

Connecting formal and informal learning in Smart Learning Environments

Sergio Serrano-Iglesias
GSIC-EMIC Research Group
Universidad de Valladolid
Valladolid, Spain
sergio@gsic.uva.es

Advisors: Eduardo Gómez-Sánchez, Miguel L. Bote-Lorenzo

Abstract—This PhD research explores how Smart Learning Environments can support the connection between formal and informal learning. Thanks to the information offered by learning systems and tools such as Virtual Learning Environments, mobile and Internet of Things devices, SLEs can characterize the individual learning needs and context of students to provide them with personalized support across the boundaries of the classroom. In a similar fashion to approaches related with mobile learning, the connection offered by SLEs can help students to reflect on learning concepts in real scenarios, but also adapting the offered resources to their progression and performance throughout the learning situation. However, existing attempts in SLEs face difficulties regarding the preparation of possible interventions by teachers or the understanding of the formal learning situation. This work attempts to overcome this limitations with the usage of the learning design.

Index Terms—Smart Learning Environments, formal learning, informal learning, adaptation, learning design

I. MOTIVATION

In the recent years, the development of mobile devices and embedded sensors have fostered the appearance of Smart Learning Environments (SLEs) [1]. These environments rely on a variety of Technology Enhanced Learning (TEL) tools and systems to provide a personalized support to learners, considering not only their individual learning needs, but also the current context where they are [1]–[3]. Thanks to the information offered by systems such as Virtual Learning Environments (VLEs), mobile and Internet of Things (IoT) devices and learning tools, SLEs can model the progression of learners and prepare an effective, efficient and engaging support [2] across a wide set of contexts beyond the classroom [1].

Due to this support across settings, some authors [1], [4], [5] consider these environments as a promising opportunity to connect formal and informal learning. Compared with the structure of formal education, given a learning design according to some learning objectives, informal learning stands as an unstructured type of learning spanning during the daily life of learners [6]. Experiences related with informal learning are driven by learners, both in an intentional or serendipitous manner, and are characterized for being highly motivating for learners, as they reflect in real world experiences [6]–[8]. However, due to its tacit nature, specially in incidental situations, informal learning experiences may not be effective enough, as

learners may not be aware of the proper experience [9] or even due to the lack of support and its continuity through time [7]. In this regard, the connection of these informal experiences with formal education can help learners to overcome those limitations, at the same time as they further reflect on formal learning concepts [10].

Prior attempts to make this connection can be found in the literature. Dabbagh and Kitsantas [11] explored how Personal Learning Environments could support this connection by means of community of learners based on the interests of learners. An important issue in this approach is that learners are fully responsible of achieving the connection, with no support from the formal side. More recent works [10], [12], [13] explore the support offered by mobile and ubiquitous learning, relying on the context-awareness capabilities of mobile devices to provide seamless learning experiences across-spaces. However, these contributions consist on complementary activities that do not consider the suitability of the resources offered or do not adapt them to the current learning state and progress of each learner through the formal learning situation.

In this regard, SLEs also rely on contextual information to suggest appropriate activities under the current circumstances of the learning environments learners are interacting and to achieve the connection of formal and informal learning. However, to the best of our knowledge, there are a limited number of works that explore this connection within SLEs. Leonidis *et al.* [14] help teachers to define interventions and feedback *a priori* for both formal and informal learning settings according to the actions of the learners. Bravo-Torres *et al.* [15] try to facilitate the collaboration and interaction of nearby learners based on both their interests and students' performance in previous workplans. Freignang *et al.* [16] differentiate from the previous works by the promotion of this connection within workplace learning, with a framework for the encouragement of interactions between employees according to the skills they have to develop. In all these cases, the connection is hindered by the lack of information regarding the formal context. In [14], the preparation of every possible intervention by the teacher is not feasible due to the additional amount of work and because teachers cannot consider all the possible contexts where learners can be supported. In [15] and [16], the formal context is represented by either their interests or

the skills they have to achieve. Information related with the performance and progression of learners can help to adapt the support according to their current needs.

II. RESEARCH QUESTION

Within this context, the research question posed in this PhD research is: *How can Smart Learning Environments support informal learning in a personalized manner that is aligned with the formal learning objectives considering the individual contexts of learners?*

In order to answer this question, the following research objectives have been defined:

- To identify the learning activities and spaces involved in a formal learning situation.
- To monitor the participation and interaction of learners through the different learning activities and spaces, and the current conditions of the context of each environment.
- To provide students with appropriate feedback and resources based in the information collected from learners and from the learning situation.

III. METHODOLOGY

This research will follow the Design Science Research Methodology (DSRM) [17], which aims at the creation and evaluation of artifacts that solve problems, such as constructs, models or any designed object that offers a solution to the research problem. This methodology defines a process model involving the following activities: (i) identify a problem and motivate its interest, (ii) define the objectives of a solution, (iii) design and develop an artifact for the solution, (iv) demonstrate how the artifact solves the problem, (v) evaluate it, and (vi) communicate its performance. These activities do not need to happen sequentially.

The overarching objectives of this thesis and its iterative nature make DSRM a suitable methodology to frame this thesis work. This PhD research aims at designing and developing artifacts that facilitate the adoption of SLEs in real settings, assisting in the use of diverse technologies by non-expert audience. During the demonstration of the solutions, we will collaborate with the main stakeholders in order (i) to evaluate the degree in which the solutions meet the needs of the participants and (ii) to carry out stable interventions in formal and informal learning settings.

Three iterations of DSRM have been planned for this research, as depicted in Fig.1. In the first iteration, a literature review of the current state of Smart Learning Environments in formal education has been carried out to identify research gaps. Moreover, a set of sample learning scenarios that illustrate the relevance of the proposal have been identified. The second and current iteration embraces the current development of a functional SLE system able to support the sample learning scenarios designed in the previous iteration. This system will be evaluated in controlled settings to study its affordances and limitations. The resulting implementation of the system during this iteration will be used for demonstration purposes with teachers and instructors. As a result of the demonstration,

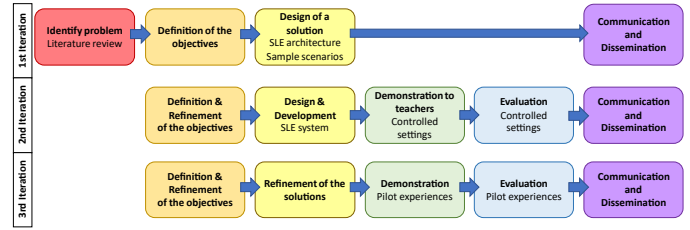


Fig. 1. Work iterations planned for this PhD research, based to DSRM [17].

we will perform further modifications to the system to fulfill the needs of the stakeholders. Finally, the third iteration will involve the collaboration with teachers for the enactment of pilot experiences of the proposed SLE in real settings and students.

IV. CONTRIBUTIONS

The main expected contribution of this research is SCARLETT (Smart Context-Aware Recommendation of Learning Extensions in ubiquitous settings), an SLE capable of supporting learning situations that span different learning settings and spaces with the automatic provision of informal learning recommendations. SCARLETT has been designed to support a wide set of learning systems and tools, such as VLEs and mobile application, in order to *sense* the interactions of learners across the involved learning environments. This information helps SCARLETT to model and *analyze* their evolution in formal learning situations which can be used to *react* and provide them suitable learning recommendations.

Educators can provide the system with a learning design specifies the structured set of activities, their supporting resources and resulting artifacts, and the roles performed by learners, which have been designed to achieve a set of explicit learning objectives [18]. Through accepted specifications of the learning design, SCARLETT is expected to properly relate the information from formal learning with the possible informal learning activities provided. SCARLETT can computationally identify their inner information from the learning design to coordinate the operation of its inner modules, as shown in Fig.2. This coordination involves:

- The identification of the learning resources and learning environments to monitor and collect the information.
- The management of a learner model that relates the learning analytics from each activity with the learning objectives.
- The provision of informal learning resources related with both the learner model, their current contextual information and the topics discussed through the learning situation.

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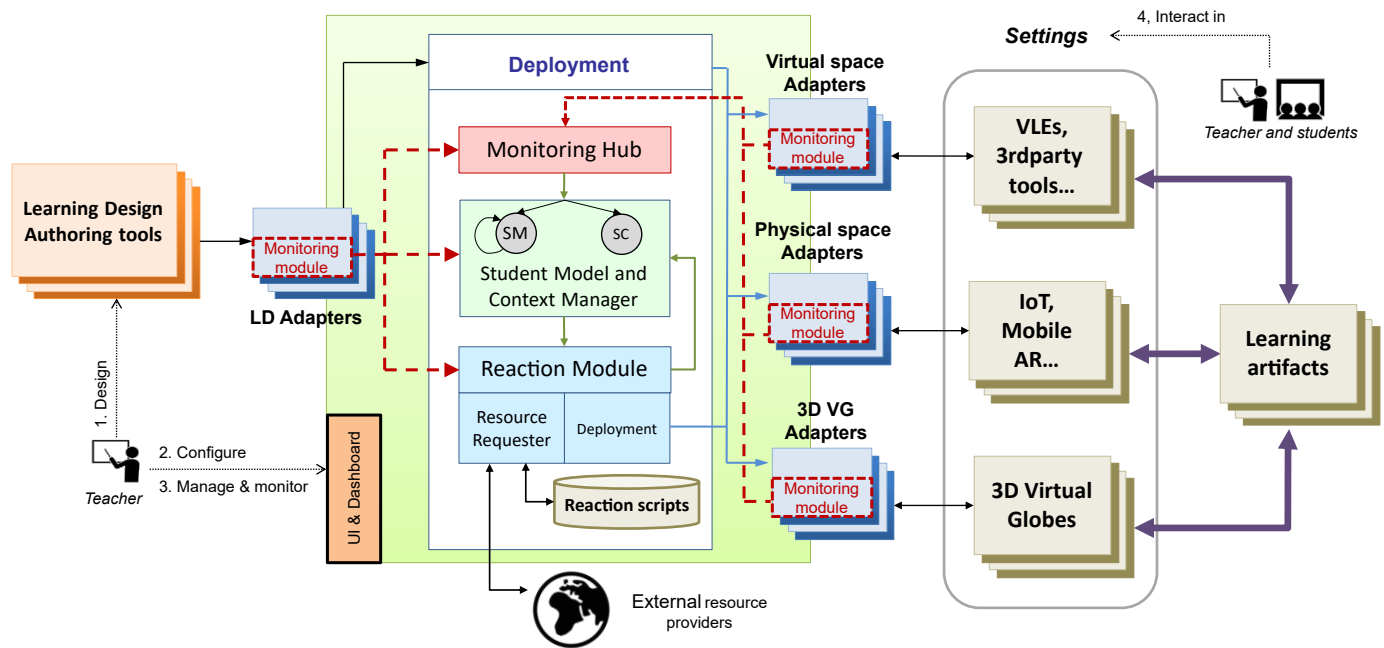


Fig. 2. Architecture of SCARLETT. The information of the learning design is used within the inner modules of SCARLETT to coordinate the different operations. Each module interacts with 3rd party tools and systems for gathering information from learners and deploying the proposed recommendations. The interaction with the external systems is achieved through specific adapters for each action.

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