An Integrated Approach for the Enactment of Collaborative Pedagogical Scripts Using Mobile Technologies

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Abstract: This paper describes our current efforts that combine the potential and affordances of two approaches and systems aiming to provide educators and researchers with the ability to design and enact pedagogical scripts to support collaborative learning activities to be conducted in classrooms and outdoors settings. We present and explain how the different technical features of our systems have been integrated combining web-based solutions and mobile applications. One illustrative scenario is described and discussed in order to get a better understanding of the different aspects and outcomes resulting from the integration of our approaches. Our initial results indicate the potential benefits of our approach in order to support and orchestrate collaborative learning trajectories across different contexts.

Introduction

Technological advancements in mobile computing and wireless communication 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., (2006) 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 (Liu et al., 2008; Vavoula et al., 2009), facilitate social learning process (Liu & Kao, 2007; Zurita & Nussbaum, 2007), and contextualize the learning experience (Hsi, 2003; Vogel et al., 2010). This wide spectrum of different learning scenarios allows for the creation and design of new possibilities to augment learning.

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. An additional important issue that needs to be addressed in "seamless learning" scenarios relates to the constraints of different systems and technologies that rely on the use of various standards for data exchange what makes the development of interoperable applications a challenging task. Interoperability in these settings would enable multiple applications to interact and seamlessly share data (Vogel, Kurti, Spikol & Milrad, 2010).

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 (Dillenbourg et al., 2009). 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 (Liu & Kao, 2007, Dillenbourg & Jermann, 2010, Zurita and Nussbaum, 2007). Zurita and Nussbaum (2007) 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 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 can be briefly described as follows: 1) the development of mobile and wireless applications and tools to support collaborative learning (Kurti et al., 2008; Vogel et al., 2010) and 2) the design and deployment of a web-based system to enable educators to create and reuse online collaborative scripts to support learning activities (Ronen et. al, 2006; Ronen & Kohen-Vacs, 2010). Our current research efforts focus on integrating these two approaches in order to explore how best to support the design and enactment of collaborative pedagogical scripts. Our envisioned learning activities include experiences across different learning contexts that are performed with stationary computers and mobile devices both in the classroom, in outdoors settings and at home. Our current contribution presents our efforts in this

direction. The paper is organized as follows; the next section briefly describes the CeLS (Collaborative e-Learning Structures) approach for designing and enacting online collaboration using scripts. The following section presents the potential of combining our two approaches and systems in order to offer teachers and CSCL researchers the ability to design and enact integrated pedagogical scripts that include collaborative activities in the classroom and in outdoors settings. One illustrative scenario is described and discussed in order to get a better understanding of the different aspects and outcomes that may result from the integration of our approaches. Finally, in the last section, concluding remarks are drawn and future steps are put forward.

Designing and Enacting Online Collaboration Scripts with CeLS

CeLS is a web-based system designed to enable teachers to design, enact, share and reuse structured online collaboration scripts and to incorporate them in existing instructional settings (Ronen et. al, 2006; Ronen & Kohen-Vacs, 2010). One of the salient features in CeLS 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 that can include presentation, input, interaction, communication and operational objects.

Each object has particular properties that can be adjusted by the author (teacher) in order to adapt the resulting interface and its function to the specific needs of the activity. Some properties are generic, for instance, if the completion of a task is mandatory or not, and others are particular to the object or to its type, for instance, maximum and minimum text length and imposing the use of a certain vocabulary for a Text Input object. While using CeLS, social aspects are the key for controlling the data flow within a script. Each building block can be assigned with particular *Social Settings* that determine what information should be presented or which artifacts would be offered for interaction to each participant. The *Social Settings* may use pre-defined *Social Structures* that represent the characteristics of students' grouping. Since the functionality of a script is determined by attributing social properties to the script's building blocks, different participants may encounter different information, perform actions on different data items, or perform different actions, during the same activity stage.

CeLS 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. The CeLS approach and its student interfaces were originally designed for being used with stationary and laptops computer connected to the World Wide Web only. Even if some of the scenarios implemented with the system involved outdoor activities (such as taking pictures at outdoor locations and submitting them to a competition activity), these aspects were not supported in ways that could take fully advantage of the potential offered by existing mobile technologies.

Towards an Integrated Approach for Scripting Mobile CSCL

Our current effort focuses on integrating the different approaches and features of CeLs and the Mobile Collaborative Learning System (MoCoLeS) (Vogel et al., 2010) in order to offer teachers and CSCL researchers 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	CeLS	MoCoLeS
Potential & Affordances	Enables design, enactment, sharing and reusing of rich multi-stage web-based collaboration scripts.	Enables implementation of rich collaboration scripts enacted via mobile devices.
Limitations	Does not provide the functionality to deliver collaborative scripts to mobile devices.	Does not enable teachers authoring the script and it is specifically adapted for implementation with mobile devices.
Goal	Integrate our two approaches in order to explore how best to support the design and enactment of collaborative pedagogical scripts across different learning contexts. Learning activities are performed with stationary computers and mobile devices	

Integrating CeLS´ capabilities with some of the features of MoCoLeS provide educators with the ability to design scripts to support collaborative activities that could be fully or partially enacted in outdoor settings using mobile devices. The integration of our approaches faces some issues related to interoperability

and exchange of data between these two environments. The creation of a CeLS script should be readable and executable by the mobile environment and the data and contributions provided by the mobile device should be processed in a way that makes sense when uploading them to the CeLS script representation. Since the CeLS system relies upon pre-defined types of building blocks, the incorporation of *mobile components* in the scripts poses additional challenges:

- Addition of new *Input building blocks* should be relevant and applicable only to inputs from mobile devices, such as positioning data.
- Adaptations of existing *Input building blocks* that would allow processing of data generated via mobile phone communication (cradle data sync, SMS, MMS or internet connection).
- Adaptation of relevant *Presentation and Interaction objects* to small scale displays that are typically used in mobile devices.
- Adaptation of the *Authoring interface*: define building blocks activated via mobile devices.

We have recently completed the initial integration phase of our systems, assuring interoperability between the two environments as illustrated in Figure 1.

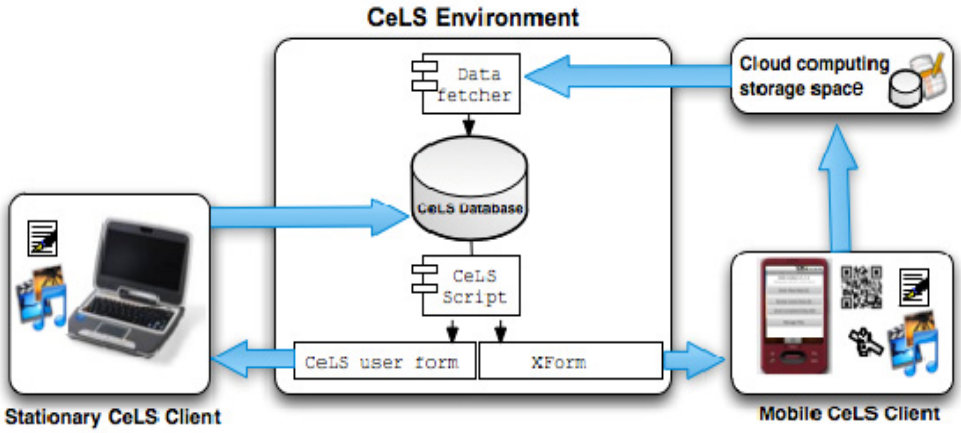

Figure 1. Integrating Mobile Activities in Cels Scripts.

The CeLS environment is used to define the script that consists of collaborative learning activities that include tasks that are supported by the stationary and mobile CeLS clients. The XForm component and the Open Data Kit (Anokwa et al., 2009) 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. 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 a learning activity using computers or mobile devices, according to the type of task defined for 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. Currently, we are about to deploy a number of learning activities in which these kind of integrated scripts will be tested by students. These scripts typically 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. In the following section we described one specific scenario that illustrates our envisioned activities.

Scenario: Our Village

This activity is designed having in mind 5th grade students and it is part of the school curriculum. The objective of the activity is to allow students to gain knowledge about their own village and to learn about its history and important sites. The activity is performed by teams of students from the same class, from different classes in the same school or even with students from different schools. The script is described in Figure 2. All stages start with an introduction (A). The first stage consists of grouping students and assigning "messengers" groups to

various locations (G). The grouping can be automatic generated, or controlled by the students. In the second stage each group arrives to the assigned site, collects and submits information about the site (pictures, GPS location and queries about the site) using a mobile device (B).

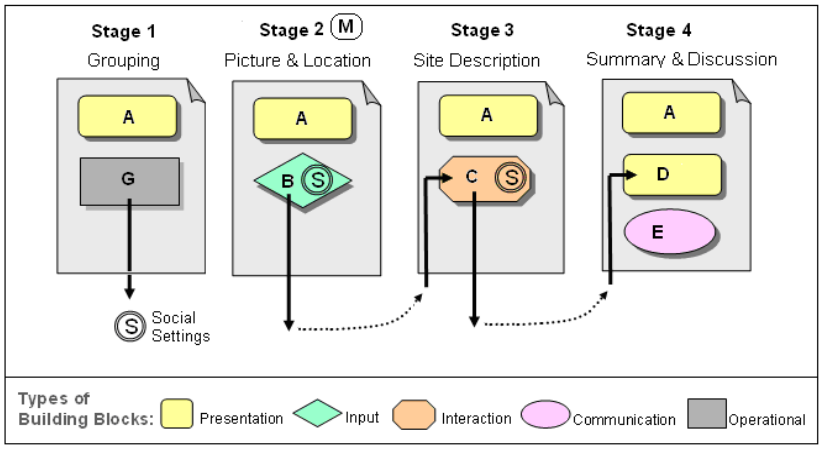

Figure 2. The Script of Our Village Activity. M – Mobile Stage.

At stage 3, groups become "explorers" and the sites are switched: each group is presented with the "messengers´" information and queries about a site (C). Group members need to explore the site attempting to provide answers to the messengers' queries using various resources such as web sites, books, interviewing relevant people or family members. This stage is performed as homework. Stage 3 can be followed by an online negotiation between the "messengers" and the "explorers" until all queries are answered. "Messengers" can now present new questions. The last stage consists of a presentation of the compound results produced by the learning community in various formats (table, photo album, digital maps) and a summary and discussion on the activity. This illustrative scenario has been conceived in order to take advantage of the features resulting from the integration of our systems. In this example, we have defined various learning tasks/activities (including artifact creation and submission, visualization and categorization, site description and discussion and summarizing) that required different types of technological support. Integrating different features of our two systems generates new opportunities to augment classroom activities enhanced by mobile technologies. These features enabled cross-context collaboration between groups of students in outdoors and indoors settings.

The flow and the logic of these activities have been supported by the technical functionalities of our integrated systems, as described earlier in figure 1. The mobile client of the MoCoLeS system provides the outdoor groups with the support required for completing their activities (i.e. artifact/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. The description of this scenario provide some initial indications illustrating the potential benefits of our integrated approach, namely the possibility of blending the functionalities of both systems in order to create additional support for cross-context collaborative learning activities. Integrating scripting and aggregating the capabilities of the CeLS system with the mobility support provided by MoCoLeS provides new opportunities for the design and deployment of collaborative learning activities.

Concluding Remarks and Future Efforts

In describing our current research efforts, we have illustrated one seamless learning scenario that augments classroom activities with information exchanges including geo-tagged mobile content. This scenario demonstrates how the combination of mobile and fixed technologies can sometimes support different aspects of the learning experience. More importantly, it demonstrates how this blend of technologies and educational approaches can support the design of learning experiences that go beyond the classroom settings and interweave with the learner's everyday life and into her web of personal knowledge, interests and learning needs.

The ideas and the scenario described in this paper demonstrate 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. In order to achieve their learning goal, students may need to go through both collaborative and cognitive processes that are slightly different from those performed without such many artifacts. Our coming efforts include the implementation of the scenario described in this paper in order to understand the kind of classroom dynamics that can emerge based on these activities. We expect to collect enough empirical data in order to validate the potential benefits of our approach that can be characterized by the continuity of the

collaborative learning experience across different contexts. The results of these studies may suggest some initial pedagogical guidelines and ideas about how to orchestrate collaborative learning and scripts across contexts using stationary computers and mobile devices. Such type of investigations may help us to re-think the principle of "Less is More" (Buxton, 2001) and to reflect upon what is really helpful or harmful in these learning environments.

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