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DESIGNING A SITE TO EMBED AND TO INTERACT WITH WOLFRAM ALPHA WIDGETS IN MATH AND SCIENCES COURSES

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ABSTRACT

This paper reports design and implementation outcomes at middle development advance of an educative program based on use and construction of widgets on Wolfram Alpha platform at higher education level for engineering and sciences areas. Widgets were based on Physics and Mathematics curricula under Project Oriented Learning and Blended Learning methodologies. Widgets constructed by teachers are first used by students to appropriate basic concepts of each course on a mobile learning basis; after, students construct their own widgets applying that concepts but involving different applied situations based on curriculum integration. Two phases of this activity help to develop basic and high level thinking. Description of design combining Wolfram Alpha widget developer, Weebly and Jotform tools to set up the widgets, institutional current advances on teachers training, courses involved and current outcomes of project are presented.

KEYWORDS

Resources, Blended, Design, Mathematics, Sciences.

1. INTRODUCTION

New generations have an increasing expectative about freedom to work, learn and study. Technology has made last expectative easier by establishing an increasing demand of accessible online resources. As educative trends identified with use of technology are related with more successful professional life, there are a higher value in digital abilities, best educative goals and higher demand on adaptative instruction (Johnson, Adams and Haywood, 2011) and technology has an increasing role in education. Every day is more common to include online elements as a planned educative strategy. Terms as blended and hybrid learning has been coined because mobile technology lets to be connected with information, evolving as a media on which education can be delivered to its final recipients. Currently, mobile technologies are main media to access internet (Johnson et al, 2011) while lots of tools for education purposes appears (Edublogs, 2013).

What kind of learning is developed with those tools? Meaningful learning (Ausbel, 1963) is a consolidated term established in modern education when knowledge is growing exponentially and university curricula is continuously diversifying, so students should learn contents whose relationship with themselves, their environment and future requirements is unclear and confuse (Woolfolk et al, 2010). For meaningful learning, any new learning should be based on a prior cognitive structure, to show a deliberate effort to relate it to structures of higher level thinking, to be related with experiences on events or objects, and to include an emotional connection toward prior knowledge and applications. Many authors bring into question meaningful learning (Gaer, 1998; Woessmann, 2001) based on skills for life instead of dense curricula as policy.

2. PROJECT BACKGROUND

Ubiquitous connectivity has generated a large-scale development of applications (Apps) which accompany users all time. With them, each user interacts with its environment. Thus, internet has grown as not official source of learning, so, teachers should be involved with creation of resources using meaningful applications which could improve learning quality and encourage students to apply knowledge in real constructions at same time. In last twenty years, Monterrey Tech has been changing its educative strategies. Ten years ago, Problem Based Learning (PBL) (Polanco, Calderon & Delgado, 2001), Project Oriented Learning (POL) (ITESM, 2007), Curriculum integration and Use of technology (Delgado, 2011) for engineering disciplines (Delgado, 1999) was introduced to improve quality and meaningful learning. Currently, an institutional program for mobile learning seeks to use several technological tools to improve some aspects of education. Tools require to be accessible, easy and useful for each discipline and learning activity, letting an ease implementation by general faculty, not necessarily specialized on them. In this program, use of online tools developed by third parts are been useful to reach last condition. Main intention is that mobile resources should be useful to scaffold learning weaknesses.

A tool which is thoroughly used in math courses is Mathematica (Wolfram, 2013a). Due its syntax, this tool requires a sustained effort of teaching and learning, which remains viable under premises of periodical tracking and a faculty with the same learning orientation. Wolfram Alpha (Wolfram, 2013b) is a recent development with similar characteristics but simpler and more specific; currently free for some of their main applications and including a widget developer with similar structures those included in Mathematica (Educastur 2012). These elements can be displayed on mobile devices when are embedded in applications as Weebly (2013) and their use allows obtain or analyze information. Widgets and their construction could be focused on the domain of knowledge to be shown. iTec initiative (2013) has selected them as a key piece in learning.

Wolfram Alpha widgets let an online mathematical educative interactivity in two ways: a) exploring an abstract concept through interactive visualization developed by a third part (teacher or another student), and b) developing complex thinking when student constructs his own widget carrying out an abstract concept into real visualization. In this project, widgets are included in a didactical purpose where student is encouraged first to discover some aspect of theory and after, to use their knowledge designing new widgets to visualize related concepts. It is the aim of project been considered here whose main lines were depicted by Delgado (2013a) and covering around of 1200 students.

The aim of this paper is describe the final didactic and technologic design for implementation and some qualitative previous results. In the next section, a brief description of project context is stated. After, the tools involved are discussed together with the final structure of activities and basic construction for whole site is shown. Finally, some partial outcomes related with implementation are shown, including teacher training and further recommendations. Paper is closed with conclusions about future implementation.

3. PROJECT ADVANCES: DESIGN AND TRAINING PROGRAM

Mathematics and Physics curricula in Monterrey Tech is ambitious and requires a heavy training by students to appropriate concepts, laws and algorithms taught. Learning is not always based on applications or visualizations, neither the use of it to develop a higher level thinking. Inclusion of growing contents and skills development in mathematics and science courses, together with reduction in effective hours in them has generated weaknesses in concepts comprehension, so students requires more educational elements as support. An educative program based on use of widgets generated properly by teacher will permit a better comprehension through visualization of theoretical concepts in two ways: from application to theory when student uses a widget, and from theory to application when student design and construct own widgets. This two folded intention closes the learning process around a theoretical concept.. Student construction of widgets, through small projects in courses, would allow learning processes at level of analysis and creation in the Bloom taxonomy, which, together with mobility and gamification (Zichermann and Cunningham, 2011) components involved, would work as a strong affective and meaningful learning.

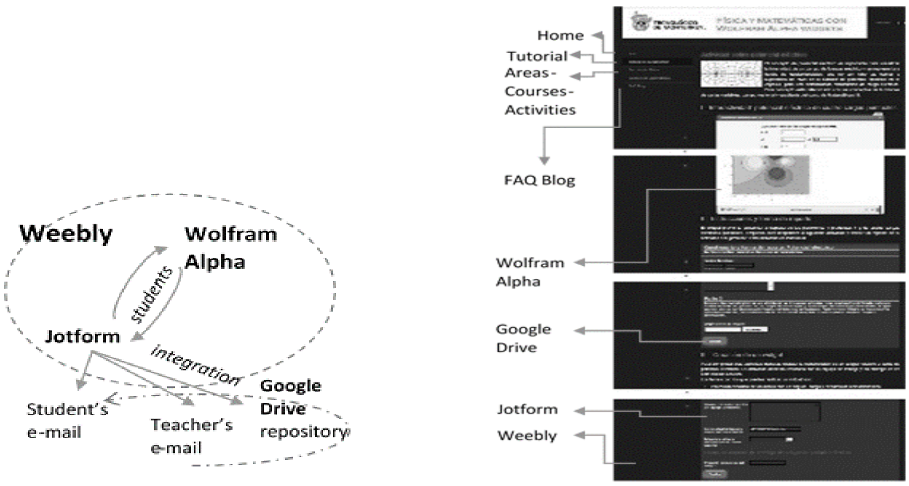
3.1 Technological Elements to Reach Educative Goals

In the first part of each activity, the widget constructed by teacher fulfills two educative goals: a) to identify relevant variables associated with specific abstract concept, and b) to comprehend how an abstract concept is related with an element of reality. This part is accompanied with a questionnaire to generate interaction with the widget. Both elements should appear together to let: 1) interaction, 2) report information and results (text, images), and 3) get a receipt of acknowledgment for student and confirmation of submission for teacher. This integration was solved with Weebly constructing a site with those elements embed. Thus, Wolfram Alpha widget was inmersed in a planned didactical activity. Jotform tool lets to create submission forms of data or files embed in that site, letting to send receipts and alerts of submissions as was desired.

Second part of activity is a complementary practice in widget construction by students, developing high level comprehension based on: a) identifying the full set of variables to visualize an applied problem, and b) integrating the main concept involved with other concepts in related courses. Construction and comprehension are normally inverted: widget construction is possible just if student has used widgets, but construction generates comprenhension benefit with other students (Delgado, 2013a). Description of activity and a form of submission to report the widget externally constructed is provided here (requirement covered with Jotform) and information related with student (author). Figure 1a resume interactions generated in the whole activity: relation with the three tools used in the implementation and delivered products.

3.2 Design of Site and Activities

POL based on use and construction of widgets should involve a set of courses (transversal and sequential) in which integration of concepts would be present, requiring an initial construction of widgets based on critical main topics based on curricular integration. This basic construction will serve as guide to other teachers to extend it to other courses. Final impact expected includes 25 teachers and approximately 1200 students (80% of students in Physics and Mathematics department's courses, a 30% of whole population). First phase will be deployed in January 2014 covering 30% of this statistics, at this time teacher's training course had been offered. Widgets use and development in parallel courses will promote curriculum integration in basic and engineering sciences courses, promoting a better domain of basic concepts. Courses involved and their curricular relations boost curricular integration when a specific widget is constructed (Delgado, 2013a). Figure 1b shows sections of a characteristic activity, as was developed in Weebly, showing general menu of site (Home, Areas and Courses, FAQ blog) and an activity section (Widget, Parts I and II activities with associated submission forms). Jotform lets an integration with external repositories as Box, Dropbox, Google Drive (last was used here).



a) b)

Figure 1. a) Interactions description between student and widgets site through tools inegrated on Weebly; b) characteristic activity sections: Wolfram Alpha widget, widget interaction questionaire (part I) and widget construction specifications (part II). Upper section contains a general menu with support sections of site.

First phase was centered on mobile site construction (Delgado, 2013b) integrating Mathematics III, Electricity and Magnetism, and Differential Equations courses containing: a) Tutorial. b) Analysis activities by widget built by teachers on strategic and representative topics (there, reader can actually review widgets and activities constructed). It includes interactive widget, questions associated to generate interactivity and online report format to send to teacher and includes complementary activities for widgets development by students (based on analysis and concepts comprehension before taught). c) FAQ blog. Didactic guides for each widget were designed grouped in four blocks (in agreement with chronological advancement contents) as proposed brief projects to be developed monthly. Second phase development will include courses as Differential and Integral calculus, Probability and Statistics, Mechanics, Fluids and Thermodynamics.

3.3 Teacher Training

Actually, first phase is complete to start on August 2013. Training program was designed on 70% about the use of Wolfram Alpha Widget Developer and 30% in Weebly and Jotform (last contents is no so relevant because general formats of activities was created being applicable for whole courses with just minor changes. Training includes an extended workshop of following to teachers teams complete defined activities by course. Actually, a central group of teachers, working in phase I, are fully trained. For remaining faculty, training will result in the creation of collegiate mobile sites similar to previous, now for Mathematics I and II, Physics I and II, and Probability and Statistics courses. Last will require design similar sites, organized by a selected teacher as team leader. Training will include following: 1) Wolfram Alpha accounts; 2) Wolfram Alpha widgets construction; 3) Weebly account sharing, cloning and editing current activities; 4) Creating a Jotform account for each course; 5) Jotform basics: sharing, cloning and eding project submission forms; 6) Integrating Jotform with Google Drive; 7) Making a full activity in a selected course.

3.4 Preliminary Insight

Three pilot groups using Wolfram Alpha widgets in Differential Equations, Physics I and Numerical Methods courses were runned in august-november 2013 applying a perception test of students obtaining a qualitative insight about impact on learning. Outstanding positive comments were: 1) visualization lets a better understanding of abstract concepts and connects those concepts with reality, 2) widgets construction extends the range of comprenhension of a concept and it reveals hidden connections with related concepts in other courses. A reiterative improvement suggestion of process was remarked as offering a brief introductory workshop for students about widgets construction is necessary in order to speed up student abilities.

4. CONCLUSIONS AND FUTURE WORK

Mobile educative tools are spreaded for different purposes, so nowadays technology is easily available for teachers to generate learning products. Wolfram Alpha widgets let teachers to show different concepts through visualization and to let students explore and interact with theory and reality. Higher level comprehension is achievable when process is reverted and students generate own widgets related with similar concepts because it requires a deep understanding and analysis about critical variables involved.

Visualization normally goes faraway reaching good level of representation, other related elements should be present because concept being represented will require additional mathematics. Thus, teachers could generate curricular integration adding educative gain in learning, in particularly if it is conducted by the same faculty and collegiate groups because them are able to decide each construction based on selected concepts in parallel courses. Curricular integration is being warranted taking care to emphasize that kind of relationships.

Wolfram Alpha developer has an advantage on Mathematica being relatively easy and programming free. Last means that the whole faculty could generate their own widgets easily. Each student will spend just the time for planning and reflecting about how construct each widget, in order to integrate the different contexts involved in almost just one instruction of Wolfram Alpha, but gathering the several variables and concepts which are relevant to represent each problem. In this sense, time investment should be continuously recovered through periodic activities which let student to deep in course concepts and associated applications. In the past, those constructions were based with more complex tools and programming was involved. Today, there are a lot of compatible tools which can interact in order to develop a more complex educative idea, which in addition is every time more independent from hardware and operative systems in mobile platforms. Such is the case of tools used to solve and to develop interaction requirements stated here: integration, embedding, submitting, stocking up and gathering. Thus, knowledge about tools as Wolfram

Alpha, Weebly, Jotform and Google Drive lets construct a more complex product for educative goals in easy way. This knowledge could boost other educative projects or give to teachers more ideas about further development in same project. Teachers training could be directed to extend the project in other courses because tools involved are so friendly that people could learn them easily. Is remarkable that computer technology has been rapidly developed being this project carry out exclusively by teachers as a collegiate group, where any technological assessment has been provided.

Future work will be based on two aspects: a) to extend the program to the whole courses of Physics and Math department, and b) to include a complete evaluation of educative outcomes by collecting and analyzing students results. A follow-up study should be carried out before and during the initial and global deployment.

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