Integrating educational video games in LAMS: The <e-Adventure> Experience

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Educational computer and video game are a digital medium that have been proved to be useful in improving both students' motivation and learning outcomes enhancing the overall learning experience. On the one hand, games can introduce new appealing interfaces and highly interactive experiences. On the other hand, e-learning environments can help to address some of the open issues that come up when digital games are introduced in the curricula. In this paper we present how the LAMS e-learning system and the <e-Adventure> gaming platform have been integrated, resulting in mutual benefit: on the one hand LAMS learning designs can be enhanced with educational games; on the other hand, <e-Adventure> games can use LAMS monitoring and flow-driving features to increase educators' control in game-based learning experiences.

Keywords: <e-Adventure>, e-learning, LAMS sequences, learning-flow adaptation, students' assessment

Introduction

Educational computer and video games and simulations (i.e. digital games, a.k.a. as serious games) have raised the interest of both the academia and the educational industry. One of the signs of this interest is that the number of organizations developing serious games or simulations for learning or training purposes has increased during the last years (Wexler, Corti et al. 2008). In addition, digital games have been proved to succeed in improving both students' motivation and learning outcomes (Squire, Barnett et al. 2004; Blunt 2007; Annetta, Minogue et al. 2009; Sancho, Torrente et al. 2009).

In the context of e-learning environments digital games have captured some attention as well, as they can enhance the overall learning experience in several ways. On the one hand, digital games can introduce new appealing interfaces (Kickmeier-Rust, Peirce et al. 2007). In addition, games can contribute to bridge the disconnection between students and educators due to their high interactive nature, also providing educators with advanced mechanism to track students' performance (Moreno-Ger, Burgos et al. 2009). On the other hand, e-learning environments can help to address some of the open issues that hinder a wider adoption of educational games (Hays 2005; Van Eck 2006). When the literature about experimental setups with educational games is reviewed, some issues appear recurrently. For example, technical issues such as the lack of proper infrastructure in the educational organization, problems dealing with the installation and/or delivery of the games are usually reported (Rice 2007). In addition, linking games to the curricula can be complex since learning outcomes turn to be sometimes unpredictable for game-based activities (McFarlane, Sparrowhawk et al. 2002) and it is hard for educators to gauge the learning flow when sessions do not develop as expected. Moreover, evaluating the students' achievements with digital games can be troublesome for educators as they are not always provided with the appropriate tools. As a consequence assessment is usually conducted through post tests and debriefing sessions, which are important in the learning process but demand a considerable amount of educators' extra time. Since modern e-learning environments are starting to provide advanced features to control the learning process and evaluate the students' performance (Brusilovsky and Miller 2001), they can also contribute to reduce the cost of assessing students' learning outcomes and improve the effectiveness in game-based learning.

Nevertheless, integrating digital games in e-learning environments is not a straightforward task. In addition to the basic technical requirements that must be fulfilled, advanced communication mechanisms between games and e-learning environments have to be implemented so the interaction within the game could be tracked and used to adapt the learning flow or to be processed and presented to the educator for

assessment. The challenge is how to design the system so educators without a strong gaming background can use that information through a familiar and user-friendly interface.

In this paper we describe our approach to address these issues by integrating the <e-Adventure> educational gaming platform into the LAMS e-learning system. The combination of both platforms results in mutual benefit: not only LAMS learning designs can now be enhanced with educational games but also <e-Adventure> games can use LAMS wide monitoring and flow-driving features to increase educators' control in game-based learning experiences.

This paper is structured as follows: we present a brief literature review in section 2. In section 3 we describe the <e-Adventure> authoring game platform with especial emphasis in their different kinds of games and educational features. In section 4 we present the <e-Adventure> integration into LAMS by finally present some conclusions and lines of future work.

Literature Review

There are different works in the literature related to the integration of games in educational settings. One of the trends is to produce ad-hoc integrations of specific game frameworks and e-learning environments. For example, (Edwards, Elliott et al. 2001; Barab, Thomas et al. 2005) describe experiences where the game interface of a 3D Multi User Virtual Environment (MUVE) has been enhanced with other educational tools to improve the communication between the educators and students during the game. There are other examples of MUVEs like NUCLEO or SLOODLE that integrate the game world with a Moodle environment, allowing the use of the assessment, communications and other tools provided by the LMS inside the game (Kemp, Livingstone et al. 2009; Sancho, Torrente et al. 2009). The main drawback of these approaches is their lack of interoperability, scalability and difficulty to be repurposed.

As opposite to ad-hoc approaches we find authors that strongly advocate towards the integration of games in Learning Management Systems (LMS) following popular specifications and standards of the e-learning field (Burgos, Tattersall et al. 2007) improving the reusability and interoperability. Therefore the deployment and communication between game and LMS must be done following e-learning specifications and standards to enable an effective assessment and adaptation of the games. However, not all the more popular e-learning specifications support that LMS and content exchange information in an active fashion, which limits the current potential of the approach (Burgos, Tattersall et al. 2007). In this sense, SCORM provides one of the most accepted communication mechanisms and data models. Nonetheless, SCORM's communication interfaces are not mature enough to support the vast amount of information that highly interactive contents such as games can produce and send to the LMS (Shute and Spector 2008).

<e-Adventure>

<e-Adventure> is an educational gaming platform that aims to bring the world of digital games closer to the field of education by tackling some of the main issues that hinder a wider adoption. <e-Adventure> is instructor-oriented, allowing teachers to add real educational value to the games. This platform allows for the development of 2D digital games and simulations, reducing the development cost and hiding the technical details. The created games can be executed in web-based environments in general and LMS in particular. Besides, <e-Adventure> includes special features such as the definition of assessment rules to automatically track the students' performance within the game. A similar system also allows the definition of rules to automatically adapt the game flow to the specific student and educational context.

High level overview

The <e-Adventure> platform present two main elements: an easy to use editor and a game engine. The structure of an <e-Adventure> game is similar to the script of a theatre play. The author prepares all the elements that will take part in the game (e.g. characters, scenes, objects and dialogues) and creates the story of the game later on using those elements. The editor (**Error! Reference source not found.**) allows

the definition all the game elements and a mechanism to plot the narrative of the adventure and define the challenges or puzzles.

As providing students with feedback it is an important requisite, especially in educational contexts, <e-Adventure> allows displaying information to the student in different ways (e.g. conversations between characters). The author of the game can also define special types of scenes to show videos or scenes compounded by slides. In order to show large chunks of information, <e-Adventure> includes a specific type of element that can be inserted in the games: the *books*. Using these elements educators can reuse some of their educational materials as the books can be rendered dynamically using external resources (e.g. an HTML web page).

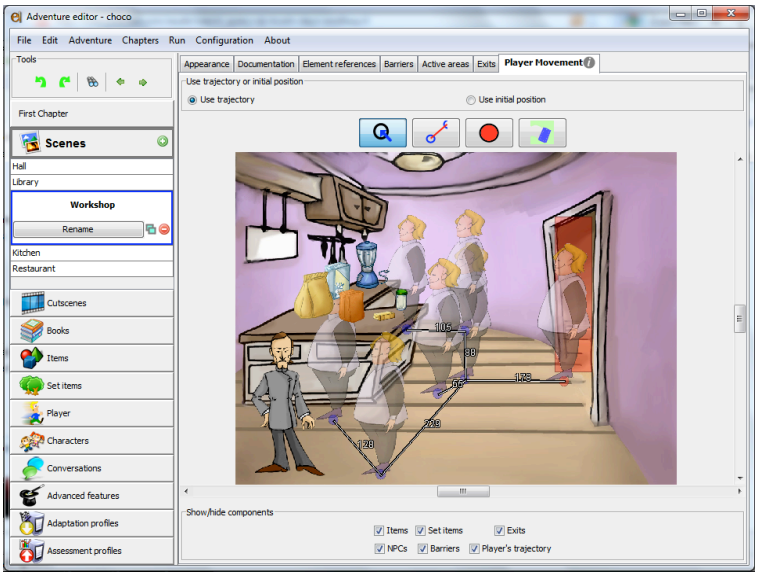

Figure 4: The <e-Adventure> editor.
All the game elements can be accessed and edited using the left side panel of the editor.

<e-Adventure> allows for developing two main types of 2D games: *third person*, where the player is represented by an avatar; and *first person*, where the player is directly immersed in the game world.

Show cases

During the last years several games have been developed with <e-Adventure>[1] (Torrente, Lavín-Mera et al. 2008; Moreno-Ger, Torrente et al. 2010). One example is *1492* (Torrente, Lavín-Mera et al. 2008) (**Error! Reference source not found.**.a), a third person game where students learn about Spanish history while immersed in the story about Cristobalín, a bad student who has to prepare a work for his history teacher. Under strange circumstances Cristobalín is transported to Granada in 1492 and experiments the historical feats occurred that year. This game is a good example of how third person games can be used to facilitate the acquisition of conceptual knowledge.

First person games can be implemented easily with photos, creating in this manner interactive photo-realistic worlds. Therefore this mode of games can be used to implement interactive *simulations*. One example is *HCT* (Moreno-Ger, Torrente et al. 2010) (**Error! Reference source not found.**.b), a game developed in collaboration with the Complutense School of Medicine. This game reproduces the procedure of measuring the Hematocrit level in blood samples using photos of the real laboratory where the practice takes place. This way students not only can practice the procedure safely as many times as desired but also get introduced to the equipment they will use in the actual lab session. However, *first*

[1]All the presented examples can be accessed by entering as guest at http://e-adventure.e-ucm.es/course/view.php?id=18&lang=en_en_utf8

person games allow for the creation of other kind of games which exploit the possibilities of *drag&drop* interaction present in <e-Adventure>: *puzzle* games. Therefore game developers can create games where the students have to link concepts or complete jigsaw puzzles using this type of interaction. This feature can be used in combination with other elements. One example of this kind of games is *Parity*, (**Error! Reference source not found.**.c) a game for 6-years-old kids where the parity concepts are introduced embedded in a story about two turtles called *Odd* and *Even*. In this game students have to complete several challenges were both turtles have to be connected to groups of even and odd elements that appear on the scene. In these three games the interaction is tracked and automatically analysed to produce an assessment report.

Educational features

The author can incorporate specific educational characteristics (i.e. features not usually found in commercial games) once a draft or sketched version of the game is available. <e-Adventure> includes an

Figure 5: Different kinds of <e-Adventure> games.

assessment mechanism based on rules to monitor the student progress in the game. The rules allow educators to identify any game situation that is educationally relevant (Del Blanco, Torrente et al. 2010) and collect them in a human readable report. The report can be delivered to the educator via e-mail or sent to a back-end LMS. This report can also be shown to the student at the end of each game play as self-assessment allowing students to check their responses and thus redefine possible erroneous assumptions. Another option is to communicate an attribute-vale pair to the LMS. (e.g. "score", "70") when a rule is met in the game. The LMS will need to understand that parameter and process the request, likely resulting in an update on the student's profile. Besides, the <e-Adventure> platform offers the possibility to carry out a modification of the game experience taking into account the specific characteristics of each student. Thus educators can maximize the effectiveness of the game to a wider range of students adapting the game to the needs of each of them in terms of learning preferences, initial level of knowledge, socio-cultural reasons, learning styles, etc. Furthermore this mechanism allows for the reuse of the games created in different educational contexts without changing the game's structure.

The games created with this platform can be included in LMS (e.g. *Moodle*, *Sakai*, *Blackboard*) following the Learning Object model (Polsani 2003). The <e-Adventure> platform follows some e-learning standards and specifications content annotation and packaging such as the IEEE Learning Object Metadata (IEEE 2002) and the IMS Content Packaging (IMS Global Consortium 2004), which allows to export the games as a self-contained package that can be automatically deployed in multiple e-learning environments. Besides, <e-Adventure> games can be exported as SCORM objects (ADL 2006), allowing not only the deployment of the game in the LMS through this specification but also to connect <e-Adventure>'s assessment and adaptation features with the LMS. Using the different exportation profiles the same game can be executed in a wide range of LMS and content repositories, fostering the reutilization and the interoperability of <e-Adventure> games.

Integration of <e-Adventure> in LAMS: The <e-Adventure> Activity

Current LAMS release allows adding games into an activity sequence using the "Shared Resources" activity. As "Share Resources" was not designed with the purpose of deploying games, LAMS cannot get any information from the student-game interaction and use this information for flow control or students'

activity monitoring. Therefore with the actual features of the LAMS system the full educational potential of the games cannot be exploited.

In order to introduce the <e-Adventure> games into the LAMS platform we have developed a *LAMS tool* following the requirements of *LAMS 2 Tool Contract* (Ghiglione and Dalziel 2007). As a consequence LAMS authors (e.g. educators. as LAMS is an educator centred tool) have now a specific game activity which allows them to take advantage of the <e-Adventure> educational specific features in their sequences. The <e-Adventure> activity allows authors to introduce games in their sequences using LAMS' *authoring view*, execute the games using the *learner view*, and track the students' performance using the *monitoring view*, as this section describes.

Authoring view

In the *authoring view* the educator can create or add content to the activity and configure related options. The <e-Adventure> activity has four tabs in the *authoring view*. The Basic Tab allows changing the game, editing the title and adding some initial instructions The <e-Adventure> game exported for LAMS includes a set of variables that the game can communicate to LAMS containing information about the students' interaction. Some of these variables are predefined (e.g. completion time) while others can be user defined. When a game is loaded in Basic Tab, the <e-Adventure> activity identifies which are the possible game outputs and inputs and their types (i.e. boolean, string, integer or time). The predefined variables allow educators to use the game outputs without a deep knowledge about the game design (Del Blanco, Torrente et al. 2010). The predefined variable "completed" allows for identifying when the objectives in the games are met. There is an extra option in the Advanced Tab that links the "finish button" with the "completed" variable. If this option is set, the button will be hidden until the game sets the "completed" variable as true, preventing students to continue in the sequence in this case. There are other options in Advanced Tab that allows configuring if the activity can be executed more than once and if an additional notebook with instructions should be presented at the end of the game. The Instructions Tab allows for adding both online and offline detailed instructions.

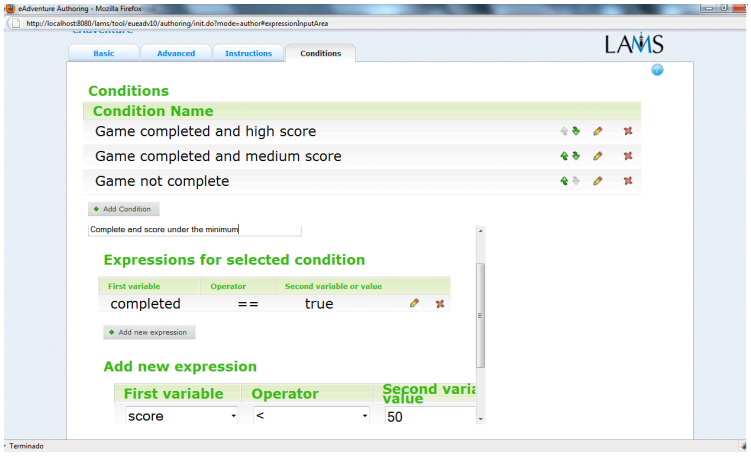

Figure 6: The <e-Adventure> activity Conditions Tab at *authoring view*.
Note: the fonts have been modified over the original image to improve readability.

The Conditions Tab allows the definition of specific LAMS conditions by using the parsed variables. Each condition is composed by a set of expressions. In the expression, the parsed <e-Adventure> variables can be used to define a specific condition over the possible values. For example, in the
Figure 6, the LAMS condition "Complete and score under the minimum" is edited. This condition has one expression which will indicate whether "complete" is equals to "true" and another expression is being created which will test if "score" is less than 50. This condition will be met if the whole expression is met. The created conditions can be used to select automatic flow control at Branching and Gates in the same way as with other LAMS Activities. The author can also define simple conditions (i.e. using only

one <e-Adventure> predefined variable) when the <e-Adventure> activity is linked with a flow control activity (i.e. in the same way that educators can define a condition over the number of task completed when a "Task List" activity is used at branching).

Educators can link the performance of the students in previous activities in the sequence with the <e-Adventure> game for adaptation purposes at the principal *authoring view.* The conditions of the previous LAMS activities can be linked with the alternative paths in the game for adaptation purposes in the same way that the LAMS conditions are linked with different branches in a Branch activity. For example, in
Figure 7.a, a Task List activity precedes the <e-Adventure> activity. The educator has to select which is the activity from which <e-Adventure> receives the input (using the drop-down menu "input tool"). In the example provided this is the "Task List" activity. By clicking the "Create Conditions" button, the educator can create a condition using some values of the previous activity or select one of the conditions created in the *authoring view* (
Figure 7.b). In this example, the "Learner entered conditions" is selected. Afterwards the authors can choose how to map each condition with a different <e-Adventure> path. When the LAMS condition is met, the game will begin using the path selected, modifying the game experience accordingly. In this example, when the condition "Student has not the initial concepts" is met, the game will load the path "Low initial level and reinforce concepts". This path reduces the initial difficulty and shows additional materials for reinforcement. The alternative game path hides these concepts and uses a higher difficulty level.

Monitoring view and Learner view

Once the sequence is running, the educator can monitor the learners' progress and modify part of the flow and content at the *monitoring view*. This view allows educators to access some information about learners' activity such as the status of the sequence (started/finished/inactive), the current point where they are in the sequence, the time that they spent in each completed activity, etc.

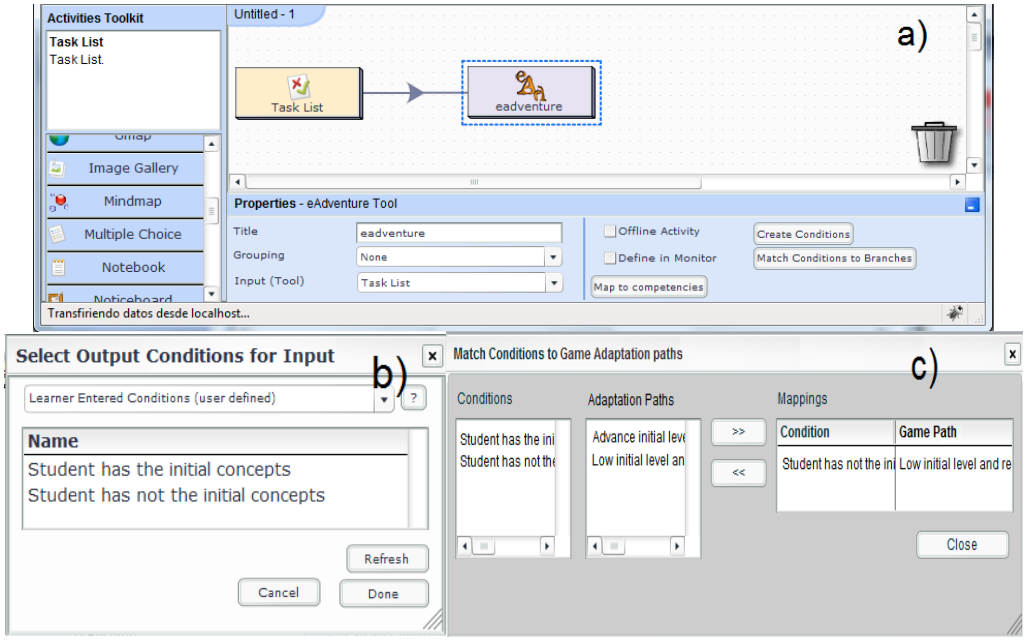

Figure 7: Linking a LAMS condition with different adaptation paths in the <e-Adventure> game.

The *monitoring view* also provides some data that is specific of the activity. The <e-Adventure> activity has four tabs at *monitoring view*. In the Summary Tab there is a list of names of students that have executed the game, the access time and the <e-Adventure> assessment report generated when the game ends. The Edit Activity Tab allows changing the current game even if the sequence has already started.

The Instructions and Statistic Tabs show the instructions filled at authoring time and the number of learners that have finished the activity respectively. LAMS also includes the possibility to collect some of the relevant information shown at *monitoring view* structured by activity in a portfolio. For the <e-Adventure> activity, the information added to the portfolio is the same as in Summary Tab but including also the assessment report attached. Using the information of the assessment reports the educators not only obtain an evaluation of the game for each student but also can select a branch in a Branch activity or open a Gate activity on the fly when they are set as "Teacher allocated".

As the <e-Adventure> games can extract information within the game experience in different ways, these data is also connected with the LAMS Gradebook, where an assessment data collection of the all activities are gathered. This way both educators and students can access the time of the game executed, if the game was completed or not and the final score of the game.

The *learner view* is presented when the student executes the sequence. In this view the content of each activity is displayed. The <e-Adventure> activity executes the game as a Java Applet. The learning design structure appears in this view allowing the student to navigate through the sequence. The student can also get a personal portfolio where the information about his/her activity is gathered. The <e-Adventure> activity adds to this portfolio the <e-Adventure> report for the specific student.

Conclusions and Future Work

In this paper we present how the <e-Adventure> platform has been integrated in the LAMS e-learning environment. The integration of the <e-Adventure> games into LAMS simplifies the introduction of games in the learning flow including different features such as automatic deployment of the games or student assessment capabilities. The idea is to reuse the already existing e-learning infrastructure to deploy the games and provide educators with tools to improve their perception about the development of the session and the students' actual performance during the game execution.

On the one hand, the assessment system of the <e-Adventure> games can be connected with LAMS' sequence flow control elements by defining conditions over the variables that the game can return. In contrast to the constraints of the SCORM data model, the game can send any user-defined variable to LAMS. Just the teacher should be able to know its meaning to use it properly in the LAMS conditions. Therefore the game outcomes can be used as inputs for flow decisions. This data is also included in the LAMS Gradebook to be taken into account with the assessment information produced by other activities. Furthermore, the assessment report is gathered along with other activities reports in the portfolio and can be used by the educators to modify the sequence flow on the fly. On the other hand, the game experience can be modified taking into account the students' performance in previous activities, pushing forward the adaptation possibilities in LAMS sequences.

Taking into account the reutilization features of both platforms, this integration allows for sharing good practices between sequences of activities with digital games by storing them in the LAMS sequence repository provided by the LAMS community. Thus educators can download a sequence and modify it to fit in their specific educational settings. In this sense, educators can not only modify the structure and the activities of the sequences but also the game content and the assessment and adaptation capabilities.
Future lines of work are related to the inclusion of games in the LAMS pedagogical planners. In this sense the next step is to study the patterns that LAMS offers to identify how games can be introduced in a more effective way. Besides, we are also looking for different patterns that can be implemented in pedagogical planners where the games help to improve the educational value.

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