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Incorporating Mobile Elements in Collaborative Pedagogical Scripts

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Abstract: This paper describes our on-going efforts regarding how combining the potential and affordances of two approaches and systems can be used to provide teachers with the ability to design and enact online learning scenarios that include activities performed in outdoor settings. We describe how different technical features of our systems have been integrated combining web-based solutions and mobile applications. We present a detailed example of a learning scenario that was implemented with undergraduate students and included outdoor activities performed via mobile phones, as well as other learning tasks using the web and computers in the classroom and at home. Our results imply of ways teachers and students may use technology in order to support collaborative learning trajectories across different contexts, as well as insights pointing to the pedagogical and design challenges involved in combining a variety of technologies to support outdoors and indoors learning activities.

Keywords: Mobile learning, collaborative learning trajectories, collaboration scripts

1. Introduction

Technological advancements in ubiquitous computing and wireless communication combined with the rapid adoption of sophisticated mobile multimedia devices and applications have created new software tools for people to connect and interact; therefore changing the ways we communicate, learn and collaborate. These developments offer the potential for a new phase in the evolution of technology-enhanced learning (TEL), marked by a continuity of the learning experience across different learning contexts. Chan et al. [1] use the term "seamless learning" to describe these new situations. These scenarios include learning individually, with another student, a small group, or a large online community, face-to-face or in different modes of interaction and at a distance in places such as classrooms, outdoors, parks and museums. Recent examples of such scenarios using mobile technologies can be characterized by emerging patterns of interaction and classroom dynamics that may support learning in many ways: they connect the classroom to the outside world [2], facilitate social learning process [3, 4], and contextualize the learning experience [5, 6]. This wide spectrum of different learning scenarios allows for the creation and design of new possibilities to augment learning. Rogers and Price [7] have categorized these new learning opportunities into four major types: physical exercise games, participatory simulations, field trips and visits and content creation.

Spite all these promising developments, there is still a need to improve our knowledge in this field in order to better support the pedagogical design of "seamless learning" tasks and it is necessary to further investigate how students interact with learning contents, peers, teachers and parents through a variety of technologies and contexts. Another challenge is to provide teachers and educators with a set of flexible authoring tools that will allow them to orchestrate these kinds of collaborative learning activities that may take place beyond the classroom.

Current efforts in the field of CSCL address those aspects related to the integration of collaborative activities that combine digital and physical spaces in which teachers need to orchestrate a wide variety of activities supported by diverse tools [8]. Although it can be claimed that CSCL supports the design of learning activities and the introduction of different types of interactive tools to support collaborative learning, most of the research efforts in CSCL have been focused on collaborative activities in classroom settings using different devices such as handhelds, interactive whiteboards, and tabletop interaction systems [3, 8, 9, 10]. Zurita and Nussbaum [4] discussed the benefits of using mobile devices in the classroom to foster collaborative learning and have pinpointed that new opportunities exist to extend this to work outside of the classroom.

In the last five years, our groups have been conducting research in two distinct but *complementary* research directions in line with the ideas described above. These efforts focus on the development of mobile and wireless applications and tools to support collaborative learning [6, 11, 12] and the design and deployment of a web-based system to enable educators to create and reuse online collaborative scripts to support learning activities for all subjects and levels [13, 14, 15]. Our current research efforts focus on *integrating* the two approaches in order to explore how best to support the design and enactment of collaborative pedagogical scripts that are performed with stationary computers and mobile devices both in the classroom, in outdoors settings and at home. In the remaining of the paper, we describe how the different technical features of our systems have been integrated combining web-based solutions and mobile applications. We present a detailed example of a learning scenario that was implemented with undergraduate students and included outdoor activities performed via mobile phones, as well as other learning tasks using the web and computers in the class and at home. The paper concludes with an analysis of the lessons learned during this activity and ends by pointing out at the pedagogical and design challenges involved in combining a variety of technologies to support outdoors and indoors learning activities.

2. Designing and Enacting Online Collaboration Scripts with CeLS

CeLS (Collaborative e-Learning Structures) is a web-based approach and system designed to enable teachers to design, enact, share and reuse structured online collaboration scripts and to incorporate them in existing instructional settings for any subject and level, from elementary school to higher education [13-15]. One of the salient features in the CeLS approach is its ability to control the data flow in order to reuse learners' inputs and products from previous stages and to relate actions on these products to different social requirements. A script designed using CeLS may include any number of stages. A stage is comprised of a combination of basic building blocks, while each building block generates a certain type of interface in the student's environment. There are five types of building blocks that can be used to create a script as described below:

- **Presentation** objects generate passive display of information (text, links, media). This information can be provided by the teacher or consist of learners' products from previous stages.
- **Input** objects generate interfaces that allow participants to submit new data to the system as individual or as group artifacts. Inputs may include: text, hyperlinks, media, files, voting on various scales, replies to questionnaires or rubrics and shared documents.
- **Interaction** objects generate interfaces that allow participants to interact with individual or group products submitted in previous stages, in various ways: by commenting, grading, ranking, and categorizing via text or graphic manipulations.

- **Communication** objects generate interfaces that allow participants to freely communicate with each other and with the teacher.
- **Operational** objects are used to group participants according to different criteria based on their inputs and actions and enable the design of adaptation patterns [15].

CeLS flexible architecture enables the design and enactment of a large variety of online collaborative activities representing various pedagogical approaches such as: creating content, collaborative problem solving, responding to questionnaires, peer product assessment, competition, jigsaw and any combinations of the above. CeLS and its student interfaces were originally designed to be used with computer workstations (stationary and laptops) connected to the web only. Even if some of the scenarios implemented with the system involved outdoor activities (such as taking pictures at outdoor locations), these aspects were not supported in ways that could take full advantage of the potential offered by the existing mobile technologies.

3. Towards an Integrated Approach for Scripting Mobile CSCL

Our first efforts focused on integrating the different approaches and features of CeLs and the Mobile Collaborative Learning System (MoCoLeS) [16] in order to offer teachers and educational researchers with the ability to design and enact integrated pedagogical scripts that include classroom and outdoor activities supported by mobile technologies. The table below illustrates our approaches, their potential, affordances and limitations.

Table 1: An overview of the MoCoLes and CeLS approaches

Approach	MoCoLeS	CeLS
Potential & Affordances	Enables implementation of rich collaboration scripts enacted via mobile devices.	Enables design, enactment, sharing and reusing of rich multi-stage web-based collaboration scripts.
Limitations	Does not enable teachers authoring the script and it is specifically adapted for implementation with mobile devices.	Does not provide the functionality to deliver collaborative scripts to mobile devices.
Goal	Integrate these two approaches in order to support the design and enactment of collaborative pedagogical scripts that include activities to be performed outdoors using mobile devices as well as indoors using stationary computers.	

The integration of our approaches faces some issues related to interoperability and exchange of data between these two environments; creating a CeLS script should be readable and executable by the mobile environment and the data and contributions generated using the mobile device should be plausible and should make sense when upload it to the CeLS script representation. Since the CeLS approach is modular and generic and it is based on pre-defined types of building blocks, the incorporation of *mobile components* in the scripts poses additional challenges, such as addition of new Input building blocks should be relevant and applicable only to inputs from mobile devices. We have recently completed the initial stage of integration of our systems, assuring interoperability between the two environments as described in Figure 1.

The CeLS environment is used to define the script that consists of collaborative learning activities that include tasks that are supported by mobile and the stationary and mobile CeLS clients. The XForm component and the Open Data Kit [17] are responsible for generating the mobile phases of the learning activity based on the CeLS script. It should be noticed that this mobile script is presented in a way that complies with the format required for small displays.

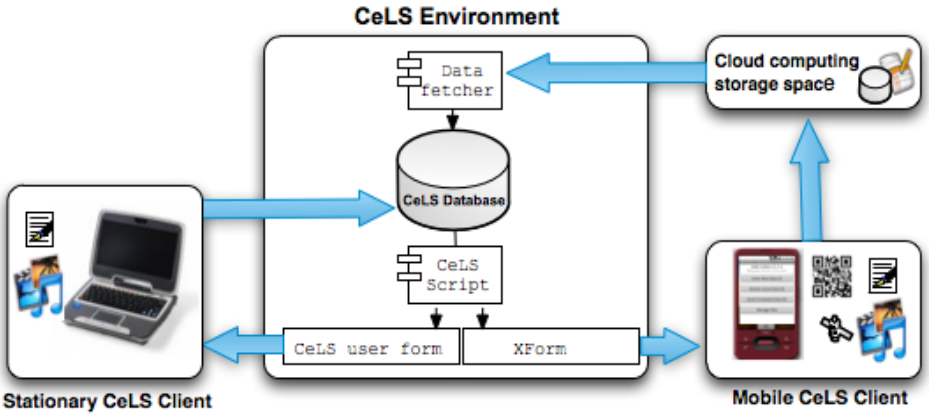

Figure 1: Integrating mobile activities in CeLS scripts

The content generated by the students using the mobile CeLS client (images, sounds or video objects, answers to questions and so on) can be stored locally in the mobile device or alternatively in a cloud computing storage space (in this particular case we are using Google Fusion Tables). The Data fetcher (as described in Figure 1) is a software component responsible for retrieving the data from the cloud computing storage space and transferring it to the CeLS database.

Students can participate in the learning activity using computers or mobile devices, according to the type of task defined in each specific stage. The integration process described above ensures a continuous data flow within the script that enables to take full advantage of both mobile and 'stationary' elements: the contributions produced outdoors serve as reference inputs for further analysis and online discussion performed via large displays that enable complex and rich representations. We have recently designed various learning activities in which these kind of integrated scripts are tested with students. These scripts include at least one phase that is performed outdoors, individually or collaboratively, while the other parts of the activity could be performed online (using stationary computers) or face to face in the classroom [16]. In the following section we present a detailed example of such scenario that has been enacted with undergraduate students.

4. An Integrated Learning Activity: Usability in the Campus

The activity *"Usability in the Campus"* was presented as an introduction to an undergraduate 1st year course on Interface Design and it was performed by a class of 37 students. The first part of the Interface Design course deals with physical interfaces and introduces the concept of Usability. The major instructional challenge at this point is to raise student's awareness to usability issues that may be involved in any aspect of real life. Therefore, the activity aimed to engage students in an *authentic* challenge of identifying, documenting and analyzing usability problems in their natural close environment – the campus. The activity was launched by a short preparation session in class (15 minutes) and it was fully supported by a script designed in the CeLS environment (Figure 2).

Stage 1 (1-2 hours) was performed outdoors using mobile phones. It is important to note that the activity was performed with mobile phones (Android operating system) provided by the institution and not with the students' personal devices. The devices were selected due to their typical properties such size, weight, communication abilities and sensory capabilities.

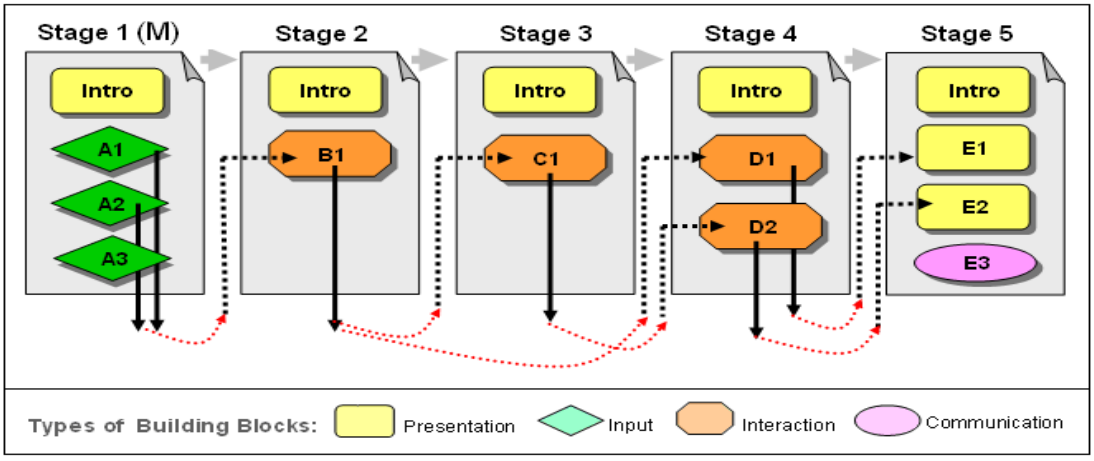

Figure 2: The script for the Usability Competition activity. (M) Mobile stage. Each stage starts with an introduction (Intro).

Highly computational abilities that are typical to laptops, where not considered crucial for the outdoor activities and therefore not selected. Ten groups of 3-4 students were challenged to tour the campus and to identify usability problems. Each student could take and submit one picture (A1). In addition, the students also submitted via the mobile device a short description of the usability problem represented by the picture (A2) and several word tags that were used to best describe the problem (A3). All the pictures were geo-tagged and the information was also used by the Institution's Authorities to amend the problems identified by the students (Figure 3).

Figure 3: Students in action: Documenting a usability problem using mobile phones (left). Students' artifacts displayed on a Google map as presented to the Institution's Authorities (right).

The following stages were performed *at home* using a web browser and computers during the following week. In Stage 2, the members of each group selected the best item produced by their group (B1). Stage 3 focused on analyzing the tagging; each student was presented with four of the usability problems documented by the other groups and was asked to select up to 3 tags from a given list, that best describe the problem (C1). Stage 4 consisted of two parts: voting for the best, most significant problems represented by the pictures (D1) and for the case that was best tagged by the peers (D2). In the fifth and final stage, the results of phase IV were presented: the competition results (E1) and the class collaborative tagging (E2) including an optional open online discussion (E3). The activity was summarized and concluded in a class session.

Figure 4 illustrates the competition's results and depicts the flow of the activities and how the processes have been supported by the technical functionalities of our integrated systems. The mobile client of the MoCoLeS system provides the outdoor groups with the support required for artifact and content creation. These results are aggregated into a single presentation view provided by the CeLS system. Users using the web client of the CeLS system are able to perform additional collaborative activities (such as voting and categorization of content) about the artifacts created in the outdoor activities.

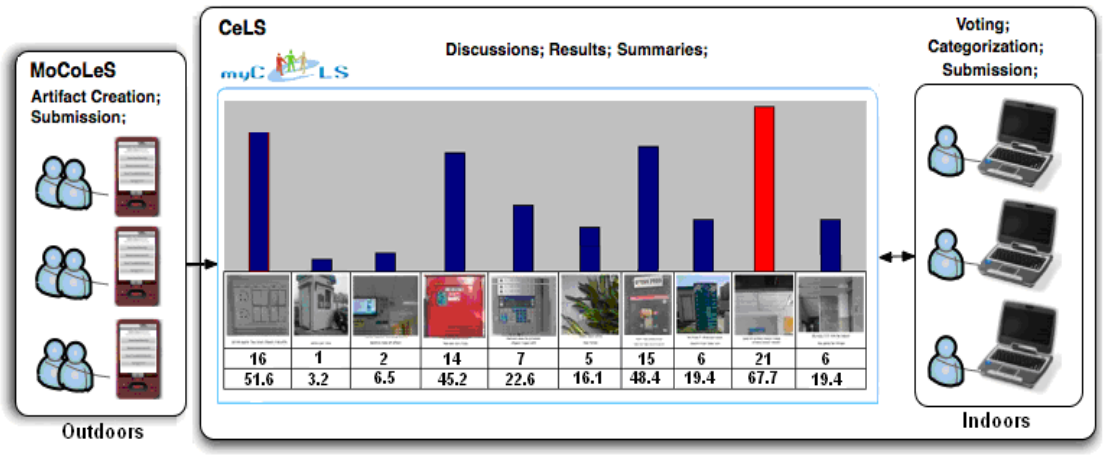

Figure 4. The data flow of the outdoors/indoors collaborative learning activities.

Students' reflections on the activity and its impact were documented and collected using a short questionnaire and sample personal interviews. All the students that participated in the outdoor phase declared that this experience has changed their approach to user interfaces and to usability issues, and especially to their awareness to the existence of such problems. Many expressed surprise of the abundance of such problems existing "everywhere around us" and stated that they now look at devices and interfaces in a critical manner. Figure 5 presents the summary of students' evaluations of this activity in three dimensions: *contribution to learning of new ideas and concepts*, *difficulty* and *interest*.

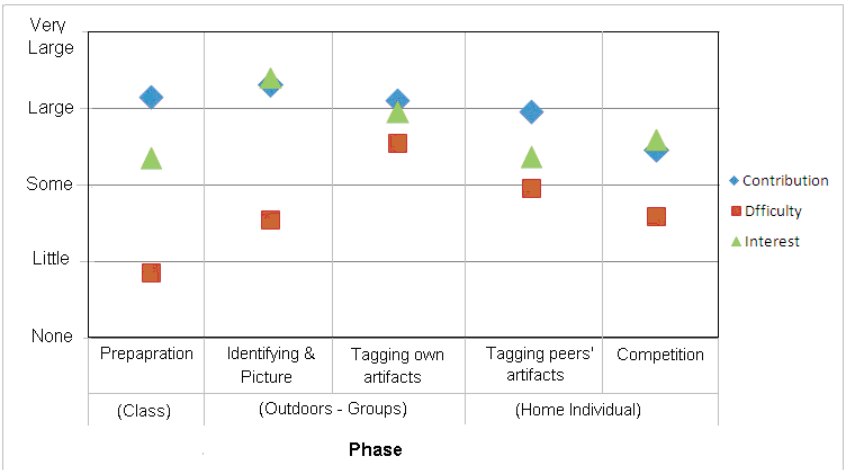

Figure 5: Students' evaluations of the activity phases.

The outdoor phase was graded as the *most interesting* one, while its two parts distinctively differed in the difficulty dimension: identifying a problem and documenting it was graded as the easiest action while the cognitive challenge of tagging the usability issue using meaningful terms was graded as the most difficult task.

Students were asked to specify difficulties they have encountered during the activity. Students' feedbacks reveal three types of difficulties:

- **Interface**: The most frequent difficulty mentioned by the students was manipulating the mobile interfaces in Stage 1 since it involved the use of devices that they were not familiar with.
- **Technical**: Some students were worried about the limited accuracy of the geo-location recorded by the GPS system for sites that may not be sufficiently exposed to open sky.
- **Conceptual**: coping with the conceptual challenge of analyzing and tagging the problems as part of the outdoor activity. Students recommended to perform this task in a calmer environment (class or at home) since it does not require facing the actual site.

5. Concluding remarks and future efforts

We have illustrated how the combination of mobile and stationary technologies can support different phases of the learning experience that cross spatial, temporal and conceptual boundaries, and interweave with the learner's everyday life and into her web of personal knowledge, interests and learning needs. The ideas described in this paper imply that students will need to deal with several learning devices and digital media, as well as different modes of interaction in order to complete a learning task. The specific lessons learned from this study are currently applied to improve the interfaces used for the mobile phases and to offer optimized operability with different kinds of mobile devices available to students. This is done in order to tackle some of the described difficulties (e.g., GPS accuracy problem could be alleviated by the usage of A-GPS). The integration of scripting capabilities with the mobility support provides new opportunities for the design and deployment of collaborative learning activities. Nevertheless, the affordance of technology that can support learning scenarios combining indoors and outdoors activities also pose new challenges: the need for *careful planning* of the ***type of tasks allocated*** *to different settings*. Assigning complex conceptual tasks to be performed in an outdoor environment (sometimes distracting) may not be advisable (even if technology may support it) and the mobile components of an activity should be used only whenever necessary.

Our future field studies are aimed to explore the design and implementation of a variety of integrated scenarios in different subjects and their enactment with different age groups in order to understand the kind of dynamics that can emerge based on these activities. The results of these studies may suggest pedagogical guidelines and ideas about how to design and to orchestrate collaborative learning and scripts across contexts using stationary computers and mobile devices and combining class, outdoors and home learning activities. We expect that the results of our future efforts will help us to gain new knowledge in order to cope with the challenges recently stated by Goodyear [18] that claims we are facing two perceptible changes in the field of educational research. The first is a shift in our sense of the spaces and contexts in which education takes place, as different learning activities are becoming more commonly distributed across a variety of contexts. The second change is a wider understanding with regard to the conception of educational praxis, acknowledging the growing importance of design, which in our case involves didactical design – to develop, implement, assess and enhance the learning activities with respect to hypothetical learning trajectories. Finally, the actual exploitation of the potential offered by technology in the educational system depends on the teachers. Therefore, a major concern is to provide teachers with usable, yet flexible and powerful tools they can use in their daily practice. Our coming efforts will focus on the designing of authoring environments that will enable teachers to design and enact integrated learning scenarios for their students and to tailor these activities to their specific needs.

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