

<e-Adventure>

Introducing Educational Games in the Learning Process

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Abstract—Within the last years educational games have attracted some attention from the academic community. Multiple enhancements of the learning experience are usually attributed to educational games, although the most cited is their potential to improve students' motivation. In spite of these expected advantages, how to introduce video games in the learning process is an issue that is not completely clear yet, which reduces the potential impact of educational video games. Our goal at the <e-UCM> research group is to identify the barriers that are limiting the integration of games in the learning process and propose approaches to tackle them. The result of this work is the <e-Adventure> platform, an educational game authoring tool that aims to make of video games just another educational tool at the disposal of the instructors. In this paper we describe how <e-Adventure> contributes to the integration of games in the learning process through three main focuses: reduction of the high development costs of educational games, involvement of instructors in the development process to enhance the educational value, and the production of the games using a white-box model. In addition we describe the current research that we are conducting using the platform as a test-bed.

Keywords—<e-Adventure>; educational games; authoring tool; LAMS

I. INTRODUCTION

Instructors, parents and public authorities are astonished by how dropout rates have grown in education at all levels for years. This alarming trend suggests a drastic decrease in the motivation of the students towards learning.

Several hypotheses have been formulated to explain this controversial issue. In this line, several authors like Prensky [1] argue that there is a clear disconnection between students' expectations and what they receive in the classroom. According to Prensky, current students are *digital natives*, people used to interact with rich interactive digital media such as computers, mobile devices or video game consoles; this differs from the typical pedagogical strategies in terms of content and interaction [1, 2].

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To tackle this issue, a deep reform should come to the educational system, updating the content and interactivity used to support learning. One of the proposals is the use of video games and other kind of interactive technological content. Actually, the application of games in education is a trend on the rise. There is a belief that video games have potential to enhance the learning processes in multiple ways. One of the most frequently discussed is the ability that games have to increment students' motivation towards learning as they are able to capture their attention and keep them engaged and immersed [3, 4]. Other interesting traits of educational video games is that they provide immersive in-game worlds that can be explored freely by the students, promoting self-directed learning [5], their short feedback cycles with perception of progress [6], or their relation to constructivist theories and support of scaffolded learning [7].

This interest in the use of educational video games laid the basis for the <e-Adventure> project [8-10]. <e-Adventure> is a platform that has been developed by the <e-UCM> research group at the Complutense University, and its main aim is to facilitate the introduction of the games in the learning process. Nonetheless, to achieve this goal several barriers have to be tackled first. In this paper we describe the main problems that are preventing a more general adoption of educational gaming, according to our own research experience. Between the most relevant issues we find the high development cost of video games, the difficulty of involving instructors in their development, and the complexity of using the games in traditional pedagogical approaches. After that we describe how these issues have been addressed in our proposal, the <e-Adventure> platform.

All the research conducted in our group about educational games, and the effort invested in pushing the development of the <e-Adventure> platform forward has turned <e-Adventure> into a solid product that is available for download and ready to use¹. Thus <e-Adventure> is not only the result of our past research, but also a great test-bed where we are implementing our new work on educational games. In this paper we also include a discussion about the main research lines we are working on.

¹ <e-Adventure> can be downloaded from the next website:
<http://e-adventure.e-ucm.es>

Therefore this paper is structured as follows. Firstly, in section II we briefly discuss the main limiting factors for the general adoption of educational games. After that, in section III we summarize the approaches that we have proposed to tackle them, and how they have been implemented in the <e-Adventure> platform. Later, in section IV, we describe the main research lines we are working on and how we are integrating them in <e-Adventure>. Finally some conclusions are presented in section V.

II. TOWARDS THE INTRODUCTION OF GAMES IN THE LEARNING PROCESS: OPEN ISSUES AND BARRIERS

As stated in the introduction, video games seem to have potential as learning tools, but their use in real scenarios is limited by multiple factors that span all over the product life, affecting the design, implementation and deployment phases. In this section we discuss, according to our opinion, some of the more relevant issues that affect educational games in these three stages.

A. Issues at the Design Stage: Balancing Educational Value and Entertainment

One of the main challenges of developing an educational game is the achievement of an adequate balance between entertainment and educational value [7]. Both factors are indispensable for the success of the game. If the students do not have fun playing they will finally quit the game and all the investment would be useless. However, if all the efforts are focused on the fun-factor and the educational value is left aside, the game would have little impact on the learning outcomes of the students. Therefore the development of educational games adds, to the difficult task of designing game elements that are fun and engaging, the challenge of achieving educational value [11, 12].

To ensure that an educational game has educational value we need to effectively involve instructors in its development. On the one hand instructors are the domain experts, who can check that the accuracy of the knowledge ‘stored’ in the game is appropriate. On the other hand, instructors have the crucial responsibility of applying the games in the real learning scenario. Nevertheless current game development methodologies limit the involvement of instructors due to the technical background required. As a consequence, there is a need for the creation of specific development methodologies that take into account all these issues and propose effective mechanisms to get instructors involved in the development process.

In addition, educational games have their own needs that may differ from more traditional, entertainment-driven developments. In this sense it is very important to choose a game genre that suits these needs. There are several studies that have analyzed what are the more suitable genres for educational applications. Authors like Dickey argue that story-driven genres, like Interactive Digital Storytelling or *point-and-click* adventure games can better fit the needs of educational gaming for a broader set of domains as they promote content instead of plain action [13-16]. For instance, the presence of elements such as a slow pace, reflection, study of the

environment, and problem-solving make point and click adventure games relevant from a pedagogical perspective [17].

B. Issues at the Production Stage: the Costs

One of the most drastic disadvantages of applying video games in education is their high development costs. High-profile commercial (non-educational) video games have often budgets of several million dollars. For instance, as analyzed in [18], a high percent (40% approximately) of the educational game developments active or recently finished in 2005 were expected to cost more than \$100K. Arguing in the same line, the study described in [19], estimates the development costs of commercial video games in the range of \$10M-\$25M for 2008.

Those estimations are a barrier for the introduction of video games in the educational process, as it is almost unfeasible for most educational organizations to develop their own educational games if no external funding is available. Obviously that issue virtually narrows the applicability of educational games to pilots and research projects, impeding a general adoption.

The lack of reusability of video games is another hindering factor. Video games are usually sold and distributed as *black boxes*: self-contained, closed products that are rarely scalable to other domains and contexts. This lack of flexibility reduces the potential of video games for learning as instructors need to adapt, reuse, maintain and share their materials and those developed by others (actually these are frequent behaviors of instructors).

C. Issues at the Deployment Stage: Delivery and Assessment

Finally, some of the main barriers that hinder the adoption of educational games are related to the complexity that they introduce in the learning process from the instructors’ point of view. In this sense, the actual use of educational games is limited due to several factors.

On the one hand, there are inconveniences concerning the delivery, distribution and deployment of the games. Video games are complex pieces of software that are usually distributed in CD or DVD and that require some installation on the player’s system. In addition, while a lecture typically requires a blackboard and some pieces of chalk video games require up-to-date computers and controlled environments which are seldom present in schools [20]. Moreover, even when this kind of equipment is present in the schools, they usually lack the staff preparation and/or the time required to organize educational gaming sessions.

On the other hand, it is burdensome for the instructors to track and assess the learning experience. As games are usually *black boxes*, from which extracting information is arduous, instructors need to plan carefully how they are going to evaluate the learning outcomes and achievements of each student (usually through time-consuming debriefing sessions).

III. THE <E-ADVENTURE> PLATFORM

The result of the research carried out in our group on educational gaming is the <e-Adventure> platform for educational game development. In this section we discuss the

solutions that we have proposed for the issues discussed in section II and the more relevant features of <e-Adventure> that implement them.

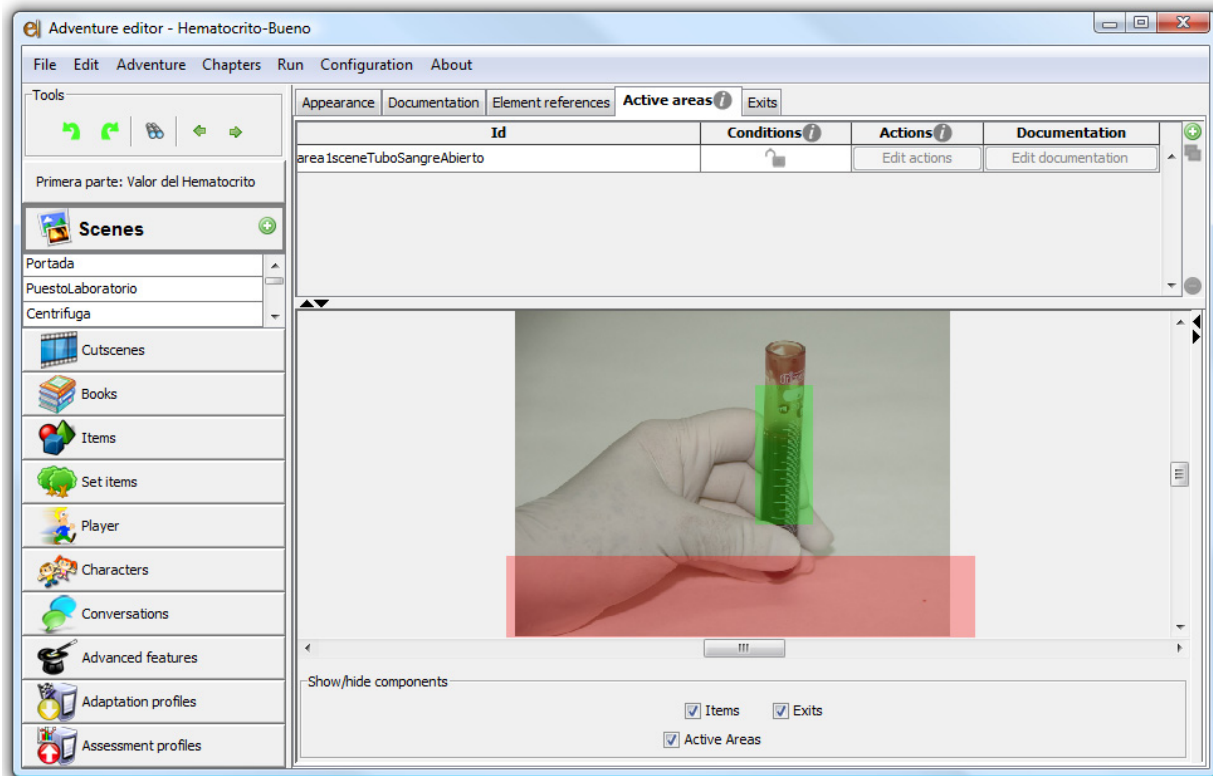


Figure 1. Screenshot of the <e-Adventure> game authoring tool.

A. Increasing the Educational Value, Decreasing the Development costs

As aforementioned, some game genres have traits that make them more suitable for educational purposes than others. In this line, story-driven games can be good educational tools as they improve the problem-solving skills and promote reflection instead of action. Thus the <e-Adventure> platform is focused on the *point-and-click* adventure game genre (in the style of games such as *Monkey Island*© or *Myst*©).

This genre is not only interesting because of its high educational value, but also because the development cost of these games is minimal. Besides, in order to broaden the potential domains of application of <e-Adventure> the platform supports the creation of two different types of games taking adventure games as a basis: *third-person* and *first-person* games. While the first type of games has been applied in concept-intensive domains like History [21], the second has been useful in the development of games for teaching procedural knowledge, for instance, in several medical applications [22, 23].

In addition, an appropriate game genre is not the only enhancement of the educational value that <e-Adventure> includes. As discussed so far, the level of instructors' involvement in the development of the games is a sound prerequisite to achieve a good educational value. <e-Adventure> aims to allow instructors to develop their own

educational games, or at least contribute in their production by following two strategies.

First, along with the <e-Adventure> platform, we have proposed a development methodology for the development of story-driven educational games [24]. This model allows the cooperation of multiple roles (e.g. storywriters, programmers, artists, etc.) of different technical background in the development of the games. In this manner the methodology supports the integration of instructors in the process as non-technical staff, trying to make sure that "a good story never ends in a bad game".

Secondly, <e-Adventure> includes an instructor-oriented game authoring tool (see Figure 1.) which does not require any kind of technical background [25]. The authoring tool allows instructors to create their own games as no programming is required, and also contributes to reduce the development costs. Moreover, even if some instructors may find creating entire games from scratch too ambitious, this approach at least allows those instructors to open the games developed by others in order to review the contents, make minor modifications, adapt games for different contexts, etc., allowing them to contribute in the development process.

Furthermore, the authoring tool also promotes reuse as it has been developed in compliance with standards and specifications of the e-Learning field, allowing in this manner the exportation of the games as Learning Objects (LO) [26] that can be shared in content repositories (e.g. the AGREGA

LO repository developed by the Spanish ministry of education).

B. Facilitating Deployment and Assessment: Integration with e-Learning Environments

Once the games are already created, <e-Adventure> also helps to make their use in the actual learning scenario easier. The main strategy that we have followed to address this group of issues relies on the integration of the games in e-Learning environments like Moodle™, Sakai™ or Blackboard™. In our opinion this approach brings numerous benefits.

As we previously mentioned, <e-Adventure> games can be packaged as Web-based Learning Objects. This facilitates their distribution through e-Learning environments to the students' computers without requiring any installation (only a web browser is needed) [27].

Secondly, once the <e-Adventure> games are deployed on the e-Learning environment, the platform also enables a communication channel between game and server [28]. Through this channel the instructors can extract information about the progress of the student in the game, the goals that are achieved, etc., and have it submitted to the e-Learning environment to be attached to the students' profile [10, 29]. For instance, instructors could identify using the authoring tool game situations that have a relevant meaning from a pedagogical point of view (e.g. a specific puzzle is not completed and some knowledge is not unveiled), define a score for those situations and get that score sent to the e-Learning environment just as any other kind of test for the student. Hence <e-Adventure> games are not *black-boxes* but *white-boxes* where instructors are aware of what happens during the execution of the game.

IV. OPEN RESEARCH

As discussed so far educational gaming is a trend that has attracted the efforts of different researchers in the last few years. Nevertheless, in spite of all the work done, there are still different open issues to be solved in order to achieve the final goal of turning video games into feasible, affordable learning tools. We are thus currently exploring several lines of research and testing them within the <e-Adventure> platform, including mobile game-based learning and adaptive and accessible educational games. In this section we will focus on two specific projects: the integration of <e-Adventure> in the LAMS e-Learning environment (section IV.A) and the development of a story-driven game authoring tool (section IV.B).

A. Integration with e-Learning Environments: LAMS

As discussed previously, our approach to ease the integration of educational games in the learning process heavily relies on the integration with e-Learning environments. Although lot of research has already been conducted, resulting in the integration of <e-Adventure> in systems like Moodle™ using standards and the Learning Object Model, we are still exploring new approaches.

As part of this research line we are working on the integration of <e-Adventure> with LAMS (Learning Activity Management System), an open source e-Learning environment [30]. Like other e-Learning environments, LAMS manages all the features of the online courses in a centralized way for all the roles involved. But the most interesting feature that makes LAMS different is that it also allows teachers to create *activities sequences* (that is, to model the learning flow and the activities it includes).

With the easy-to-use sequence authoring tool that LAMS includes instructors can define the learning flow by graphically combining out-of-the-box activity tools (e.g. chat, forum, question and answer activities, etc.) that LAMS integrates. Moreover, instructors can define branches in the sequence by defining conditions on the outcomes of some tools, allowing alternate paths for different students or groups and depending on their achievements. Finally, LAMS also provides a monitoring mechanism that allows modifying the flow of the sequence while it is being executed, giving the teacher more control of the educational experience.

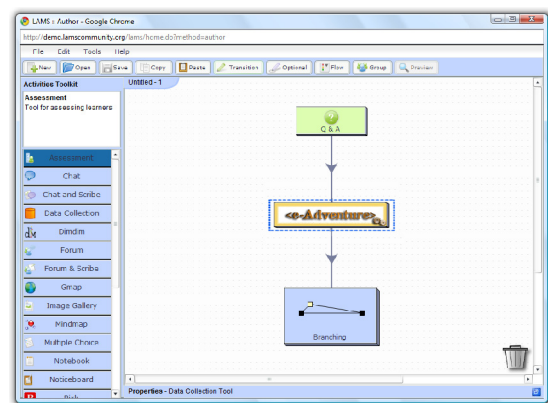


Figure 2. The activity sequences authoring tool in LAMS. A sequence of activities including an <e-Adventure> game that is used for branching.

Our aim is to make of <e-Adventure> another 'out-of-the-box' LAMS activity tool (see Figure 2.). Therefore instructors could upload their own educational games to the system and integrate them in their activity sequences. In addition, <e-Adventure> games will be able to receive the outcomes of other tools as inputs (e.g. the score) and produce their own outputs (e.g. score, time played, etc.). This opens a lot new possibilities that are interesting from a pedagogical point of view. For instance, instructors could define branches in their sequences using the outputs produced by <e-Adventure> games. In this manner instructors could provide activities to reinforce learning if the outcomes are not the expected. Moreover they will also profit from the high interactivity of the games to know more about the students and provide them more adequate activities. Finally, the inputs received from the sequence could be also used to make internal branches in the game according to the history of the student, allowing the adaptation and personalization of the game-based learning experience for the needs of each student.

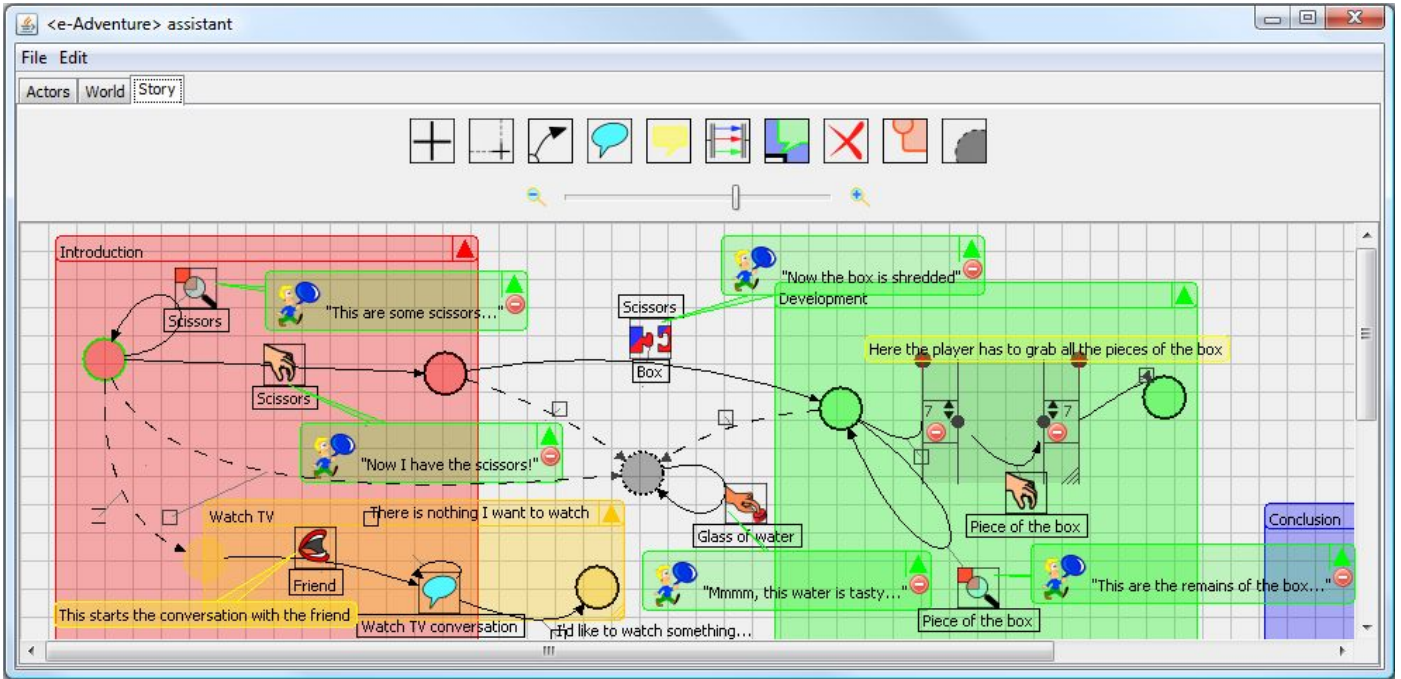


Figure 3. Screenshot of the story-driven authoring tool (prototype)

B. Easing the Authoring of the Narrative Thread: A Story-Driven Authoring Tool

One of the design issues discussed in section II refers the impact that a powerful narrative thread may have on the educational value of educational games, as discussed by other authors. Nonetheless the production of a good storyboard for an educational game is not an easy task, given that to the burdens of making the story engaging and fun we add the difficulty of achieving the adequate educational value.

That is the motivation for one of our current main research lines. Our goal is to develop a graphic authoring tool that simplifies the production of a good storyboard for an educational game in terms of engagement and educational value. Besides, we will integrate this new tool with the <e-Adventure> editor, where the description of the games and the story lays hidden behind, and intertwined with the multitude of different elements that make up the game. As a consequence of this integration, <e-Adventure> will be an innovative development framework that integrates multiple tools for each stage of the development process of the games, including not only a content-based authoring tool but also a story-driven one.

The story-driven editor will use a visual modeling language to describe the game. In this representation there are visual elements to represent the different states that the narrative thread of the game can have and the possible actions the player can take (see Figure 3.). Therefore the storyteller can visualize and edit the narrative flow and how the interactions of the player affect the course of the story.

Working over the representation of the storyline described above, the game author will be able to define automatic assessment behavior, which will ease the addition of educational value to the games.

Additionally the new authoring tool will also include a feature to model, in a separate graphic sheet, the 'virtual world' of the game. This will facilitate the establishment of a bijective relation between the story and the places where it takes place. Using these new tools the initial description of the games is streamlined, leaving details to be dealt with in a later step. This is also, in general, a good practice in game design methods [13, 31].

The design of this new authoring tool is based on ideas introduced by experts in other areas (particularly Interactive Digital Storytelling) and systems used to create interactive computer stories in the early 90s [32-34]. Besides, it introduces new elements that make it easy to guide the user in the creation of new games by reusing patterns, applying methods developed by specialists in storytelling and game-making and creating recommendations based on the structure of the story [4, 35].

V. CONCLUSIONS

In this paper we have presented the research we are conducting at the <e-UCM> group at Complutense University in educational gaming. Our aim is to identify the barriers that are preventing the generalization of educational video games and propose solutions from a technical perspective. Between the relevant issues that we have identified so far, some of the most important are the problem of balancing educational value and entertainment,

the high development costs, and the complexity that games introduce in the classroom dynamics.

To address these issues we have developed the <e-Adventure> educational gaming platform, which aims to reduce the development costs while keeping high quality standards in terms of educational value and entertainment. Using <e-Adventure> it is easier for instructors to create, adapt, share and use their educational games in their courses. Thanks to all the efforts invested in developing the platform, <e-Adventure> has reached the state of 'product', going beyond a 'research prototype'. This allows us to conduct new research on educational gaming and test it within <e-Adventure>.

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