Workshop Proceedings of the 11th International Conference on Intelligent Environments
D. Preuveneers (Ed.)

An Expert Review of REVERIE and its potential for game-based learning

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Abstract. REVERIE (REal and Virtual Engagement in Realistic Immersive Environments) is a research project with the aim to build a safe, collaborative, online environment which brings together realistic inter-personal communication and interaction. The REVERIE platform integrates cutting-edge technologies and tools, such as social networking services, spatial audio adaptation techniques, tools for creating personalized lookalike avatars, and artificial intelligence (A.I) detection features of the user's affective state into two distinct use cases. The first shows how REVERIE can be used in educational environments with an emphasis on social networking and learning. The second aims to emulate the look and feel of real physical presence and interaction for entertainment and collaborative purposes. This paper presents an expert evaluation of the first use case by potential users of REVERIE (teachers and students). Finally, the potential of REVERIE for game-based learning is discussed followed by an overview of the actionable recommendations that emerged as a result of the expert review.

Keywords. avatars, virtual human interaction, 3D audio and visual content, expert evaluation, game-based learning

1. Introduction

Social media is gradually finding its way into the educational sector. According to an annual survey done by Pearson Learning Solutions [1] the use of social media in classrooms increased by 21.3 % in 2013 compared to 2012. The most used social media methods are blogs and wikis but other platforms such as Facebook and Twitter increased in use from 2012 to 2013. Most educators agree that the interactive nature of e-learning and mobile technologies increase the teacher and student communication. But to date, learning on social media and other e-learning platforms has been a poor substitute for classroom learning. To address this issue a number of academic institutions have introduced *blended* [2] and *flipped* [3] learning strategies. In the former classroom strategy, students learn through a "blended" model of in-person (with a teacher) and technology-based instruction with some student control over time, place path and/or pace of the curriculum. For example, in a blended learning course, students might have face-to-face instruction by a teacher in a traditional classroom setting, while

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also independently engage with online materials of the course, created by the same instructor outside of the classroom. In a flipped classroom model, students gain the necessary knowledge before class, typically through the use of educational technology such as online videos, and during class time they explore that knowledge in greater depth through various methods including discussions, project-based learning and laboratory experiments guided by a teacher. In an effort to motivate and engage students in these new "hybrid" environments, instructors have recently started introducing game-based learning experiences as part of the learning process in the classroom as well as part of the online instructional materials. These serious games combine engaging gameplay with instruction designed to achieve specific educational or behavioural goals [4]. Class Craft for example [5], is an online role-playing video game that is been actively used in teaching a wide variety of subjects in schools. The game provides a gamification layer on top of any existing curriculum by teaching students personal and social skills in the classroom (e.g., the value of cooperation and hard work) and the idea that learning can be fun. Each student takes the role of a character (e.g., healer or warrior) and works to earn points and unlock special abilities. The teacher assumes the role of gameplay master and manages the gameplay experience in the classroom. Students can earn points to use in the game (e.g., to level up and gain powers) based on their behaviour in the class (e.g., by being positive and hard-working or answering a question correctly in the class). In the same way, disrupting class behaviour (e.g., showing up late to class or not turning in homework assignments) can lead to deduction of points. State-of-the-art learning content management systems (LCMS) such as ALICE [6], offer serious games as part of the online instructional material managed by the underlying platform. Instructors using the available platform tools can create unlimited training scenarios in the area of civil defence and in particular, building evacuation for use in blended or flipped learning experiences. However, none of these learning approaches can effectively work for geographically separated students. To bring the benefits of real-classroom experiences online to those students there is a need for a framework that introduces full multimodal communication between learners and their teachers. REVERIE (REal and Virtual Engagement in Realistic Immersive Environments) is a communication framework designed to address the increasing demand for realistic interpersonal online communication. The platform integrates state-of-the-art technologies in areas such as, spatial sound processing, autonomous avatars, acquisition of 3D data and processing, networking and emotional engagement in virtual worlds. These are combined into two use cases of which the educational one, is the focus of this paper.

2. Immersive Learning in Social Environments

REVERIE's educational use case (UC1) has two scenarios. The first scenario is an assisted educational virtual excursion to the Brussels EU Parliament. It involves one teacher, one autonomous guide agent who has the role of a virtual guide and a group of students. Both the teacher and students are registered members of the TrueTube social educational network[2] that gives them automatic access to the REVERIE platform. The teacher creates a group on TrueTube, to invite the students he wants and gives them instructions on how to use the REVERIE platform. To access the virtual parliament,

[2] http://www.truetube.co.uk/

students and the teacher are given the choice to select a default virtual representation\avatar from REVERIE's standard library or to create a custom one using an avatar authoring tool (RAAT) [7]. The teacher chooses to access the parliament with a default avatar while the students with their own custom avatars impersonating their appearance. Avatars (standard or custom) can also reflect the participants' facial expressions, captured in real-time by the web camera. Once the teacher and students have entered the virtual scene (see Figure 1), the scenario starts with an autonomous tour guide agent guiding the students in an exploratory tour of major areas of the parliament. The teacher is in control when to start the tour. The agent asks the teacher if he's ready to start and the teacher can give positive reply with a head nod at his webcam or a "yes" vocal reply through his microphone. Destinations to the participants' semi-autonomous avatars are given automatically by REVERIE during a tour in order to follow the agent throughout the tour. Participants can choose to navigate away from the group, but always within the boundaries of the virtual scene. The participants' attention and emotional status is analyzed throughout the tour and the agent responds to those observations accordingly (e.g., by trying to get a student's attention if that was lost). The autonomous agent exhibits a range of pre-scripted body and facial behaviors (e.g., clapping, waving, happy and angry expressions) in synchrony with her speech. The tour ends with the agent asking participants to take a seat in the front row of the parliament and explaining the process of the debate. In particular, students have to present their views (with arguments for and/or against) on the topic of multiculturalism to their fellow students who can state their agreement or disagreement using REVERIE's voting feature. To get students into the context of the topic, the teacher s decides to share a relevant video with all of his students. The video streams in real-time over the Internet to all of the students' computers. Once the video finish playing the teacher decides which student should present first. The student walks to the lectern at the center of the parliament and enter the topic of the presentation on REVERIE's GUI (at the top of the screen). After the student has completed the presentation, the teacher can give the floor to the audience for questions and comments. Students may request to speak by raising their avatar's hand. Apart from the avatar's animation, the teacher's GUI menu is also updated to notify him that a student has requested to speak. The teacher may select to give the floor to the particular student by activating his/her audio, but he may also choose to ignore the request (e.g., if the student has a disrupting behavior).

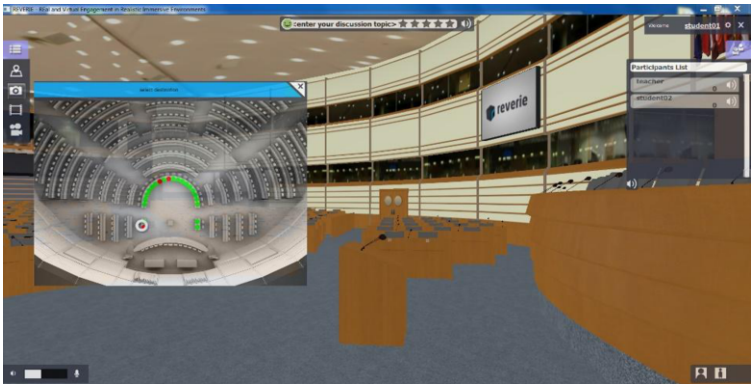

Figure 1. A screenshot of the virtual EU Parliament in REVERIE.

Once all questions/comments are completed, students are requested to vote about the presentation on a 5 point-scale (with 1 being the lowest and 5 the highest). Students can also take snapshots and record a session on video to share on social networking web sites such as Facebook and Twitter. After all students have presented their views on the topic, the session ends with the teacher announcing the student with the highest vote count as the winner of the debate. Participants may then choose to play a different scenario or to exit the REVERIE platform. When exiting this scenario the group is automatically led to the exit door of the parliament where the agent runs a goodbye animation.

The second educational scenario is a virtual gallery with 3D reconstructed objects (see Figure 2) representing various historical eras. This scenario is a virtual gallery competition, where students have to search the virtual gallery, find objects assigned by the teacher and talk about them with the aim to convince their fellow students and teacher about the importance of the object. Specifically, once they are all in the virtual gallery, the teacher shares with each student a card containing information and a number of questions to consider in their presentations (e.g., when was the object made, why is it important?) about a random object in the gallery. The student has to walk around the world, closely observe the exhibits in order to find the object. Once the student finds the object, s/he needs to guide the rest of the group by providing navigation instructions using the spatial audio features around the object so the presentation can begin. Once the student is ready, s/he must enter the name of the object on the REVERIE GUI and start presenting.

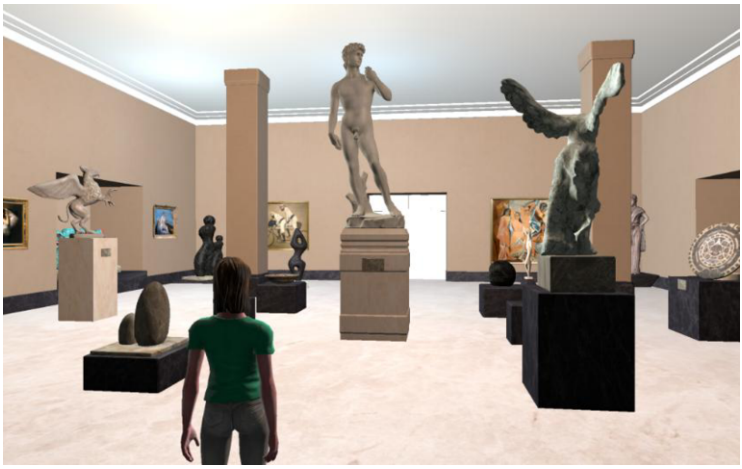

Figure2. A screenshot of the virtual gallery in REVERIE.

Once the presentation is completed, the rest of the group votes on the quality of the presentation using a 5 point scale (with 1 being the lowest and 5 the highest mark). When all students have presented their object and voted on each other, the teacher announces the student with the highest total votes as the winner of the competition.

3. An expert evaluation of the immersive learning scenarios

A formal usability inspection was done of the two immersive learning scenarios using the Cognitive Walkthrough method [8]. The Cognitive Walkthrough (CW) uses an explicitly detailed procedure to simulate a user's problem-solving steps in tasks they can perform with the system. The process starts with an analysis of the required tasks, where the experimenter specifies a sequence of actions required by the user to complete the task, and the system response(s) to those actions. The experts' walk-through the steps, asking themselves the following questions: (a) Will the user realistically trying to do this action? (b) Is the control of the action visible? (c) Is there a strong link between the control and action? (d) Is the feedback given by the system appropriate? Below the input to the cognitive walkthrough for the educational use case is defined:

3.1. Who are the experts who reviewed the immersive learning scenarios

In total, nine experts reviewed the educational scenarios of REVERIE's UC1. A pilot evaluation was conducted with three experts to test the design our approach. Experts completed the same tasks as the rest of the experts, but spent more time in the lab than other users. They provided valuable feedback on the process followed and identified a number of technical problems with the prototype that were corrected in the lab. Feedback from this activity and guidelines found in the literature [9], led to the simplification of the standardized cognitive procedure that was eventually used in the evaluation of both scenarios. The first group of the main study included three experts (see expert 1 to expert 3 in Table 1) with a variety of technical and media backgrounds. They were asked to review:

- Tasks related to the integration of the REVERIE platform with Facebook, TrueTube and REVERIE social network to ensure maximum usability
- The RAAT tool, to ensure its usability. RAAT is REVERIE's integrated tool that allows users to fully customize their avatars before accessing any of REVERIE's virtual worlds. The version of the tool that was reviewed by the experts is available online (see [7]).
- The virtual 3D gallery competition scenario of UC1.

Table 1. The group of experts who reviewed the two immersive learning scenarios

Experts	Profile	Role	UC1 Scenario
Expert 1	Media Producer	Teacher	Scenario 1
Expert 2	Media Producer	Student	Scenario 1
Expert 3	Media Producer	Student	Scenario 1
Expert 4	Teacher	Teacher	Scenario 2
Expert 5	Office Assistant	Student	Scenario 2
Expert 6	Marketing/Research assistant	Student	Scenario 2

Each expert was asked to role play one of REVERIE's typical users based on a given persona and within the context of a given scenario of use. The personas illustrate

typical REVERIE users according to the requirements of each use case. The personas that were used in the educational scenarios illustrate the profile of a teacher and two students and were used by both groups of experts. The scenario for UC1 provided a typical use case situation for the personas and it was done to contextualize the experience for the experts. Then, experts had to walk-through the action sequences for each task from the perspective of each user and within the context of the specific scenario.

The second group of experts (see expert 4 to expert 6 in Table 1) reviewed the *"Interactive Guided Tour and Debate in EU Parliament"* scenario. The set-up of this Cognitive Walkthrough was the same as above. Three experts role played the same personas (i.e., one teacher and two students), reviewed the tasks involved in this scenario. As the tasks involved in this use case scenario were more complex and longer to complete than those completed by the previous group, the second group of experts did not review any other activities. The analysis resulted into 48 actionable recommendations for both scenarios of REVERIE's UC1. From those we chose only 15 recommendations based on their importance for the successful completion of the project [10] and with a high educational and/or gamification impact value. This value signifies the potential impact (high, medium or low) of a recommendation when implemented to the educational and gamification value of REVERIE UC1 scenarios. An in-depth explanation of each recommendation can be found in [10] using the assigned unique identification numbers.

1. User Authentication Services – Social Networking Integration

Requirements	ID	Potential Education Impact	Potential Gamification Impact
Automatically import all student groups from TrueTube and allow Teachers to choose the groups (and students) they want to invite on the platform.	3	HIGH	LOW
Integrate a social media sharing functionality within REVERIE.	24	MEDIUM	HIGH
On the REVERIE desktop platform ensure proper feedback is provided as a result of the user's login action.	6	HIGH	LOW
During account validation (Facebook or TrueTube) redirect users to the relevant web sites without the need to enter any credentials.	2	LOW	LOW
Ensure clarity, consistency and relevance of the user's account menu bar on the REVERIE portal, for to each type of user (student/teacher).	4	MEDIUM	LOW

2. General GUI Functionality

Requirements	ID	Potential Education Impact	Potential Gamification Impact
Provide detailed information for each scenario to aid the user's selection.	7	HIGH	MEDIUM
Every time an asset loads in the RAAT tool a loading text should appear in the middle of the screen.	9	MEDIUM	MEDIUM
Provide clear instructions how users can access a selected scenario.	11	HIGH	LOW
Provide a toolbar button for users to change their point of view (POV).	18	MEDIUM	HIGH

3. Avatars

Requirements	ID	Potential Education Impact	Potential Gamification Impact
All users (teachers and students) should be able to see the output of the real-time avatar facial pappeting on demand.	34	MEDIUM	HIGH
Basic information about the participants to the virtual interaction should be provided by default, giving the possibility to hide it.	57	LOW	HIGH

4. 3D Virtual Scene Characteristics and Functionality

Requirements	ID	Potential Education Impact	Potential Gamification Impact
Revisit the design of the autonomous tour guide agent to improve its educational impact.	17	HIGH	HIGH
Provide a bird-eye view for teachers to be able to see where their students are in the parliament.	19	HIGH	MEDIUM

5. User-user and user-agent specific virtual interaction features

Requirements	ID	Potential Education Impact	Potential Gamification Impact
Teachers should be able to moderate a rating before it becomes publicly accessible and recorded on REVERIE.	23	HIGH	MEDIUM
Give teachers the option to speak to students in private.	22	HIGH	LOW

It is evident from the above, that REVERIE already has several gamification features with educational value that can be improved. The recommendation with ID 17 for example, *"Revisit the design of the autonomous tour guide agent to improve its educational impact"* clearly shows that a number of simple design interventions to the virtual tour guide agent would have a high impact on both the educational and gamification impact of the platform.

4. Conclusions and Future Work

In this paper, we presented REVERIE's educational use case (UC1). This use case is consisted of two educational scenarios: (a) an Interactive Tour and Debate in the Parliament and (b) a virtual gallery competition. It shows how the REVERIE framework can be used in educational environments with an emphasis on social networking and learning. This use case integrates social networking services, tools for creating personalised lookalike avatars, spatial audio techniques and Artificial Intelligence (A.I) on a single platform. The use case was evaluated by experts in a cognitive walkthrough. The results of the analysis were used to develop a series of

actionable recommendations for future improvements to UC1 prototypes. The recommendations that were deemed as important are presented above clustered into five categories which also identify the directions for future development of REVERIE's UC1 prototypes: (1) User authentication – Social networking integration, (2) General GUI menu functionality, (3) Avatar Virtual Representation, (4) 3D virtual scene characteristics and functionality, and (5) user-to-user and user-to-agent specific virtual interaction features. Two patterns emerge from the evaluation activities reported in this paper. First, that REVERIE UC1 has a good potential to support game-based learning but more work should be done to maximise the impact of its gamification and educational features. Second, REVERIE's UC1 lacks several of the standard game mechanics found in video games and gamified applications (e.g., PBLs (points, badges, and leaderboards)). Therefore, a potential avenue for future research is to analyse REVERIE based on the Octalysis gamification framework [11] and add relevant game mechanics as necessary to maximize the educational and gamification value of the platform.

Acknowledgements

The research that led to this paper was supported in part by the European Commission under the Contract FP7-ICT-287723 REVERIE.

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