Flexible CSCL scripting using paper, generic Augmented Reality browsers and GLUEPS-AR

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Abstract: Scripting is a common way to scaffold collaborative learning supported by ICT, but often such approaches are inflexible since all the details of the script's technological support may have to be set at design-time. In this "grain of sand" contribution, we describe our early efforts with Action Server, a system that uses paper elements, widely available Augmented Reality browsers and a ubiquitous learning environment orchestration system (GLUEPS-AR) to flexibly manage the technological support for CSCL scripts in run-time. Our early prototypes show how the translation of physically-represented script elements into orchestration actions might make for a more seamless social-technological coordination of ubiquitous and blended learning activities, including their co-orchestration with students.

Introduction (Motivation)

Within the CSCL research community, there is a clear understanding that effective collaboration among learners is often difficult to achieve. A common approach to scaffolding CSCL is the use of *scripting* approaches (Fischer, Kollar, Mandl & Haake, 2007), that aim at structuring the learning activities to achieve a more effective collaboration. Despite the benefits that have been observed in the application of scripting to collaborative learning, several researchers have warned against the dangers of inflexibly applying such scripts (e.g., Dillenbourg, 2002). Consequently, different conceptual and technological approaches have been proposed to provide flexible scripting support in technological systems for collaborative learning (e.g. Dillenbourg & Tchounikine, 2007). Indeed, such research work on flexible support for CSCL scripting is related with the increasing interest, within the CSCL community, about the challenges of applying CSCL to authentic educational settings and practice (as opposed to controlled environments such as a research lab), gathered under the term "orchestration" (Prieto, 2012).

In parallel with this growing concern for the application of CSCL techniques to authentic settings, classrooms themselves are being permeated by a variety of ICT tools and systems, including the use of Virtual Learning Environments (such as Moodle), Web 2.0 tools (see Conole & Alevizou, 2010), or even Augmented Reality (see Wu, Lee, Chang & Liang, 2013), often used in conjunction with one another. Against this backdrop, we can readily see how orchestrating CSCL scripts in a real educational setting can be challenging for both practitioners and learner, especially if they are to react flexibly to contingencies that are bound to occur in such a "messy" environment.

There are several alternatives when applying collaboration scripts to authentic learning situations, be them either socially-mediated or technology-mediated (Dimitriadis et al., 2007). Usually, social mediation is inherently natural and flexible, while technological mediation can be more easily automated and enables new collaborative situations, such as those in distance or blended learning (although often at the expense of more limited flexibility, since the technological scaffolding very often has to be defined a-priori, e.g., through some kind of authoring tool).

This "grain of sand" position paper proposes an open, extensible *system to combine social and technological mediation to flexibly orchestrate CSCL scripts*, by using tangible and paper elements, mobile devices and a software platform for the orchestration of ubiquitous learning environments (called GLUEPS-AR). This flexible orchestration is achieved by defining a set of "orchestration actions" upon the script and its elements (e.g., activities, groups, participants, ICT resources), and triggering those actions in run-time using mobile devices and paper elements, if and when they are needed. The combination of paper's natural affordances and the automating capabilities of a ubiquitous learning orchestration system may provide not only a more intuitive user interface for the teacher to manage the technological scaffolding of the CSCL script, but also it may enable other forms of learner organization (i.e., co-orchestration or self-orchestration).

In the next section, we briefly describe the main research efforts related to our proposal, and later describe the proposal itself and our research plans along this line of work. Afterwards, we highlight a number of open questions and challenges that we are facing at this early stage of our endeavor (with especial emphasis on those related to HCI). These issues will serve to open up the discussion about our proposal in the workshop.

Related Work

There exists an ample body of research about the use of collaboration scripting in CSCL and its benefits (see Fischer, Kollar, Mandl & Haake, 2007 for good a sampling of the field). From the point of view of the technological support to the design and development of CSCL scripts, it is especially relevant the notion of script lifecycle (the phases that the script undergo from its conceptualization to enactment). Most of existing proposals defining the CSCL script lifecycle include design, instantiation (or operationalization) and enactment (Hernández-Leo et al., 2006) among their phases. Many authors imply that this is an iterative lifecycle on which scripts are progressively refined and adapted. Other researchers highlight that in real educational scenarios this lifecycle is not linear, but rather its phases are entwined with one another (Jullien, Martel, Vignollet & Wentland, 2009). For instance, re-design may be needed at instantiation-time, or instantiation has to be changed during enactment. This leads to a well-known need for flexibility in the application of CSCL scripts to authentic settings, which has been analyzed and conceptualized in more detail by Dillenbourg & Tchounikine (2007).

Our proposal is also closely related to research on the design of technological systems for classroom orchestration, especially recent efforts that employ both Augmented Reality and "paper computing" (Kaplan & Jermann, 2010). Some authors have suggested that using this kind of paper interfaces may have benefits, given its integration in the current classroom's workflow (Cuendet, Bonnard, Do-Lenh & Dillenbourg, in press), and paper's own natural affordances, such as tangibility or portability (Sellen & Harper, 2003). This is also in line with HCI research advocating tangible user interfaces as a more seamless, natural way for user interaction - compared to virtual ones such as web interfaces (Billinghurst, Kato & Poupyrev, 2008).

Our proposal stems from two strands of our own group's research about the orchestration of CSCL scenarios. From the technological perspective, the proposal is particularly aimed at the orchestration of CSCL scripts that are supported by an heterogeneous, distributed array of ICT tools that are being used increasingly often in education: web Virtual Learning Environments (VLEs, e.g., Moodle, Blackboard), Web 2.0 tools (e.g., blogs, wikis, shared webapps) and publicly available Augmented Reality browsers and mobile devices. GLUEPS-AR (Muñoz-Cristóbal et al., 2012) is an open, extensible web-based orchestration system that enables practitioners to semi-automatically deploy CSCL scripts across this kind of distributed learning environment, and to manage such scripts during the enactment of ubiquitous learning situations. From the pedagogical perspective, our proposal stems from fieldwork observing CSCL practice in authentic settings, such as primary schools and universities. As noted in Prieto et al. (2011b), informant teachers used a limited set of recurrent pedagogical strategies (which we called *atomic patterns*) when orchestrating CSCL situations - especially when they flexibly improvised upon unexpected events. Examples of these strategies include "Reform groups in face of current attendants", "Students choose their tools" or "Distribute participants physically to facilitate interaction". Later, Prieto (2012) described a catalogue of these atomic patterns extracted from CSCL practice with distributed learning environments, analyzing it from the point of view of orchestration and relating it with orchestration systems that might help teachers in their implementation with distributed web learning environments, such as GLUEPS-AR.

The Action Server: Description and Research Plans

Our proposal, which we have dubbed (orchestration) *Action Server*, fuses the aforementioned GLUEPS-AR orchestration system (which helps teachers organize CSCL situations across VLEs, Web 2.0 tools and AR browsers) with the notion of atomic patterns described above. As depicted in Figure 1, the Action Server provides an Augmented Reality user interface for GLUEPS-AR, enabling on-the-fly re-design, instantiation and adaptation of a CSCL script supported by a ubiquitous learning environment, using physical elements such as paper-based markers. If, for example, students were each assigned a marker (which they carry with themselves), and markers distributed in the classroom were assigned to different groups, the teacher could do the script's group distribution at enactment time (rather than a-priori in design-time), by coordinating participants socially and then sequentially reading those markers with a mobile device and a generic AR browser such as Junaio (1). The Action Server would receive the events of such marker readings and use GLUEPS-AR's API to modify the ubiquitous learning environment scaffolding accordingly (e.g. creating the group in the VLE, linking it with external Web 2.0 tools to be used by that group, accessible through another AR browser in that classroom location). Similar "orchestration actions" can be also implemented for adapting this group distribution on the face of participants leaving, creating new improvised activities, choosing ICT resources to be used in an activity, etc. Furthermore, using typical AR browser functionalities, further orchestration actions and activity states could be triggered by participants reaching a certain geographical location (e.g. marking an activity as complete in an outdoor activity).

Our research objective with this proposal is to *explore new ways of providing flexible CSCL scripting support in authentic learning scenarios*, with the ultimate aim of making it easier to orchestrate learning activities that involve multiple technologies, social levels and (physical and virtual) contexts. By bridging the gap between social- and technology-mediated coordination of CSCL activities (with the Action Server translating between socially-mediated actions and the expected technology-mediated effects), the expected

benefits of our proposal are multiple: a) the use of paper and other physical elements may increase classroom usability creating a more seamless teaching and learning experience (when compared with going back and forth between physical/social and virtual/web-based actions); b) it may empower teachers and participants to orchestrate CSCL technologies in the face of unexpected events; c) it may reduce orchestration load by removing the need for detailed a-priori design and instantiation of groups and resources, and by making design/instantiation load shareable between teachers and students; d) due to its open and extensible architecture, it may do all of the above in a wide range of learning situations (not limited to a single authoring tool, VLE, AR browser, etc.), in a way that is compatible with widely available and already existing ICT infrastructures.

This research, however, is still in its infancy. Only very recently a first proof-of-concept prototype of the Action Server has been implemented, which uses simple heuristics to translate script elements into GLUEPS-AR orchestration actions. We plan to evaluate the approach in real educational settings. Additionally, further research is necessary to integrate the action server with orchestration systems that use other kinds of user interfaces (instead of AR), such as ambient displays (see e.g., Hernández-Leo, Nieves, Arroyo, Rosales, Melero & Blat, 2012).

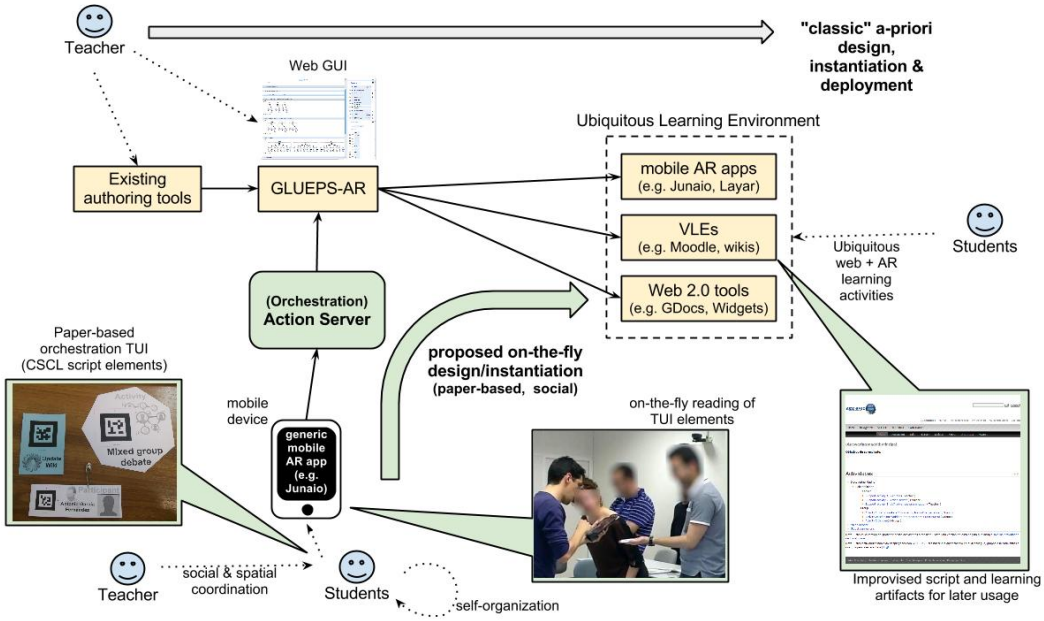

Figure 1. GLUEPS-AR and Action Server simplified architecture and use

Challenges and Open Questions

Albeit this research effort is still in its initial stages, we have already encountered a number of design alternatives, challenges and open questions that have yet to be tackled. Many of them in fact are issues related to the field of Human-Computer Interaction (HCI), since our group has a background in CSCL and the Learning Sciences (and not so much in HCI):

- We have found that designing the *details of the paper-based interaction* is not a trivial question. For example, given that many AR browsers allow the overlaying of virtual controls over the physical scene, what is the right balance between physically-represented elements (e.g. a marker representing a participant) and virtual ones (a button for confirming the action that has been interpreted)?
- Aside from the visual/tangible details, another interesting challenge is how to define the *syntax of the actions*: which elements of the script should make up an "orchestration action" (e.g. now we use participants, groups, ICT resources, activities), and in which sequence (either temporal or spatial) should they be used? Should the action be "stateless" or dependent on the current context (e.g. group formation actions always applied to the currently running activity)?
- How can we *maintain the number of actions and action elements under control*? As we could see in Prieto (2012), even if the number of "atomic patterns" is finite, this number might easily become unwieldy to be represented with paper/physical elements.
- What is the *actual impact of using this Action Server in a real educational setting*? Is orchestration load really decreased? Is the teaching and learning experience really made more seamless by its use? Currently we see how going about the classroom with a mobile device might not seem natural to some teachers (although this is something that other wearable AR devices like Google Glass (2) might change in the near future).
- What are the more adequate research methods to answer the aforementioned questions and challenges? Although we are now operating under a classical iterative systems development methodology

(Nunamaker, Jay, Chen & Purdin, 1990), we are open to discussing the benefits of other approaches (e.g., case studies, design-based research).

In conclusion, this position paper has proposed an approach that enables participants in CSCL situations (including both teachers and learners) to do a more flexible orchestration of CSCL scripts supported by ubiquitous learning environments. We believe that this kind of system can not only increase the usefulness of scripting approaches in authentic educational settings, but also might be applied to making the technological support of semi-structured and self-organized collaborative activities easier.

Endnotes

(1) http://www.junaio.com (Last visit: 20 Apr 2013).
(2) http://www.google.es/glass/start/ (Last visit: 20 Apr 2013).

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