

# Digital Workbook: A Mobile Learning Environment to Support Collaborative Examinations

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**Abstract.** It is already known that some collaborative assessment processes can provide students not only the possibility to show how well they have understood knowledge content, but also the opportunity to enhance and increase such knowledge. Such learning activities also allow instructors to diagnose the quality of the instructional process. However there is evidence that this type of activities involve an important effort. This article presents a mobile learning environment named digital workbook, which was designed to support students and instructors when applying a Collaborative Examination Technique. The tool was evaluated in a Computer Science undergraduate course, and the obtained results are highly encouraging.

**Keywords:** collaborative assessment process, mobile computing.

## 1 Introduction

From a collaboration point of view, sharing information is one of the most important activities in teaching-learning scenarios. Most of the time students share information without using exchange structures or adequate supporting tools. In that sense, collaborative learning techniques provide strategies to support the student learning process by doing some activities more than simply watching and listening. However, collaborative learning activities are still difficult to design and apply inside the classroom; especially if those activities include new technological elements. In that way, we are interested in the development of technological solutions to be integrated in an educative setting supporting social interactions among different group members. The solutions will allow students to achieve the pedagogical goals in an effective manner, by acquiring abilities like problem solving, critical thinking, meta-cognitive thinking (learning to learn), and information retention, as it was proposed by Johnson & Johnson [1]. Some years ago the authors proposed a Collaborative Evaluation Technique (CET) [2], which involves three stages composing a collaborative examination process: a *pre-test*, a *test* and a *post-test*. The *pre-test* main goal is to help students to understand and assimilate, in an early stage, the knowledge that is going to be considered in the test phase. The test phase involves the individual resolution of an exam, similar to a traditional examination process, which is face-to-face and hand-written. Finally, the *post-test* intends to reach two main goals: (1) that students find the right

answers to the test questions/items through a discussion among them, and (2) that students identify the right points and the mistakes in their answers. At the end, in an individual manner, each student grades his/her own exam and give it back to the instructor. For the correction of their own exams, the students use the solution outline constructed by the group during the discussion session. Finally, students grade their own exam as a whole, in accordance with the individual grades assigned to each answer of the test. The students' answers are then examined and graded by the instructor or the teaching assistant. Students that find the right answers during the post-test receive a bonus in their exam final score.

On this context, the authors propose to use a collaborative software tool to support some activities involved in the CET. It will help to reduce the effort involved in performing the CET process. Such tool has been named the *Digital Workbook*. This solution keeps the traditional paper notebook metaphor in order to allow students to express their ideas and annotations in a natural way. The digital workbook also offers to the users several interaction mechanisms among group members, which can be used to support collaborative activities. In that way, students can build in a collaborative manner, their responses to the problems proposed in the pre-test and post-test stages by using services of the digital workbook, e.g. the creation of work sheets they can share, annotate and publish. Mechanisms such as annotations or publications convey communication elements in synchronous and asynchronous way.

A particular module of this tool, which was named CETProfessor, was implemented to support the instructor during the activity preparation and monitoring processes. This module includes several services, e.g.: (1) a list of questions that can be reused during tests, (2) services to configure access grants for the accounts of users participating in the activity, and (3) various communication services that are useful to publish the questions and responses involved in the activity. Some of these services include: a sociogram, participation records, and registered users list and on-line.

The rest of the paper is organized as follows: next section presents background information related to the development of the proposed collaborative tool. In section 3 describes the architecture of the digital workbook and its main components. Section 4 presents the experimentation process performed to evaluate this tool, and also the preliminary results. Finally, section 5 presents the conclusions and further work.

## 2 Background

It is important to mention that CET already counts on a collaborative system that automates several of its activities. The tool, named MOCET [6] runs on tablet PCs and PDAs, and utilizes a stylus to keep the metaphor of the paper notebook. This system allows each student to share information just with the instructor. For example, a student can retrieve or submit his/her exam using this service. Data persistency and synchronization are managed by a platform named SOMU (Service-Oriented Mobile Units) [3].

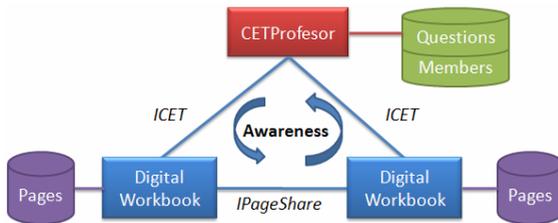
Shared objects, e.g. images, text documents or exams, can be accessed on-demand by members of a mobile work session. These persons communicate among them using a mobile ad-hoc network [7], which forms a distributed system. During pre-test, each student can share his/her resources with other students; however during the test

and post-test students can interact just with the instructor. In every stage these persons can do annotations on their private or public resources. If the stage allows them, two or more students can exchange or combine their annotations in order to get a consolidated view of their comments. MOCET separates the object from the annotations done over them. It simplifies the implementation of several services, such as the annotation exchange and synchronization, and also the replication of shared objects.

This tool uses an application programming interface provided by Microsoft One-Note [1], to access services for hand-writing on tablet PCs and handheld devices. Although these services are useful, every device running MOCET must include the product OneNote as a supporting service. It limits the possibility to reuse the tool in more than one scenario. In addition, MOCET have shown some usability limitations mainly in the module that allow instructor to prepare and monitor a CET activity. These reasons motivated to the authors to develop a completely new system that solve the already mentioned MOCET limitations. The result was the Digital Workbook.

### 3 Digital Workbook

The digital workbook was also designed to be used on a Tablet PC; however it does not require any plug-in or software product to provide the services to students and instructors. The tool implements a public and a private space to manage the resources in each computing device. It also implements two communication services: *ICET* and *IPageShare*. *ICET* represents the design contract between CETProfesor (module used by the instructor) and digital workbook (module used by the students) in order to obtain information about proposed questions and group information. *IPageShare* allows sharing pages between digital workbooks.



**Fig. 1.** General Diagram of the architecture in the communication level

questions and users. This information and also the exams can be shared with the students using the *ICET* communication service. Each digital workbook manages its own pages (or working sheets) that could be published or shared according to the participants needs.

#### 3.1 Digital User Interface

Figure 2 presents a screenshot of the digital workbook main user interface. The interface involves five components or interface areas:

Such service is executed in an autonomous way, and allows students to perform distributed presentation or share information (e.g. pages of the workbook) as part of a private session. Fig. 1 depicts a general diagram that allows understand how the workbook works.

The module CETProfesor manages a database of

- (A) A list of questions given by CETProfessor. Each question has its own responses, describing the communication process.
- (B) A list of users that are part of the work group. It uses green color for the connected users and white for the disconnected ones.
- (C) A working area. There it is possible to add lines and some graphical components like geometric figures, images and text. Notes or annotations are a special type of components allowing students to make some comments about the content of certain task. Based on these annotations a sociogram is displayed about the interaction of the students.
- (D) A menu bar with different components could be integrated and also the communication services that allow sharing page, working sheets or students' options that can be sent to the instructor.
- (E) An information line that allows accessing to the awareness management tool, which was proposed in [5]. In order to obtain awareness independence, the digital workbook and CETProfessor modules implement their own awareness mechanisms. This aspect is going to be evaluated in future experimentations.

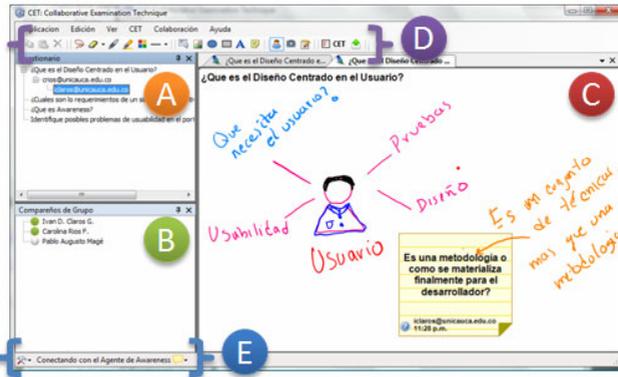
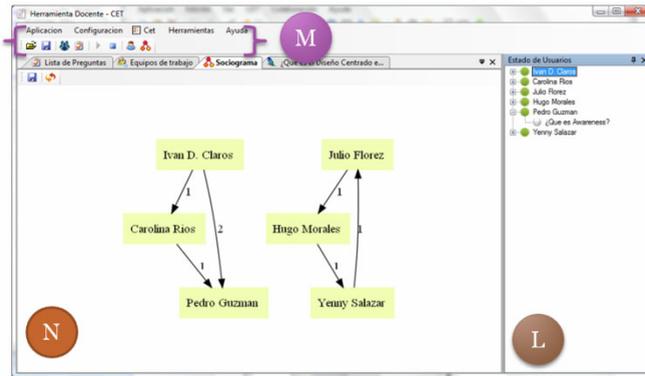


Fig. 2. General View of the Digital Workbook (in Spanish)

### 3.2 CETProfessor

This module is used just by instructors and it allows: 1) managing the list of questions and users; 2) executing communication services that allow users access shared information, and publish students' contributions through pages or working sheets; and 3) facilitating tutor mechanisms to monitor a CET activity.

Fig.3 presents a screenshot of the CETProfessor user interface. In N) we can observe an example of how different users have made some comments to the working sheets of the teammates. In B) it is possible to observe the list of users registered per activity, their connection states and the different responses published in every working sheet. If the user clicks a question in L), the module displays the responses. In M) we can observe the buttons to access the edition window, the questions and the commands to launch and stop the ICET service.



**Fig. 3.** General view of CETProfessor

The CETProfessor module does not include functionality to edit the responses in the students working sheets. If the instructor wants intervene, s/he must send a message to the students. In future versions we hope to include mechanisms that allow tutor to intervene in a direct manner over the responses working sheets. Next we describe the experimentation process performed to evaluate this tool.

## 4 Experimentation

During the experimentation phase we worked with students of a Human-Computer Interaction course in the Computer Science Program at University A (Colombia). The topic evaluated was *user interfaces in collaborative systems*; particularly: awareness mechanisms in CSCW environments, usability and tangible interfaces. A set of questions were formulated to support the learning of these topics. We worked with 21 students divided into working groups composed of three randomly selected students. Due to lack of Tablet PCs only two of these groups worked with the digital workbook (ULD), and the other ones (UT) without digital workbooks. In this experiment three tabletPC were used, the ULD groups had to interchange the tabletPCs during the activities. In one of these tabletPC, both Digital Workbook and CETProfesor were executed, in the others, only the Digital Workbook was executed.

### 4.1 Methodology

The process began with an introductory talk about the topic, where concepts like collaborative work and collaborative learning were explained. The working groups were organized and every student was responsible to acquire the knowledge related to a certain topic (awareness mechanisms in CSCW environments, usability and tangible interfaces). Each student studied in an individual manner the assigned topic and s/he proposed a brief summary that is going to be worked in the activity. Next section explains how do the different activities that conform CET were performed during the experimentation process.

## 4.2 The Process Step-by-Step

During the pre-test stage the following activities were performed:

*Definition of a coordinator (5 min):* Each group selected a coordinator, who has the responsibility to promote and solve discussions, and also to coordinate the activity in a way that permit to achieve the group goal in an efficient manner.

*Resolution of questions in an individual way (15 min):* Based on the preliminary research, every student gave an answer to questions of every topic. UT groups did the work using paper sheets, while ULD groups used the Digital Workbook.

*Experts Meeting (15 min):* Students from different working groups, that have the same question to answer, were organized by pairs in order to discuss every question and response (Fig. 4). Changes or updates to their responses are saved as a new version of the answer.

*Group meeting (15 min):* Once the experts meeting has finished, working groups meet and discuss the responses to the assigned questions. Any change is saved as another version of the response. All documents are sent to the instructor; the ULD groups do not need to do that, because the tool provides such service automatically.



**Fig. 4.** Expert meeting (ULD left, UT center, working groups right)

During the test stage we applied a traditional test, where one of pre-test question was included. We did not use any technological application to support this stage. During the post-test the working groups were organized in order to analyze their responses, including some annotations and notes if they needed. The post-test considered an additional bonus in the score that was added to the average between pre-test and test. The activity finished when students graded the exam as a whole.

After that, students participated in a discussion about the topics worked and they talked about the experience of this collaborative practice. At the end, they did an exercise that consisted in an essay about the formulation of awareness mechanisms in tangible interfaces, in order analyze if students really understood the topics. Although this phase is not considered as a part of CET, we think adequate to perform this activity to analyze if there was an appropriation of the concepts worked in the CET activity. Finally, we did an interview to the students and they also fill a survey about the experience.

### 4.3 Obtained Results

Table 1 depicts the results obtained during the experience. Groups A, B, C, D, and E were working without digital workbook. However groups F and G were working with the digital workbook. At the end of each phase the students presented a document with responses to the proposed questions. According to these results we can observe all groups improved their scores after pre-test. This could imply the CET is a mechanism that permits to support teaching-learning processes in an independent way, if it is mediated by a computer. Although all groups improved their results comparing grades from pre-test to test, those who were working with Tablet PC got a better performance (their grades improved from 3,5 to 4,37 and from 3,8 to 4,4 into a scale from 1 to 5). More important is the level of improvement obtained by the groups using the digital workbook, which was between 0,6 and 0,9 points.

**Table 1.** Experimental Results

	CET				Final Document	Final Grade
	Pre-test	Test	Bond Post-test	Final CET		
<b>A – UT</b>	4.00	4.10	+0.10	4.20	4.1	4.15
<b>B – UT</b>	4.27	4.43	+0.05	4.48	4.4	4.44
<b>C – UT</b>	4.23	4.23	+0.10	4.33	4.6	4.46
<b>D – UT</b>	3.90	4.07	+0.05	4.12	4.3	4.21
<b>E – UT</b>	4.3	4.33	+0.15	4.48	4.5	4.49
<b>F – ULD</b>	3.50	4.37	+0.10	4.47	4.5	4.48
<b>G – ULD</b>	3.80	4.40	+0.10	4.50	4.6	4.55

It is clear that in CSCL scenarios technology is not the only variable that could influence an improvement of the students' performance. It is necessary to structure the collaborative activities convey a real collaboration. In our experience CET has shown to be a good technique that helps improve teaching-learning process and the use of supporting technology helps to perform the activity in a better way. The results we obtained were based on quantitative data of the results of the test, for future experimentations we are going to include qualitative aspects like some survey about the experience of the technique and software tool. During these experimentations we have not included the comments of the teacher about the experience. We hope to include experience of the teachers using the Model and software tool we have developed for further work.

## 5 Conclusions and Further Work

This article presented a mobile collaborative application, named digital workbook, which supports activities involved in the collaborative evaluation technique (CET) [2]. The metaphor embedded in the digital workbook seems to be appropriate to perform the CET activities. This result can be observed through positive impact the tool

has had not only to support the experience but also the learning goals. However there is a need to establish design guidelines to mitigate the usability problems that still have the technologies for hand-writing on Tablet PCs.

The digital workbook can also be used to support other collaborative learning activities, because it is possible to use its services in an autonomous way and independently of any other component. The monitoring capability of the tool can also be used to support other collaboration activities. Although the obtained results are still preliminary, the use of the tool has shown to be consistently attractive and useful for students and instructors. The next steps in this work involve more experimentation instances that allow understand the real impact of this proposal including the evaluation of the CETProfessor in order to determine how awareness aspects we have includes could support instructor in the teaching-learning process.

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