

# Helping educators to deploy CSCL scripts into mainstream VLEs that integrate third-party Web and Augmented Reality tools

Juan A. Muñoz-Cristóbal, Juan I. Asensio-Pérez, Luis P. Prieto, Iván M. Jorrín-Abellán, Yannis Dimitriadis, Alejandra Martínez-Monés, GSIC-EMIC Group, University of Valladolid, Cno. del Cementerio, s/n, 47011 Valladolid, Spain

Email: juanmunoz@gsic.uva.es, juaase@tel.uva.es, lprisan@gsic.uva.es, ivanjo@pdg.uva.es, yannis@tel.uva.es, amartine@infor.uva.es

**Abstract:** This paper presents a novel system for helping educators to create Computer-Supported Collaborative Learning (CSCL) scripts that make use of Augmented Reality (AR) resources and tools. The presented system is also capable of deploying the created CSCL scripts into mainstream Virtual Learning Environments (VLEs). Such deployments integrate into the VLE of choice third-party web and AR resources according to the pedagogical decisions of the educators. Also, the paper describes a motivating non-trivial CSCL script that includes AR resources, and illustrates how a prototype of the proposed system supports educators in the design, instantiation, deployment, and enactment of the script. The final goal of the research reported in this paper is to provide means for a gradual appropriation of AR technologies within collaborative learning practices in technology-enhanced classrooms.

## Introduction

The affordances of Augmented Reality (AR) for education have been reported in numerous research works during the last 20 years (Dunleavy, Dede, & Mitchell, 2008; Wellner, 1993). Student engagement and the possibility of using interfaces based on objects of the physical space are only two of the potential improvements that might be fostered by AR technologies. Indeed, the recent advances in visualization and computing capabilities of mobile devices (smartphones, tablets, etc), together with the progressive addition of physical sensors to them (e.g. cameras, GPS, accelerometers), have paved the way to a widespread availability of affordable (and mobile) AR-based applications (van Krevelen & Poelman, 2010). Additionally, the irruption of general-purpose so-called “AR browsers”, as e.g., *junaio*, *wikitude*, or *layar*<sup>1</sup>, opens new possibilities for a user-driven configuration and delivery of AR contents.

Nevertheless, and in spite of this new promising technological landscape, it is still unclear how teachers and students might appropriate AR within regular teaching-learning practice. First of all, most previous research reports refer to specific learning situations, difficult to generalize (see, e.g., (Dunleavy, et al., 2008)). Although there is a significant recent trend towards authoring tools involving teachers in the design of AR-based learning situations, these tools are mostly limited to variations of outdoors gymkhanas (Klopfer et al., 2011). Moreover, the educational usage of AR resources is typically illustrated as something separated from other technological-enhanced learning assets (e.g., Virtual Learning Environments, Web 2.0 tools, etc). This separation does not show some of the potential orchestration challenges (Dillenbourg & Jermann, 2010) that could come up when using AR in an authentic classroom, and that might be difficult to face by teachers without advanced technical skills.

This paper motivates, proposes and illustrates the architecture and prototype of a system for supporting educators in the inclusion and orchestration of AR-based learning activities in scripted Computer-Supported Collaborative Learning (CSCL) settings (Weinberger, Kollar, Dimitriadis, Mäkitalo-Siegl, & Fischer, 2008). The presented system consists of a set of software tools that allow educators to: a) *design* CSCL scripts, which incorporate AR resources (thus explicitly relating their usage to the educators’ pedagogical intentions); b) *customize* the incorporated AR resources and automatically distribute them among the students according to the (potentially changing) planned grouping structures, thus facilitating the management of resources and lowering the educators’ workload; c) *deploy* the designed CSCL scripts (and the associated AR, and non-AR learning resources) into mainstream Virtual Learning Environments (VLEs), thus avoiding the disruptive nature of AR-based learning activities with respect to other activities supported by such a widely accepted technological support. The presented system builds upon previous authors’ research proposals aimed at deploying CSCL scripts into VLEs that integrated third-party web 2.0 tools (Alario-Hoyos & Wilson, 2010; Prieto, Asensio-Pérez, Dimitriadis, Gómez-Sánchez, & Muñoz-Cristóbal, 2011).

The paper first introduces a motivating CSCL scenario that justifies the usage of AR and non-AR learning resources, and that identifies the orchestration challenges to be faced by educators when deployed in a classroom. Then, it describes the proposed system and illustrates, by means of a prototype, how it might support educators in enacting the motivating scenario. Finally, the paper includes a prospective discussion about the affordances of the presented approach.

## ARchitectural Styles: An example CSCL scenario including AR

The proposed learning scenario deals with an Art History lesson in secondary education. For the sake of the explanation, we will assume that 12 students participate in the lesson at a high school in Valladolid, Spain. Both the educator and the students typically use a *MediaWiki* installation as the centralized access point for the delivery of learning material both at the classroom and at home (although other VLE such as *Moodle*, *LAMS*<sup>2</sup>, etc. could have been equally used). The goal of the scenario is to foster the acquisition of competences required to identify and compare the distinctive features of significant architectural styles. To that aim, the educator decides to use the well-known jigsaw collaborative learning technique. Three Valladolid monuments are studied in the activity: the Cathedral (Herrerian style), San Pablo Church (Plateresque style), and Santa María de la Antigua Church (Early Gothic style). Figure 1 provides a description of the sequence of learning activities devised by the educator, as well as the type of learning resources and tools to be used by the students.

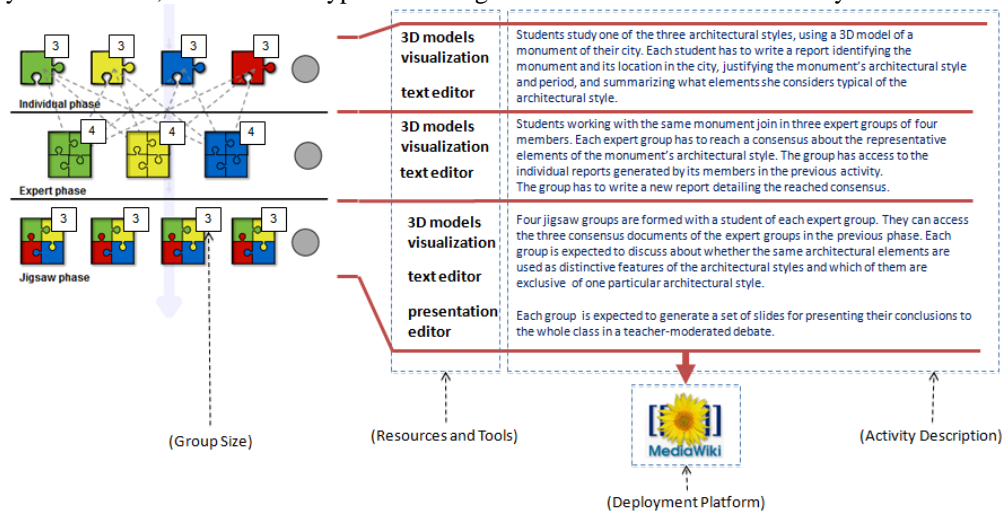


Figure 1. The ARchitectural Styles jigsaw

The use of AR in the above scenario might facilitate the visualization of the 3D models of the monuments in the classroom. Actually, detailed models of the three aforementioned buildings are freely available (e.g., in the *Google Sketchup Gallery*<sup>3</sup>) and could be displayed, associated to 2D markers, using AR browsers (such as *junaio*) running in mobile devices. The usage of mobile devices might even allow the educator to arrange the experts' discussion in an outdoor activity while visiting the actual monuments, delivering the individual reports by means of AR geo-positioned web resources. Alternatively, the same activity could be carried out indoors, simulating the physical environment of the city within the classroom, by means of geographical markers that make mobile devices believe they are at a different location.

Nevertheless, all the aforementioned AR affordances would pose several significant orchestration challenges to the educator. For instance: to assign the appropriate 3D models to particular 2D markers and deliver them to the students; to configure the students' devices so that they access the appropriate set of 3D models; to provide the students with the appropriate information to switch from VLE-based work to AR browser-based activities and vice versa; to manage physical locations (real or simulated within the classroom) so that each group gets access to the appropriate resources according to their position. Actually, the relationship between learning resources (documents, tools, etc) and pedagogical decisions (activities, groups, etc) is not exclusive of AR, but is complicated by the nature of the artifacts (e.g. paper-based 2D markers) and the usage of different devices (e.g. laptops in the classroom and mobile devices when outdoors).

## Helping educators in orchestrating non-trivial CSCL scenarios integrating AR

The GSIC/EMIC research group<sup>4</sup>, at the University of Valladolid (Spain), has developed a suite of tools for the integrated support of the lifecycle of CSCL scripts such as the one described above, from their inception to their enactment: the *Collage*<sup>5</sup> tool for the authoring of reusable CSCL designs based on so-called Collaborative Learning Flow Patterns (CLFPs); the *InstanceCollage* tool for the instantiation of *Collage* designs according to the groups of participating students in a particular learning setting; the *GLUE!-PS* architecture and data model for the translation of learning designs (collaborative or not) written in different specifications to a common *lingua franca* as a previous step to their deployment in different mainstream VLEs (Prieto, et al., 2011); and, the *GLUE!* architecture that integrates existing third-party web tools into those same mainstream VLEs according to the instructions contained in the scripts (Alario-Hoyos & Wilson, 2010). The GSIC/EMIC suite of tools aims at making educators' pedagogical intentions explicit (and thus potentially reusable) without tying them to one particular VLE or technology, as well as supporting multiple learning design specification languages (e.g., IMS

Learning Design<sup>6</sup>). Furthermore, the suite allows educators to select which tools to be used by their students without being restricted by those available in the VLE, thus enabling the creation of richer learning situations.

When implementing a non-trivial CSCL scenario (such as the one presented above, or any other produced by an authoring tool compliant with GLUE!-PS, see (Prieto, et al., 2011)), the *GLUE!* architecture would deal with the integration of third-party web tools external to the VLE of choice (e.g. using *Google Docs* as the collaborative text editor, embedded in the *MediaWiki* environment, to generate the reports). Using this *GLUE!* architecture, *GLUE!-PS* would automate the management (creation, configuration, deletion, delivery) of all the *Google Docs* documents required by the learning scenario (15 in that case), thus decreasing the workload of the educator. The integration of new third-party web tools into the VLE of choice, following the GSIC/EMIC approach, only requires the development of a lightweight adaptor that translates *GLUE!* common operations into tool-specific invocations.

The integration of AR tools into the GSIC/EMIC suite has followed the same approach. Therefore, three new adaptors have been developed for three new types of “tools” that, in this case, will not be accessed through a Web browser, but rather by means of an AR browser. These new tools are: geolocated web resources (e.g. a *Google Docs* document); geolocated 3D models; and 3D models displayed on top of 2D images or markers. These three new tools can be selected by the educator when designing the collaborative situation, from within the Collage authoring tool.

Additionally, the *GLUE!-PS* and *GLUE!* architectures have been upgraded in order to allow third-party AR browsers to access stored information about 3D models and geolocated web resources employed in a CSCL script. Such access is enabled by registering appropriate web callbacks into the infrastructure of the AR browser provider. This way, the AR content accessible through the AR browser is not provided directly by the educator using AR provider’s general-purpose authoring tools. Instead, the content is automatically delivered by *GLUE!-PS* and *GLUE!* following the instructions contained in the designed CSCL script. Again, this approach reduces the workload of the educator and relies on previous script design decisions that related AR resources with activities and groups. Figure 2 depicts the relationship among GSIC/EMIC tools and the new AR support.

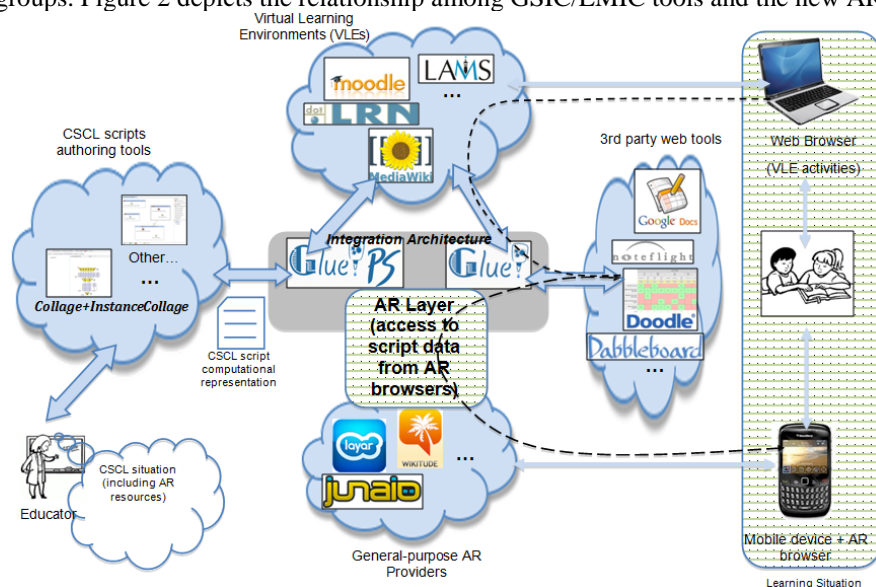


Figure 2. GSIC/EMIC tools, with AR extensions, supporting the CSCL script lifecycle.

Figure 3 illustrates the implementation of the ARchitectural Styles scenario by means of a prototype, developed as a proof of concept of the inclusion of AR objects in the generic CSCL script life-cycle.



Figure 3. Implementation of the ARchitectural Styles scenario

## Conclusions and perspectives

The presented learning scenario shows how learning activities that make use of AR resources can be enacted, as part of non-trivial CSCL scripts, using general-purpose and widely available AR applications. Using this approach, AR objects are used and delivered in the same way as other resources that are already being used during the learning process (e.g. web applications). Therefore, if a teacher needs students to be physically in a particular location (inside or outside the classroom), she can augment such a location with materials generated previously by the students, or obtained from the Web, according to her pedagogical intentions. All in all, the presented approach shows that AR-based activities can be part of a wider pedagogical design that uses AR as a (yet another) means, with some specific affordances, of achieving learning goals. Our position is that the described approach might reduce the “adoption barrier” of AR technologies in the classroom by: 1) using the described tools to reduce the educator’s workload when orchestrating this additional technology in the classroom; 2) using AR resources not only as an engaging technology for carrying out sophisticated gymkhanas, but also as an additional asset framed within wider designs, following different pedagogical approaches such as, e.g., collaborative learning; 3) using AR resources in conjunction with other technologies available in the classroom, with special emphasis on VLEs.

## Endnotes

- (1) <http://www.junaio.com>, <http://www.wikitudo.com>, <http://www.layar.com> (Last access 4/30/2012)
- (2) <http://www.mediawiki.org>, <http://moodle.org>, <http://www.lamsfoundation.org> (Last access 4/30/2012)
- (3) <http://sketchup.google.com/3dwarehouse> (Last access 4/30/2012)
- (4) GSIC/EMIC Web site: <http://www.gsic.uva.es> (Last access 4/30/2012)
- (5) <http://www.gsic.uva.es/collage> (Last access 4/30/2012)
- (6) <http://www.imsglobal.org/learningdesign> (Last access 4/30/2012)

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