

# From Informal to Formal: Connecting Learning Experiences in Smart Learning Environments

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**Abstract**—Learners have ubiquitous informal learning opportunities, but it is difficult to take advantage from them and relate them to their formal education. The connection of formal and informal learning is one of the aims of SLEs, but how to do it is still a question. This paper explores such connection by integrating the mobile application Casual Learn to the SLE SCARLETT and it discusses the challenges faced in such integration.

**Index Terms**—Smart Learning Environments, formal learning, informal learning, personalization

## I. INTRODUCTION

Thanks to advances in mobile and ubiquitous learning, novel learning experiences have emerged in informal learning settings. However, learners are not always aware of informal learning opportunities, that are serendipitous in nature [1]. Besides, lack of appropriate support may hinder the effectiveness of informal learning, specially if learners do not relate the experience to their prior knowledge [2]. These limitations could be tackled by using technological tools capable of automatically detecting and adapting informal learning opportunities that are somehow related to the formal learning contexts in which students are taking part [3].

Some authors [4] consider Smart Learning Environments (SLEs) a promising solution for such connection. SLEs foster personalized support to learners based on their individual needs and context to achieve an effective, engaging and efficient learning experience [5]. SLEs rely on systems and tools such as Virtual Learning Environments (VLEs) and web and mobile applications, among others, to track the progress and context of learners. When these systems are used beyond formal settings, SLEs can provide learners with personalized informal learning experiences. However, the integration of SLEs and technological tools aimed at informal learning poses significant challenges that derive from the need of tracking and relating the progress of students in both formal and informal contexts.

In this paper we explore such challenges when integrating Casual Learn [7], a mobile application for informal learning about History of Art, with SCARLETT [6], an SLE aimed at providing personalized recommendations to learners across physical and virtual spaces.

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## II. OVERVIEW OF SCARLETT

SCARLETT is an SLE designed to facilitate the management and coordination of multiple learning environments across spaces in order to deploy personalized learning recommendations [6]. SCARLETT reads a Learning Design (LD) created by the teacher and prepares the learning spaces by configuring tools and resources (*deployment*). While the learning situation is happening, it collects data from the learners' actions across the different environments (*sense*); incorporates this information into a student and context models that represent their current learning state and conditions (*analyze*) and evaluates these models to trigger suggestions of learning tasks in an eventually appropriate place and time (*react*).

SCARLETT interoperates with third party tools during the *sense* stage, in order to collect information about student interactions in those environments; and in the *deploy* and *react* phases, to create and configure tasks to support either formal or informal learning. During a learning situation, SCARLETT monitors students' activity across the environments specified in the LD. Using this data, SCARLETT tries to build parametric student models containing performance indicators associated with the learning objectives and topics defined in the LD. Then, SCARLETT evaluates the information from the student and context models with different reaction scripts, determining which objectives or topics deserve reinforcement, and deploys an appropriate resource in one of the involved environments.

SCARLETT requires third party tools to be integrated to offer their action logs storing the user's interaction and to allow the management of the task lifecycle (*e.g.* task retrieval or task deployment) through an API. Note that SCARLETT does not impose the technology, methods or representation formats of the API, but only the functionalities. Also, only items with semantics aligned to SCARLETT's concepts can be consumed (*e.g.* the user has started or completed a task, or achieved a grade). To cope with the inherent variability of third-party interfaces while keeping its inner modules uniform, SCARLETT makes use of adapters developed for each tool.

## III. INTEGRATION OF INFORMAL SYSTEMS

We illustrate the integration of informal learning tools in SCARLETT to connect formal and informal learning experiences. We chose to integrate Casual Learn [7], a mobile application designed to provide informal learning tasks about

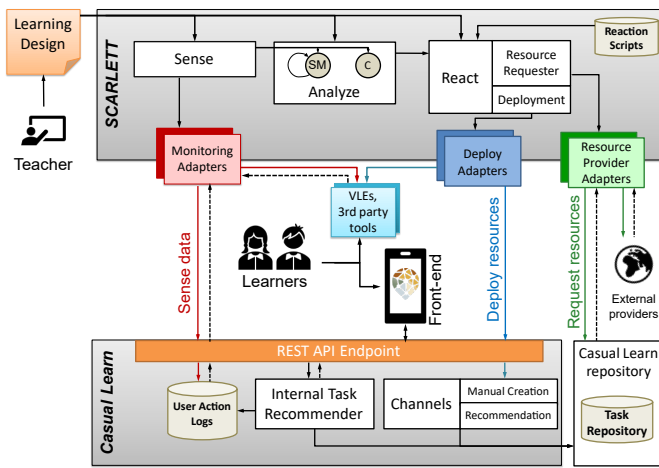


Fig. 1. SCARLETT (top) and Casual Learn (bottom) architectures. VLEs, third-party tools and Casual Learn are integrated through specific adapters for each action (middle).

History of Art related with nearby monuments from students' current position. This integration implies that: 1) SCARLETT is capable of asking Casual Learn to trigger learning activities that are personalised for the different students: 2) CasualLearn is capable of providing SCARLETT with data about students' actions so that SCARLETT can use it for updating the model of the students. This integration is represented in Fig. 1. For the sake of illustration, consider a teacher that has defined an LD for a course in History of Art, with videos, readings and quizzes carried out through the school VLE. The instructor also specifies that students can use Casual Learn during the learning situation, but does not prescribe any particular tasks. Once the LD has been deployed, SCARLETT starts monitoring student activity in *both* the VLE and Casual Learn, as specified in the LD.

For each student, Casual Learn keeps record of which learning tasks she carried out, as well as the answers she provided and the location in which the tasks were attempted. SCARLETT needs an adapter (shown in red in Fig. 1) that, for each student, queries Casual Learn through its exposed API for this information. The adapter combines them and returns SCARLETT evidence of the interactions of a certain student with different tasks.

The Analyze Module incorporates the semantics of the data provided by the tool (that have been mapped by the adapter) into the student model, along with the information coming from other tools. For example, SCARLETT may model the interest and knowledge level of a student on the topics covered in the LD, such as the Romanesque style, based on the interaction with videos and quizzes in the VLE and the tasks performed in Casual Learn. Also, SCARLETT can be aware of the city where this student has previously visited monuments. With these metrics, SCARLETT executes reaction scripts and, as a result, selects appropriate resources to be suggested in relation with her knowledge level and previous experience. These resources are not prescribed by the teacher,

*i.e.*, are not part of the formal design, but are nevertheless connected to its pedagogical objectives. The enactment of this recommendation is a two-step process. First, SCARLETT communicates with a resource provider (green) to retrieve possible resources relevant for the current learning situation and for the student according to their model. Then, through the deployment adapter (blue) this resource is presented to the learner. For Casual Learn, it is added to the private channel of the student. Thus, the learner will be notified when she walks near the monument associated to this recommendation.

Note that resources from different repositories could be retrieved and deployed in different environments, such as the VLE, through the corresponding adapter. For example, SCARLETT could search for medium-difficulty questions about Gothic art and, using an VLE-specific adapter, create there a private optional quiz for this student, enriching the platform used initially only for formal learning.

#### IV. CONCLUSIONS

Informal learning experiences can be more significant if they can be connected with formal learning and reflect on prior knowledge. SLEs can promote such connection, but the integration of informal learning tools is not simple, due to the exchange of information about learner actions and learning resources in multiple spaces. SCARLETT uses the LD to guide the deployment, govern the information retrieval from each learning space, drive the construction of a parametric model of students to offer personalized recommendations. Future work involves evaluating this ensemble in authentic conditions.

#### REFERENCES

- [1] C. Schumacher, "Supporting Informal Workplace Learning Through Analytics," in *Digital Workplace Learning*, pp. 43–61, Springer, 2018.
- [2] T. Ley, J. Cook, S. Dennerlein, M. Kravcik, C. Kunzmann, K. Pata, J. Purma, J. Sandars, P. Santos, A. Schmidt, M. Al-Smadi, and C. Trattner, "Scaling informal learning at the workplace: A model and four designs from a large-scale design-based research effort," *British Journal of Educational Technology*, vol. 45, no. 6, pp. 1036–1048, 2014.
- [3] C. Pimmer, M. Mateescu, and U. Gröbbl, "Mobile and ubiquitous learning in higher education settings: a systematic review of empirical studies," *Computers in Human Behavior*, vol. 63, pp. 490–501, 2016.
- [4] B. Gros, "The design of smart educational environments," *Smart Learning Environments*, vol. 3, no. 15, pp. 1–17, 2016.
- [5] B. Tabuenca, S. Serrano-Iglesias, A. Carruana-Martin, C. Villa-Torrano, Y. A. Dimitriadis, J. I. Asensio-Perez, C. Alario-Hoyos, E. Gomez-Sanchez, M. L. Bote-Lorenzo, A. Martinez-Mones, and C. Delgado Kloos, "Affordances and Core Functions of Smart Learning Environments: A Systematic Literature Review," *IEEE Transactions on Learning Technologies - Early Access*, pp. 1–17, 2021.
- [6] S. Serrano-Iglesias, E. Gómez-Sánchez, M. L. Bote-Lorenzo, J. I. Asensio-Pérez, A. Ruiz-Calleja, G. Vega-Gorgojo, and Y. Dimitriadis, "Personalizing the connection between formal and informal learning in Smart Learning Environments," in *Proceedings of 'Hybrid Learning Spaces - Design, Data, Didactics' Workshop*, vol. 2712, pp. 47–52, CEUR Workshop Proceedings, 2019.
- [7] A. Ruiz-Calleja, M. L. Bote-Lorenzo, G. Vega-Gorgojo, S. Serrano-Iglesias, P. García-Zarza, J. I. Asensio-Pérez, and E. Gómez-Sánchez, "Casuallearn: A smart application to learn history of art," in *Proc. 15th European Conference on Technology Enhanced Learning (EC-TEL 2020)*, pp. 472–476, 2020.