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Demonstration of SCARLETT: a Smart Learning Environment to Support Learners Across Formal and Informal Contexts

Sergio Serrano-Iglesias[0000−0002−3110−1096], Eduardo Gómez-Sánchez[0000−0003−0062−916X], Miguel L. Bote-Lorenzo[0000−0002−8825−0412], Juan I. Asensio-Pérez[0000−0002−1114−2819], Adolfo Ruiz-Calleja[0000−0003−1717−6304], and Guillermo Vega-Gorgojo[0000−0002−6916−9213]

GSIC-EMIC Research Group, Universidad de Valladolid, Valladolid, Spain.
{sergio@gsic, edugom@tel, migbot@tel, juaase@tel, adolfo@gsic, guiveg@tel}.uva.es

Abstract. This demo paper presents SCARLETT, a Smart Learning Environment designed to track the evolution of learners across formal and informal contexts in order to provide personal support to learners. SCARLETT benefits from a variety of Technology Enhanced Learning systems and tools for collecting information about the students actions across physical and virtual spaces and, based on it, deploying and recommending personalized resources and activities to be performed in the students' current formal or informal context. To provide such support, the learning design plays a key role in how SCARLETT works, as it helps to coordinate the data collection, to model and characterize learners, and to deploy the resulting personalized resources and activities.

Keywords: smart learning environments · learning design · formal learning · informal learning · across-spaces

1 Pedagogical and technological background

In recent years, the growth and diversity of learning systems and tools has fostered the appearance of Smart Learning Environments (SLEs). SLEs aim to provide personalized support to learners taking into account both their individual learning needs and context [8]. SLEs make a combined use of Virtual Learning Environments (VLEs), mobile devices and applications, and Internet of Things (IoT) devices so as to gather data about the interactions of learners and their current learning contexts across different physical and virtual spaces.

Some authors [1, 2] consider SLEs an opportunity to connect formal and informal learning experiences across spaces. Compared to formal education, with learning situations carefully prepared by teachers based on specific learning objectives and topics according to the curriculum, informal learning experiences are driven by learners at any time, either intentionally or serendipitously, in a more unstructured manner [5]. The connection of both types of learning experiences

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can be beneficial for learners [3]. Learners can reflect on concepts discussed in formal education in appealing informal learning activities, while informal learning experiences can be extended and complemented with formal lectures for the provision of appropriate feedback that can help to settle the reflections. However, a limited number of contributions have explored this connection in SLEs [8], specially due to the combination of multiple learning environments from both formal and informal contexts supporting learning activities that happen in different physical and virtual spaces. This demonstration shows how SCARLETT addresses them in order to provide informal learning support to learners connected with the formal learning situation.

2 SCARLETT overview

SCARLETT (Smart Context-Aware Recommendation of Learning Extensions in ubiquiTous seTtings) is an SLE designed to integrate third-party learning environments and tools (VLEs, mobile apps, IoT-enriched settings, *etc.*) with the goal of supporting students during learning situations that make use of physical and virtual spaces, enriching formal learning with suggestions for informal learning opportunities [6, 7]. Its architecture is presented in Figure 1. The support provided by SCARLETT is accomplished through (i) *sensing* and collecting data traces from the involved learning systems, including learners' actions and contextual information; (ii) *analyzing* this information in order to model and characterize the progression and participation of learners through the different activities, and to identify contextual conditions of the learning environments they are using; and (iii) *reacting* and providing suitable and personalized learning recommendations under the current context of learners.

To provide such support, the learning design (LD) of the situation plays a central role in how SCARLETT works. Through it, the instructional designer specifies the activities and resources that learners should perform, their associated learning goals and topics, and the learning environments and spaces learners are exptected to participate in. This information helps SCARLETT to coordinate the collection of data, derivation of student model and assessment of the alignment of informal learning activities with the formal learning goals.

3 Use case

Anna, a teacher of History of Art in a high school, has prepared a learning situation with the main goal to understand the influence of the Romanesque style in the architecture of the region. During three weeks, her students have to explore their city and identify examples of the main characteristics of the Romanesque style in local monuments. The LD comprises the following individual activities: an initial quiz about their prior knowledge on the Romanesque; an assignment about the identified monuments and characteristics; and its presentation to the rest of the class. Anna has deployed all these activities in Moodle, with additional resources like videos and web pages that may help her students. Moreover, Anna

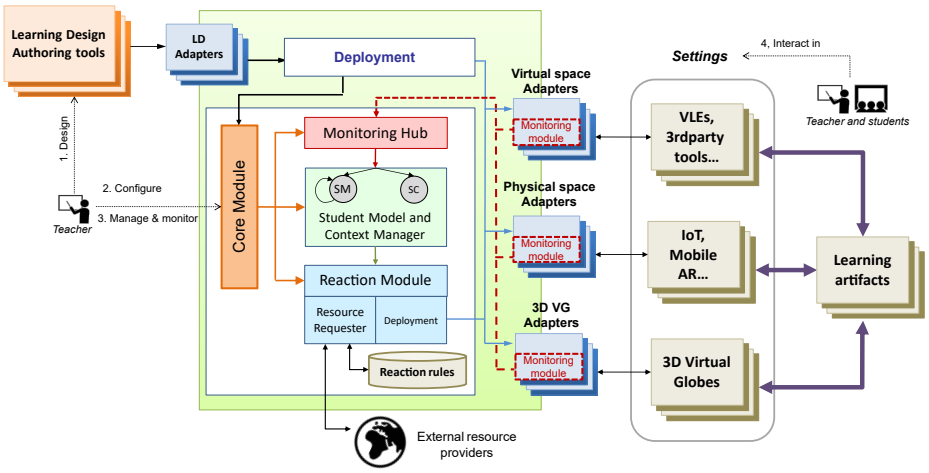

Fig. 1. SCARLETT architecture.

has encouraged them to install and use the CasualLearn application [4] in their mobile devices if they want to get recommendations of learning tasks to be carried out when visiting Romanesque buildings in their city.

Figure 2 represents the information flow to support this scenario. Anna makes SCARLETT import the learning design she deployed in Moodle, so that SCARLETT can obtain both the ids of the resources and activities in the different environments, and the ids of the learners participating. With this information, the `monitoring hub` of SCARLETT periodically tracks the actions of learners within the learning environments (flow 3 in Figure 2). In the case of Christina, a student of Anna, she has regularly visited the available resources in Moodle, achieved a high score in the quiz, submitted in time her assignment and made use of CasualLearn while she explored the monuments. In comparison, Peter, another student of Anna, is not so interested in this topic and he has not participated that much in the activities, roughly passed the quiz and not submitted his assignment yet. However, he likes the tasks available in CasualLearn and he has spent some time doing them, even if they are not mandatory. All this information is collected by the monitoring hub, and stored in a database. The acquisition of the data is performed through different monitoring adapters, that convert the requests to the specific API of each platform and translate the incoming data into a common format within SCARLETT.

These traces are later processed in the `student model and context manager`. This module manages the instances of the student model (4), with variables devoted to track student progress associated to the learning goals specified in the LD (*e.g.*, knowledge of Romanesque), that evolve as action data is gathered and learning analytics are performed (*e.g.*, analysis of the grades in a quiz on Romanesque). In our case, the information previously collected shows the num-

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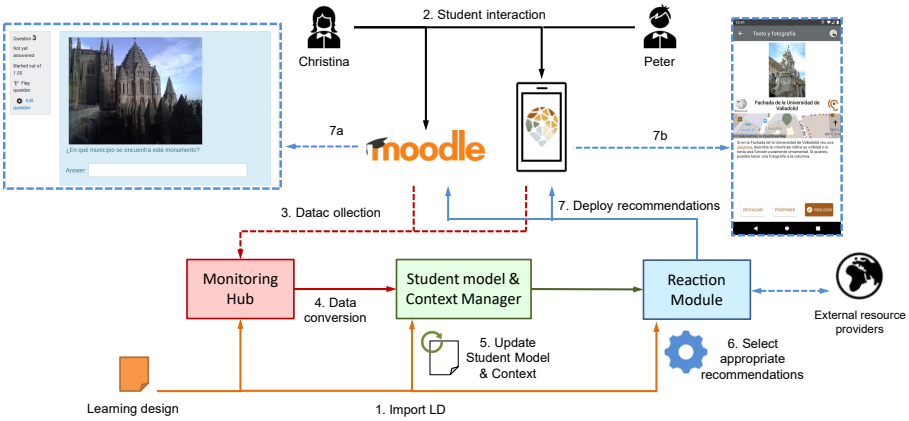

Fig. 2. Information flow of SCARLETT during the use case

ber of accesses to the complementary resources and the score obtained in the quiz, among other. This information is used to update Christina's model, adding indicators about a high interest and knowledge level in Romanesque, while in Peter's model can be seen his low performance and lack of participation in the assignment.

Apart from the students' actions, the `monitoring hub` collects information related with the current context of the learners, which is processed by the `student model and context manager` to determine further information. Thanks to this data, combined with the student models and the LD, SCARLETT can deploy recommendations of resources and activities in the appropriate learning environment. This process is performed in the `reaction module`, conformed by a rule engine that checks the information contained in these three entities to select a suitable recommendation to make (6), consisting of some resource recovered from external providers, that is deployed in one of the involved learning environments (7). For example, given that Christina's student model reflects her high knowledge of Romanesque and the list of monuments visited with CasualLearn is known, the reaction module retrieves some videos and a medium difficulty quiz associated to those Romanesque buildings and deploys them in Moodle in her private space (7a). As for Peter, since he is using CasualLearn and he is "behind" on Romanesque, the reaction module retrieves an easy geolocalized task (like providing a picture of the gates of a church) and asks Peter to perform it in that very context (7b).

4 Prototype and Future work

The current version of the prototype is able to read the LD created by instructors (using bricolage approach) in Moodle or Canvas. It then senses, through

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adaptors, the interactions with resources (quizzes, submissions, *etc.*) in these platforms, as well as CasualLearn mobile app, and transforms the data to an internal homogenous format. This is used to update the student context and model, through simple, but extensible, performance indicators. The reaction module is then triggered and can look for videos (in YouTube), pages (in Wikipedia) and quizzes (in CasualLearn SPARQL endpoint) and deploy them in Moodle, or send a link to the student through mail. In the near future, other resource providers and learning environments will be integrated, and more elaborated learning indicators implemented.

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