

Collboard: Supporting New Media Literacies and Collaborative Learning Using Digital Pens and Interactive Whiteboards

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Abstract: The high-penetration of information and communication technologies in our daily activities renews the question about the type of skills learners need to develop on the 21st century. Seeking to foster the development of new media literacies skills in the classroom, we developed Collboard. The Collboard approach combines a pedagogical rationale based on a collaborative strategy aiming at solving open-ended tasks and a technological workflow that incorporates the notion of seamless interactions across different kind of media. Collboard integrates digital pens to support individual work and interactive whiteboards as a collaborative knowledge construction space. We report on the conception of Collboard, its different technological and software components, as well as our initial findings from the experiences we conducted in a Swedish school with 7th grade students in the field of mathematics. Our qualitative observations and initial results provide some indications that this type of learning environments can support the development of new media literacies skills such as collective intelligence, distributed cognition, transmedia navigation and visualization.

Keywords: New Media Literacies, CSCL, digital pens, interactive whiteboards

1. Introduction

Our society is now evolving at a faster pace than ever before, challenging individuals and organizations to deal with changes and, educational institutions to prepare learners for the future. In this context, educational researchers and practitioners have demonstrated a growing interest in developing pedagogical practices towards fostering a participatory culture in all levels of education [1, 2]. These actions respond to current trends regarding participatory literacies as a key social value of the 21st century workforce [3]. Contrastingly to traditional formal education based on lectures and individual assignments, the emergence of a participatory culture in schools changes the focus of literacy from one of individual expression to community involvement [4].

In recent years, different technologies and teaching practices have been proposed with the purpose of encouraging community participation and active involvement of students in their learning [5, 6]. Particularly, collaborative learning theories have exerted a prominent influence in these efforts [7]. While it is argued that technology by itself has not an intrinsic value and effect in supporting teaching and learning [8], numerous recent investigations support that technology usage guided by an effective pedagogical rationale can be beneficial for learning in the classroom [5, 6, 9]. An effective pedagogical ground can be enacted based on the proper design of integrated sets of coordinated interventions at different levels (i.e. social, epistemic & technological), leading to synergistic scaffoldings in the classroom [7]. Approaches to the orchestration of scaffolding are still quite general and there is a need to deepen on more rigorous empirical research [7].

The emergence of easy to use digital tools, hardware devices and software applications provide teachers and students with new means for augmenting traditional classroom media and activities [10]. Digital pens (DPs) and interactive whiteboards (IWBs) are examples of these latest developments. These technologies open new possibilities for fostering the development of new media literacies [4] in schools, based on collaborative learning strategies. However, integrating DPs and IWBs in the classroom's pedagogical flow to support individual and collaborative work requires that students are able of following the flow of information across multiple modalities and different forms of visualizations [4]. These abilities, also known as transmedia navigation and visualization skills are integral components of participatory cultures [2, 4] and incorporating them in different stages of the pedagogical flow in the classroom becomes thus a design challenge.

In this paper, we present our current research efforts of ascertaining the potential of digital pens and interactive whiteboards, towards creating a learning environment that fosters the development of new media literacies in the classroom, namely: collective intelligence, distributed cognition, visualization and transmedia navigation [4]. We argue that the use of these technologies combined with proper individual and collaborative problem-solving strategies can elicit new conditions for learning that support the development of new media literacies. Our approach, called Collboard, consists of a computer-supported collaboration script that takes advantage of DPs for supporting individual knowledge construction and IWBs, as tools for visualizing and scaffolding collaborative problem solving. We report on the conception of Collboard, its technological components, as well as our initial findings from the experiences conducted in a Swedish school with 7th grade students in the field of mathematics.

2. Related Work

Technology-enhanced learning environments for supporting a pedagogical workflow in the classroom based on collected and aggregated students' work include student response systems, known as clickers, classroom presenters [11], and systems supporting scripted collaboration, commonly towards solving open-ended tasks [5, 6]. Both, classroom presenters and the latter have been mostly implemented relying on the use of mobile devices with digital ink support, such as Tablet PCs and PDAs.

Student response systems are commonly based on multiple-choice questions, and give the lecturer real-time feedback of students' performance through visualization (e.g. bar graphs), so that he/she can adjust the lecturing according to the reported results. Classroom presenters generally involve Tablet PCs, and most recently, DPs, allowing a richer interaction than clickers [12]. Most generally, they allow the lecturer to manipulate the slides and annotating them with ink. More recent approaches have experimented with collaborative note taking strategies, allowing the students to collectively construct their annotations and also maintain a two-way communication with the teacher [10].

Systems supporting scripted collaboration in the classroom that promote solving open-ended tasks have been developed based on mobile devices supporting digital ink. For example, the CollPad [5] script is based on PDAs or Tablet PCs and guides the students in solving tasks through phases of individual work, small group collaboration and teacher mediated classroom discussion. It allows the individual knowledge contributions in the small groups to be sequentially refined through consensus (i.e. each small group must agree on submitting a single solution to the teacher), and later on, the teacher selects a group of answers that steer the classroom discussion towards the activity's learning objectives. Looi & Chen [6] use the GroupScribbles system based on TabletPCs with digital ink as a medium for collaborative open-ended problem solving. The solutions to the task are represented as

sticky notes, meaning that each student can write individual notes, keep them in a private area, and eventually publish them in a common area visible by all the students present in the activity.

The investigations discussed in this section present the results of several projects that have used mobile computers with digital ink support for developing constructivist pedagogical models embracing small group learning. However, the integration of digitally augmented devices, also based on digital ink, such as interactive whiteboards and digital pens to support both individual and collaborative learning have been only superficially explored. Projects integrating these technologies in the classroom have mostly focused on supporting different approaches to note taking in lectures, using digital pens, and visualizing students' contributions through mostly projectors and large screen displays, [10, 12]. In the coming section, we present the design rationale of Collboard together with its different technological and software components.

3. Design and Implementation

3.1. Pedagogical Design

Collboard follows a constructivist approach aiming at facilitating collaborative open-ended task solving, for fostering the development of specific new media literacies skills in the classroom. The approach used in Collboard is based on the CollPad CSCL script [5], i.e., it seeks fostering participatory literacies in the classroom, by encouraging active student involvement in a scaffolded knowledge construction process. The process calls for students' individual contributions as knowledge sources for constructing shared meaning in teacher-guided discussions. Language is taken into consideration as a fundamental tool through which learners elaborate thoughts, explain results, evaluate solutions through appropriate feedback, explore and clarify inconsistencies and knowledge gaps, and find new strategies and possibilities. Collboard comprises five phases which are analog to the ones found in the CollPad script [5]: (1) Problem Statement, (2) Individual Answers, (3) Answers Selection, (4) Discussion and (5) Conclusion.

In the Problem Statement phase (phase 1), the teacher provides all the students with a specific task to carry out, for example, a math problem or a conceptual question about a particular topic. The task is shown on the IWB, while the students solve it on paper using DPs (phase 2). Each student works individually on the assignment, solely based on his/her own understanding of the task and restricted to work with his/her own skills and previous knowledge. Once the students finish their work, they submit their answers to the teacher both on paper and digitally. Submitted answers instantly appear on the teacher's computer screen and they can be visualized in the IWB. The teacher then reviews the students' answers (phase 3) using the medium of his/her choice (paper or IWB) and selects according to his/her own criteria and experience a diverse subset of them involving different strategies, levels of achievement, etc., in order to initiate a discussion (phase 4).

The discussion starts with the teacher calling the students who wrote the solutions, and begins asking them, one by one, to explain their own reasoning and the result obtained. Each student will have to share his/her own view of the problem with his/her companions and the teacher will support and assist him/her as to make his/her own explanation as clear as possible. In this way, the class groups, as well as the teacher, become aware of the distributed portions of knowledge that are available in order to initiate the collaborative construction process towards a consensual answer. Figure 1 illustrates the IWB application that supports the entire process by displaying (1) an area containing the answers involved in the discussion as eligible options in a reduced size, (2) an area in which the current

individual solution selected appears (read-only), and (3) an area in which it is possible to perform drawing operations, and copy / paste elements from the individual answers through drag and drop operations. The latter capability allows students to easily pool tangible knowledge objects (or their components) and reusing them on the collaborative construction, thus stimulating the emergence of a collective intelligence.



Figure 1 - Collaborative construction space on the interactive whiteboard

The teacher coordinates students' interactions with the IWB, ensuring that proper turn taking is respected. He/she steers the discussion towards debating and negotiating a method to the final solution (phase 5). The teacher should aim at reducing the different students' dissonances by guiding them on how to reach the correct solution for the task. However, students should understand the method by themselves, mutually changing their opinions to finally converge on a common solution. The teacher can then push the discussion further, towards inducing generalizations of the methods or solutions discussed in order to trigger different cognitive and social processes [4].

3.2. Technological Workflow

Collboard integrates digital pens and interactive whiteboards to support the pedagogical flow described in the previous section. Students use digital pens to generate their own solutions for a given task, while the IWB is used as a collaborative workspace allowing students and the teacher to co-construct a solution (or a method to a solution) based on the individual solutions, and/or new knowledge that emerge during the discussions. The technology used in our investigation involves distinct hardware and software components.

3.2.1. Hardware

Evaluation of mainstream digital pens available in the market, based on economic, technical (i.e. SDK availability) and logistical criteria lead us to experiment with IOGear Mobile Digital Scribe pen, which can write on any kind of paper and offer the simplest possible functionality that satisfies the requirements of our study. The IOGear pen works with a scanner device (using ultrasound technology) clipped to the top of the paper sheet, which captures the handwriting and saves it in persistent storage. The device can then be connected to a PC by USB to download digital annotations. Both, the teacher and the students, require computers in order to use Collboard. A desktop, laptop or tablet PC is needed to run the software that operates with the IWB. The IWBs are used as standard pointing devices (i.e. the board marker is used as a mouse), so there are no requirements of specific SDKs or drivers. We have tried Collboard with 3 different IWB brands.

3.2.2. Software

The Collboard application relies on a custom software solution designed to support the proposed pedagogical design, based on the Eduinnova Teaching Platform (ETP) [5]. ETP is designed to support CSCL activities based on 1:1 and 1:3 computing in the classroom, operating with wirelessly interconnected laptops, netbooks or tablet PCs. The Collboard system follows a client-server architecture that involves the following components:

- **Server:** Provides session management functionality, state management logic, and content repository managing persistent storage for questions and answers generated using Collboard.
- **IWB Client:** Provides answer visualization capabilities and a collaborative construction space for use with the IWB.
- **Answer Submission Client:** Provides the students with means to submit their solutions digitally.

Digital annotations are stored in the digital pens in a proprietary format. For the sake of interoperability, we have developed (using the SDK available for the DPs) our own library to convert this data to an open standards format (scalable vector graphics, SVG). Questions and answers generated by the clients are stored in the server as SVG objects and delivered to the clients also in this format. All components of the system were developed based on the ETP Software Development Kit (SDK) and Microsoft .NET 3.5.

4. Empirical Validation

We conducted a trial experience with Collboard during a two weeks period in the spring term 2010. The target group for this trial were 7th grade students at Kronoberg skola in Växjö, Sweden. During the last two years, the majority of schools in the region have been equipped with IWBs, so in the spirit of exploring novel ways of using these devices for fostering better teaching and learning experiences in the classroom, our proposal was welcomed by the principal and the teachers.

4.1. Trial Objectives

The objectives of our initial trial were twofold. In the first place, we sought to validate the feasibility of enacting the pedagogical design in the classroom according to the Collboard script specifications. Secondly, we wanted to assess the usability of the digital pens and interactive whiteboards throughout Collboard's pedagogical workflow, in order to establish whether the use of the tools developed for the IWB responded effectively to the pedagogical aims, and if it could be adopted by both teachers and students naturally.

4.2. Description of the Educational Setting

Two different groups of students were involved; the first one was composed by a female teacher, 5 girls and 1 boy, while the second group was more balanced, consisting of 3 boys and 3 girls and a male teacher. Students' ages were between 13 and 14 years old. The topics of study in this experience were related to Mathematics. The teachers used previously IWBs to support their lectures rather than for endorsing collaborative learning or fostering a participatory environment. The teachers received 1 hour of training on the Collboard software which was limited to learning how to use the client application.

4.3. Experimental Procedure

The two groups described earlier worked with Collboard for 4 sessions. The first session lasted 1 hour for both groups, while the first 20 minutes were used for introducing the students to the experience, giving them instructions on how to operate the digital pen, etc. The remaining time was used for solving the task. For both groups, all three following sessions lasted for 40 minutes, covering all the phases of Collboard's pedagogical workflow. A different task was assigned to the students in each of the four Collboard sessions. The first two sessions covered fractions problems, and the following two, area calculations. The teacher began the activity by presenting the students with the problem projected on the IWB; next, the students worked individually on the problem using the digital pens (see Figure 2a), and as they were ready, they handed their solutions on paper to the teacher. A member of our team received the digital pen and submitted the digital answer to the Collboard system using the answers submission client application. When the teacher finished evaluating the answers on paper, the answers on the IWB client were selected and the teacher-mediated classroom discussions could start. From this point on, the teacher and the students began using the IWB towards creating a collaborative solution (see Figure 2b). All Collboard sessions were video recorded and all the students' answers, in both digital format and paper, were kept for evaluation purposes.

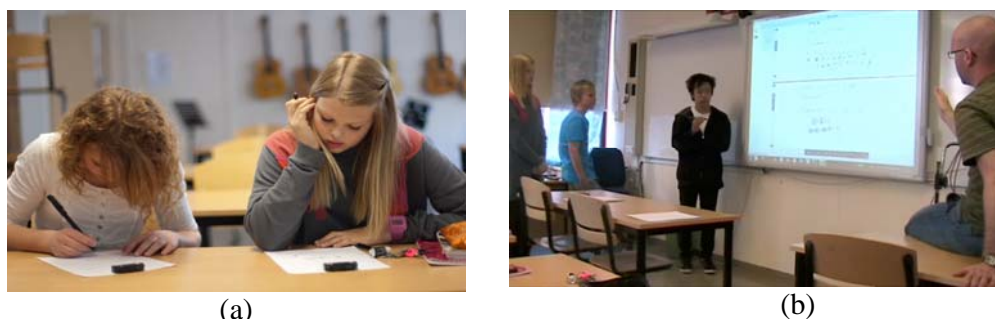


Figure 2 - (a) Students working on phase 2, (b) teacher and students discussing with the IWB tool.

4.4. Preliminary Results

After the trials, we surveyed the students and interviewed the teachers. The survey consisted of 12 questions aiming at investigating students' perception of their own participation and motivation, their impressions on technology performance and adoption, and their satisfaction with Collboard. The interviews with the teachers aimed at capturing their views and opinions about the pedagogical value of Collboard, as well as their appreciations about the technology adoption process that unfolded throughout the trial.

Figure 3 shows the partial results of the survey. From Figure 3a, it can be observed that the majority of the students had a positive attitude towards being called to the front to actively participate in ordinary math lessons. Furthermore, when working with Collboard (Figure 3b), students felt more motivated to closely work together with the teacher solving problems. We consider that the increased motivation is not solely explained by the use of the new technology, but rather, by the rich social environment fostered on the teacher-guided discussions, calling for active student participation and fostering greater interactivity than in regular math lessons. This is supported by the fact that students perceived an increased level of communication during the discussions with Collboard, not only with the teacher (Figure 3c), but also with their classmates (Figure 3d). During the first sessions, the teachers were

cautious about calling the students to the front, as they did not feel familiar with the role of moderating discussions involving multiple students at the IWB. Both teachers progressively evolved towards eliciting richer discussions with more active involvement. By the last session, both teachers could cope to work with three students at same time in the IWB, eliciting explanation, argumentation and mutual regulation, and steering the discussion towards a commonly accepted solution.

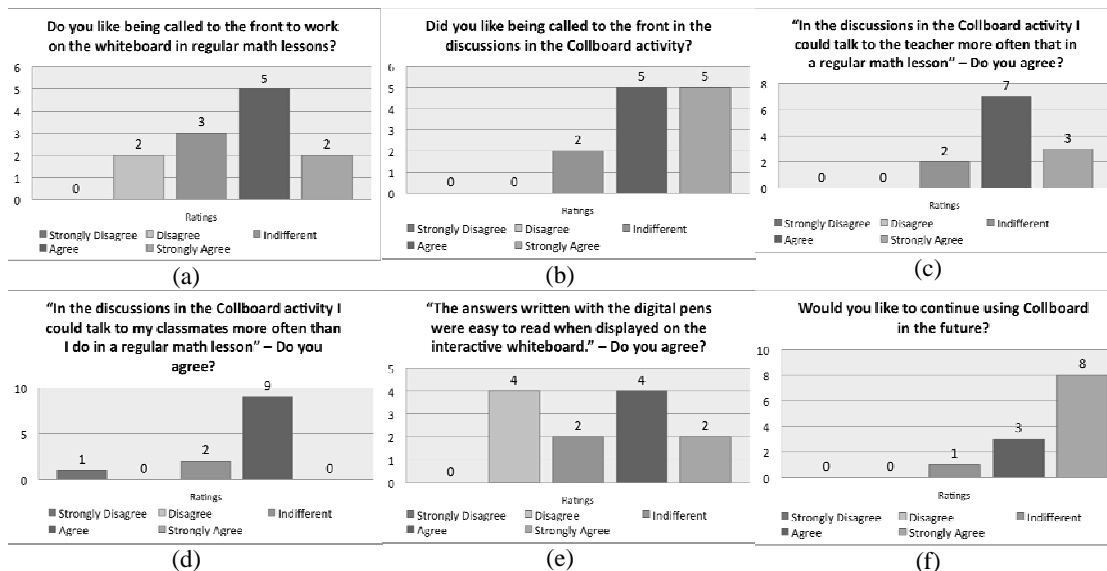


Figure 3 – Overview of survey results

One hour of training was enough for both teachers to appropriate the IWB tools provided by Collboard, without the need of a lot of practice, and no further technical assistance was required during the discussions. The students, having not received prior training on the IWB tools, could intuitively make use of the affordances of the software with some guidance from the teacher. The DPs, however, did not perform correctly at all times (Figure 3e). Sometimes pen strokes were omitted in the digital annotations, possibly because of the students not pressing hard enough on the paper. In some cases the pen's scanner captured noise or distorted strokes. By visualizing the annotations with the software bundled with the pens, we realized that these shortcomings were not due to flaws in our SVG conversion library, as the annotations looked similar in the bundled software. Generally, the answers with missing strokes or noise appeared legible on the IWB, so this was not a disruptive element in the discussions. Despite this technology issue, most students would like to continue using Collboard it in the future (Figure 3f).

5. Conclusion

In the Collboard project, we have taken a step towards incorporating the idea of seamless interactions across different kind of media in the classroom. Digital pens appear to be a suitable tool to support individual work in activities involving open-ended task solving. On the other hand, IWBs and software applications can be leveraged to support collaborative knowledge construction spaces involving small groups guided by the teacher. In this regard, teachers could understand Collboard's scripted collaboration approach and made effective use of the seamless technologies it leverages. However, emerging patterns of teaching and learning, including proper orchestration of the learning activities require coaching and committed practice. At this point, our qualitative observations are favorable towards

considering Collboard as a proper means for eliciting shared knowledge construction and developing learners' collective intelligence and distributed cognition skills. Moreover, the proper integration of digital pens and IWBs that has been accomplished indicates that transparent transmedia navigation and visualization comprising paper-based and digital artifacts is possible in the classroom environment. We are aware that these results should be complemented with quantitative data in order to give better support to these claims. Seeking to establish whether Collboard may have a positive impact on learning, we carried out pre and post-tests with the students, each of them comprising two tasks similar to the ones solved with Collboard. We are now conducting a thorough analysis on our experimental data to refine our findings, as well as analyzing further potential for developing other new media literacies skills [4].

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