

Edu-Interact: An Authoring Tool for Interactive Digital Storytelling based Games

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Abstract—In this research we present an authoring environment, Edu-Interact, that supports the creation of adaptive interactive digital storytelling based games. Edu-Interact allows to design a story that seamlessly evaluates the student knowledge, performs subsequent adaptation of the digital storytelling, and provides summative assessment. The authoring environment allows also to assign weights to different concepts the student could accumulate through the interaction with the storytelling. This can provide a score that could be used as a means of gamifying the interactive digital storytelling, or provide teachers or other stakeholders with feedback on the student performance.

Index Terms—Authoring Systems, Educational Technology, Interactive Digital Storytelling, Interactive Systems.

I. INTRODUCTION

STORYTELLING has long been used as an established method educating people in formal or informal contexts. Although the usage of storytelling in education is not new, interactive digital storytelling has become of interest for educational specialists in the last years. Interactive digital storytelling allows the user to control the story, and hence create for the user a better feeling of control, which could be important for educational purposes [1]. The ability to modify the story opens an opportunity for adaptive and adaptable educational interventions.

Several interactive digital storytelling authoring tools have been proposed [2-3], some also for education purposes [2]. Although the aforementioned authoring tools allow creating interactive digital storytelling easily, they do not support integration of different ways to assess and quantify user knowledge improvements. Such a feature would allow gamifying the storytelling through integration of student educational performance through “the score” and the personalized feedback to the student, providing not just a seamless evaluation but also serving as an extrinsic motivation for the player. This research aims to address this gap. Therefore, in this paper we present an interactive digital storytelling authoring tool, Edu-Interact, that meets the

following objectives. It allows the teacher (or other domain experts) to create an interactive digital storytelling, integrate learning objectives and evaluate them, adapt the story based on the “seamless evaluation” and also provide an easy and customizable method to quantify the knowledge improvement by the player.

This article is organized as follows. The next section presents a brief overview of the state of the art focusing on three aspects: the usage of interactive digital storytelling in education, adaptation in educational settings and existing work on authoring interactive digital storytelling. This is followed by the proposed authoring tool. We end this research by proposing future work and conclusions.

II. STATE OF THE ART

A. Usage of Interactive Storytelling in Education

The usage of interactive digital storytelling has been proposed in various contexts, such as teaching about microbe transmission and the importance of hand washing [4], to address health communication in minority populations [5], to train grapho-motor skills [6], teaching students about ethical issues [1] or to improve knowledge on medieval history [7]. The usage of digital storytelling in the classroom positively influences student higher order thinking [8]. It also allows students to create their own understanding [8].

Interactive digital storytelling is providing students with an engaging and motivating experience [1]. The story situates learning in a context [9], and interactivity allows the student to be an active actor in the construction of the story and could lead to unintentional learning [1].

Lots of research in this area focuses on a particular usage of storytelling in educational purposes [4-7] and their effectiveness [4,6,7], however, very few studies focus on the authoring part of interactive storytelling. As opposed to the aforementioned research, in this research we do not focus on a particular usage of storytelling in educational purposes and their effectiveness, but on the authoring part of the interactive digital storytelling. The educational interactive digital storytelling in our context will be created solely with the aim of showing that the authoring tool provides adaptation of the educational storytelling. This could allow teachers to customize the story and the way the student is assessed through his/her interactions throughout the story.

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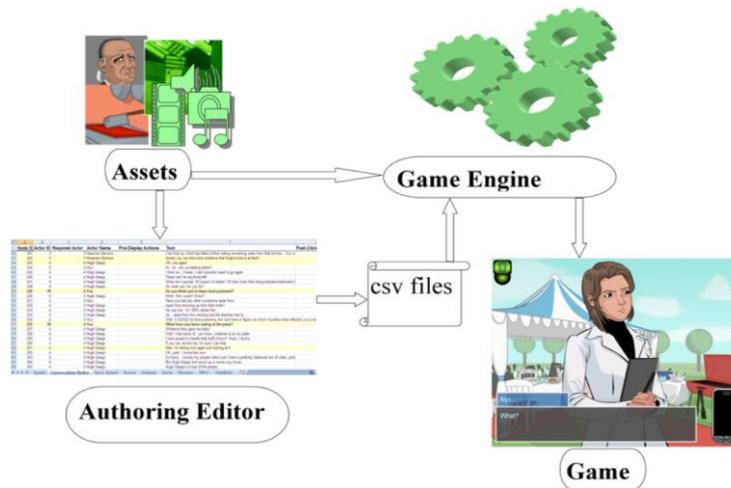


Fig. 1. Edugames4all Authoring Environment and Game Engine [2]

B. Adaption in Educational Settings

Adaptation in educational settings has been used for different purposes such as: to provide the student with different educational material and assessment depending on the result of his/her previous interaction with the learning material [10], to adapt the material based on the user cognitive characteristics [11], or to address technology, infrastructure and cost limitations depending on the user context and needs [12]. Other studies have highlighted the importance of providing students with adaptive material, as the students do not always have the same levels of knowledge and hence do not benefit in the same way from the educational material [13] or due to their previous lack of experience they may need help with the usage of educational content [14]. Games that are endogenous, adaptive and provide completion feedback to the player are more effective [15] and an increase in the adaptive features within a game could result in an improvement in the learner's cognitive strategies [16].

Adaptation in interactive storytelling could allow not only for the story to unfold based on the players' actions, but also to consider the educational outcomes. For example, if a "seamless assessment" [17] is used, the interactive digital storytelling could change based on the student knowledge. Moreover, including the feedback of the assessment in the score or the interactive digital storytelling reward system could act as an extrinsic motivation for the players and potentially increase enjoyment in the game and learning outcomes. This paper plans to address the authoring aspect of this: how to allow teachers or storytelling designers to quantify the "seamless assessment" - leading towards a summative assessment that needs to be supported, which would also facilitate the creation of adaptive interactive digital storytelling.

C. Interactive Digital Storytelling Authoring Tools

One of the challenges faced when developing interactive

digital storytelling tools, is the lack of a user-friendly story authoring tool for practitioners [18]. Although several authoring tools have been developed or proposed they do not cover all IDS needs [18]. Most of them require programming skills [18] in order to create and extend interactive digital storytelling [18-19]. However, several authoring tools such as Toontastic¹, Story Builder² and Sparkle Fish³ have been successfully used to provide authoring support for children to develop stories.

Szilas [20] argued that the highly interactive digital narratives need to involve three kinds of actors (excluding the end user) which have to come together to achieve the final goal: researchers – engine designers, creative authors and software engineers. In our approach, as we study a particular type of interactive digital storytelling that aims to deliver educational content we also need to include educational experts (most of the time teachers). The opportunity to incorporate educational content into interactive digital storytelling, evaluation of student knowledge is of crucial importance for education. In this work we focus mostly on the summative assessment and how this can be authored.

One of the authoring tools allows to create interactive digital storytelling and has been used for creating educational interventions is the edugames4all authoring tool [2]. However, although it provides ways to achieve formative assessment through "seamless evaluation" [17], it does not provide an easy way to create summative assessment or a way to integrate the user knowledge as a score. In this paper we present an extension of this authoring tool, Edu-Interact, providing teachers a summative assessment and providing feedback to the students also through a score, similar to a game.

¹ <https://itunes.apple.com/gb/app/toontastic/id404693282?mt=8>

² <http://appcrawlr.com/ipad/storybuilder-for-ipad#authors-description>

³ <http://appcrawlr.com/ios/sparklefish#authors-description>

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	A	B	C	D
1	Node Id	Score	Description	End
2	568	1		end
3	572	1		end
4	580	1		end
5	584	1		end
6	590	1		end
7	594	1		end
8	597	1		end
9	600	1		end
10	606	1		end
11	611	1		end
12	614	1		end
13	624	1		end

Fig. 2. Authoring Tool Extension

III. AUTHORING TOOL

A. *edugames4all* Authoring Tool

The Edugames4all authoring tool [2] allows the creation of interactive digital storytelling without the need for any programming skills. The files generated by the authoring tool will be used by the game engine to generate an interactive digital storytelling (see Fig. 1). Both the game engine and the authoring tool were created based on the Interactive Digital Storytelling (IDS) FSM [2] formalization which allows an easy extension and allows the summative assessment to be integrated. The authoring tool has already been successfully used to create several educational games [2]. It also allows to embed formative evaluations [17].

The authoring tool consists of a series of worksheets. There are eight worksheets, each having a different role as described below:

- *Rooms* - describe the environment in which the player could be (e.g. kitchen, lab)
- *Hotspots* – describe elements in different rooms which are clickable and the player will get feedback as a result of clicking and interacting with them
- *Items* – describe virtual objects that could be collected by the player while exploring the storytelling
- *Characters* – describes the virtual characters and their characteristics
- *Conversation Nodes* – describe the conversations which combined together lead to different stories depending on the path the user takes through the story. It also allows to describe the order in which the conversation nodes will be delivered.
- *Game Actions* – describe the actions triggered when a player clicks a hotspot
- *Quests* - refers to a story element of the game that requires activation (or deactivation) when certain conditions are met.
- *Initial State* – it is the state at which the game will be started

All these files are connected through each other through IDs attached to their elements.

B. *Edu-Interact: Summative Seamless Evaluation Extension*

Seamless Evaluation [17] has been defined as an evaluation embedded through the educational content in such a way that is not intrusive to the user. The extension presented here would allow the authors to create a summative assessment, by



Fig. 3. Score Computed based on the Weight attached to Player's Answers in the Game

assigning a value to the way players answer the assessment of a given learning objective. This could also be used to gamify the storytelling and include it as a part of the scoring system.

To allow also for the score to be integrated we decided to have a separate sheet which connects to the other one through the conversations node IDs. Due to the nature of the game and its intensity in narrative, the evaluation is embedded into the storytelling through conversation nodes. Therefore, it makes sense to include and attach weights to the conversation nodes. In this case depending on what answer the player selected, identified through the *Node Id* a different weight can be attached to the score. In Fig. 2 a weight of one has been attached to each element, meaning that every time the player selected a correct answer, one will be added to his score. However, depending on the importance of the answer, an answer could be given a negative value (i.e. when the player selects the wrong option) or half a point.

C. *Case Study*

We use this approach to modify and attach weights to the learning objectives covered by the Global Handwashing Day game [21], which would get computed in a score. This game already had seamless evaluation integrated through a dialogue between the player and the virtual characters [17]. By using this approach, the players could be provided with a score as we have done in this game (Fig. 3). Scoring could be used to create leader boards, which have been shown to increase the children's motivation in certain educational settings [22].

The authoring tool also allows providing the students with a different answer depending on whether the student was right or wrong. It allows for the story to fork in a different direction if an answer is not accurate as opposed to when the answer is accurate. This allows for an adaptive component which adapts the interactive digital storytelling and the educational content based on the player needs.

The authoring tool was used to create interactive digital storytelling by the researchers on the project and later on these stories were modified and translated by experts in the field of microbiology [2]. The authoring tool was used to create several interactive digital storytelling games [4] including the GHD Game that has used Edu-Interact to integrate assessment. The educational effectiveness of the game was presented in [21], and the usability of the game and player satisfaction with the integrated assessment in [17].

IV. DISCUSSION

Interactive Digital Storytelling is increasingly used in education. This allows control over the customization of the story; how, what and at what point the feedback of educational outcomes is provided to the users and how the assessment is performed. By extending the edugames4all authoring tool [2] we allowed the story authors to include student assessment to the learning outcomes as part of the scoring. By offering a reward to the students, storytelling can motivate students [23]. It has been shown that by using games with mathematics and leaderboards the users were more likely to do more exercises in order to achieve the maximum score [21]. This could help with increasing the players' motivation to learn more and with student retention, which could be problematic in educational games [24-26].

V. FUTURE WORK

In our future work, we want to assess how easy it is for teachers to use the proposed authoring tool. We will also investigate whether the introduction of the summative assessment would encourage teachers to use interactive digital storytelling more in the classroom. Finally, we will look into whether the scoring used in the game can be used as a proxy for the score received in the classroom, as long as the interactive digital storytelling covers the content taught in the classroom. There are also several other aspects of authoring that are missing from this work such as the usage of music, player agency, psychological factors (e.g. emotions) and these will be considered in the future work.

VI. CONCLUSION

This paper presented Edu-Interact, an authoring tool which allows the creation of interactive digital storytelling. The games could include adaptive features that change not only through the user interaction with the play but also through the user knowledge. It also allows assigning different weights to the knowledge accumulated by the players. This could be used to provide a score that could be used either to provide extrinsic motivation for the user or to provide summative assessment for the teachers.

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