Helping educators to orchestrate learning situations involving multiple physical and virtual spaces

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Abstract. The massive adoption of ICT makes feasible new learning situations involving multiple physical and virtual spaces, both within and beyond the walls of traditional classrooms. However, the orchestration of such learning situations is still a challenge for teachers. Some approaches try to help teachers in these scenarios using Augmented Reality and authoring tools. But usually, these approaches are limited to specific authoring and enactment technologies, and also oriented to specific types of activities. This PhD thesis explores how to help teachers in the orchestration of this kind of learning situations, allowing the use of a range of existing authoring and enactment technologies, pedagogies and types of activities. This paper presents the work plan and the current state of the thesis.

Keywords: Orchestration, ubiquitous learning, across spaces, augmented reality

1 Introduction

The advances in ICT enable new ways of learning within and beyond the walls of the classroom, such as in ubiquitous learning environments formed by physical and virtual spaces. An example can be a learning situation composed by activities occurring in a classroom using a Virtual Learning Environment (VLE) and at a park using a mobile application, where students, from one of the spaces, access learning artifacts created in the other space. But trying to carry out these across-spaces learning situations (ASLS) increases the effort for teachers, and becomes a burdensome task. A way of reducing such a burden relies on what some authors call "orchestration" of the learning situations [1]. The orchestration metaphor has been proposed in the TEL field, making explicit the complexity of some learning environments, and the necessity of coordinating them [1]. In ubiquitous learning environments, the transitions between physical and virtual spaces may increase these orchestration problems. In order to smooth such transitions, some approaches propose to use Augmented Reality (AR) to superimpose virtual artifacts in physical spaces [2]. Authoring tools are also provided to help teachers design and put into practice these learning situations [2,3]. But usually, these approaches are limited to specific authoring and enactment (the put in practice of the learning situation) technologies, and are focused on particular pedagogies (e.g., game based learning) or types of activities (such as routes formed by a sequence

of AR artifacts). These limitations can, in fact, affect the orchestration burden for teachers if teachers are forced to use multiple systems for different types of learning activities [4], and may hamper the acceptance of the approach in case of proposing completely new authoring or enactment technologies which the teachers are not familiar with, instead of allowing the use of existing ones [5]. On the other hand, more general orchestration approaches [6] try to reuse existing technologies, deploying learning designs [7] from different authoring tools into multiple Distributed Learning Environments (DLE). Such DLEs are Web based environments, integrating VLEs (e.g., Moodle[1]), with Web 2.0 tools (e.g., Google Docs[2] or Picasa[3]). However, these works are oriented to blended Web environments and have not tackled the orchestration issues in ubiquitous environments formed by multiple physical and virtual spaces.

The thesis aims to explore *to what extent (and how) technology can help teachers to orchestrate learning situations involving multiple physical and virtual spaces, allowing a range of existing authoring and enactment technologies, pedagogies and kinds of activities.* The thesis takes as a basis the Prieto et al. [1] and the Niramitranon et al. [4] orchestration frameworks to explore the issue and evaluate the expected contributions.

The structure of the paper is the following. Section 2 shows a general view of the thesis, including the objectives, contributions and the research methodology. Section 3 describes the evaluation plan, and finally, the main conclusions are presented.

2 Thesis objectives and contributions

Fig. 1 shows an overall view of the thesis, including the aforementioned context and research problem, as well as the objectives and contributions. The general objective (to provide educators with technological tools to orchestrate ASLS allowing a range of pedagogical approaches, technologies and types of activities) is divided into two particular objectives, each one emphasizing different orchestration aspects: (1) to provide teachers with technological support for the deployment of ASLS from the teachers' initial conception to the real enactment (emphasizing aspects such as range of applicability and design); and (2) to provide technological support for the management of learning artifacts generated by participants (teachers and students) during the enactment of ASLS, guided by the teacher learning design (emphasizing aspects such as flexibility and the sharing of the orchestration load between participants).

To achieve the first objective, the architecture of the GLUE!-PS orchestration system [6] is taken as basis, since it considers using existing authoring and enactment technologies and deals with interoperability issues. GLUE!-PS already allows to deploy learning designs from different authoring tools into multiple DLEs. To support deployments in learning environments considering also multiple physical spaces, both GLUE!-PS data model and architecture need to be extended, using AR to provide

[1] https://moodle.org. Last access May 2013.
[2] https://docs.google.com. Last access May 2013.
[3] https://picasaweb.google.com. Last access May 2013.

access to virtual artifacts from physical spaces. The resulting system and contribution is called *GLUEPS-AR* [8].

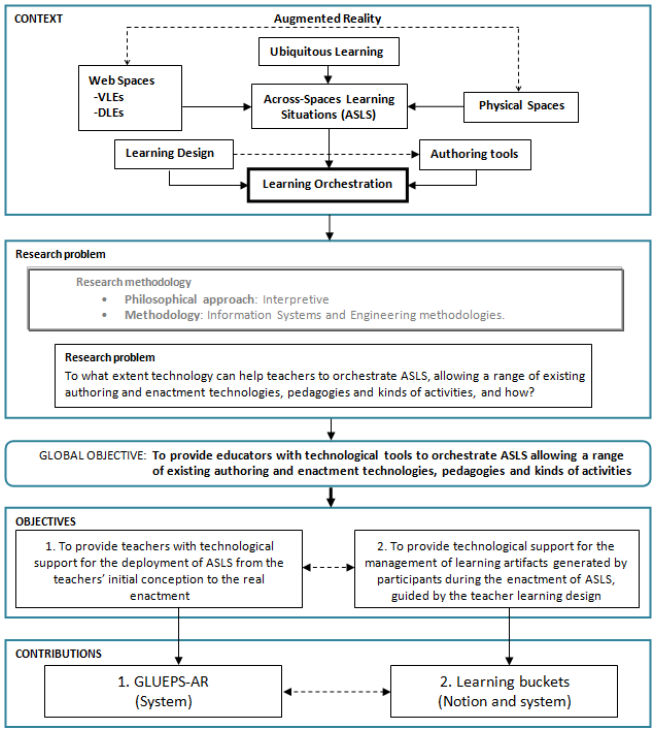

Fig. 1. Thesis diagram, indicating context, research problem, objectives and contributions.

As aforementioned, the second objective emphasizes two orchestration aspects, which are special challenges in current research works: the flexibility and the role of the actors (being current orchestration approaches mainly teacher centered [1]). The flexibility (need for changes in the learning design during the enactment) in learning design approaches is a known issue (see, e.g., [9]), being the solutions difficult to apply in the GLUEPS-AR approach, since they usually require specific authoring or enactment technologies (or modifications to existing ones). In order to help in both, the flexibility and the sharing of the orchestration load with students, the *learning bucket* notion is proposed. A bucket is a container of positioned artifacts, which is embedded in a learning environment. The bucket is created at design-time, and it can be initially empty (or not), and be filled by the participants (teacher or students) with learning artifacts during the enactment, being able to position the artifact in physical or Web spaces. This provides flexibility in the management of learning artifacts. At design-time, the teacher creates buckets and configures the buckets constraints, defining the actions that students are allowed to do in the distinct buckets. These constraints impose limits to flexibility, trying to balance (be a compromise between) flexibility and orchestration. Buckets may aid to evolve from teacher-centered approaches

to student-centered ones in ubiquitous learning environments, what is being claimed by some authors [10]. The bucket notion and system (in the form of a bucket-server) are the second contribution of the thesis. The architecture of GLUEPS-AR enables the seamless integration of the bucket notion by defining an adapter, in the same way it allows the connection of any other tool. Fig. 2 shows the integration of the GLUEPS-AR and bucket-server architectures.

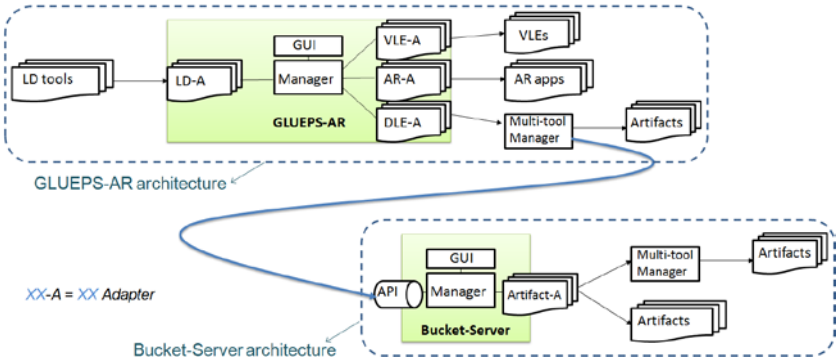

Fig. 2. GLUEPS-AR and bucket-server architectures, as well as the integration of both systems.

With the integration of GLUEPS-AR and the bucket-server architectures, learning situations involving physical and Web spaces may be created using different learning design authoring tools. Such tools do not need to consider multiple spaces (they can be generic learning design tools, such as WebCollage[4]). Also, different enactment tools may be used (widespread VLEs, Web 2.0 tools, AR browsers such as Junaio[5]). AR is used to smooth transitions between physical and Web spaces, allowing to access learning artifacts from different spaces. Not being restricted to specific authoring or enactment tools makes possible the use of different pedagogies (e.g., collaborative, game-based learning, place-based learning, etc), as well as the creation of different kind of activities (e.g., a jigsaw using Web 2.0 tools accessed from a VLE in a classroom and with AR in outdoor). Additionally, the use of buckets allows participants to manage learning artifacts during the enactment, helping GLUEPS-AR to reduce the burden for teachers in these kinds of learning situations, and improving the flexibility related to the management of learning artifacts during the enactment.

Since the thesis aims to contribute to the field by proposing ICT-based solutions, the research methodology is based on information systems and engineering research methodologies [11]. Thus, the research follows incremental iterative phases of: literature review (and research questions definition), proposal, prototype development and evaluation [12]. The thesis follows an interpretive research paradigm [13], that matches well with the context of research (persons and organizations of persons). This approach aims at understanding concrete phenomena, instead of generalizing or obtaining universal laws.

[4] http://pandora.tel.uva.es/wic2/. Last access May 2013.
[5] http://www.junaio.com. Last access May 2013.

3 Evaluation plan

In order to explore the research question, an effort was made to reduce it to concrete aspects, following the so-called anticipated reduction method proposed by Miles and Huberman [14]. As depicted in Fig. 3, an issue (I) has been defined based on the research question (RQ); such an issue has been divided into 9 topics to illuminate it; and each topic in informative questions (not displayed in Fig. 3) to help to understand the topic, mapping these questions to data gathering techniques. The topics and informative questions have been defined based on the orchestration frameworks proposed by Prieto et al. [1] and Niramitranon et al. [4].

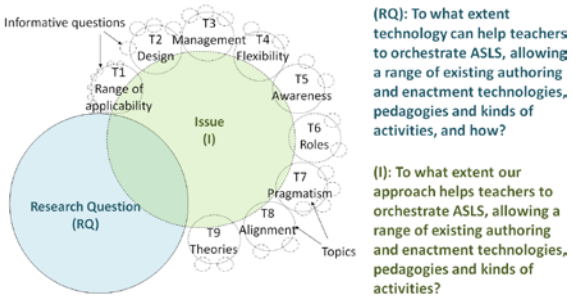

Fig. 3. Research question, issue, topics and informative questions used in evaluation.

The CSCL-EREM [15] model has been used to design the evaluation plan of the proposal, and mixed data gathering techniques are being employed to explore the aforementioned topics. These mixed techniques are directed to triangulate data, improving the accuracy of the evidences and the rigor of the analysis.

In order to evaluate also a range of applicability (part of the research question) not limited to a single context (teacher, students, educational level, etc), the evaluation plan consists of three cases, exploring the use GLUEPS-AR and buckets in: (1) K-12 school; (2) University level; (3) professional development workshop or expert evaluation or University level (currently being defined). So far, the first case has been completed, as well as a first iteration of the second one.

4 Conclusions

This thesis proposes a system (GLUEPS-AR) and a notion and a system (learning buckets) to aid teachers to orchestrate learning situations involving multiple physical and virtual spaces. The thesis is currently in the evaluation phase of the second iteration. So far, the evaluation shows initial evidences indicating that the proposals can help teachers in the orchestration of these learning situations. Additionally, emergent research lines have been identified based on this research work. Some of these lines are the generalization of the GLUEPS-AR approach to other spaces such as tabletops or 3D virtual worlds, or the study of the application of buckets in more general learning situations (not only where multiple physical and virtual spaces are involved).

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