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TOWARDS SUPPORTING THE DEVELOPMENT OF COLLABORATION SKILLS IN UNDERGRADUATE UNIVERSITY STUDENTS

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Abstract: Today's curricula for undergraduate students stress the development of skills, which have been defined as the "21st century skills". These skills include creativity, problem solving, decision-making, communication, collaboration and ICT literacy, among others. Accordingly, many higher education organizations, and particularly business schools, are designing new learning activities to train these skills. In this paper we present a learning activity and a supporting computer application called Sketchpad (sketching with iPads), which has been designed with the aim of training some of the "21st century skills". This learning activity has been introduced in the curricula of an undergraduate course of a business faculty in Santiago de Chile to foster collaborative skills by rotation of students among small groups working in a problem-solving task for an "Information Technology" undergraduate course. A questionnaire applied to the students in a first pilot experiment indicates that Sketchpad can help introducing learning activities that support the development of collaboration and communication skills in the classroom for the case where the rotation of the members among the groups is performed.

Keywords: Collaborative learning, communication, mobile devices sketching.

1. Introduction

According to the requirements of a globalized and demanding world, nowadays, professional success depends highly on whether the individual is able to adapt to new working conditions, making decisions for problem solving, working in diverse teams and using technology efficiently, (Binkley et al., 2012). Accordingly, acquiring those skills has been included as part of the curriculum's standard, proposed by (AACSB, 2013) for business schools. The AACSB defined collaboration as "(being) able to work effectively with others and in collaborative environments". Additionally, the (OECD, 2013) also mentions collaboration as a fundamental skill for a 21st century worker. Moreover, collaboration and communication skills are especially required when working with interdisciplinary and distributed groups, and are especially necessary for business with global companies.

The demand for training these skills poses a new challenge for higher education institutions, mainly because there is little expertise on how to guide students to develop them. Up to now, the most common approach has been designing and creating mostly learning activities in which students have to apply those skills without any kind of technological support (Rotherham & Willingham, 2009). Based on this approach, this paper proposes a pedagogical activity which considers includes technological support by using a computer application called Sketchpad (sketching with iPad). It has been designed with the aim of providing students with experiences in which collaboration is necessary to perform learning activities. We carried out an activity consisting on students working in small groups, developing ideas on how technology could help improve daily lives of their city inhabitants, and describing them with sketches. In order to enhance collaboration, members of each group will take turns rotating to each neighboring group. Through this rotation, a student contributes to each group with ideas from his/her own group, while learning about solutions proposed by other groups. The present work was guided by two questions: (1) does rotation of students among groups makes a difference in the students' perception of collaboration, communication and proposition of ideas? (2) What is the perceived contribution of Sketchpad to the activity?

2. Related Work

Higher education in business schools, focuses increasingly on students acquiring skills (OECD, 2013), (AACSB, 2013). Binkley et al., (Binkley et al., 2012) proposed ten skills, organized in four groups that have been identified as critical for the 21st century worker: a) Ways of Thinking (1. creativity and innovation, 2. critical thinking, problem solving, decision making and 3. learning to learn, metacognition); b) Ways of Working (4. communication and 5. collaboration (teamwork); c) Tools for Working (6. information literacy and 7. ICT literacy); d) Living in the World (8. citizenship, 9. life and career and 10. personal and social). Pedagogical activities shall be conceived in order to fulfill the demand of developing them. Even though individualization in learning is increasingly important when developing 21st century skills, interaction in classroom remains necessary to combine individual and collaborative learning, (Ananiadou & Claro, 2009). Therefore, collaborative learning activities are necessary for training students in collaboration and communication (Lai & Hwang, 2014). Collaboration is quite important in the process of learning because it can improve the ability to solve problems, interact, and communicate among others. For supporting the development of collaborative skills, computer-based tools can be used in education, when applied in the right circumstances; specifically, when these tools favor interaction, analyzing a problem from various points of view, and integration of the various points of view in the final solution, (O'Donnell, Hmelo-Silver, & Erkens, 2013). This has benefits and positive effects on teaching and learning, such as helping students developing collaboration and communication skills and improving academic performance, (Zurita & Nussbaum, 2004).

Furthermore, sketching has been successfully used for interacting, communicating with others and collaborative problem solving. First, because each person can externalize his/her ideas through a sketch and see the problem from an "outside" perspective; second, sketches can be used to explain one's ideas to the rest and for building a shared understanding (Baloian & Zurita, 2012; Shah, Vargas-Hernandez, Summers, & Kulkarni, 2001).

Regarding previous works that present applications having similar characteristics to Sketchpad, we examined the most representative undergraduate learning support tools that include mobile devices with touchscreen systems. Additionally we analyzed previous experiences including group activities in which group' participants interact among them and perform learning activities using sketches as well as problem solving tasks with a collaborative learning approach. Regarding collaboration and sketching we found three interesting applications: Collboard, Brainsketching and C-sketch. Collboard, is an application that combines digital pens and an interactive whiteboard, used for collaborative activities based on problem solving, to foster new media literacies. It allows students to draw or write down their solutions and share them in a common workspace, so the other students can see it and a teacher can monitor student's work. It can be used either on laptop, desktop or tablet PCs (Alvarez, Salavati, Nussbaum, & Milrad, 2013). With Brainsketching, students first sketch their ideas individually, then exchange them and complete and/or modify the one they receive. They only communicate through the sketches without talking to each other (Linsey et al., 2011). C-sketch is a technique for concept generation in a collaborative engineering design. It is a variant of the 6-3-5 Rohrbach's method, called so because it involves six participants, three ideas and five phases (Shah et al., 2001). C-Sketch may be called 5-1-4G, because five individuals work on one problem at a time and propose a solution through a sketch (the "G" is from the graphical approach), after doing so, they pass their sketches to the next person, who can add, modify or delete aspects of the original sketch, involving 4 phases. They do this until all members have made a contribution to the original sketch. It incorporates problem solving and rotation, but only the ideas rotate, the individuals may not communicate with each other by talking or any other means but the sketch.

Furthermore, regarding how participants are chosen and interact among them, we can mention the "Gallery methodology", which consists of a first stage in which students sketch their ideas individually, after which they are exhibited in the classroom as in a gallery. Students then can see all others' work and comment on them. After this stage they return to complete their original work. Although the work itself is not developed collaboratively, the methodology allows interaction in order to understand other students' ideas using oral communication (Shah et al., 2001). Some works have shown that dynamic configuration of working/learning groups using technology can increase student performance (Zurita, Nussbaum, & Salinas, 2005). Some even have used mathematic algorithms to ensure heterogeneous grouping (Graf & Bekele, 2006), but without including student rotation among various groups, or facilitating collaboration and ideas exchange between learners.

These experiences show that technological tools can be introduced in the classroom to enhance collaborative learning activities using sketching with mobile devices. Furthermore, mobile devices with touch-screen play an important role in collaborative learning activities, as the dynamic configuration of groups and rotation among its members does. However we did not find any research in the literature about the use of technological tools aimed at developing 21st century skills based on problem solving learning activities applied in higher education. Even though C-Sketch incorporates rotation of ideas in order to solve a problem it does not consider communication and interaction among participants.

The new aspect of our proposal is a learning activity for higher education, for which we also developed a supporting tool called Sketchpad that combines many of the characteristics and benefits of similar applications mentioned above. The activity includes rotation of students within various groups and it focuses on developing collaborative skills.

3. Description of Sketchpad

Sketchpad turns an iPad into a collaborative board, where students draw their sketches individually and then share them in order to work collaboratively within their group and with other groups. Sketchpad defines two kinds of users: student and teacher. The interface for the student allows them to create various public or private workspaces (slides shown in the main screen) where they can draw the sketches and take notes. These slides are separated, shown and organized in a small window on the right of the main interface, deployed on demand by the student (that is, the operations for managing slides by miniatures of all created slides). A palette, which is "floating" over the workspace, offers the typical sketching functionalities), like changing the width and color of the stroke, inputting text, operations for copying, pasting and deleting strokes and text. The slide on which the student is currently working on is displayed at the center of the main screen. At the top of the main screen there is a menu bar for the undo, redo, copy, paste and delete functions. Students have access to operations for defining groups, assigning students to the groups and taking them out through widgets located at the left side of Sketchpad. Any student can define a new working group and include members by dragging their login names from the list of connected students. This operation triggers an invitation message to the selected student, who might accept it or not. Students belonging to the same group will have the possibility to define shared workspaces where they can draw sketches synchronously. In order to share a private slide a student creates a new collaborative and public one, and then, copy the content of the private one with a drag-and-drop operation. The content of the private slide will be added to the existing content of the public one.

The interface for the teacher is similar to the one for the students except that the teacher can supervise all working groups. This is implemented by automatically including the teacher to each public slide which is created, thus the teacher will receive a copy of it in his/her executable version of Sketchpad.

The new aspect of Sketchpad is that it includes phases of rotation as C-Sketch, however in this case students rotate and not the sketches, allowing participants to see others' ideas. Based on the above, we assume that collaboration and proposition of ideas within a working group are different when students from other work teams participate. We also estimate Sketchpad to be successful in supporting collaboration and communication among students, especially for the working groups that perform rotation. The implementation of Sketchpad is based on a coupled object paradigm, an architecture for developing distributed collaborative applications using HTML5, and JavaScript; therefore it can be executed inside a browser like Google Chrome, Firefox or Safari in any kind of mobile devices (like iPads, Tablet with Android, and so on) connected to Internet, (Baloian, Gutierrez, & Zurita, 2013), (Baloian, Aguirre, & Zurita, 2014).

4. Methodology

A pilot experiment was conducted with students of a fourth-year "Technology Information" undergraduate course with students of the Business and Economics Faculty, from the Universidad de Chile, in Santiago de Chile. Nineteen students (13 men and 6 women, average age = 22.7 years) were randomly assigned to six groups consisting of three students each and one of four students; three of these groups were part of the experimental group (EG) and the other three were a control group (CG). The group with four students was part of the control group.

Before applying the pilot experiment, all students were instructed in Sketchpad, a week before in a 1:30 hours. For the activity, all groups were asked to identify requirements that people have in a common bus stop, in Santiago de Chile, and make a technological proposal to fulfill those requirements. Both, the design of the learning activity and Sketchpad, address the developing of "collaboration" and "communication" that we mentioned before as part of the 21st century skills.

The pilot experiment was done during a period of 1:30 hours. For performing the learning activity each student received an iPad running Sketchpad. All students worked collaboratively in their groups (EG, and CG) to come to a single solution together.

For the experimental groups we have included the rotation aspect, in order to see if this aspect allow them to benefit from a wider range of possibilities and points of view. Our focus is on supporting collaboration as much as possible and giving students the possibility to evaluate and approach the problem from different perspectives. Therefore, two students of each experimental group had to rotate to the group next to them, in order to see the other group's solution and share their own. They did this until they rotated among all the other groups and viewed all other proposed solutions. After finishing the rotation they joined their original group and helped modifying their original solution, taking into inspiration from ideas seen in other groups. The control groups performed the activity without rotating, that is only sharing ideas among their own groups.

After completing the activity, students answered a questionnaire related to the activity and the Sketchpad itself. The questionnaire was designed to measure two dimensions: *Collaboration* (D1) and *Sketchpad contribution* (D2) during the activity in the classroom. Each dimension was divided into three sub dimensions each: SD1.1 = interaction, SD1.2 = approaching through various points of view, SD1.3 = integration of various points of view in the final solution, SD2.1 = contribution to collaboration, SD2.2 = contribution to sketching, SD2.3 = contribution of technology. The sub dimensions of D1 were extracted from (O'Donnell, Hmelo-Silver, & Erkens, 2013). The questionnaire also included a box of comments.

The questionnaire contained a set of assertions to which the students had to express their agreement or disagreement using a 6-point Likert scale (1= totally disagree 2= strongly disagree 3 = disagree 4 =Agree 5 = strongly agree 6= totally agree). For the analysis, a majority of responses from 1 to 3 represents a negative result and majority from 4 to 6 is a positive result. The questionnaire also included a box of comments. Table 1 shows in detail the assertions presented to the students associated with the two dimensions and the six sub dimensions evaluated.

Table 1: Student assertions regarding *Collaboration* and *Sketchpad contribution*.

		Assertions
Collaboration (D1)	**SD1.1**	(1) The activity promotes interaction among students. (2) We were able to discuss each other's ideas. (3) We could discuss how to approach the solution.
	SD1.2	(1) The interaction with other participants allowed me to learn different points of view. (2) The interaction with other participants allowed me to see the problem from various perspectives. (3) The interaction with other participants allowed me to think about various solutions to the problem.
	SD1.3	(1) The interaction with other participants was very important for the final solution proposal. (2) Knowing other groups' solutions influenced the final solution proposed by my group (for experimental group only). (3) Knowing the ideas of my group members was of great help for proposing the final solution.
Sketchpad contribution (D2)	**SD2.1**	(1) Sketchpad facilitated the Exchange of ideas between participants. (2) Sketchpad was useful for sharing sketches with other members of the group. (3) Sketchpad helped me to better explain my own ideas to other participants. (4) Sketchpad helped me to better understand other participants' ideas. (5) Sketchpad helped me to better explain the ideas of my group to the members of the other groups (for control group only).
	SD2.2	(1) Sketching helped me gain new perspectives of my own idea. (2) Sketching helped me to better understand the problem addressed. (3) Sketching helped me think about solutions I did not considered first. (4) Sketching helped me to communicate my ideas in a better way.
	SD2.3	(1) The activity could not have been carried out in the same way without Sketchpad.

5. Results

Figure 2 shows percentages of the Likert-type answers showing the students' perception regarding the assertions for *Collaboration* (D1) and for *Sketchpad contribution* (D2) to the learning activity. Numbers are given for the control group (CG), the experimental group (EG).

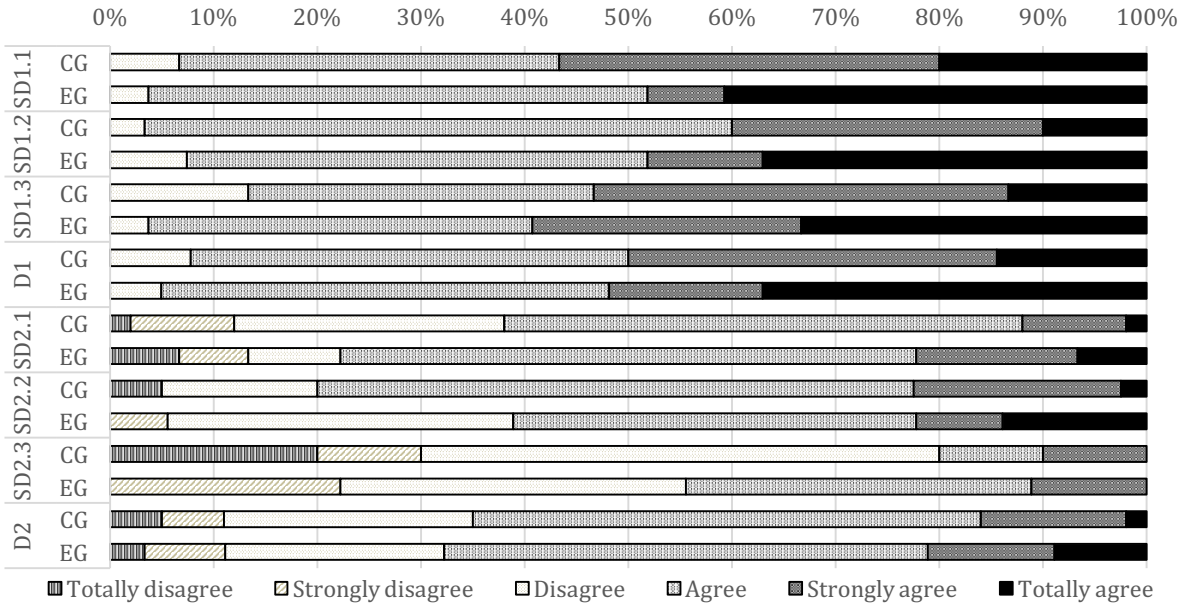

Figure 2. Percentages of questionnaire answers for CG=Control Group, EG=Experimental Group

Data shows that students of both control and experimental groups tend to positively agree with the assertions of the *Collaboration* dimension. Agree, strongly agree and totally agree numbers add up to 90.1%. An interesting result is the much higher percentage of students of the experimental group who "totally agree" with the assertions compared with the control group on all sub-dimensions. These results indicate, that the activity supported by Sketchpad including rotation among group members increases the possibility of interacting and discussing with peers, as well as obtaining and developing different perspectives.

We also observe that for the assertions related to *Sketchpad contribution* dimension the answers from the students were positive in both, the control and experimental group. In fact, percentage of all positive answers ("totally agree", "strongly agree" and "agree") is 66.31%. This indicates that the perception the students have about the contribution of Sketchpad is overall positive. Moreover, its facility of using sketches allows for a better expression of ideas, obtaining new perspectives, and supporting the activity. Once again responses tend to be much more positive among students from the experimental groups, indicating that students' perceive Sketchpad to be useful for supporting a collaborative activity with rotation between groups.

Regarding to the students' comments, there were four aspects which were more frequently mentioned: a) Sketchpad presented some problems that should be corrected (mentioned 17 times). The problems mentioned were mainly technical problems and a few about design and usability: "I had problems when I wanted to move my personal slide to the group space. Some images appeared in different places of the slide and the application sometimes got stuck when working collaboratively. The application is a little bit slow loading and performing some instructions". "The tool must be improved with more functions, for example, something to erase parts of the sketch". b) There is a positive perception of the activity and the utility of the tool (mentioned 10 times): "If the problems this prototype has are solved this tool would be very useful to support better group work". "The activity was very good, no complaints". c) The technical problems the tool has are an obstacle for an optimal performance of the activity (mentioned 3 times): "Moreover, it is necessary that the tool works in an optimal way. It is critically that the users know how to use it; otherwise it will block creativity while sketching solutions. It also hinders the individual and collaborative. I did not know how to edit something or when I did not know which button I should use to create a rectangle, etc." d) Sketching helps them express and understand ideas (mentioned 2 times): "Sketching ideas is much better than explaining them with a text".

6. Conclusions

We could find some evidence supporting the hypotheses stated at the beginning of this research work regarding the differences in the perceived collaboration between the control and experimental groups and the contribution of Sketchpad to the collaboration during the activity. The positive results for the collaboration dimension mean that the proposed activity does promote the interaction necessary for

collaborative learning and developing collaboration skills. Although we cannot assure that it will produce collaborative learning, we can say that it provides students with the necessary environment for this kind of learning. The predominantly positive results regarding the students' perception of the tool's ability to support collaboration confirm the ideas previously expressed. The use of sketches has also shown to be a good vehicle to express ideas and approach a solution to the problem including various points of view. Therefore, we think that despite the technical problems of the tool (which have been mostly solved in a new version already developed) we consider the activity successful for both, the control and experimental groups. Negative comments from the students mostly addressed technical problems with the tool and the positive ones were related to the activity itself and the contribution of the tool.

As future work we will use the already improved version of Sketchpad to support similar learning activities on a larger scale and for a longer period of time for the same "Information Technology" undergraduate course. Sketchpad will also be tested for preparing and performing presentations, taking personal and group notes in other knowledge areas.

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