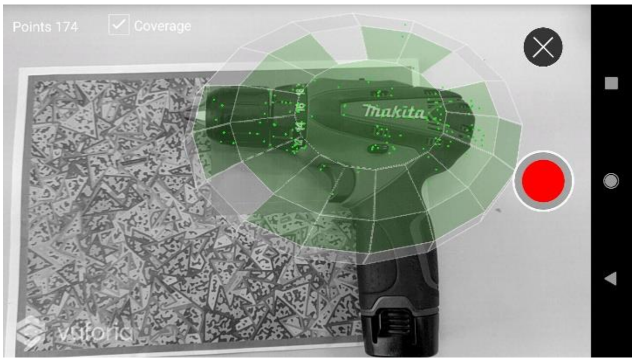

Figure 7. Surface of the Objects and Number of Vuforia Object Scanner Points for a Drilling Machine

For the testing stages of the alpha version, after the development was considered completed, it was decided to use the top 6 objects that had more scanner points (Adjustable Wrench, Allen Keys, Cordless Drill, Measuring Tape, Digital Caliper, Pliers), a laboratory with warm LED light (the natural light was shaded with translucent curtains) and the Google Pixel XL device (very good camera lens quality and superior Android version available).

4. RESULTS AND CONCLUSION

This paper presented an experimental application that follows an interactive method for learning pick-and-place operations using mobile AR technology. Intentionally, the operations were designed to be as simple as possible for the alpha version in order to focus on the following development tasks

- precise detection for smaller and medium size objects;
- game logic with custom difficulty countdown timer;
- validation of every step actions;
- basic user interface, messages and real time feedback;
- performance optimizations when the number of objects on the board was increasing.

From a development perspective, the combination between Vuforia, Unity and Android represented a really challenging technical task, but under controlled light conditions and by using the proper mobile devices, the alpha version behaved unexpectedly good.

Up to this stage, the current experiment is considered to be successful and very relevant for the bigger purpose (training station progress). During the development stage and after the first alpha version was finalized, the application was tested by more than 20 people of different ages, but with the same technical background (computer science students, professors, researchers). All the subjects were able to complete both games in less than 5 attempts. Most of the problems and delays were related to the usability of the mobile phone with AR capabilities and once the users understood the technology philosophy everything became clear. This outcome shows that the users can be trained using the described method and probably they can easily adapt without difficulties to more complex scenarios developed under the same logic.

The overall performance of the application (object detection speed and precision) is highly influenced by the performance of the device and especially by the quality of the camera. The future extended study will also include detailed and explained performance measurements and recommendations for minimum system requirements, similar with the evaluation in (Fernandes, Cota, Moreira, 2015) and (Grahn, 2017).

Until now, most of the technical challenges were identified and solved. Despite that, there are still two issues that remain unsolved and without solutions:

- colorful scenes without human faces are considered complex by the internal Android autofocus feature and it would be very important to be able to control (force) the camera autofocus in order to speed up the placeholder detection
- detection of smaller objects using the zoom feature or by approaching the smartphone to the target area

The application is currently improved by adding the following changes and features:

- expand the grid to a more complex physical board (6*3);
- detect multiple objects at the same time and ignore an object after it was correctly placed
- interchangeable images to allow various camera efficiency measurements;
- remote features as experimented in (Mourtzisa, Zogopoulosa and Vlachoua, 2017);
- gradual complexity levels to ensure a more natural learning process;
- multiplayer features for collaborative tasks;
- Microsoft Hololens AR glasses support, as experimented in (Heinonen, 2018).

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Reflection Papers

SMARTPHONES AND SELF-REGULATED LEARNING: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

This paper reviews the intersection of self-regulated learning and the smartphone. Self-regulated learning constructs are described with an eye towards the implications for the smartphone-using learner. Research supported practices that inform how the smartphone might be best used are also reviewed.

KEYWORDS

Self-Regulation, Smartphone, Metacognition

1. INTRODUCTION

The ubiquity of the smartphone presents numerous opportunities and challenges to educators and learners. Of particular interest is the role of the smartphone *in the view of the user* as it relates to learning. In any learning environment, the smartphone can serve as a support or a hindrance. The role it plays is dependent upon a number of factors. The choices of the student about how the device is used, or not used, are primary factors.

In practical terms, these choices might include decisions regarding configuration settings such as notification permissions (e.g., should the phone alert me when a friend makes a new post) or multitasking (e.g., should I listen to music while studying). These choices are guided by the user’s understanding of his or her own learning and the capacity or motivation to act on these understandings. In other words, self-regulated learning (SRL).

While the introduction of the smartphone into virtually every learning environment is relatively new, the role of SRL in learning environments is not. There is a rich body of literature investigating the role of SRL in a variety of settings (Dent & Koenka, 2016). Investigations of the direct and indirect impact of smartphones on SRL are emerging. The intersections of these two bodies of literature are such that it is now possible to provide preliminary evidence-based guidance to learners and educators on the efficient use (or non-use) of the smartphone.

This review will draw on SRL research and studies of the use of the smartphone in educational settings to propose a set of evidence-based practices. The practices discussed here will be focused on the students *studying* behaviors rather than classroom activities. Suggestions for instructors can be found in a review by Flanigan and Kierwa (2018).

2. CONTEMPORARY SELF-REGULATED LEARNING

Self-regulated learning research is quite broad and it can be difficult at times to determine the boundaries. Usher and Schunk (2018) provide the following generalization that is useful for this paper:

> The process of systematically organizing one's thoughts, feelings, and actions to attain one's goals is now commonly referred to as self-regulation. In this information rich, fast-paced world, individuals are presented with many possible paths of thought and behavior, which can sometimes feel overwhelming. (p. 19).

SRL researchers typically distinguish between knowledge and regulation of cognition (Schraw & Dennison, 1994) and this distinction will be used to guide the organization of the paper. Knowledge of cognition includes an individual's toolbox of learning strategies and the awareness of individual strengths and weaknesses. For example, a student may recognize that if they listen to music while reading, they are more likely to become distracted. Regulating cognition refers in part to the propensity of the learner to act upon his or her own knowledge of cognition. In other words, it is not enough for a learner to simply be aware of her own distractibility, they must act upon that knowledge (e.g., turn off the music while reading).

2.1 Knowledge of Cognition

In this and the subsequent section, SRL will be described in more detail. Within each description, a connection to the use of the smartphone and potential guiding principles will be proposed.

2.1.1 Cognitive Skills

The learners understanding of cognition can take several forms. For example, individuals have a sense of their own working memory capacity. When faced with remembering something like a street address, they will know whether or not they need to write down the address. This is a recognition of the limits of their own cognitive capacity. They also have some understanding of how quickly they can read. When faced with a reading assignment, they will have some sense of how much time they will need to allocate to the task.

The implications of smartphone use for one's knowledge of cognitive skills include the recognition that the phone itself may effectively reduce the student's available cognitive capacity. One study indicated that the mere presence of a smartphone can reduce cognitive capacity (Ward, Duke, Gneezy, & Bos, 2017).

Conversely, the more skillful learner might view the smartphone as a memory support. For example, an awareness of the limitations of working memory could be combined with a similar awareness of the potential use of the smartphone to augment memory. Skills such as the ability to use task management apps to their full potential would be helpful.

2.1.2 Learning Strategies

A student's knowledge of cognition also includes their repertoire of learning strategies. Skillful learners have a broad range of strategies that can be utilized across a variety of learning tasks. Common examples for reading comprehension include the use of self-questioning and note-taking while reading.

Students may or may not recognize the potential value of the phone as a tool to support learning strategies. For example, speech recognition on most phones is now advanced enough to support relatively seamless notetaking. Skillful learners can test these applications and determine how and when they can be used efficiently.

Self-assessment tools also exhibit promise. These apps need to be simple, customizable, and provide useful feedback (Lazarinis, Verykios, & Panagiotakopoulos, 2017). Like any tool, the usability, setup, and maintenance of the app must be limited to ensure time-on-task is maximized.

2.1.3 Views of Learning

The student's beliefs about what knowledge is and how to best acquire that knowledge guide how they engage in educational settings. For example, a student who believes that intelligence is innate or fixed is less likely to see the value in exerting effort towards learning (Haimovitz & Dweck, 2017). This can be contrasted with a growth mindset where the student understands the value of effortful learning.

Related views of learning concern the individual's self-concept. For some students, it is critical that they be viewed as smart by others. This can have negative consequences for learning when the more skillful action might be to ask a question but the student chooses to remain silent in an effort to maintain *smart* status.

A recognition of the need for effortful learning might support the view of the phone as a device that can facilitate the requisite effort. Alternatively, a view of the importance of effortful learning can manifest as a recognition that the device can often present a barrier to focused effort. These views are not mutually exclusive given that how the phone is used ultimately determines the impact.

One promising approach is to confront the learner with the ways in which the phone is currently being used. People tend to underestimate the time spent on the phone engaging in non-productive tasks and overestimate the time spent on productive tasks. A variety of apps are now available that can report on time spent as well as support goals directed at a more productive use of the phone (van Velthoven, Powell, & Powell, 2018). The information provided can support the learner's reflection on how the use of the phone might be more consistent with their views of learning.

2.2 Regulation of Cognition

In contrast to the previous section where the concern is the learner's knowledge, regulation of cognition is concerned with the actions of the learner. While it is necessary to have the requisite understanding of one's thinking, little can be gained if that understanding is not put into action. This section will review a number of examples of regulating cognition and the potential role of the smartphone.

2.2.1 Goal Setting and Planning

Successful students are more likely to engage in short and long term goal setting. Goals typically result in some level of planning. These students are more likely to write down goals and build plans to support the goals.

Phones can be used in a variety of ways to support goal setting and goal attainment. Regular reminders can be planted conspicuously on the phone. For example, goals can be placed on a phone's, lock screen or background. The phones can also be set to send goal reminders at regular intervals. Bedesem and Dieker (2014) describe an instructor guided approach that utilizes Twitter and Hootsuite to send automated text messages at regular intervals to students. Similar student guided approaches can be initiated through a variety of calendar and task management apps.

2.2.2 Information Management

Efficient students can organize necessary materials and information in a manner that facilitates seamless storage and retrieval. As most parents can attest, this is not an innate skill for young adults.

Today's smartphone has the potential to be a strong ally in the quest to become more organized. Unfortunately, this potential is often lost amongst the vast capabilities of the technology. For the phone to support efficient information management, the learner must utilize a simple and focused strategy for the storage and retrieval of information. This might include the use of one focal information management app or it might be a combination of tools. The important idea is that the learner has crafted a strategy that supports their own information management needs.

Regular use of a cloud-based storage app will figure centrally in the students' approach to information management. While it is tempting to believe that college age students will be adept at using these types of tools, there are indications that their facility with productivity functions is lacking (Maderick, Zhang, Hartley, & Marchand,2016). It is clear that the phones can be useful in this regard but students will need be guided in the more advanced uses of cloud storage applications.

2.2.3 Monitoring

Well-regulated learners regularly engage in monitoring for understanding. For example, while reading they are adept at recognizing when they have lost the train of thought of the author. They recognize this event and retrace their steps accordingly. They also have a good sense of whether or not they understand material sufficiently to perform well on an exam.

The role of the phone in monitoring for understanding is not clear. It could play a role in reminding the learner to consistently engage in appropriate monitoring. However, ill-timed reminders might do more harm than good (see next section). Reminders set for the beginning and ending of a study session might avoid potential harm.

2.2.4 Attention / Distraction

Efficient learning is dependent, in part, upon the willingness of the learner to establish a study environment that is free of distraction. This might include the organization of the student's desk to be clear of items that do not support the current task. Finding a quiet and isolated location can also support sustained attention.

Smartphones present substantial, but not insurmountable obstacles in this regard (Gazzaley & Rosen, 2016). Software developers have a strong incentive to encourage frequent and extensive engagement with their particular app (Carr, 2011). In support of this, virtually all applications will now request permission to 'notify the user of X'. Notifications would be more aptly termed distractions and are avoided scrupulously by the focused learner.

3. CONCLUSION

The challenges to learning presented by the ever-present smartphone are apparent. However, these challenges reflect uses of the technology rather than any deficit inherent in the device. If these devices are to continue to be present in learning environments—there is every indication that they will—it is imperative that the uses be directed toward those that promote rather than hinder learning.

Promoting SRL requires providing students with models of skillful behavior (Schraw, Crippen, & Hartley, 2006). This can be accomplished by guiding the students towards uses of the phone that are consistent with skillful SRL.

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THE POTENTIAL OF 3D VIRTUAL REALITY (VR) FOR LANGUAGE LEARNING: AN OVERVIEW

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ABSTRACT

This reflection paper attempts to draw attention to the current situation of 3D Virtual Reality (VR) in the field of language learning. During the last decade, researchers and practitioners have made use of synthetic virtual environments and open virtual spaces to help develop students' language skills. In this sense, computer-generated environments have been used to simulate students' presence within the virtual context. Nevertheless, advancements in technology may lead to change the understanding of virtual environments thanks to the use of 3D VR. Teachers may be able to situate students within the virtual situation, giving them the possibility of experiencing real-life interaction in which target language skills could be developed. Thus, this paper attempts to reflect on the potential as well as possible limitations of this technology for language learning.

KEYWORDS

Virtual Learning Environments, Virtual Reality, Virtual Learning, Language Learning, CALL, MALL

1. INTRODUCTION

The rapid growth in the use of digital technology and communication through multimedia devices as well as its growing popularity within the society has led to the exploration of new teaching techniques and materials in educational contexts. The use of digital devices becomes, in many cases, an indispensable element for the transmission, acquisition and exchange of knowledge. Among these technological advances, virtual reality (hereinafter, VR) has become a resource which may offer a great potential as an element for pedagogical purposes. In this vein, Sykes et al. (2008) categorized virtual reality in three types: open virtual spaces such as Second life; multiplayer online games; and synthetic immersive environments. The first two types of virtual reality have been widely investigated, nevertheless the latter is still on the fringes as technology keeps evolving and changes need to be made in order to adapt technological advancements to educational contents and materials. Nevertheless, the potential of immersive virtual environments for language learning and teaching needs to be emphasized as students may have the possibility of engaging in real second language interaction.

The concept of VR was defined as "an interactive database capable of creating a simulation that involves all the senses, generated by a computer, explorable, visual and manipulated in real time in the form of images and digital sounds, giving the sensation of presence in the computer environment "(Levis, 1997: 4). According to this definition, and from the didactic point of view, we can say that the RV could be considered as the didactic resource that would most closely approach the immersion of the student in a real (simulated) context, whether academic, playful or professional. Its potential as a didactic resource has been an element of debate and reflection for more than two decades by educators and teaching professionals (Appel and Mullen, 2000, Biocca, 1997, Bricken, 1990, Helsel, 1992). Numerous studies have addressed the advantages of using VR in the teaching and learning of different subjects, including, among others, a greater commitment and involvement of the student in learning activities, the development of more precise and concrete communicative situations or, when used in group situations, greater cooperation and collaboration among students (Deuchar and Nodder, 2003, Dickey, 2003, Falloon, 2010, Freitas, 2006, Garris, Ahlers and Driskell, 2002, Prensky, 2008, Van den Brekel, 2007). However, VR, as it is conceived today, is far from the use of virtual environments in which the element of greatest importance was the design of the virtual situation or the use of virtual worlds (Garrido-Iñigo and Rodríguez-Moreno, 2015). Currently, VR is able to situate the student within the virtual situation (RV 3D), therefore giving him the possibility of experiencing real and authentic situations within the immersive environment. In order to achieve this goal, simple and affordable glasses such as Google Cardboard (2015) and the use of a mobile device are enough to achieve an environment that poses various possibilities from the educational point of view. In this line, Dalgarno and Lee (2010) pointed out that VR could lead to improving the transfer of knowledge and skills to real situations through the contextualization of learning.

Nevertheless, some disadvantages of using this technology has also been found such as the motion sickness generated by the use of virtual reality head-mounted displays. This symptom may occur in some users and, more in particular, in women which were found to be at greater risk (Munafo, Diedrick & Stoffregen, 2017).

2. VR AND LANGUAGE LEARNING

Regarding the teaching and learning of foreign languages, the repertoire in the literature as regards this particular type of immersive VR is more limited. However, there are some recent studies that suggest positive findings of the use of VR for the development of certain skills and competences by the student. It is worth mentioning studies such as Lan (2015) who developed an immersive EFL learning context in order to review in-class materials. The effects of this virtual context used out of the classroom environment were evaluated during one semester. 132 participants were investigated through the use of a 2-iteration action research in which qualitative and quantitative information was collected. Results showed positive outcomes of the virtual environment, particularly with regard to the higher amount of learning opportunities provided to students, the enhancement of participants' EFL performance, and the advantages of a gamified scenario.

Another remarkable study was carried out by Chen (2016), who analyzed the effectiveness of the use of a 3D VR platform in the English classroom in order to foster cognitive and linguistic development of 448 students at a university in Taiwan. The virtual reality environment took place in a department store in which each floor represented a module of the course. This virtual context was mainly focused on vocabulary learning which was evaluated throughout the different modules. Results showed that, apart from learning vocabulary, students improved their phonological, morphological, grammatical and syntactic competence while the use of this resource promoted the development of a more complex and higher-level thinking and reasoning. Moreover, the results of his analysis indicated that the virtual learning environment, only with the characteristics of immersion and ease of use, had a positive impact on students' language cognition. Nevertheless, there is a lack of subsequent studies exploring specifically how this virtual reality environments could exploit language learning skills and which specific aspects may undergo a higher improvement as regards language learning.

Other studies such as Chen (2016) or Lan, Hsiao and Shih (2018) explored 3D VR environments through the use of Second Life to foster language development. In the first case, meaningful real-life tasks were developed and documented throughout the investigation. Findings suggested that 3D VR environments in Second Life facilitated language teaching and learning and optimized learners' experiences. With regard to the second investigation, researchers focused on vocabulary and sentence structure to develop special education students' L1. The information collected through in-class observation, videos and structure interviews indicated that the environment was found to have a positive impact on students' L1 development. More recently, Chiu (2017) explored the effectiveness of a virtual reality environment designed for primary school students in Taiwan. This environment was represented in eight learning scenarios in which students could learn their native language. Findings emphasized an improvement in students' motivation, however a more detailed analysis of the language used may have shed light on specific areas of language development in the platform.

In turn, literature reviews indicated that it is a field with increasing potential as pointed out by relevant scientific journals that address language learning through the use of technology (Lin and Lan, 2015). However, the implementation of 3D VR environments in which students are part of the virtual learning scenario is still very scarce.

3. FURTHER RESEARCH LINES AND RECOMMENDATIONS

Mobile phones manufacturers are gradually incorporating and adapting their devices to improve the immersive experience, which has also contributed to the appearance of VR companies as well as products specifically created for these environments such as remote controls or built-in functionalities within the VR glasses. In this sense, from an educational perspective, practitioners need to stay in touch with the latest advancements that could help exploit learners' characteristics as well as teaching methodologies. Research in the language learning field as regards the use of 3D VR has highlighted positive outcomes from the use of these immersive virtual environments, nevertheless the literature is still scarce, mainly because of the recent developments into this technology, and its potential is yet to be discovered.

The aforementioned studies put into practice the use of 3D VR, which supposes a feeling of greater immersion on the part of the student, who is able to experience in person what is happening around him. These investigations make use of the latest functionalities as regards virtual reality, however the role of the student within the virtual environment is still passive in terms of interaction and communication. For instance, the student is not able to communicate orally with the agents that appear in the virtual situation, therefore, the range of skills to be developed is still limited to those in which the student is the recipient of the information, in this case listening and reading. In this sense, the application of new technologies in the field of language teaching has focused, to a greater extent, on the use of the latest technological advances without prioritizing the implementation of a communicative language teaching approach as suggested by the Common European Framework of Reference for Languages (CEFR). Thus, further studies making use of 3D VR could explore the possibilities for interaction within these environments, contributing to the development of the communicative competence and second language skills in which advances in technology may put into practice the current language teaching methodologies in use.

As it has been observed, despite the benefits reported by the literature regarding the use of VR as a didactic resource, there is still a shortage of studies focusing on the design of this type of tools in the field of foreign language teaching and learning, and an absence of studies carrying out an oral communicative approach through VR. Hence, further research is sought in order to keep pace with the changes in society and technology.

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INNOVATIVE LEARNING HUB'S ROLE IN LEARNING SPACE DESIGN

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ABSTRACT

Author shares the Nazarbayev University (Astana) experience in transforming learning spaces into technology enhanced learning studios from the scratch. The process has not yet been finished, however, initial steps have been done. In particular, the Innovative learning hub was created and one of its tasks is to redesign one classroom in each block/School so that more engaging learning and different pedagogy approaches could take place.

KEYWORDS

Innovative Learning Hub, Learning Space Design

1. INTRODUCTION

The use of blended learning in higher education is considered to be one of the greatest trends in education, however, its implementation requires the core technological infrastructure, as space design. Mobile and personal technology is transforming the way learning spaces are used and configured. It allows learning to occur almost anywhere. One of blended learning efficiency factors is space that should be envisioned as a change agent in this transformational process. And this concept is vital for the Nazarbayev University, Kazakhstan's young institution, in becoming a flagman in the whole Central Asian region. NU could integrate the traditional with the innovative, using technologies, pedagogy and space, and support student and faculty research, teaching and learning which will serve a good example to follow by other institutions in the country.

2. BODY OF PAPER

The nowadays competencies like creativity, critical thinking, collaboration, digital literacy and citizenship are prerequisites for one to live, work and learn in a knowledge-based society with innovation at the core of it. this innovation is facilitated thanks to the technology created and distributed, while through technology new pedagogies are being developed, like blended learning.

The Innovative Learning Hub (Hub) was created at the Office of the Provost of Nazarbayev University (NU) in 2018 as a centrally located space that would serve as a "test bed" for multidisciplinary, blended learning transformation projects involving technology in teaching and learning, showcasing emerging applications and technologies promoting the innovative culture among faculty and staff as one of the main missions of the Hub is to provide ongoing faculty development of their teaching practices and course design.

In October 2018 at the meeting of the Academic Council the Provost tasked the Hub to start to redesign the classrooms. The Hub's staff started faculty focus groups, comprised of volunteers among the faculty, and it had been stressed that the redesign should provide:

- collaboration capacity so that all types of learning interactions can occur in the classrooms,
- mobility so that environments can adapt to new ideas and technologies, and
- innovative flexibility to give students the lifelong learning skills that they need to be effective in the workforce.

Currently, the typical classroom at our University looks like a teacher area in the front with a whiteboard, a projector, a computer, a desk and a chair, an empty floor space and then students' seats with tiered floor.

According to the report by European Schoolnet and Microsoft, “Transforming learning spaces in schools: From vision to impact” , dated by May 2018, in many countries the importance of developing more flexible learning spaces is already a part of the national strategy for innovation in schools. It is acknowledged that innovative use of tech and flexible learning spaces go hand in hand. Given that learning spaces have been identified as a developing trend in education, it is likely that the situation will continue to evolve rapidly and that adapting learning spaces will become an increasingly important issue for policymakers and school leaders in more countries (European Schoolnet, Microsoft, 2018).

Our hub is aimed at provision of space for technology rich experimentation, collaborative work areas, support for communities of practice on distance education, workshops and one-to-one tutoring for software and hardware innovations in new media technologies, educational presentations on emerging tech and practices. Our Innovative learning lead is conducting workshops for faculty on how to use IT to enhance the classroom experience in a “sandbox” environment. We also invite trainees not only among the Faculty of our University but also from abroad to share their experience. In April-May this year the Hub will purchase 1 iMac, 2 Macbook Air, 10 iPads for the e-textbooks creation, as well as a 360 camera and drone with the necessary software to enable tech projects and start producing multimedia digital resources for some of the disciplines to be transformed onto blended/flipped ones.

Many projects are launched with a “let's first build it and then everyone will adjust their practices” philosophy. But we want that here at NU we first decide what sort of teaching and learning activities will take place and then design the space. Therefore, Faculty were consulted broadly on the vision of the classroom via focus groups held for each classroom that needs to be redesigned. Currently, there are four classrooms that were selected to be the first ones to be redesigned. The main features that are fair to all the rooms are the following: teacher centered stand, more tech solution needed (not one monitor, but two and more to engage all the students), no tiered floor at all. Besides, faculty prefers small group interactions, face-to-face contact is critical to the culture of teaching and learning.

Thanks to our strategic partner in learning spaces design, University administration started to realize that when designing learning spaces it is vital to take into account learner expectations, the principles and activities that facilitate learning, and the role of technology. The following factors, if in place, will make our project successful:

- collaborative design (produce collaboration among IT, Library, Offices of the President and Provost, as well as hardware, software and furniture companies);
- technology and instructional support (our mission is to enhance teaching and learning through the thoughtful integration of innovative instructional technologies. Our recently hired Graphic instructional designer is available to work with faculty. Besides, we plan to hire interns who will get trained in building online course content and components, as well as e-textbooks);
- trainings for faculty (we have innovative fellows who voluntarily contribute in promoting the innovation culture among the faculty (for example, one teaching fellow conducts trainings on Moodle). When the equipment that had been ordered for our Hub's room arrives, faculty will be able to consult our staff or student interns to decide for example what technologies might better engage learners);
- Hub visitors may participate in a vendor-led product showcase or join a hands-on workshop on topics like “Blended course design” or “Copyright video features”.

Student experience is an important starting point to the design process. It is well known that among the most successful institutions will be those that find ways to infuse student ideas into the design process. As collaboration is becoming more important soft skill that is natural for today's students modern learning space design seeks to provide freedom of access and interaction with peers. The percentage of students that come to our University from rural areas is not high, but still more collaborative space would provide them with equal opportunities and not hide – due to some societal features - behind more active (usually, urban) students.

An ideal classroom, according to our faculty and students, has flexible furniture arrangements, decenters the room from teacher to student activity, stresses collaboration and is tech integrated. In the long term we would like the design process enable the creation of permanently unfinished spaces that would be suitable for any type of adjustments due to the new technologies and pedagogical approaches.

3. CONCLUSION

Major learning space design projects and their associated technology design efforts can effect significant transformations on a campus. Although the big transformational project is going on currently at NU, any changes are skeptically received from the administration and faculty side. For example, in terms of Rogers' Five Categories of Innovation Adopters, NU can be referred as to Early majority category when the adopters are fairly comfortable with technology but they only adopt a new innovation when they have compelling evidence of its value and solid recommendations from other adopters.

Overall, the main message to be delivered to the leadership on learning space design is that interior architecture and environments should be reconfigurable to accommodate multiple uses in a fixed space. Beyond seating, desk height, and equipment placement, the planners should consider appropriate lighting as well as climate and sound control. Speaking about the Astana climate, it is especially vital to install special systems that would not collapse when the temperature outside in summer may be 35C, while in winter -40C.

The way the learning spaces are used and configured is transformed by mobile and personal technology. It allows learning – including research, collaboration, creating, writing, production, and presentation – to occur almost anywhere (D.Pierce, 2015). And as nowadays students are mobile digital citizens, every institution that has a plan to grow needs to be ready to service them as best as possible.

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Posters

NOTE-SUBMISSION FUNCTION FOR MOODLE QUIZ AND COLLECTING PEN-STROKE DATA

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ABSTRACT

Moodle, a Learning Management System (LMS), is a learning platform that provides flexible tool sets to support both blended learning and fully online courses. One of the most important features of LMS is online assessment, specifically, the computer-aided assessment (CAA) that allows evaluators to automatically and instantaneously assess students' answers as correct or incorrect. Currently, teachers can check students' answers but are not aware of the methodology used to obtain the solution. We have developed a module for Moodle through which students can submit their solutions along with related notes on their methodology and calculations by taking photographs or writing the notes directly onto devices, such as with a tablet and digital-pen. Therefore, teachers can view students' notes together with submitted answers to gain more in-depth understanding of the students' comprehension levels. Teachers can also insert feedbacks on the notes and return them to the students, who would consequently understand the subject better by referring to the notes. Furthermore, pen-stroke data on the note can be collected for further analytics.

KEYWORDS

Math e-Learning, Learning Analytics, Moodle, STACK

1. INTRODUCTION

One of the most important features of the e-Learning system is online assessment, specifically, the computer-aided assessment (CAA), as it allows evaluators to automatically and instantaneously assess students' answers as correct or incorrect. Common types of CAA questions are true-or-false and multiple-choice questions. There are other question types wherein students provide mathematical expressions as answers, determined by calculation; such a system is called a mathematics e-Learning system. STACK is one example of such systems. Teachers can also derive useful information from the students' answers, such as the kind of incorrect answers typically given by students and which students require tutoring. Even with these insights, however, the methodology associated with a student's solution remains unknown to the teacher. It is not adequate to solely evaluate answers when the student's level of comprehension remains unevaluated. This problem occurs in all the above-mentioned type of CAA questions.

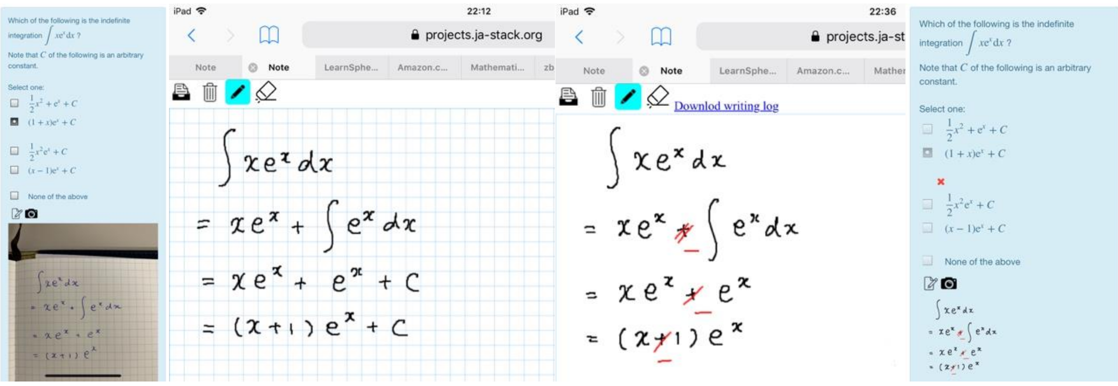
To carry out CAA for e-Learning more effectively and efficiently, we developed a module for Moodle, a Learning Management System (LMS), in which students can submit calculation and methodology notes along with their answers. We call this function a 'note-submitting function'. This function was already developed as an input-type plug-in only for STACK. However, this function should be available for other question types on Moodle. Thus, we developed one-size-fits-all module not only for STACK but for any question type on Moodle.

2. NOTE-SUBMITTING FUNCTION

We implemented the note-submitting function by developing a question behaviour plug-in and a report-type plug-in for the quiz module of Moodle. The plug-ins have just been developed and have not yet been officially released. Those who wish to try the plug-ins can request a free copy of the code from the authors.

The note-submitting function comprises two stages. The first stage is note-submission by the students who can submit notes on calculation and methodology used to obtain an answer. We specify two methods for students to submit notes: one is to submit the images of the corresponding notes that are suitable for mobile devices, and the other is to handwrite the notes directly onto the tablet-type device. When students submit images of a note using smartphones, they first write the calculations on a sheet of paper and then take their pictures (Figure 1(a)). As another option, if the students have tablet devices, they can submit their notes directly by writing them on their tablets with an electronic pen (Figure 1(b)).

The second stage is note-marking by the teachers. Teachers can view students' notes together with their submitted answers and can also insert comments onto the notes (Figure 1(c)), and students can subsequently review these comments (Figure 1(d)) for further learning.



(a) (b) (c) (d)

Figure 1. Note-submission by taking a picture (a) and by hand writing (b). Note-marking (c) and Review by Students (d)

3. CONCLUSION

We implemented the note-submission and note-marking functions for Moodle by developing a question behaviour plugin-in and a report-type plug-in for the Moodle quiz module. Students can submit notes by taking photographs of them or by writing the notes directly onto devices, such as with a tablet and digital pen. In addition, teachers can view students' notes together with submitted answers to gain in-depth understanding of the students' comprehension levels. Teachers can also insert comments on the notes and return them to the students, for better learning. Furthermore, pen-stroke data of students' notes can be collected and used for future learning analytics projects. How frequently students rewrite their notes by using the eraser could be related to the students' comprehension level. OCR could be applied and automatic computer-based assessment might be possible but this challenging project is the subject for future research.

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CLOUDCLASSROOM (CCR), FOR THE NEXT GENERATION

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ABSTRACT

This poster presentation aims to demonstrate an advanced version of clickers, CloudClassRoom (CCR), to conference participants. CCR is written in HTML 5.0 and works on every Internet-capable device without software or plug-ins installation. CCR enables teachers and students to participate in question-answering activates by using their own mobile devices, such as laptops, smartphones, or tablets. By this means, every student in the classroom can express his/her thoughts instantly as well as anonymously. CCR provides the teacher a rough picture of student learning progress in real time. Leveraging the capacity of mobile devices, CCR supports text and multimedia responses. Moreover, CCR is equipped with a role-swapping function; students are endowed with the power to pose questions to the teacher and peers, and then collect responses instantly from the whole class. We expect that the role-swapping function can engage students in deeper learning. The advanced functions of CCR will be demonstrated live, during the poster presentation.

KEYWORDS

Clicker, Instant Response System, Smart Phone, Classroom Learning, Group Discussion, Cloud Classroom

1. INTRODUCTION

According to the report conducted by the Ministry of Education in Taiwan (2015), the percentages of students who possess their own smart phone devices include 48.7% of elementary school students, 78.8% of junior high-school students, and 93.3% of senior high-school students. The average time students spent on the Internet per school day is more than 45 minutes. As of March 2017, recent statistics from the Internet World Stats (2017) reveal that Taiwan's Internet users account for 88% of the total population. Given the prevalence of smart phone devices and Internet usage, more and more schools start embracing the Bring-Your-Own Device (BYOD) policy to make learning more enjoyable and effective. Along with this trend, my research group has developed the CloudClassRoom (CCR) to transform smart phone devices into powerful interactive tools for classroom learning. CCR works on every Internet-capable device without further software or plug-in installation(s). It operates across-platforms, including iOS, Android, and Windows, regardless of the computer system being used. Once the teacher connects his/her device to CCR, he/she can easily initiate anonymous quizzes. In addition to the traditional, forced-choice answer format, CCR enables students to respond with short texts, pictures, or even emoticons. Students' answers are automatically aggregated and analyzed, providing the teacher with a rough picture of student learning progress just in time. To date, approximately 40,000 teachers and students have registered in CCR. More than 330,000 classroom activities have been conducted by using CCR. Thirteen different language versions of CCR have been released, including Chinese, English, Estonian, French, German, Indonesian, Japanese, Macedonian, Montenegro, Korean, Spanish, Thai, and Vietnamese.

2. STRENGTHS OF CCR

CCR is an advanced version of clickers, formally called instant response devices, designed to collect students' responses to in-class questions. Once the teacher poses a question, generally a multiple-choice type inquiry, students can use clickers to vote on the answers they prefer. A central monitoring system then automatically aggregates a histogram of students' votes, providing the teacher with the information about how well students currently understand the learning material. Several reviews (e.g., Chien et al., accepted; Kay & LeSage, 2009) have indicated that the use of clickers can nurtures a sense of classroom participation and thus makes students feel accountable to the academic task exercised in the class. Moreover, the real-time data collected by clickers can assist teachers in tailoring feedback to address students' difficulties in real time. However, to deploy traditional clickers into every classroom, schools have to invest a lot of money for buying or renting hardware. Furthermore, the distribution and safekeeping of clickers are not easy tasks for teachers. To solve the aforementioned difficulties, we have therefore developed CloudClassRoom (CCR) that transforms personal mobile devices into clickers with ease (Chien & Chang, 2015; Chien et al., 2015). CCR is written in HTML 5.0 and it runs on MySQL and PHP-enabled Apache servers. CCR, therefor, enables teachers and students interact with each other by using their own mobile devices, such as laptops, smartphones, or tablets, without software or plug-ins installation(s). Such a solution will become more cost-effective as more and more schools start embracing the Bring-Your-Own-Device (BYOD) policy (Johnson et al., 2014). Moreover, the question formats are not limited to just true-false and multiple-choice questions anymore. CCR facilitates open-ended questions because textual responses are enabled through the use of laptops, smart phones, or tablets. Answering open-ended questions, compared to true-false and multiple-choice questions, is a more effective way to stimulate students' higher-order thinking (Brookhart, 2010). Students can also upload photos, snapshotting either their own drawing or those of others, to CCR as their responses. Compared to solely accepting textual responses, asking students also to turn in photographic responses can make students more cognitively engaged and provide teachers with more information to evaluate students' understanding (Van Meter & Garner, 2005). In terms of obtaining learning analytics on a large-scale manner, CCR is a far better research tool than traditional clickers are. Since CCR operates on clouds, researchers are enabled to use one central monitoring system to access all students' data, regardless of where the data is collected from, or from which classroom. This system design also facilitates national or even global level research on learning analytics obtained from real classrooms.

3. INNOVATIVE PEDAGOGICAL USE

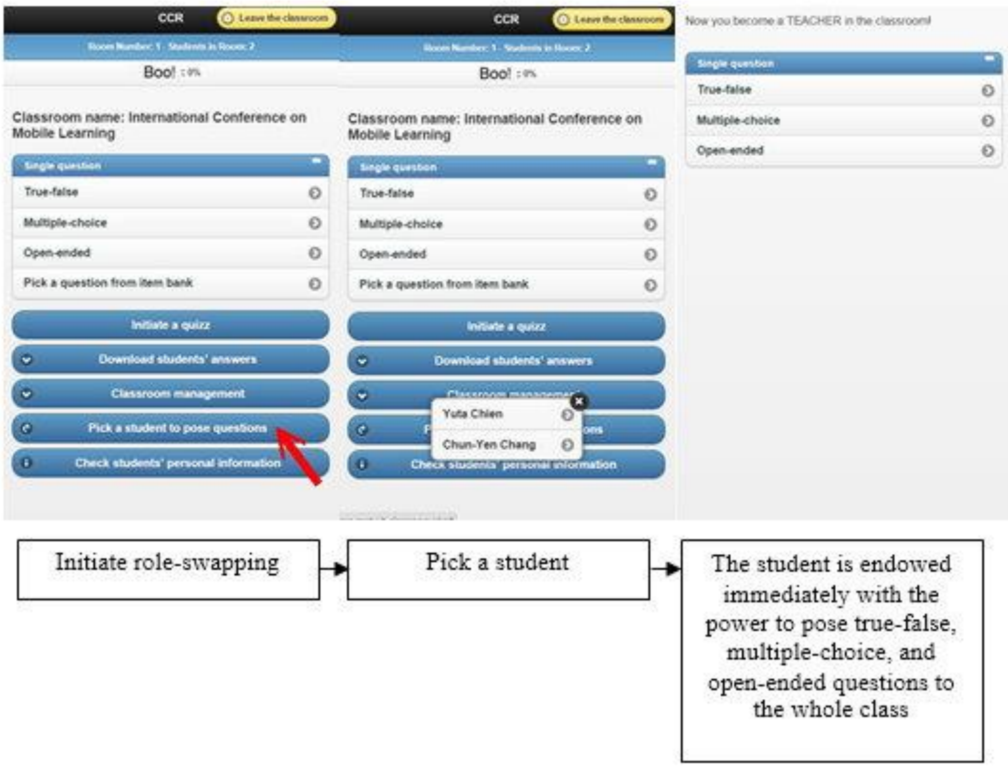

Figure 1. The Role-swapping Function of CCR

CCR enables innovative instructional methods that are difficult to be implemented with traditional clickers. For instance, as shown in Figure 1, CCR is equipped with a role-swapping function. The teacher can use CCR to pick a student to pose questions. Once a student is appointed, he/she will be endowed immediately with the power to pose true-false, multiple-choice, and open-ended questions to the whole class by using CCR. He/she will be also able to collect, inspect, and broadcast peers' responses. We expect that the role-swapping function can engage students in deeper learning since previous literature (Brown & Walter, 2005; Cunningham, 2004; Kilpatrick, 1987; Perrin, 2007) has suggested that asking students to generate questions can foster greater learner agency, reflection, responsibility, insight, ownership, and engagement. We will give conference participants a live demonstration of CCR. CCR is a promising tool to improve the interactivity of East Asian classrooms, in which students are usually silent and hesitate to express their ideas out loud. Therefore, my team is currently leading an international project to investigate the impact of CCR on classroom learning across Taiwan, Thailand, Vietnam, and other Asian countries. It is expected that the results can inform researchers, teachers, and policy makers in terms of how to better leverage the potential of mobile technology to boost learning and teaching.

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Workshop

DESIGNING MOBILE INQUIRY-BASED LEARNING ACTIVITIES: LEARNERS' AGENCY AND TECHNOLOGICAL AFFORDANCES

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ABSTRACT

Recent discourse and research studies on mobile learning showed increasing awareness of the complexity of mobile learning in the digital age. Notwithstanding mobile devices, Web 2.0 and Web 3.0 technologies have greatly empowered learners and educators to overcome the constraints of conventional education, such as time, space, location and to learn on the move. However, balancing technological dependency and learner autonomy remains an area of contention in designing meaningful mobile learning activities. Hence, this interactive and participatory workshop aims to bring together researchers and practitioners working on this issue to share their experience and to engage in facilitated activities and discussions on designing mobile learning activities that effectively balance learners' agency with mobile technology. Additionally, this workshop also provides a platform for unsolved challenges and future research directions on smart technology and smart learning spaces in the context of mobile learning, laying the groundwork for joint research efforts.

Plenary session (45 min)

Part I: Discussion on the design challenges and issues pertaining to mobile learning in the era of digital mobility. This integrates perspectives on mobility of learners, smart technologies and learner agency, bridging formal and informal learning spaces, outdoor enclosed and open spaces.

Part II: Using the six-dimension analytical framework (Appendix 1), learners' agency and technology support in the following categories of mobile learning activities (Appendix 2) will be discussed:

- Direct instruction: location guidance, procedural guidance and metacognitive guidance
- Content: fixed and dynamic
- Data collection: cooperative and collaborative
- Peer-to-peer interactions: social asynchronous and social synchronous
- Contextual support: augmented, immersive and adaptive feedback

Hands-on session (1hr)

Participants will work in small groups on designing mobile inquiry-based learning scenarios in their respective education institutional contexts.

Following is a checklist to guide your mobile learning design:

1. Target group - for whom is the mobile inquiry-based learning scenario intended?
2. Learning objectives - what do you want the students to learn and experience?
3. Content - What type of content will the students be confronted with and the (technological) support required to facilitate learning and promote learner agency?

4. Context - where do students learn this? what are essential elements in the (formal and informal) contexts needed to achieve the learning objectives? What are relations to practices beyond the curriculum?
5. Learning activities and phasing - what do students do? How do the learning activities (in the different (formal and informal) contexts relate to each other? E.g., where do you start (or school or at ...), what follows?
6. Didactics: Starting points - what type of learning process (e.g, inquiry-based learning, self-regulation, feedback and reflection) do you want to support?
7. Didactics: Control - What is the responsibility for the learning process?
8. Didactics: Guidance - What (pedagogical) support do students receive? from what or from whom?
9. Peer-to-peer interactions: What forms of interaction (synchronous/ asynchronous) will engender learning in your activity design?
10. Contextual support (Tools and technological) - What is the role of technology in the learning and support process?
11. Evaluation and assessment - when is your design successful? what should the result be? how do you determine that?

Materials (will be provided)

- Analytical framework & tools
- Design template

Concluding session (45 min)

Gallery walk and presentation of mobile inquiry-based lesson designs, followed by a concluding discussion about issues arising and directions for future work in the mobile learning: smart technologies, smart data and smart learning spaces.

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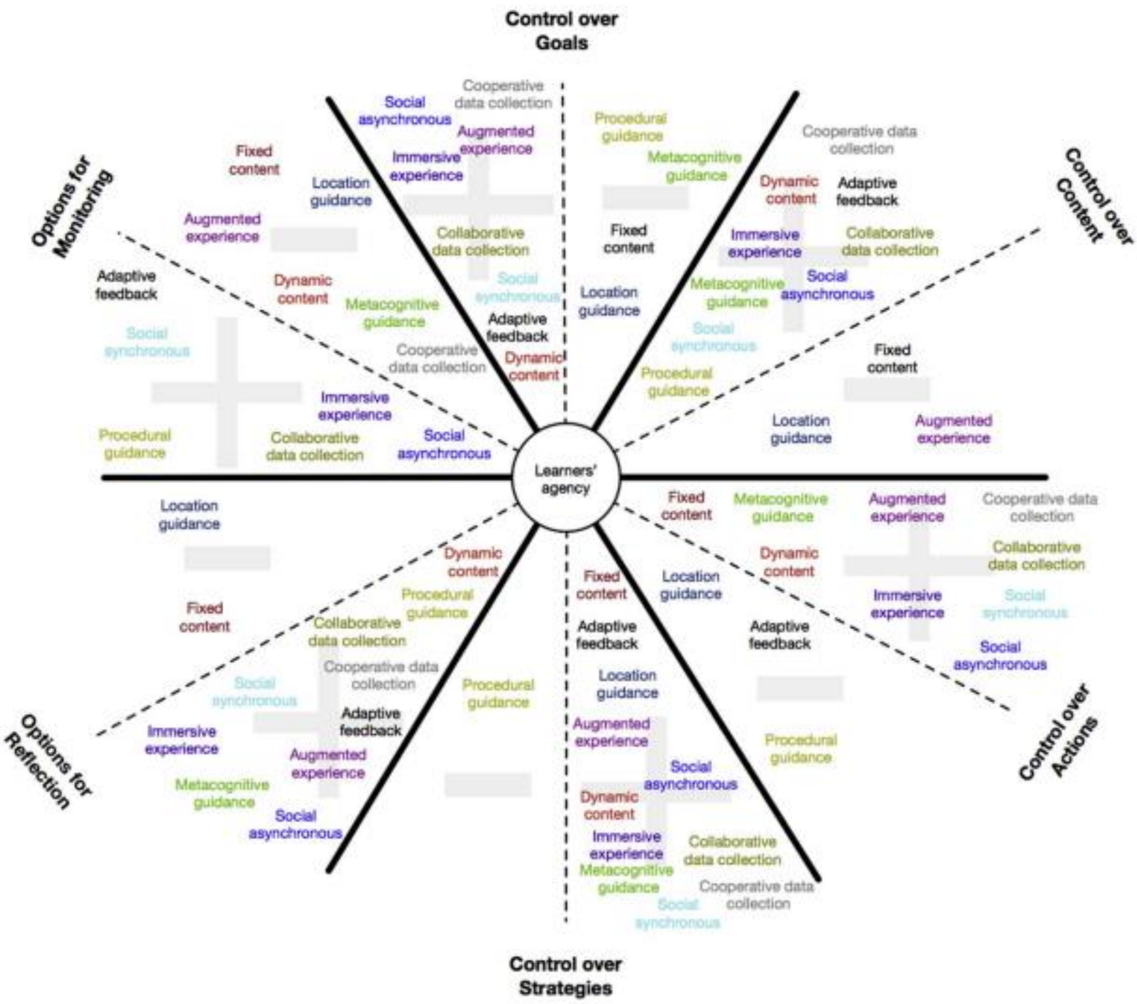
APPENDIX 1

The 12 types of mobile activities based on the six-dimension analytical framework (Suárez, Specht, Prinsen, Kalz, & Ternier (2018).



APPENDIX 2

Technological support for mobile inquiry-based learning and learner agency (Suárez, Specht, Prinsen, Kalz, & Ternier (2018).

Table 1. Contextualized Guidance and Instruction

Direct instruction	**Technological affordances**
Location guidance	GPS, Radio Frequency Identification (RFID), Quick Response Codes (QR codes), Personal Digital Assistants (PDAs) & Geocaches
Procedural guidance	Task/process execution, question-guided tours, process or collaboration scripts
Metacognitive support	Mental model construction, carry out interpretations, scaffolding to understand scientific concepts, reducing cognitive load in data collection & interpretation processes.

Table 2. Access to Content

Access to content	Technological affordances
Fixed content	Local repositories, preloaded e-libraries, preloaded mobile apps, RFID tags, QR codes, Geocaches and digital artifacts triggered with GPS and AR
Dynamic content	Browsing, filtering, interpreting information found on the web, remote databases, concept maps, discussion forums, KWL (What do I know/ wonder/ learn) tables, online blogging, wikis and social networks.

Table 3. Data Collection

Data collection	Technological affordances
Cooperative	Capturing multimedia data, taking notes, drawing schemas, multiple choice questions to guide data collection and collect information for KWL tables.
Collaborative	Collaborative concept maps and graphical data visualization of data jointly collected.

Table 4. Peer-to-peer interaction

Peer-to-peer interaction	Technological affordances
Synchronous	Instant messaging, chats with notifications.
Asynchronous	Forums, online discussion panels, online platforms without notifications and social boards.

Table 5. Contextualized support

Direct instruction	Technological affordances
Augmented experience	GPS, timer or accelerometer
Immersive experience	GPS, big display for immersive simulation, stargazing simulation, 3D weather simulation.
Adaptive feedback	intelligent systems that give hint for making further observations

Corporate Showcase

VISIAGORA BY CLL LANGUAGE CENTRES: AN INNOVATIVE DISTANCE LEARNING EXPERIENCE AND PEDAGOGICAL APPROACH IN A VIRTUAL CLASSROOM

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ABSTRACT

Providing an innovative solution for distance language learning is nowadays very challenging. The distance teachers are most of the time left alone to set up their classes and teaching material whereas learners are struggling to keep motivation at a high level.
After 2 years of research and experimentation, CLL Language Centres (associated to the Catholic University of Louvain-la-Neuve in Belgium) developed and launched an innovative solution, Visiagora, where classes are based on a communicative approach and are built up around a pedagogical structure of 30 minutes in a virtual classroom: learners benefit of the experience of a short but intense one-on-one class with the features of a physical classroom but are taking their language course from the comfort of their home or office. As a result, the learning experience and motivation is increased and the foreign language acquisition becomes more efficient.
This paper goes through the innovative and communicative pedagogical approach and structure of our 30-mn classes: they are composed of 7 phases (introduction, lesson overview, comprehension activity, consolidation activity, presentation activity, production activity and delay correction & summary). It also develops the features of our virtual classroom and whiteboard, which enable the learners and teachers to benefit from all the features of a physical classroom. To conclude, the learning and teaching experiences from the perspective of learners and teachers are presented.

KEYWORDS

Distance Learning, Virtual Classroom, One-On-One Classes, Innovative Pedagogy

1. INTRODUCTION

Technological development has resulted in new consumption patterns and the world's population being increasingly connected. Changing consumption patterns (with a focus nowadays on flexibility, immediacy and availability) are also present in the world of education and training. Developments in the way content is provided is a core part in this movement.

Online training, it often noted, takes place almost entirely asynchronously however we believe it is essential to offer synchronous training in the model of distance learning. For this reason, CLL developed and launched Visiagora, a unique distance learning solution in Europe.

2. VISIAGORA

CLL Language Centres was founded by the *Catholic University of Louvain* (UCL) in 1984. Since then, we have been providing language training to over 25,000 people each year in 37 languages.

In 2018, after 2 years of extensive research on technological and pedagogical innovation and thanks to our 30-year expertise and experience, we launched Visiagora; a high-performance and unique solution in Europe that represents a major asset in the learning process allowing students to follow language classes from anywhere and at any given time.

Visiagora presents a strong solution towards language learning via an online platform. While innovative due to its pedagogical and technical aspects, the platform also offers tailor-made language training enabling learners to achieve their objectives, live and online, whenever and wherever they wish. The platform incorporates all the tools necessary for a user-friendly experience; an intuitive dashboard on which learners can access the profiles and calendars of teachers, book their live online classes, manage class bookings and access the virtual classroom.

The virtual classroom is notable for its ease of use and efficiency, which is inspired by classroom teaching while facilitating interaction. The virtual classroom features an interactive whiteboard, a chat room, innovative teaching materials and the ability to interact orally and visually with the teacher. It is a comprehensive tool, easy to use yet powerful, and that requires no installation or plugin. Only an internet connection and a computer with a webcam, microphone and speakers are necessary.

3. PEDAGOGICAL APPROACH

3.1 Vision

• Tutoring

Our research demonstrates that almost half of learners do not complete their training if they are not accompanied by a teacher. A digital tool is thus only useful if it is well directed and can become meaningless without teachers' active intervention. Tutor intervention is therefore an essential part of live online learning and increases the completion rate of online courses.

• Tailor-made

The primary factor encouraging learners to pursue training is the link with a specific issue or need. Additionally, most learners are encouraged by the availability of self-service learning at any moment. Learners increasingly want personalised and relevant pathways for their learning needs, and are willing to take responsibility for their training, and to access it when they see a pertinent need.

• Commitment

Quality of content encourages learners to complete and return to their training. Interactivity, pedagogical approach, teacher quality as well as the overall user experience are important factors.

Visiagora's pedagogical approach is therefore based on the following concepts. Learners:

1. interact with expert native-speaking teachers.
2. are exposed to authentic tasks and to a variety of creative activities.
3. are guided through the learning process.
4. work in a positive atmosphere.
5. autonomy is encouraged.

3.2 Course Organisation

3.2.1 Placement Test

Beginning their course, learners undergo CLL's placement test to determine their level according to the Common European Reference Framework for Languages. This initial test has two purposes: to assess the candidates' current levels of knowledge and to test their motivation.

The language test consists of five parts (grammar, vocabulary, written expression, listening comprehension and oral expression), four of which are interactive and electronic (adaptive online test), and one happens during the first live class. This allows Visiagora to validate the learners' levels but also to set up ice-breaking activities ensuring learner-teacher cohesion. Teachers also identify learners' strengths and progression of learning.

3.2.2 Live Online Class

The classes take place in our virtual classroom and last 30 minutes. Individual class sessions are scheduled between learners and teachers via teachers' calendars, accessible online using our platform.

3.2.3 Evaluations

Teachers query learners during the fifth class to gather their opinions on the course and to ensure that the training corresponds to their expectations: this allows to rebalance the work required for each linguistic skill and to review the strategies adopted until then.

To allow learners to assess their progression, teachers regularly organise ungraded evaluations: those are simulations in which learners are brought to reinvest the communicative and linguistic elements seen in class. Learners also perform a self-evaluation that allows them to reflect on their progress, difficulties and overall satisfaction. Teachers may also mention any successes, areas of progress and means to be put in place to facilitate the consolidation of the language.

An evaluation test is organised at the end of the cycle. The test is carried out by teachers and concerns the content of the program followed by learners. It determines whether learners have achieved the objectives that were set according to their level. Similarly, to the placement test, the evaluation test consists of a series of varied and calibrated exercises that define learners' levels in oral comprehension, written comprehension, written expression, oral expression and interaction.

3.3 Course Structure

3.3.1 Participation

Learners are considered as actors in their own learning, progress and areas of improvement. They are active participants in the progression of their courses, taking part into the preparation process, thus becoming more responsible and more motivated.

Teachers' role is no longer limited to the transmission of knowledge. They also accompany, guide, support and encourage learners in their activities. They help learners enriching their vocabulary, assist them into expressing their needs and provide constructive feedback.

3.3.2 Session Structure

Classes follow a specific structure:

- Phase 1: Introduction and lesson overview

This phase allows learners to feel at ease and motivate them as a mean of reassurance toward the linguistic context. In order not to discourage them, no direct corrections are made. The goal is for learners to realise that communication is possible despite errors.

The learning objectives are clearly stated and include both the content and the outcomes of the learning session.

- Phase 2: Icebreaker/starter

Icebreakers are crucial to build rapport with learners, to put them at ease and to allow teachers to start assessing the learners' levels.

- Phase 3: Comprehension activity

This consists in presenting the vocabulary that will be explored in the functional language within the lesson and establishing the semantic content of the lesson.

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• Phase 4: Consolidation activity

This is the opportunity to practice the vocabulary presented and consolidate the semantic content. This will lead into the following activity which will consolidate the language functions that have already been touched on.

• Phase 5: Presentation activity

This is the re-presentation of the key language functions and integration of new vocabulary looked at during the lesson. The grammar and vocabulary are presented as a functional tool to assist in the objective of the lesson, or, in other words, a “toolbox”.

• Phase 6: Production activity

This is an opportunity to put everything together and practice speaking using the functional language and other aspects (grammar and vocabulary) of language together. This takes up most of the lesson and is the best way for learners to speak and practice what they have learnt.

• Phase 7: Delayed correction and summary

Learners are left with a good idea of what they have done and what they need to do to improve next. It starts with delayed correction and feedback on the speaking activity. This is a good opportunity for drilling and other practice. The lesson concludes with a summary of the objectives and learning outcomes.

4. TEACHING AND LEARNING EXPERIENCES

The advantages of Visiagora for learners are numerous. They include the automated and simplified registration and placement test, the online and fully flexible class booking, a real and complete virtual classroom, classes with qualified and experienced teachers as well as innovative pedagogy and expertise. These advantages offer the flexibility and immediacy required by learners and therefore encourage learners to commit to their learning, reinforcing their autonomy and improving their progress.

Teachers also benefit of numerous advantages: they have access to a single platform allowing them to manage their availability, access their online classes and teaching materials, and thus provide their classes from any location connected to the Internet. The structure and teaching materials necessary for a course session are fully provided and can be accessed directly online. In addition, teachers receive a full onboarding as well as ongoing professional development ensuring that they are up-to-date with Visiagora’s innovative pedagogy.

AUTHOR INDEX