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SMALL PRIVATE ONLINE RESEARCH: A PROPOSAL FOR A NUMERICAL METHODS COURSE BASED ON TECHNOLOGY USE AND BLENDED LEARNING

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ABSTRACT

This work presents a proposed model in blended learning for a numerical methods course evolved from traditional teaching into a research lab in scientific visualization. The blended learning approach sets a differentiated and flexible scheme based on a mobile setup and face to face sessions centered on a net of research challenges. Model is presented being supported by previous research works about its performance in terms of effective evaluation and skill development.

KEYWORDS

Blended, MOOR, Engineering, Mathematics, Research.

1. INTRODUCTION

Education is changing in an irreversible way due to technology, while digital natives' generation is pushing education into the technological arena. Nevertheless last concept is questioned and technology is not guiding completely learning processes, there is a challenge demand for science and engineering education for the next decades in terms of availability and quality standards in math, science, and engineering. Despite, deep differences in the incoming levels of technical skills for engineering programs' students will require optimal and differentiated schemes of instruction.

Laurillard (2005, 2008) has appointed that mobile technologies could enhancing the professional learning of disciplines under adequate contextual designs. That is particularly true for engineering education, which continuously involves new technologies as professional software to simulate, plan or calculate scientific and engineering processes. Today, this skill development is frequent in the university courses, promoting computer lab components together with the theoretical concepts. In addition, informational technology has gained terrain in education by proposing advanced and flexible scenarios to support the face to face sessions as a blended approach now centered on advanced learning activities. In terms of demand, Massive Open Online Courses (MOOC) and Research (MOOR) are being imposed as possible models of large scale instruction at the university (Gleeson, 2014). Nevertheless, other models have bet to lower scale instruction (Goral, 2014) as Small Private Online Courses (SPOC).

This work proposes a blended scenario for the Numerical methods course based on Challenge Based Learning (CBL) resting on mobile technology as support to introduce or reach in the face to face sessions, learning processes more elaborated oriented to the professional or research competencies development. The aim is set the concept and methodology of a Small Private Online Research (SPOR), whose justification was reached in a previous research work based on a first year of implementation (Delgado, 2016b). Last work exhibit the possibility to blend the basic knowledge content as online study together with oriented research face to face sessions in terms of the individual performance tracking for each student. The proposal moves the instruction on research based activities while the basic content is mainly covered online. The second section depicts the Numerical methods course as key in engineering education to support the orientation of the proposal. Third section presents the learning approach as is currently being applied in the course and its current outcomes based on an initial deployment to support its viability. Fourth section includes the conclusions.

2. NUMERICAL METHODS AS PROMOTOR OF HIGH LEVEL SKILLS

Numerical Methods courses are mandatory in the engineering programs at the university. This course is normally located after theoretical math and science courses, bringing the opportunity to review and to apply concepts since the numerical perspective of Calculus as well as to analyze more complex problems than those reached by analytical methods, connecting deeper math and science with engineering. For this reason, the traditional teaching has evolved with the spread of computer systems, demanding a transition from a Numerical Analysis course into a Computer Simulation one, moving to students into the professional practice. Numerical methods is a key course to align Higher Education with STEM prerogatives, in addition, it promotes scientific skills in the university engineers education.

Several years ago, an improvement was generated in the course by the inclusion of projects development related to scientific visualization in a curriculum integration context (Delgado and Martínez, 2011). To support this challenge, the author began to introduce complementary technologies in the course in addition to those oriented to develop the planned course skills (Excel, Mathematica, Phyton, etc.). As a result, since 2011, consolidated technologies and some additional emerging technologies let to reach a mobile learning approach in the course (Delgado, 2013). Through time towards, a blended scheme was constructed reaching compatibility between mobile resources and CBL orientation for the course (Delgado, 2016a). Blended learning has demonstrated its supposed efficacy there (Lothridge et al, 2013) through of modern and affordable technologies as Blackboard, Weebly, Socrative, Classmarker, Jotform and You Tube to round the blended strategy covering efficiently Flexibility, Evaluation, Learning styles inclusion, Scaffolding, Screencasting, Reporting and Feedback (Delgado, 2016b), which currently are supporting the basic knowledge acquisition (before given in the face to face sessions), not only as supplement (Wood et al, 2004).

3. SMALL PRIVATE ONLINE RESEARCH APPROACH

The last changes and requirements in the Numerical methods course have boosted the learning evolution into more flexible activities now reached through a blended scheme. Defining alternative paths to teach, to develop skills and to construct engineering competencies, a scaffold teaching strategy has been realized. In parallel, more complex, intensive and integrated research scenarios were introduced as guidelines and goals for the course.

Massive Open Online Research (MOOR) is conceptualized basically as a reduced MOOC with emphasis on research. Goals and recipients are different, MOOR's are oriented to work together in teams to solve a practical problem, thus working on targeted research projects under the guidance of a researcher (Hosler, 2014). Nevertheless, a better approach in Numerical methods course should consider the programmed inclusion of several course topics in the research in order to cover the contents, together with a more dynamic movement on short problems. Other version of MOOC's is a Small Private Online Course (SPOC), defined as an online course based only on a segment of the university. Then, being based on blended learning, this approach focuses on local requirements, including some face to face interactions (Goral, 2014). For these reasons, the ad hoc proposal for the Numerical methods course was labelled as Small Private Online Research (SPOR), being allocated on a selected segment of university and oriented to multidisciplinary research (Numerical methods course involves students of Chemical, Mechanical, Mechatronics, Electronics, Industrial and Biotechnological Engineering programs).

3.1 SPOR structure

Based on the analysis developed by Delgado (2016a), the new interactions emerging behind of the mobile approach for the course and the effective outcomes of blended activities included as individual and predictive evaluations of individual performance, a parallel instruction scheme is understood in the SPOR approach. By replacing the basic contents coverage in the face to face sessions with a series of research problems as guidelines (covering the basic contents in their development) and moving that basic coverage into a pure mobile learning strategy, the SPOR skeleton was stated. Thus, each student selects their resource learnings, pace and evaluation route in a flexible version for the course through resources as: a) daily screencasting series in a You Tube channel, b) extended repositories including simulations and programming codes,

c) theoretical reviews through an interactive e-Book for the course, d) individual homework (no mandatory, but alternative) and d) formative and summative evaluations alternated and being reached with Socrative and Classmarker tools. In parallel, in the face to face sessions, the teacher presents and develops in teams, scientific and engineering problems requiring numeric simulation and computer visualization. The connection between two knowledge layers is reached by integrated activities derived from the individual learning in the screencasting and in the basic evaluation. Thus teamwork activities are little projects or developments at the end of each knowledge unit and co-evaluated with periodic exams. Figure 1 shows a global scheme about the SPOR strategy, showing the basic exams (allowed to be presented in more than one time) at the end of each unit and the three component exam for each term including (only in necessary cases) this basic evaluation together with topics related to teamwork and research projects. Each semester includes three of these terms or segments (Delgado, 2016b).

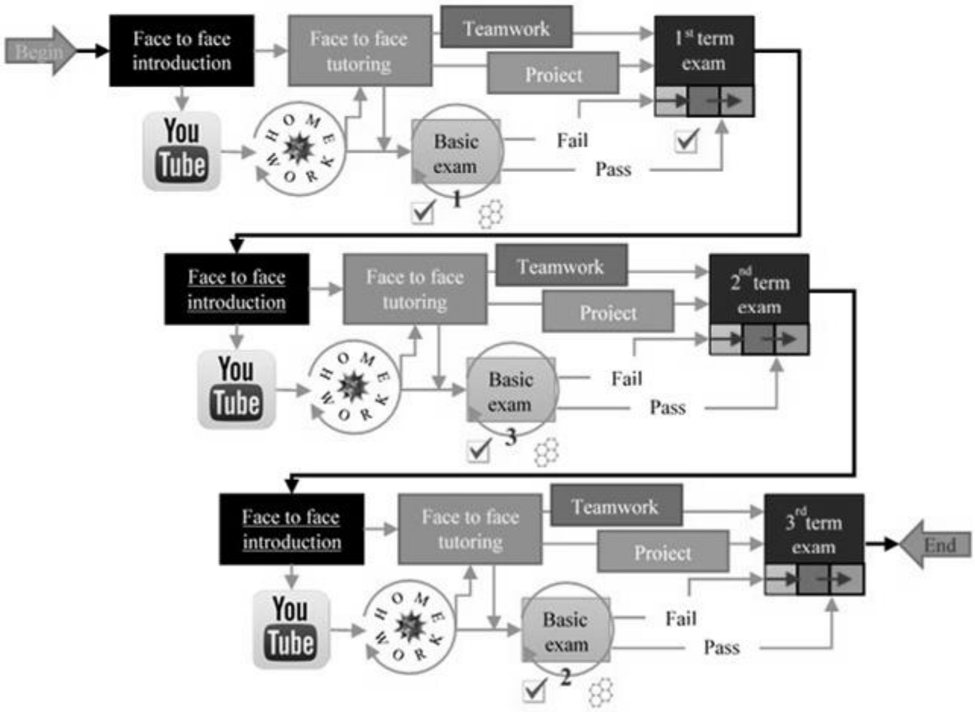

Figure 1. Main course activities and their chronology in the SPOR approach (Delgado, 2016b).

3.2 SPOR viability

One of the main concerns in online learning is related with the grade discrimination between individual and team evaluation components. This issue has been focused in a wider open way for the Numerical methods course. A CBL course develops skills and competencies as goal, so a stronger system of evaluation should be developed to reflect realistically this pretension. The SPOR approach has been validated by comparing individual and team performance of several dimensions: knowledge, skills, and competencies (Delgado, 2016b). In the analysis, the learning model shows a good discrimination for good and low performance students, in particular for the online evaluation. To summarize the outcomes reported there, the Figure 2 plots for the students in the first two years of implementation (2014-2015), the ratio between the averages of individual and teamwork grades (I/T x 100) –those associated with individual and team homework or exams- versus the average of teamwork grades for each one. The color of each dot correspond to the final grade in the course (Dark gray: <70, fail; Medium gray: between 70 and 85; Light gray: >85) and its radius was settled as the average number of times each individual Basics Exams was presented by the student through the overall course. In the course, 70 is the threshold to pass. First note the teamwork well performance. Then Figure 2 shows that individual activities discriminates very well to the good and satisfactory students (correspondingly located next to the dotted vertical line where team and individual effort is comparable). For unsatisfactory students, discrimination still works except for some few cases not properly allocated (those students next to the dotted vertical line). The number of applications in the individual Basic Exams is not correlated with their average (R^2=0.02), so this aspect of flexibility in the course do not give or remove advantage.

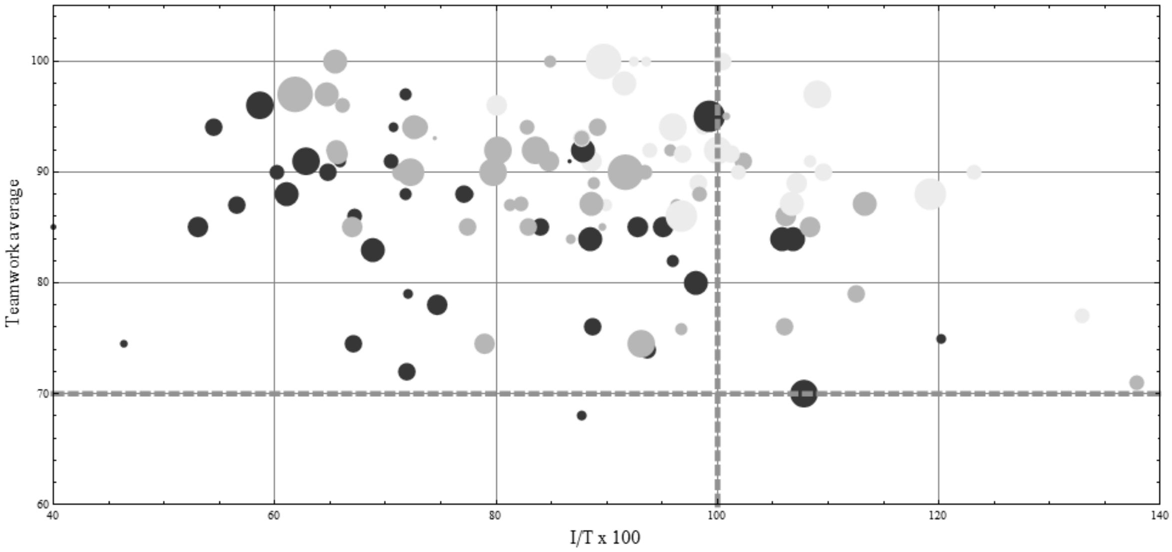

Figure 2. Scatter graph for individual performance outcomes in the SPOR approach implementation.

This scheme doesn't show an increasing in the grades corresponding to the basic knowledge segments, instead a deep development in solving applied problem skills. For the middle level students, a deep interpretation about the course final goal is still open in terms of the model to construct a global grade in it. Additional research in SPOR evaluation is still in order.

4. RESEARCH PROJECTS IN THE COURSE

Research projects using CBL strategy are based on short simulation and visualization tasks for science and engineering in each one of the three periods in the course term. The net of projects used in the first year of deployment for the SPOR approach is depicted in the Table 1. The projects are related to Mechanics, Cellular Automata rules, Heat diffusion, Electromagnetism, Lighting, Chaos, Complex kinematics and Bacteria growing models. Each project reviews several numerical methods included and developed in the online activities. The projects promote innovation and specialized research in the group of students. Teams of utmost four students are created in each period to develop the teamwork activities. The net of projects enhances and extends skills and competencies because each one summarizes previous knowledge into visual applications. In the SPOR scheme, basic knowledge and research problem solving become complementary.

Table 2. Net of projects and relation with the five units of the original course contents.

Projects	Non-linear equations	Derivatives and Integrals	Equations system	Interpolation and Approximation	Differential equations
Mechanics	X	X	X		X
Kinematics	X	X			X
Lighting	X	X		X	
Chaos	X	X	X		X
Heat diffusion	X	X	X	X	
Electromagnetism	X	X		X	
Cellular automata	X		X		X
Bacteria growing	X		X		X

5. CONCLUSION

Renewed schemes of instruction and education should be running to get a better approach in terms of effective promotion and flexible strategy. Blended schemes as the depicted here should be experimented and improved currently to be disposable for new generations. In a few years, several courses should be evolved into MOOC, MOOR or SPOR schemes, changing the traditional higher education as it has been known.

Skills and professional competences require a continuous practice and several steps before to be owned, superseding any course extent. Traditional evaluation is limited to the contents dominion, with uncertainty and not at the skilled level that each student need. The evaluation goes beyond the content knowledge, in the arena of skills and of competences development, there is a really complex task for teachers (Schwartz, 2014).

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