

Supporting learning situations connecting formal and informal learning in Smart Learning Environments

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Abstract. The recent advances in technology have increased the proliferation of informal learning experiences in both physical and virtual spaces. In this sense, the connection between formal and informal learning can potentially help students reflect and experience in real life settings the learning contents and goals defined by teachers in learning designs. To this end, Smart Learning Environments (SLEs) have been proposed as a promising solution to achieve such connection, considering the learning designs and the students' context to better personalize learning interventions in informal settings. This PhD. thesis addresses the problem of how SLEs can provide automatic and personalized support in informal settings considering students' context across learning spaces, being aligned with the goals defined by teachers. This paper presents a brief motivation, the methodology and the current state of the thesis.

Keywords: formal learning, informal learning, across spaces, context, Smart Learning Environments

1 Motivation and Problem Description

The advancements in technology have fostered learning situations happening in formal and informal settings across physical and virtual spaces [13]. While in formal learning teachers are responsible of the definition of the learning goals students are expected to achieve, in informal learning, learning experiences happen during the learners' daily life either in an intentional or incidental manner [2, 7, 16]. As informal learning involves a reflection process of prior knowledge [16], the connection between formal and informal learning would allow students to connect and reflect about the learning contents provided in formal settings in real life contexts. In these sense, mobile technologies [18] and Augmented Reality [19, 4] have fostered the provision and access to learning resources in informal settings. During the last years, Smart Learning Environments (SLEs) have been also proposed as a promising solution to achieve such connection [6].

Smart Learning Environments are TEL environments able to adapt students' learning experience and to provide them with personalized support considering their individual needs and context [9, 11, 20]. Technologies and systems present

in physical and virtual spaces [12, 18, 22] facilitate the interaction and presentation of appropriate learning resources and recommendations, along with the acquisition of information that help to characterize the context of learners. Prior knowledge of the students, their learning progress, their learning style or the expected goals of the situation are some variables that can be considered by SLEs to shape this context [1, 21], but also the information about where the learning takes place gains space relevance [6].

Therefore, when the learning context is not restricted within the limits of the classroom, SLEs can potentially provide students with learning resources and activities to be performed across spaces, related with the learning designs configured by the teachers and instructional designers. Other authors have explored such connection between formal and informal learning through Personal Learning Environments (PLEs) [3, 8] or within workplace learning [5, 15]. However, these attempts have shown limitations in the provision of support that consider the context of learners or the expected learning goals. To overcome this limitations, SLEs can benefit from the information in learning designs.

In the learning design, teachers and instructional designers configure the sequence of learning activities that students are expected to perform in the different learning spaces, along with the supporting resources and the learning goals expected to be achieved [12]. Thanks to specifications like IMS-LD [10], learning designs can be structured and computationally understood by systems and applications, allowing, for example, their deployment in multiple learning spaces. In a similar approach, SLEs can benefit from the learning designs to align the context of the students with the expected learning goals and also provide automatically generated learning resources and recommendations that are not defined beforehand by the teachers. Therefore, the underlying research question of this doctoral thesis is: *How can Smart Learning Environments provide automatic and personalized support to students considering their individual context across learning spaces in informal settings, aligned with the learning goals defined by teachers?*

In order to answer the research question, three research objectives have been defined: (i) to help stakeholders in the adoption and deployment of SLEs in traditional learning settings, (ii) to measure the students' context across learning spaces and align it with the expected learning goals, and (iii) to provide students with personalized learning resources in an automatic way and connected with the learning space students are participating in.

2 Methodology

The proposed methodology to answer the research question is Design Science Research Methodology (DSRM) [14]. This methodology 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 necessarily sequentially.

The overarching objectives of this thesis and its iterative nature make DSRM a suitable methodology to frame this thesis work. This PhD. thesis aims to design and develop 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.

The iteration plan for this doctoral thesis foresees three iterations. The first iteration consists on a literature review on the current state of Smart Learning Environments to identify research gaps. This literature review is complemented with the exploration of relevant variables useful to shape students' context and the proposition of a set of sample learning scenarios that illustrate the relevance of the proposal. The second iteration embraces the 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 with teachers and instructors. Through this demonstration, we expect to collaborate with practitioners to refine the solution and prepare the interventions shown to students. This work will result during the third iteration in the enactment of pilot experiences in real scenarios, co-designed with teachers.

3 Current state of the research

So far, the author has been working on the first iteration of the thesis plan. The author has carried out a review of the state of the art of SLEs, focusing on the definition of the concept of SLE, the adoption of these environments and the enabling technologies in real settings, and the identification of research gaps. As a result of this review, the author has designed a set of different learning situations in different learning domains that emphasize the connection between formal and informal learning across spaces. Following the research plan, the author has designed an architecture that support the enactment of the previous learning scenarios involving the inclusion of diverse technologies across spaces, and the provision of learning resources according to the students' context [17]. The proposed architecture is presented along with an operational model that describes the actions SLEs should perform in order to provide the personalized support to the students.

The next studies performed in this thesis work will be aligned with the development of a preliminary prototype of the system. These studies will explore how the learning design can be involved in the operational model of SLEs in order to foster an automatic support for the learners based on their context and performance.

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