Orchestrating TEL situations across spaces using Augmented Reality through GLUE!-PS AR

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Abstract— **TEL situations may occur in multiple physical and virtual spaces, beyond a physical classroom or a VLE. Teaching in this kind of situations may become very complex, since the learning activities may occur across different spaces and times using diverse technologies. In order to help teachers in the orchestration of these learning situations, we propose the GLUE!-PS AR architecture. GLUE!-PS AR allows the automatic deployment of learning situations defined using multiple learning design authoring tools, and involving multiple physical and virtual spaces, in widespread Virtual Learning Environments and Augmented Reality browsers. A prototype is presented as a proof of concept, explaining the usefulness of such a prototype in a concrete learning scenario.**

Index Terms—**Augmented Reality, orchestration, Technology Enhanced Learning, ubiquitous learning**

I. Orchestrating ubiquitous learning through Augmented Reality

LEARNING, and especially Technology-Enhanced Learning (TEL) does not only occur in settings such as a classroom or a web learning environment (e.g. Moodle). Rather, learning takes place anywhere, throughout formal and informal learning spaces (e.g. at home, in field trips, in virtual 3D worlds, etc), thus leading to the notion of "ubiquitous learning" [1]. The acknowledgement of this ubiquity and the increasing variety of learning resources and tools has made the coordination of such learning by teachers a very complex task. Researchers refer to this coordination of multiple learning activities, tools, and contexts as *orchestration* [2].

Augmented Reality (AR), as a technology that displays virtual data along with the physical world, can be used to ease the transition of educative artifacts between learning experiences happening in the physical space and in other spaces, such as the Web or a 3D virtual world. Indeed, there is evidence hinting that the use of AR can provide learning benefits for students [3]. However, such research normally considers the AR-based learning activity in an isolated way, disconnected from the rest of the curriculum and the everyday life of authentic educational settings. Moreover, current applications of AR to education are usually ad-hoc systems, specific to particular scenarios, activities or pedagogies [4]. Thus, a practitioner desiring to implement AR activities across the whole curriculum would be forced to learn and master multiple authoring and enactment ICT tools. In conclusion, *current AR systems seem to pose strong orchestration challenges* in formal educational settings.

We present below a novel technological approach that enables teachers to orchestrate multi-space learning scenarios that include AR, by integrating existing and widely used sofware tools, including generic learning design authoring tools, mobile AR browsers, existing learning platforms (e.g. Moodle), as well as an extension of the GLUE!-PS infrastructure [5] to use AR artifacts (GLUE!-PS AR).

II. An approach to orchestrating learning across spaces using general-purpose AR browsers

The architecture of the GLUE!-PS AR proposal is shown in Fig. 1 (see also [6]). The main idea behind this architecture is to have a central set of services that allow for the deployment and run-time management of teachers' activity ideas (expressed in any learning design language) over multiple Web and AR environments. Learning design authoring tools for different pedagogies already in use, widespread learning environments (such as Moodle or Blackboard), and different freely available mobile AR browsers, are all made interoperable by this intermediate layer. In order not to increase the technological complexity faced by teachers, the proposed architecture reuses widespread existing applications and systems. Thus, blue clouds in Fig. 1 represent currently existing technologies, that GLUE!-PS AR integrates.

This research has been partially funded by the Spanish Ministry of Economy and Competitiveness Projects TIN2008-03-23, TIN2011-28308-C03-02 and IPT-430000-2010-054, the Autonomous Government of Castilla and León Project VA293A11-2, and the Partnership in Mobility and Education of Telefónica and the University of Valladolid Projects CTEFUva-DIV-2011-02-P3 and CTEFUva-PID-2011-02-P4.

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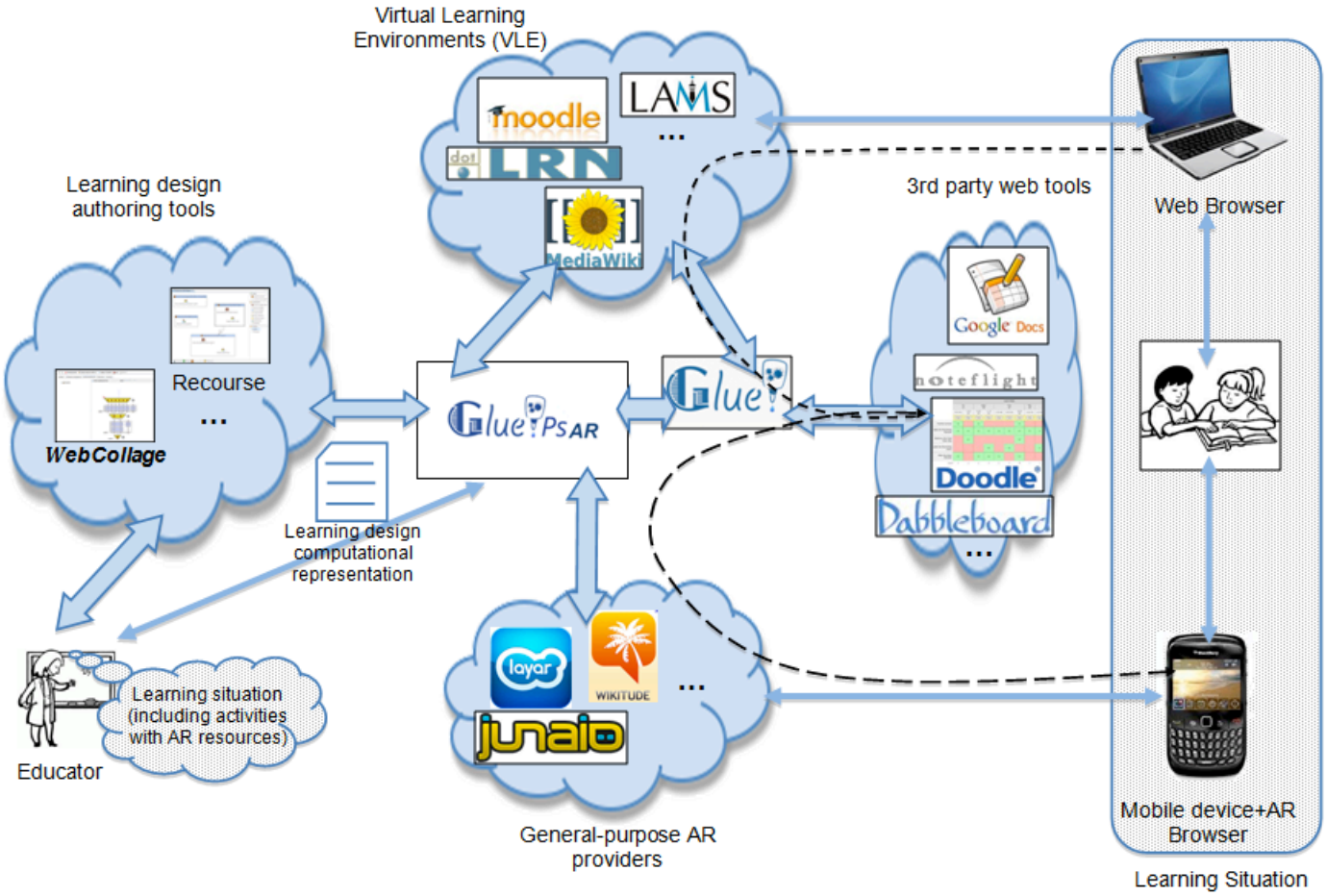

Fig. 1. General architecture of the GLUE!-PS AR proposal

Additionally, the proposed system also includes a Graphical User Interface for the teacher to particularize and/or modify the original pedagogical ideas according to her specific context, including the activities, students, groups, and very especially the location of AR resources in the physical space (e.g. by geoposition or tagging). Once the original design ideas have been introduced into a learning design authoring tool (left cloud in Fig. 1), the learning activities are automatically set up for the teacher, linking the activities in the virtual space (top and right clouds in Fig. 1, e.g. in a Moodle environment that integrates GoogleDocs documents in it) and in the augmented physical space (bottom cloud in Fig. 1, e.g. making the previously mentioned GoogleDocs available to certain groups of students through the AR browser, only in a specific location).

As we can see, this approach enables teachers to translate their pedagogical ideas (expressed through any learning design authoring tool that she sees fit) into the ICT infrastructure needed for her students to enact them, including not only web tools, but also other virtual artifacts available in physical spaces through AR. Also, the proposed system enables other important pedagogical affordances such as the sequencing and monitoring of activities and their resources, or collaborative techniques such as small groups communicating and accessing/generating different artifacts from different spaces.

A proof-of-concept prototype of this approach has already been developed. In Fig. 2 we can find a concrete example of the kind of multi-space learning scenario that can be made available to non-expert teachers through this prototype.

This scenario aims at promoting university campus knowledge in first-year undergraduate students through location-based collaborative activities, inspired in the scenario described in [7]. The activities follow the well-known jigsaw pattern, including also peer review activities.

From the point of view of the teacher, learning activities can be designed using *generic*, easy to use authoring tools such as WebCollage[1] [8], and then, through GLUE!-PS AR, the location of each resource (in the Moodle web environment or in a physical location) can be defined. Finally, the ICT infrastructure for the scenario is automatically deployed and accessible for both students and teachers (e.g. for monitoring purposes) across the web and augmented physical space (e.g. visible through an AR browser such as Junaio[2] in a tablet). Thus, the orchestration load of the teacher (compared with setting up such learning activities manually across the different ICT systems involved) is greatly diminished.

ACKNOWLEDGMENT

The authors thank the rest of the GSIC-EMIC research team for their contribution to this work.

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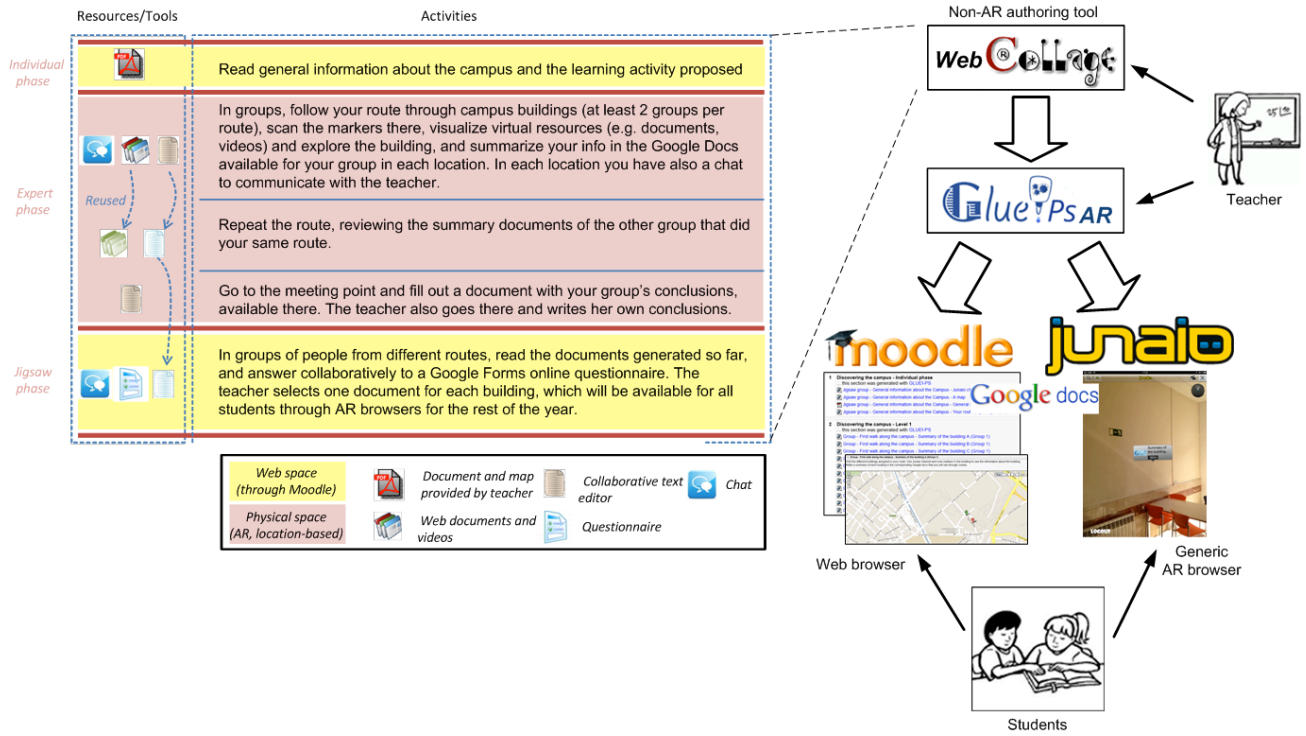

Fig. 2. Location-based learning scenario combining web and augmented physical resources, and screenshots of its implementation through the GLUE!-PS AR proposal

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