Towards the Generalization of Game-based Learning: Integrating Educational Video Games in LAMS

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Abstract—In e-Learning the interest on the use of new kinds of highly-interactive content is increasing. In this regard video games are one of the media that is gaining momentum because of their high potential for enhancing both students' motivation and learning outcomes. Nevertheless, the actual adoption of games in the educational system is scarce. In this paper we identify different open issues to be addressed to reach the aforementioned goal. To deal with these issues and broaden the use of educational video games, we propose their integration into the existing e-Learning infrastructure. Moreover, we present the integration of the <e-Adventure> educational game platform into the widespread Learning Activity Management System (LAMS) and discuss how this approach contributes to push forward the generalized adoption of educational video games.

Keywords-activity sequences, <e-Adventure>, e-Learning, LAMS, LMS-game integration

I. INTRODUCTION

The e-Learning arena is experiencing an increased interest in the adoption of richer highly-interactive content in general and video games in particular. The potential of video games to enhance the learning process has been discussed thoroughly in the literature [1, 2]. Some of the most cited benefits of educational gaming are their potential to motivate and engage students, to promote self-directed learning, or to present safe test environments that students are free to explore, receiving appropriate feedback in short cycles [3, 4].

So far educational games have been applied in different settings and following a variety of approaches. Although custom developments are growing in acceptance [5], many of the use cases of educational video games are related to the application of COTS (*Commercial-Off-The-Shelf*) video games such as *Civilization*™, *SimCity*™ or *Roller Coaster Tycoon 3*™ [6]. Some of COTS video games are so rich in content and realism that can provide an extra educational and motivational value. Nevertheless the use of video games in educational settings is still limited due to several issues. First, there are issues concerning the social acceptance of video games within the educational community, as instructors do not always consider video games as real and viable learning tools and they have not received the appropriate training to apply them in their classes. Second, compared to other contents, video games are difficult to distribute and deploy as they are complex software programs that usually demand top-tier computers and complex installation processes. Third, educational video games add an extra complexity to the process of tracking the students' performance. Last, but not least, it is still unclear how to embed video games into sound educational frameworks, which constrains the educational value of the games.

These issues can be addressed at least partially by integrating video games into the already deployed e-Learning infrastructure. Modern Learning Management Systems (LMS) such as *Moodle*, *Sakai* or *.LRN* are now widely used and accepted in educational organizations. In this paper we describe the integration of the <e-Adventure> educational game authoring platform [7] into the widespread *Learning Authoring Management System* (LAMS) [8]. This initiative not only contributes to promote the generalization of video games in educational settings but also allows for using their educational value to improve the creation of pedagogical strategies.

This paper is structured as follows: first, in section 2 we discuss the integration of educational video games, identifying open issues and how e-Learning technologies such as LAMS could help to address them. Then, in section 3 we describe the integration of <e-Adventure> games into LAMS. In section 4 we provide some discussion and finally conclusions and future lines of work are provided in 5.

II. INTRODUCING GAMES IN THE LEARNING FLOW THROUGH E-LEARNING SYSTEMS

The integration of video games into real educational settings is a complex task as they have their own special requirements. In this regard, one of the most relevant issues that are hindering the general adoption of educational video games is related to the educators' perception of games. Instructors do not usually think of video games as educational tools. In many cases educators are not gamers themselves and do not have the appropriate background to feel confident when using video games. Therefore it is necessary to train instructors in the use of this kind of content and simplify as much as possible the task of dealing with video games to make them accessible for a wider range of educators.

In addition, video games cannot be distributed as traditional content. Many video games demand last-generation computers that students may have neither at home nor in their educational institutions. This implies not only investing in new equipments but also its periodic updating, which is complex and even unaffordable for most of the educational institution budgets.

Another issue that must be considered is that in educational settings the students' interaction and

performance must be tracked. Some authors have identified assessment as a mandatory requisite for educational video games [9] as instructors need to be aware of the students' progress. In typical instructional approaches this is not a problem as teachers can control the process more tightly. Nevertheless in game-based learning approaches tracking students' performance becomes burdensome as students are completely free to explore, turning themselves into the leaders of their own learning. Therefore in most of the game-based learning scenarios that are described in the literature, instructors base the evaluation of the experience on planned pre-game and post-game debriefing sessions that are effective but time-consuming [10].

Finally, it is still uncertain how to embed educational video games into sound pedagogical frameworks. That is, even if we accept that video games have educational potential, how can teachers use them in their classes? How can educational video games be combined with other activities? How can game-based learning experiences where students could interact between them and with the instructor be planned? In this sense reusable and scalable instructional frameworks that provide answers to all these questions are still required.

Some of the issues we have identified could be addressed through current e-Learning infrastructure. Modern LMSs such as *Moodle™*, *Sakai™*, *LAMS*, or *.LRN* are present in most educational institutions and provide effective solutions for the aforementioned problems.

First, LMSs usually provide various mechanisms for distributing content to all the students almost immediately. The integration of the games in these platforms will simplify the distribution and deployment process and remove the need of last generation hardware, as only a web browser would be needed to run the games. Nevertheless, this assumption imposes some restrictions on the design of the games, in terms of size and complexity, as these should be Web-deployable. In addition, teachers and instructors are increasingly getting used to interacting with LMSs. Therefore, using LMSs to introduce the games in the courses would also reduce adoption barriers from the perspective of the instructors.

Second, LMSs include facilities for tracking the students' performance (e.g. reports of grades, activity within the system, etc.). We could take advantage of these features for gathering data from the interaction of the student with the game, evaluate that interaction and integrate the results into the LMS tracking system, thus making it that information readily available for the instructor.

Finally, although LMSs do not usually bind to any specific pedagogical approach, they supply educators with enough tools to allow the implementation of multiple sound instructional strategies. Furthermore, even some LMSs such as LAMS explicitly support rich pedagogical approaches. Integrating the games in this kind of environments could be beneficial as it could help to design new game-based learning scenarios supported by a solid pedagogical base. However there are multiple issues to take into account when integrating a new tool in mainstream LMSs [11].

III. INTEGRATION OF <E-ADVENTURE> IN LAMS

In this section we present the <e-Adventure> game authoring tool (section A), the *Learning Activity Management System* (LAMS) (section B) and how both platforms have been integrated (section C). Nevertheless, it is not the purpose of this section to provide a thorough description of <e-Adventure> and LAMS, but to describe those aspects that are necessary to understand how the integration was carried out.

A. Assessment Facilities in <E-Adventure>

<e-Adventure> is an authoring platform created to facilitate the development of educational *point-and-click* video games [12]. One of the most remarkable features of <e-Adventure> is that it includes some education-specific features that leisure video games do not present, like the possibility of launching the games through standard-compliant LMSs [13]. Additionally, <e-Adventure> allows the design of explicit assessment profiles for the games [12]. In this manner game authors can identify game situations that are relevant from a pedagogical perspective, and use them to design feedback (for the student) and assessment (for the instructor). The assessment behavior is defined in the games through the *Assessment Profile* which is composed by a set of rules. These rules identify states of the internal variables of the game as the mechanism to identify those states of the game that are relevant. For instance, an assessment rule could wait for the activation of a variable "*goal1 achieved"*, and once that happens, write some text to the feedback report and increase in one point the current grade. When the game enters that state, the evaluation rule is triggered and its payload executed (write to the log and increase grade). The feedback report and the calculated values are then gathered in a report that will be submitted to the LMS that launches the game for processing and attachment to the student's profile.

B. LAMS

The *Learning Activity Management System* [8] allows the design of collaborative educational experiences through a visual authoring environment by creating sequences of activities [14] based on IMS Learning Design specification [15] and the Educational Modeling Language [16]. In this manner LAMS promotes the reuse and share learning designs. The sequence can be executed and monitored by the instructor at runtime in this system. LAMS also manages the courses, the lessons (which are the activity sequences) and the users. Thus LAMS covers the expected functionalities of a LMS. Nonetheless, LAMS is more tightly bound to a specific underlying pedagogical approach, while other LMSs just give their users the tools to implement their own strategies.

LAMS has three main view modes [17]:

- Author: manages the authoring process of the workflow (the LAMS sequence). Using this view instructors decide the contents of the sequence and design the sequence flow by setting branches (alternative paths) and gates.
- Learner: is the run environment. This view is how the student sees the sequence of contents when it is running.

- Monitor: using this view the instructor can follow all the students' interactions in a sequence at runtime. This view allows the teacher to alter the sequence in real time (e.g. the instructor could decide to provide further guidance to students performing poorly).

LAMS supports the inclusion of different contents (e.g. chat, forum, Q&A, IMS–CP packages) in the activity sequence and the definition of prerequisites between them (e.g. the activity Y cannot be taken until activity X is completed). In these sequences we can also introduce Sequence Management Tools like branches or conditioned paths and stop points in order to create more complex educational designs (Fig. 1.a). There are three ways to do branching in a sequence. The "Teacher allocated" branching mode where the teacher establishes at runtime the branch that each student must follow. The "Group-based branching" allows for defining different paths according to the group each student belongs to. Finally, the last one is "Tool-Output based branching" in which the output(s) of the last activity is taken into account in order to decide which will be the next path. Some conditions can be defined in a subset of LAMS activities devised for evaluating the student's performance. These conditions are used in this branching mode to assign the next path for each student. For instance, sequence authors could define a "Question & Assessment" activity and use the outputs of this element (e.g. the answers of each question) to decide whether the student should go on in the activity (path 1) or chat with peers to reinforce some concepts (path 2).

The gates or stop points in LAMS are similar to branches, but these permit to halt the sequence execution until the conditions set by the instructor are met (e.g. all students reach that sequence point, the output of a previous activity satisfy a specific condition, etc.).

C. *Integration of <e-Adventure> in LAMS*

<e-Adventure> has been integrated in LAMS as a new tool that allows running <e-Adventure> games. This new tool implements all the LAMS views (Author, Learner and Monitor), taking into account the *LAMS 2 Tool Contract* [17]. In the Author view it is possible to add a game to the sequence and preview the result. Also in this mode you can define a set of conditions (Fig. 1.b) that can be used to make decisions in branches and gates (Fig. 1.c). The conditions for branching can be defined over the expected game outputs (e.g. the game score is greater than 70%). The outputs which are extracted from <e-Adventure> games can be either *default outputs* (Table 1) or *custom defined outputs* that are specific for each game. While default outputs are provided by all the games, custom outputs are specific variables defined in the <e-Adventure> assessment profiles.

When the sequence reaches an <e-Adventure> activity in the Learner view, the game is launched. In the Monitor view the instructor can see the student interaction with the game and modify the instructions that are attached to each game or check the student's access. The teacher can also view the assessment reports generated by the <e-Adventure> games which are attached to the Monitor view when the game is completed. This opens up a new way of using the game outputs both for branches and stop gates related to the "at teacher will" mode. For instance, the teacher can stop the execution of the sequence until he or she analyzes the assessment report. Once the teacher verifies the report, he or she may select which branch should be followed by the student next. In case of the stop points, the teacher either can open it or force the student to repeat the game, for example, if the instructor does not consider that the educational goals have been fulfilled.

TABLE I. DEFAULT <E-ADVENTURE> OUTPUTS.

Name	Description
Game-completed	Indicates whether the game has been completed or not
Score	Indicates the numerical assessment of the student's performance.
Game-time	Total time from the begining until the end of the game.
Real–game-time	Real play time, exluding the periods where the student is not interacting with the game (e.g. is visiting the menu panel)

We also have made modifications in <e-Adventure> to accommodate the platform for the integration with LAMS. We have included the LAMS particularities in our integration architecture [18]. This required adding a LAMS-specific communication module (to enable the exchange of data between <e-Adventure> games and LAMS at runtime) and a new exportation profile (to allow for the packaging of the games as content that LAMS can process). We package our games following the IMS Content Package specification [19], adding an extra file which contains the custom game outputs expected in the LAMS side. Thus LAMS knows which data can be used to formulate conditions when the game is loaded by reading and interpreting this file in the <e-Adventure> activity tool.

IV. DISCUSSION

The integration of <e-Adventure> in LAMS improves the current state-of-the-art of educational gaming by addressing some of the open issues discussed in section 2. Today more than ninety institutions, universities and colleges in over twenty five countries throughout the world use LAMS as a tool to support their educational and training programs[1]. Moreover, LAMS can be integrated with other popular LMSs such as *Moodle, Sakai, .LRN* or *Blackboard* [20].

Therefore making <e-Adventure> available as another out-of-the-box LAMS tool will increase the visibility of the <e-Adventure> platform in particular and educational video games in general for a broader range of audiences. In addition, this work supposes the continuation of our previous work in the integration of <e-Adventure> with some of the aforementioned LMSs following the IMS Content Packaging and SCORM specifications.

From an educational point of view, LAMS introduces an easy way to create learning designs that can be bound to many pedagogical strategies [21]. This becomes more interesting when these strategies can be stored, shared, reused and adapted for different contexts and educational situations.

[1] http://wiki.lamsfoundation.org/pages/viewpage.action?pageId=2855

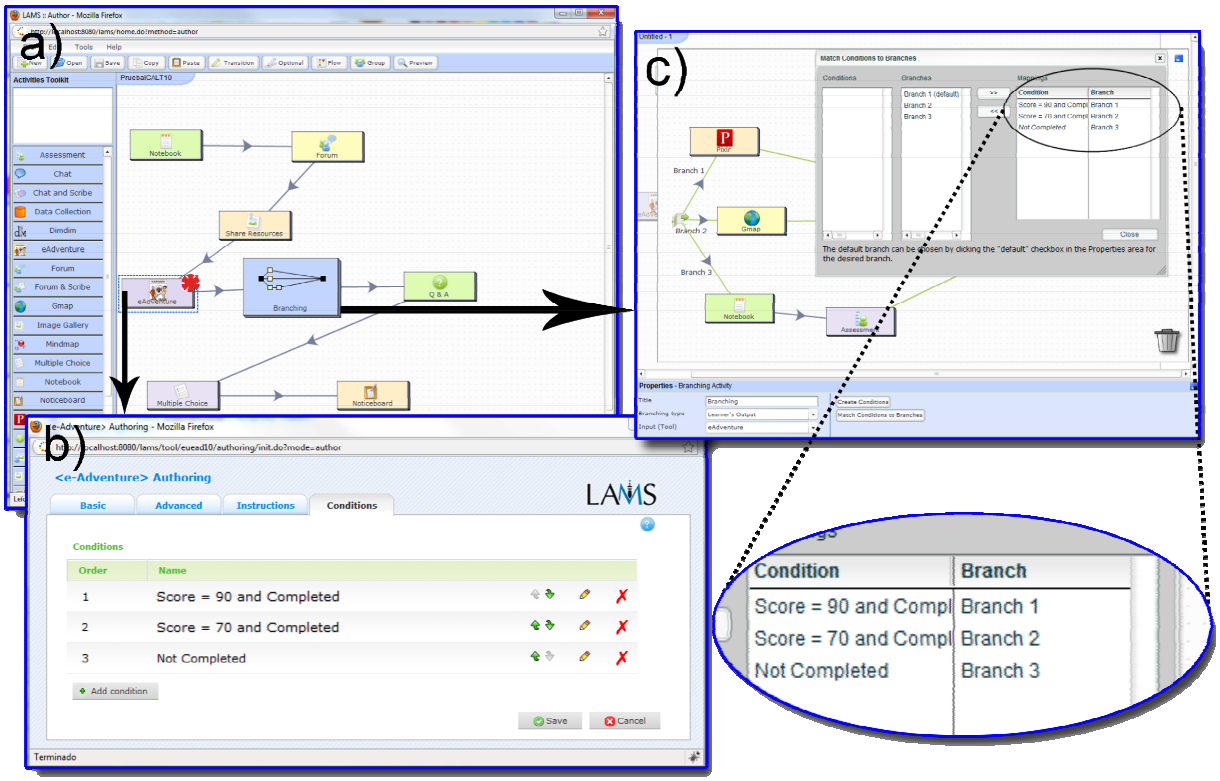

Figure 1. Screenshot (a) shows an activity sequence including an <e-Adventure> game (*) in the main LAMS authoring window. By clicking on the <e-Adventure> activity the sequence author can open the conditions edition dialog (screenshot (b)). Screenshot (c) depicts how different pahts in a branch are linked to conditions over the game outputs.

The notion of modeling complex educational strategies in an interoperable way is an important idea that is also reflected in *IMS Learning Design and SCORM Sequencing & Navigation* but LAMS eases the authoring process allowing teachers to create sequences of contents without demanding detailed knowledge about these specifications. We expect the educational advantages provided by games (e.g. motivation, adoption of learning by-doing approaches) to improve the educational value of these sequences.

Other advantages are related to the use of game and activity outputs. The <e-Adventure> outputs can be used to make more sophisticated conditions for branches and stop gates elements (Fig1.c). A lot of different game situations can be expressed by the combination of outputs. For example teachers can use the default "game-completed" output to express if the student has completed the intended objective of the game and the "score" to indicate the level of accomplishment. In addition the games can communicate lots of different final states by combining conditions over both default outputs. The evaluation of the students' performance could be more fine-grained by gathering and analyzing the default and specific outputs. From the instructor's perspective the system of outputs provided by <e-Adventure> combines ease and flexibility. On the one hand default outputs are available without requiring any additional effort, which promotes the use of the games between the most novice instructors. On the other hand, custom outputs allow the instructors to define their own assessment strategies in the games; nevertheless in this case instructors will need to modify the design of the game with the <e-Adventure> editor.

Other interesting <e-Adventure> game output is the assessment report. It can be used not only to track information about the students' interaction but also to allow teachers for using that information to modify the sequences flow at runtime. When the Sequence Management Tool used is a branching tool, the teacher has to read the assessment report of each student in order to decide what will be the next activity. If the Sequence Management Tool is a stop point, the teacher has to decide if the student can access to the next activity or if he/she must repeat one or more previous activities to improve him/her results after going on. Therefore the integration of the assessment features provided by <e-Adventure> games with the Monitor view in LAMS facilitates the task of tracking the students' performance in the games.

V. Conclusions and Future Work

Educational video games are gaining momentum within the academic community. While the potential of these new learning tools is generally accepted, the debate about how to appropriately integrate them into the learning process is still ongoing. Among the most relevant open issues on the educational gaming agenda, we identify social issues (e.g. instructors need to be informed and trained in the use and management of game-based learning experiences);

distribution issues (e.g. complexity of deployment); tracking issues (i.e. the need to monitor the students' progress within educational video games) and pedagogical issues (e.g. how to embed educational video games into learning environments with a solid pedagogical base).

In this paper we describe the integration of any educational game produced with the <e-Adventure> platform into the Learning Activity Management System and how this initiative contributes to address the aforementioned issues. Now <e-Adventure> games can be used just as any other learning tool in the design of LAMS activity sequences. Given the wide acceptance of LAMS, and its broad community of educators and developers, the introduction of a tool specifically devised for educational games will enhance the visibility and appeal of game-based learning. In addition, as LAMS is completely web-oriented, <e-Adventure> games embedded in LAMS activity sequences can be easily deployed using just a web browser. The integration of the assessment reports that <e-Adventure> games produce (logs that record the progress of the student in the game and evaluation information) into the LAMS Monitor view facilitates the tracking and evaluation of the game-based learning experiences. Finally, the solid pedagogical principles behind LAMS (e.g. focus on the design of learning activities, promotion of collaboration between students and instructors, alignment with constructivism principles, etc.) allows for an easier integration of the games into sound instructional strategies. For instance, teachers can include a game as a new LAMS task and use the detailed game assessment data obtained at runtime to assign alternative paths in a sequence of contents. This process can be performed either automatically or requiring the intervention of the instructor at runtime. Another interesting feature of the <e-Adventure> platform is that the assessment profile can be easily modified in order to fit different pedagogical strategies. This idea aligns well with the LAMS reuse and share principle. Although we expect that this work will contribute to the generalization of educational gaming, many open issues are still to be faced. Making <e-Adventure> visible through LAMS on its own will not make teachers start creating their own games and using them in their own LAMS activity sequences.

The next step in this project is the evaluation of the integration of <e-Adventure> in LAMS with end users. This includes the evaluation of the final system with experts (i.e. instructors) and the development of online LAMS-supported courses including <e-Adventure> games. Besides, we are planning to develop other ad-hoc integrations of <e-Adventure> in popular LMSs such as *Moodle*. We expect that the combination of these initiatives with the e-Learning standards and specifications already supported in <e-Adventure> will facilitate the integration of games into the e-Learning infrastructure. We consider that these steps represent an additional push in the roadmap to achieve widespread adoption of game-based learning approaches.

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