Sketchpad: A Learning Tool Supporting Creativity in Collaborative Learning Activities

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Abstract. There is consensus among curriculum developers of Business Schools around the world that along with technical knowledge students should be trained to also acquire soft skills. Communication, collaboration, creativity, critical thinking and problem solving are mentioned by some authors as the most important for professionals of the 21st century to be successful. In order to develop these skills learners have to perform learning activities where they need to apply them. In the literature we found many works about learning activities designed for training creativity which have been used in Business Schools. They do not make use of technology. On the other hand, there are many works about learning activities which make use of technology to train collaboration and problem solving skills. In this work we present a learning activity which makes use of a technologic tool for supporting it, which promotes collaboration, creativity and critical thinking. A first experiment shows that the perception students get from the activity and the ability of the tool for supporting these factors is positive.

Keywords: Creativity · Collaboration · Business schools · Mobile devices · Brainsketching

1 Introduction

In today's globalized world, there is an increasing need that professionals develop not only technical competences but also the so called "soft skills" in order to perform their activities in an effective and efficient way. This is especially true for professionals of the business and economics sphere, who need to perform tasks in a high competitive, changing and demanding environment, in order to adapt themselves to the constant changes and generate strategies which convey added value to the diverse business processes. In order to achieve this goal it is necessary to include pedagogical activities, methods and tools in their university curricula.

Griffin et al. [1] presented the KSAVE (Knowledge, Skills, Attitudes, Values, Ethics) model which defines ten key competences professionals of the 21st century should have

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in order to be successful. The KSAVE model categorizes creativity as part of the *Ways of thinking* competences, along with others, like critical thinking, problem solving, decision making, learn to learn, and meta-cognition. The operational definition of creativity provided by the KSAVE model includes knowledge, skills, and attitudes related to thinking and working creatively, individually and collaboratively. In the same way, KSAVE highlights the relevance of collaboration and communication skills, which are classified as *Ways of Working* skills.

According to Schlee & Harich [2] and Fekula [3], creativity and the ability of working in teams are the most relevant and required skills in professionals of the business area in order to be successful. Moreover, the AACSB (Association to Advance Collegiate Schools of Business) highlighted the importance of considering various competences, among these creativity and the ability of working in teams, when designing curricula for business schools students [4] which is in line with the KSAVE model. In 2015, the AACB held various seminaries on Curriculum Development Series. One of them was called *Teaching Design for Creativity and Innovation* [5], which again highlights the importance of creativity as the way to cope with the requirements of the modern business environment. The Harvard Business Review also shows the importance of creativity by publishing many articles on that subject [6].

The literature reports about many works on how to support the development of creativity in university students, presenting learning activities introduced in courses in business schools. However, we have not found pedagogical practices supported by recent technologies among them. On the other hand there are some works reporting on successful pedagogical activities supported by technology in order to promote creativity but applied to other learning scenarios. Thus we want to take these works as example, adapt and extend them, in order to be used for the business school curricula.

This work presents a pedagogical activity designed to help the development and application of skills and attitudes related to collaborative work and creativity in pregraduate students of a business school. The activity, which is performed inside the classroom, is supported by a collaborative application called Sketchpad, which runs on tablets wirelessly interconnected among them. Sketchpad was designed based on the principles of collaboration and externalization using brainsketching, promoting the development and practice of creativity according to previous research works on this subject reported by the literature. Compared with previous works, the contribution of Sketchpad is that it promotes considering various points of views when students work on a creative task. This is done by incorporating rotation among the members of various groups working on the same task. Sketchpad was tested in a real classroom in order to formally evaluate its contribution to creativity.

Based on the ideas described above, this research work has been guided by the following questions: (1) According to the students' perception, to what extend the provided tool (Sketchpad) contributes to the development of creativity?; (2) which is the perception the students get about the contribution of Sketchpad to promote collaboration; and (3) is there a difference in this perception when students work in groups where members have to rotate among the various groups and when they do not?

The results obtained show that Sketchpad enhances creativity in teams working with rotation compared to those working without rotation. There was also positive evidence

on the perception students had about the ability of Sketchpad supporting collaboration and externalization.

2 Supporting Creativity Development

The complexity about teaching students to be creative lies in the fact that we cannot teach that skill but to foster its development through educational activities that include specific design principles, pedagogical practices that generated positive previous experiences based on theories explaining how to generate creativity [7].

The design principles of the pedagogical activity, and consequently of the tool supporting it, presented in this work is based on a pedagogical frame that incorporates mainly two elements: collaboration and externalization. Regarding collaboration, Fisher [8] proposes that creativity emerges from the interactions between individuals and the world, and between the individual and others; in the same way, Csikszentmihalyi emphasizes human interaction as the place where creativity emerges [9]. Egeström adopts a similar approach when proposing that creativity lies in interactions between persons' thoughts and their socio cultural context, [8, 10]. Sawyer [11] proposes that creativity breakthroughs occur during the dialog among persons when they answer to each other; this contrasts with the myth of individual inspiration, which represents the idea that creative inspiration comes from the individual. Similarly, Wegerif and others [11, 12], identify that the base of creativity lies in the tension between different perspectives. Therefore, interactions among people having different point of views, which are in opposition (tension), can be the base for a suitable activity where creative ideas may arise. From the importance of collaboration we can derive the convenience of designing activities that include intensive and varied interaction with other persons, allowing the sharing and discussion of ideas, and observing new points of views.

The second element of creativity we consider, externalization, refers to "taking out of her/himself" the ideas and thoughts in order to translate them in concrete artifacts which represents them, in order to make them accessible for working and reflect about them [13]. This attribute of externalization is based on what Schön calls the "*back-talk*". The meaning is that the process of externalizing ideas can unveil questions about them which were initially ignored, facilitate the emergence of new perspectives, show new possibilities or obstacles, as well as new relationships to other ideas [14]. Sketching, drawing and diagramming are good examples of externalization processes, which can facilitate creative work and foster the development of this competence. From the advantages of externalization we can derive the usefulness of designing activities which include the elaboration of sketches or other forms of graphic expression. [15, 16].

2.1 Pedagogical Practices and Technological Tools Supporting Creativity

The literature reports on a number of pedagogical practices that make no use of technology which are aimed at fostering expressiveness and externalization in order to stimulate creativity. Some of them make use of diverse methods which combine the collaborative exchange of ideas [17] based on drawing and sketching [18–20].

The most simple case is the *brainsketching* [21] technique, in which students first draw their ideas individually and then exchange them, so that other participant can complement or modify them, either silently or explaining them at the moment they pass them to other participants [22]. C-sketch was conceived to foster collaboration in industrial design. Five persons work individually on a problem simultaneously proposing a solution by drawing a sketch. After this, they pass their sketches to the following person who complements, modifies or deletes parts of the original design. Sketches are passed among the members of the group until each participant has worked on each proposal once, thus incorporating the aspect of rotation of the ideas to implement collaborative work [23].

There is positive evidence about the use of technology for supporting brainstorming processes using sketches and drawings, although not precisely focused on creativity support: Inkboard [24], Collboard [25], Magic Paper [24], y Co-lab [26] are some examples.

Inkboard, was designed to be used along with videoconferencing, where participants synchronously can draw sketches over a shared workspace (a virtual board) [24]. Collboard, incorporates collaborative elements and freehand sketches using digital pens and interactive boards with private and public spaces; sketches first drawn on private workspaces can be then shared in public ones in order to continue working collaboratively [25]. Magic paper was developed by the MIT and allows teacher and students to draw physical model on a virtual board working collaboratively [24].

All mentioned applications use technology to support creativity. A common aspect to all of them is that participants first develop ideas individually and then share them, in order to converge to a single idea collaboratively; therefore we incorporate this aspect in the design of Sketchpad. Another common aspect to all mentioned applications is that working groups remain static from the beginning to the end of the activity.

Regarding pedagogical practices in business schools' curricula for developing creativity skills in students, the literature reports some research works made on pedagogical methodologies introduced in the curses of their curricula. For example in the year 2007, the *Creative Marketing Breakthrough* (CMB) presents a reference frame for the development of creativity in lectures through specific activities related to Marketing [27]. The CMB model defines creativity as the process through which disruptive ideas are generated, and considers five theoretical concepts as its key elements: (1) *task motivation*, (2) *cognitive flexibility,* (3) *disciplinary knowledge,* (4) *serendipity* and (5) *uncertainty* [27]. In the year 2008, Aylesworth [28] propose to develop creativity in the business classroom through the *improve-mindset* based on the use of techniques of theater improvisation applied to discussion of case analysis. For this, students must follow five steps of theater improvisation: (1) "*Yes, and…*" they have to accept what their classmates say and add something to it. They cannot deny or reject what others previously said. (2) "*Deny, order, repeat and question*", none of these actions is permitted. (3) "*Driving in the rearview mirror"*, they have to build on the context proposed at the beginning. (4) "*Take Care of yourself … by Taking Care of Everyone Else"*, collaboration instead of competition is promoted. (5) "*Mistakes are good offers in disguise",* there are no mistakes during the discussion since all ideas can lead to new perspectives and better understanding of the case. [28]. The *improve-mindset* is meant

to generate a collaborative and highly participative atmosphere in the classroom, which leads to spontaneity and creativity [28].

We think it is worthwhile to explore which is the role technology can play for developing creativity in students of a business school, like for example, using tablets for supporting externalization through brainsketching.

2.2 Evaluating the Creativity Factor in Technological Tools

Carroll et al. [29] proposed a questionnaire called Creativity Support Index (CSI), which evaluates the contribution of a technological tool to creativity. CSI identifies six factors which are considered relevant when designing such a tool: (1) *exploration* of the various ideas, concepts or proposals; (2) *collaboration* among participants; (3) *engagement* with the activity being performed; (4) the *effort/reward* of the task must be adequate; (5) *tool transparency*, which means the tool be a mean and not the center of the task; (6) *expressiveness*, (or *externalization*) of ideas must be supported by the tool [29].

The collaboration and externalization factors identified by [29], are relevant aspects for designing a computational tool. Additionally exploration and tool transparency should also be considered. In our opinion engagement and effort/reward result from the perception the user has from the tool.

3 Sketchpad Design

Sketchpad is a collaborative tool running on tablets (specifically iPads) designed to support pedagogical activities which are aimed at developing creativity in undergraduate students of the fourth year in the Business School of the Universidad de Chile. It has been implemented using HTML5 and the Coupled Object technology (described in [30, 31]) so it can be run using web browsers Chrome, Mozilla, or Safari regardless from the operative system of the computational device. Its main interface, shown in Fig. 1, consists of a workspace, which can be private or shared, where the user create sketches by freehand drawing and text typewriting, including basic edition functionalities like deleting, copy and paste, undo, redo, changing colors, zooming in and out, etc.

Students can make their contributions through brainsketching to several individual and/or shared pages but they can work on one only at a time. Icons with a small view of the page content are shown at the right hand side of the interface, separated in a private ("Personal") and a public ("Grupal"). The page that is currently edited is highlighted with a blue frame (see Fig. 1). In order to share a private page the user has simply to drag and drop its icon from the private to the public area. A copy of the page will appear in the public area, keeping the original in the private one. After this, all users participating in the session will see this page as a new icon in the public area. They can start working collaboratively by selecting it, clicking on the icon. Figure 1 shows that the user has created two private pages; one of them has been copied to shared area and has received another icon of someone else who shared a page. The second public page highlighted with a blue frame indicating that the user is currently working on it, thus it is shown in

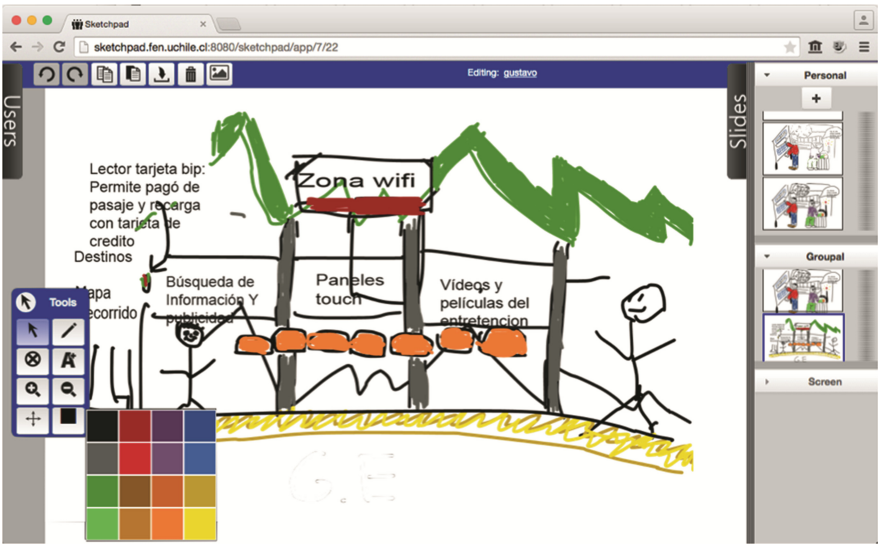

Fig. 1. Main interface of Sketchpad showing in the main workspace a proposal for the design of "technological bus stop"; that is being edited collaboratively. The selected page (highlighted with a blue frame) is in the public ("Groupal") area (color figure online).

the main workspace at the center of the interface. By sketching, students can externalize ideas and proposals, thus promoting creativity [13, 15, 16]. Bruner [13] and Schön [14] mention the advantages of translating ideas into sketches in order to gain new points of views.

Collaborative work using Sketchpad promotes creativity according to what was stated by Fisher, Csikszentmihalyi, Egeström [8] and Sawyer [11], who says that the base for creativity lies in the interaction with others. The easy way that students can access the working pages in the collaborative area contributes to the *tool transparency*, (see Sect. 2.2). Since Sketchpad can be used on tablets it is easy to perform rotations of students among the groups. We think the more students can contribute to one idea or proposal, the better will be the *exploration* factor described in Sect. 2.2, since various points of views can defy the thinking and knowledge structures previously built.

4 Evaluation Methodology

Sketchpad was preliminary evaluated in an exploratory way, through an experiment which consisted of a pedagogical activity in which students had to work in teams each one with three members. Students had to rotate, that means, go from one group to another, in order to work with other teams.

The activity consisted of students proposing ideas through sketches and texts about how to implement technological bus stops that could help solve diverse problems related to the waiting time. First, students had to work individually and then they had to share their ideas with the members of the group and reach consensus on a single proposal for

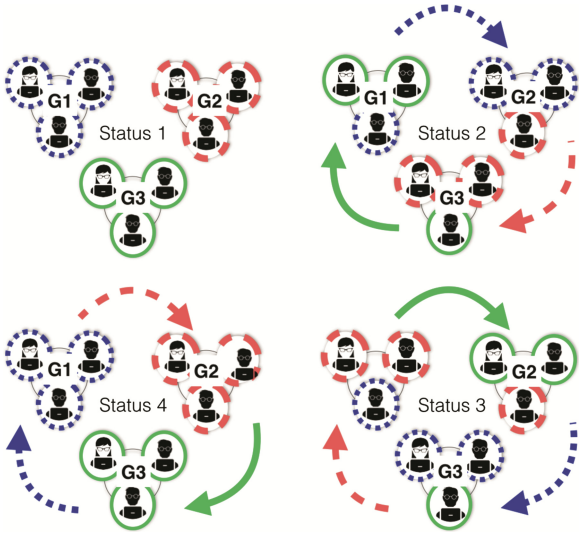

Fig. 2. Descriptive schema of the collaborative activity during rotations of members among groups. The four statuses show the composition of the groups after the rotations indicated by the arrows.

each group. Once the groups have reached consensus they had to rotate in the following way: two members of each group (previously defined) had to leave the group and join the next one, in order to analyze and discuss the idea previously proposed by the group they join. After a while, they rotate to the next group where they see the solution of the new group they join. This rotation is performed until the students reach their original group, where they prepare the final proposal for this group. Figure 2 shows schematically how rotations were performed. There were three working groups G1, G2 and G3, each one with three students. The first sketch (upper right) shows status 1, where participants are in the original arrangement. The second sketch (upper right, status 2) shows the groups after two of them have moved to the next group. The third sketch (bottom right, status 3) shows the groups after the second rotation. The fourth sketch (bottom left, status 4) shows the group after the final rotation where students return to their original groups. It is important to highlight that sketches do not rotate, but only the students. So when students arrive to a new group they have to join the new group by joining the public session in which the sketch corresponding to that group is being worked out. After all rotations are performed, students have seen all the ideas proposed by all groups when they reach their original one. They had also the opportunity to contribute to them. This activity shares some similarities with brainsketching, Gallery method and C-sketch, because it involves sketching and the possibility of having various perspectives on them. The main difference lies in the interaction with other group members before producing the final proposal of the group.

In order to have a control group against which we can compare results, the course was divided in two groups, one working with rotation and the other without.

The universe of students for the experiment consisted of fourth year students of the Faculty of economics and Business of the Universidad de Chile studying during the second semester of 2014. The sample consisted of students enrolled in the Informatics Technology course. Therefore the sample was not probabilistic and was defined by convenience, because it was possible to perform the activity without being disruptive to the course planning. In total, 19 students participated in the experiment, 9 of which performed the activity with rotation divided in three groups of three students each. The rest was divided in two groups of three students and one group with four. The groups were formed randomly. In order to collect information about the experiment we used a closed questionnaire based on the on the Creativity Factor Evaluation (CSI) proposed by Carroll et al. [29]. Additionally we used an open questionnaire in order to evaluate the interaction among participants, and their opinion about the possibility of approaching the problem from different points of views. We also included an external viewer who registered aspects about collaboration and externalization. The CSI questionnaire consisted of two parts. In the first one, students answered questions from the Likert type, assigning values from "totally disagree" to "totally agree" to five assertions, each one expressing positively that the tool was able to support one of the five factors (*collaboration*, *exploration and expressiveness (externalization), effort/reward, tool transparency, and engagement*) *according* to their opinion. In the second part they were presented with a list of all possible factor pairs. Since there are five factors the list consisted of 10 pairs. From each pair they had to select which factor they considered more important than the other one for performing the activity.

The obtained data were analyzed in two steps. First, the data collected with the modified CSI questionnaire were processed according to what the authors propose in [29] in order to generate values from 0 to 100 for each factor. Second, the data was processed for obtaining descriptive statistical information using a standard software application (SPSS). On another hand, the data obtained by the observations were analyzed manually.

The activity was performed during a normal class, which lasted for one hour and thirty minutes, after which the questionnaires were applied.

5 Results

Results associated to the CSI questionnaire are shown in Table 1. According to them, Sketchpad favors creativity on a 67,85 level, from 0 to 100. Students who participated in the activity with rotation evaluated better the support of the technological tool with a CSI of 75,07, compared with a CSI of 58,96 from the students who participated in the activity without rotation. However, this difference is still not statistically significant and cannot be generalized. Now we will analyze the CSI factors applied to Sketchpad, this is the pair wise comparison of the factors: (a) the *collaboration* was the factor which was perceived as the most relevant by the students who worked with rotation as well as by the students who worked without rotation; (b) *exploration and expressiveness (externalization)* are the factors which come next, and are within the 53,2 % of the total relevance of the factors, therefore, we can consider that Sketchpad supports the expression

and exploration of the proposed ideas; (c) although *effort/reward* factor received a good evaluation (VP = 6,97), it was seldom selected as the most relevant factor for performing the activity (d) Also the *tool transparency* was good evaluated but was seldom regarded as important for the activity; (e) *engagement* was the factor with the lowest evaluation and at the same time the less important for performing the activity.

Table 1. Results of the first part of the questionnaire

	Total			Group without rotation			Group with rotation		
FACTOR	ANF	VP	Rate	ANF	VP	Rate	ANF	VP	Rate
Collaboration	5	6,40	21,33	5	5,32	17,73	5	7,60	25,33
Exploration	4	6,68	17,82	4	5,86	15,63	3	7,60	15,20
Expressiveness (Externalization)	3	7,16	14,32	3	6,58	13,16	3	7,80	15,60
Effort/reward	2	6,97	9,29	1,5	6,58	6,58	3	7,40	14,80
Tool transparency	1	6,21	4,14	1	6,22	4,15	1	6,20	4,13
Engagement	0	5,64	0,94	0,5	5,14	1,71	0	6,20	0,00
	Rate:		67,85	**Rate:**		58,96	**Rate:**		75,07

ANF = mean number of times this factor was selected as the more important in the pair wise comparison; VP = Average score assigned by the students to each factor computed as (number of times the factor was selected *ANF)/1,5. Rate = the rate of the factor according to the answers to the Lickert scale evaluation, modified according to the CSI to obtain values between 0 and 100.

From the analysis of the answers given to the open answers questionnaire related to the aspects of interaction among participants, approaching the problem from various points of views and having them included in the final proposal, the possibility to approach the solution we can conclude the following remarks: (a) regarding the ability of the activity and the tool to support interaction among participants, students in general responded with totally agree, or strongly agree; they said they could discuss with their classmates various ways to approach the problem and the ideas that were proposed. Only 5 % of the answers were negative. (b) Regarding the ability for approaching the solution through various points of view the perception of the students was also positive and most answers were totally agree, strongly agree or agree. Again only 5 % were negative. (c) Regarding the ability to contribute from various points of view to the final result, students said they could know ideas from other participants and this helped to refine the final proposal. Most answers to this assertion were totally agreed, strongly agree or agree. Only 7,9 % of the answers were negative.

The analysis of the observation guideline has shown that actively interacted with their classmates, sharing their ideas and explaining them to the rest. Then students proceeded to merge the individual proposals. In this way, new solutions emerged from the elements of the initially proposed ideas and the discussion. In this way we can

consider that the activity fosters creative products collaboratively. During the discussion the individual ideas complemented each other and disagreements were part of the merging process. New ideas emerged when individual proposals were challenged transforming the original ones in new contributions. Sketches made individually helped students to explain their proposals promoting discussion among students. We observed that the number of ideas proposed by the groups which worked with rotation were higher.

6 Discussion

The obtained results allow us to answer positively to the research question about the perception students got from the contribution of Sketchpad to the collaborative activity. They expressed they could interact with the rest of the participants during the activity and that this interaction was fruitful. This assertion is backed by the 67,85 over 100 score they assigned to the creativity factor of the tool. In the same way, we can conclude that students had a positive perception about working with rotations, since students who worked with this modality evaluated all factors better than those working without rotations. Performing the activity with rotations gave students the opportunity to get acquainted with various points of view, often different from their own ones, in a short period of time and consider them when preparing the final proposal. In this way, we wanted to shape a pedagogical activity with a strong collaborative component, a key element for the emergence and development of creativity, based on the approaches proposed by Fisher [8] Csikszentmihalyi, Egeström (described also in [8]) and Sawyer, 2006 [11]. This has been backed by the observations of a collaborative activity performed by students, where we identified that new ideas emerged from discussions among participants. Another key element considered for shaping the activity was externalization, proposed by Bruner [13] and Schön [14], which was achieved incorporating sketching which students have to elaborate and share, which gave students the opportunity to know new perspectives, thus promoting creativity. During the activity sketches were used to explain ideas, being a central element for discussion.

Results obtained about collaboration during the collaborative activity let us believe that the proposed tool, Sketchpad, can be successfully used to support pedagogical activities in classroom that promote creativity skills. The difference between the results obtained with participants who worked with rotations and without them let us think that Sketchpad could be more effective when is used for supporting collaborative activities, as well as in activities requiring a tool for sharing ideas.

Students who worked in both groups, with and without rotation mentioned collaboration as the faction which Sketchpad supports most, which indicates this is perhaps the most relevant factor of the tool. Although the expressiveness (externalization) was the third one selected by the students as the most important factor, was the best evaluated. This let us consider that Sketchpad is successful for supporting an activity based on collaboration and externalization for promoting creativity through brainsketching.

As future work we consider important to make more experiments with a higher number of students to validate these preliminary results.

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