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Addressing computer-supported collaborative learning in the classroom: Experiences in engineering education

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Abstract

Every day more and more undergraduate and graduate students use their mobile computing devices during lectures. This situation has been identified by several researchers as a distracting factor. This article presents and discuses two CSCL activities that help delivering the knowledge in engineering courses, at two traditional Chilean universities. These activities have also been used during the last years to deal with the problem of students' distraction, caused by laptop usage during lectures. The results obtained could represent good alternatives to deal with the stated problem.

Keywords: Engineering education; distracting factors; CSCL.

1. Introduction

Students of almost any undergraduate and graduate program use computers to support their educational activities. During the last years these students have began to use their mobile computing devices (e.g. notebooks, tablet PCs and cellular phones) during lectures. Sometimes they use these devices to write comments or explanations that will afterwards be used to understand the knowledge delivered by the instructor. However, they are most frequently used to carry out other activities; e.g. respond emails or look for information on the Web.

Several researchers have highlighted the contribution of mobile computing devices as facilitators of the teaching-learning process (Alvarado et al., 2004; Hyden, 2005; Tront, 2007; Prey et al., 2007; Fried 2008). However, many other researchers have shown these computing devices, particularly when they have access to Internet, can be a

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distracting factor during the lectures (Reisman, 2005; Adams, 2006; Fried, 2008; Wurst et al., 2008; Casas et al., 2009). If they do not play a clear role in the classroom, their use will compete with the instructor's speech or the students' attention; and usually the computer wins.

On one hand, computer mediated social applications, such as email, chats, forums and social networks get the attention of the students during lectures. These applications require just short interactions. Therefore students think these activities (e.g. responding an email) will not affect his/her capability to understand the knowledge delivered by the instructor. Here we can identify several problems:

1. Students think the interactions are short; therefore they always have time for an extra interaction. After a couple of email responses, the students have lost the key issues that allow them to understand the knowledge delivered by the instructor.
2. Although each interaction is usually short, the ideas or thought behind each intervention are kept in the student's mind for at least an extra minute. It accelerates the process in which the student gets lost.
3. Students have raised the conception they have to be connected all the time, even if they are in the classroom. Therefore they want not only to have their devices with them (e.g. laptops and cellular phones), but also to be aware of possible interactions waiting for their intervention.

On the other hand, many instructors do not take advantage of ICT solutions during classes. It could generate a kind of resistance from technology dependent students and also a gap between those instructors and their students. Clearly, ICT has brought several advantages and also challenges to the educational process; particularly to engineering education.

An alternative to deal with the influence of ICT in the classroom is to redesign the lectures dynamic in order to make them more active and participative. The lecture design requires assigning a clear role to mobile computing devices during classes. Including computer-supported collaborative learning (CSCL) activities seems to be a good idea, not only because the students feel comfortable with such activities (Bustos & Nussbaum, 2009; Valdivia et al., 2009), but also because they have shown to get very interesting results (Martinez et al., 2002; Nguyen & Gillet, 2003).

Next section introduces some challenges that are present in engineering education. Section 3 presents a brief background of CSCL activities and describes the activities that we are proposing to deal with the ICT effect in the classroom during engineering lectures. Section 3 also presents some preliminary results. Finally, section 4 shows the conclusions and future work.

2. Some Challenges in Engineering Education

The American Engineers' Council for Professional Development (ECPD), which was the predecessor of Accreditation Board for Engineering and Technology (ABET), has defined engineering as follows (ECPD, 1941):

"*The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property*".

Engineering is a discipline that requires relating knowledge from several domains in order to solve problems in particular areas. Typically, the solutions obtained from an engineering process are represented through a design. Such designs have to be evaluated using several mechanisms in order to ensure that the result of the construction process will keep the features of its design. For that reason the designs have to be evaluated from several points of view; for example, robustness, maintainability, usability, performance and cost.

Engineering education is always a challenge for instructors and students. Advances in materials and construction techniques continually force instructors to re-think the engineering processes. The recent advances and spread of ICT solutions have caused a revolution at several levels. Nowadays, most of the modeling processes, and also the validation of such models, can be carried out in a simple computer that are available for almost every engineering student. Therefore the design challenges to address during instructional process changes in one order of magnitude.

Moreover, several courses materials are currently available on the Web. These instructional materials range from slides to the videos from the course's lectures. Software for modeling and evaluating designs, and also the design of several artifacts are currently part of the knowledge available on the Internet. Students have access to them, also

time (and motivation) to look for such information. It pushes the instructors to know the last advances in their knowledge areas in order to keep the students interested in the courses.

This competition with the Internet knowledge and ICT advances does not make sense. Clearly, this situation requires a change of paradigm in the way of delivering the engineering knowledge. Instructors and institutions must be aware of that, and re-think their teaching-learning process. This paper proposes to use computer-supported collaborative activities to deal with these challenges. The role of the instructor changes from knowledge source to knowledge facilitator. Moreover, the role of the students changes from passive receptors to active learners.

3. CSCL Activities in Engineering Education

Merely sitting a group of students around a table to perform a task does not guarantee that they will cooperate or collaboration with each other. Therefore, it is necessary to structure activities that convey a real collaboration among a group of students (Collazos et al., 2003). In order to obtain real collaboration some CL techniques have been proposed like JIGSAW (Aronson et al., 1978), Student Team-achievement Division (Smith, 1996), Cooperative Integrated Reading and Composition (Slavin, 1991), and Group Investigation (Sharan & Sharam, 1994), among others. Although these techniques have shown to be useful in educational scenarios, they were not designed to deal with the stated problem. Next sections present two CSCL activities, which were designed to deal with the stated problem: *design competition* and *alternatives competition*.

3.1. Design competition

This activity involves four steps. First, the instructor explains a problem that needs to be adressed applying the knowledge the students are acquiring in the course. Second, the instructor assigns teams of 2-3 students. The goal of each team is to develop, in an established period of time (e.g. 20-30 minutes), the design of a solution to the problem. Then, a member of each team draws the solution on the whiteboard and explains the solution to the whole class (Figure 1). Students of other teams have to ask for several issues in order to validate each proposed design.

Finally, after the evaluation process the instructor gives a reward to the teams that proposed interesting designs. The policy to assign such rewards depends on the goal the instructor wants to reach. Typically, this reward is a bonus for the student's score onthe next examining activity.

This activity has been used in computer science courses at the two traditional Chilean universities: University of Chile and Pontificia Universidad Católica de Chile. The design competition activity was introduced in 2008, trying to deal with the stated problem. After the first round of results, this activity has been consistently applied during 2009.

After an introspection process, students and instructors have found this activity removed the focus of the attention from the laptops to the team work. Some of the students used their laptops to specify and redesign their proposals, but nobody used them for sending email or being connected. In addition, students understood that a good design does not depend on the technology you are using. It depends on good ideas and team work.

Students and instructors have increased their motivation to teach and learn because of the design completion activities during lectures. The laptop is no longer an opponent; now it has a role as supporting tool. The authors think this activity can be applied to several other engineering branches.

3.2. Alternatives competition

Most engineering students are experienced in searching information on the Web, and also most of them carry a personal mobile computing device. This activity takes advantage of such situation in order to create a learning scenario. The goal of the alternatives competition is that a team, consisting of 2 or 3 students, learns about two alternatives to solve a problem. The team has to compare them in order to determine in which situation each alternative is the best.

Typically, this activity involves four steps. During the first step the instructor delivers a problem and a couple of alternative solutions to each team. Usually more than one team works on the same problem and alternatives. During the second step, the team has to look for information on the Internet, learn about the alternatives and compare them

(Figure 2). Then, they develop a presentation including 3 slides; one slide per alternative and one slide with the comparison.

During the third step the instructor chooses one student, depending on the distribution of the assigned problems to the teams. Such student has to present the assigned problem, their alternatives and the comparative analysis. The rest of the classmates have to validate the work done by this team. The instructor can choose a member of other team, which analyzed the same problem and alternatives, if s/he thinks the analysis was not good enough.

Finally, the instructor gives bonus points to the teams with good performance. Alternatively, the instructor can ask for the slides to all teams in order to grade them. This is a way to assign bonus points to the teams that were not selected to present their research work.

This activity can take between 60 and 90 minutes. The alternative competition has also been applied in computer science courses in the same universities than the previous CSCL activity. The obtained results were similar in terms of attitude and feeling of instructors and students.

Engineering education represents a challenge for instructors and students. The knowledge involved in such discipline requires relating concepts from several knowledge domains in order to propose interesting solutions to a problem. Advances in ICT have brought opportunities and also challenges to engineering education. One of these challenges is the inclusion of mobile computing devices in the classroom. Typically, students use these devices during lectures to perform activities that do not contribute to the instructional process. Therefore, the use of these devices competes with the instructor speech and reduces the knowledge acquisition carried out by the students.

This paper presented two CSCL activities that take advantage of the technology use in order to enhance the instructional process. These activities have been used during the last years to deal with the problem of students' distraction and also with the knowledge assimilation process. The recurrent use of these activities and the results obtained in experimental courses are showing these activities represent good alternatives to deal with the stated problem. Although they have been used just in computer science courses, it is highly probable they can be used to support the instructional process in other engineering areas.

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