Using a 3D Virtual World to Teach Children about Flood and Fire Safety

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Abstract

This paper presents a 3D virtual world environment that is created to facilitate teaching children about natural hazards and in particular the ones related to floods and fires. Based on the results from an extensive study in which 3,138 teachers and 39,607 students participated, a number of scenarios simulating flood and fire situations is developed in order to expose children to these hazards but in a safe manner (based on simulated experiences and not on real life experiences). The entire work is based on the ‘learning by doing’ concept and as result it offers an immersive environment that presents attractive and educating scenarios to students, allowing them to participate and learn about the relative hazards. Furthermore, this environment could serve as a powerful teaching tool for the teachers willing to include non-traditional methods in their practice.

Keywords: e-Learning, Game-based Learning, Virtual Learning Environments

1. Introduction

Over the past several decades, naturally occurring disasters have increased in frequency and number, due to rapid population growth, rise in sea level, global climate change and increasing environmental degradation. In Europe, during the period 1980-2008, around 122,000 people were killed and 33 million negatively affected because of natural disasters (Disaster statistics in Europe, 2016). The social and economic impacts of natural hazards may severely hinder growth and development. Economic losses from natural disasters have also tripled in the last thirty years. Natural phenomena, such as earthquakes, floods and fires have always been a part of nature and history, but natural hazards do not need to become disasters. Natural hazard awareness and education on Disaster Risk Reduction (DRR) are the keys for effective catastrophic risk management strategies.

Therefore there is a specific need to promote a culture of safety in Europe against natural calamities. This can only be achieved by cultivating a holistic disaster management approach, which requires a prior knowledge an emphasis on disaster risk reduction tools and strategies. According to the Hyogo Framework for Action (2016), there is a major need to “... use knowledge, innovation and education to build a culture of safety and resilience at all levels”. As children are one of the most vulnerable groups, we must teach them from the early age about the risks, so they will have a better chance to save their lives during disasters. Children

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are the future architects, mayors, doctors, and parents of the world of tomorrow and if they know what to do to reduce the impacts of disasters, they will create a safer world. What is learned in childhood becomes incorporated into collective knowledge and carried into future decision-making (Hohmann & Weikart, 2008).

Based on these facts, a project named FORETELL (Flood and Fire safety awareness in virtual world) is launched aiming to develop an on-line 3D virtual world learning environment, which will simulate specific incidents of environmental hazards, such as floods and fires and prepare children to cope with these phenomena in a safe manner, through experiential learning activities (e.g. games). The first results of this project are presented in this paper. The rest of the paper is structured as follows: After a short literature review and presentation of the motivation of this work (section 2), the methods used to collect user requirements and investigate what children need is presented at section 3 as well as the main findings. Section 4 presents the system components, the game narrative and the early developments in the 3D virtual world learning environment and provides insight on the features of the environment, while the main conclusions of this paper are presented in section 5 and future work is discussed.

2. Literature Review and Motivation

Experiential learning principles support pedagogies such as “learning by doing” (Ying, 1967), which engage students in critical thinking, problem solving and decision making. Children should learn at an early age to respect the environment and understand development consequences that last for a lifetime. In this context, this work promotes the fundamental ideas of active participation and citizenship of young people, by helping children realize that they are also an important social actor. Article 12 of the UNCRC (United Nations Convention on the Rights of the Child) establishes the children’s right of active engagement, which has been broadly conceptualized as ‘participation’ and requires information-sharing and dialogue between children and adults, based on mutual respect (Lansdown, 2011).

Having in mind that, as well as the fact that ICT technologies are important driving factor for the developments in education, this work aims additionally to empower the profile of the teaching professions in order to adopt novel approaches in teaching. Many teachers find the idea of adding scenario-based learning to their teaching methods interesting, as it makes classroom experiences more appealing and highly engaging. Generally, scenario-based learning immerses the learners in real life or situational simulations or learning experiences that allow them to gather skills or information that they will recall for future use. This work, therefore, exploits innovative technology-based learning strategies and pedagogical frameworks which are in compliance with the 2013 EU initiative: “Opening Up Education: Innovative teaching and learning for all through new technologies and open educational resources” (European Commission, 2013). Through these innovative methods, the ultimate aim of this work is to provide children and public with awareness and knowledge and help them develop essential skills necessary to cope with natural hazards.

According to educational theorist, Kolb D., “Learning is the process whereby knowledge is created through the transformation of experience” (Kolb, 1984, p. 38). According to Beard & Wilson (2002), experiential learning engages students in critical thinking, problem solving and decision making. So, children should learn at an early age to respect the environment and understand development consequences and building habits that last a lifetime. The emergence of ICT, has added another aspect that influences to a significant extent the way both educators (teachers) and children view the learning process. In the context of the work
presented in this paper, ICT technologies are used to enrich children’s learning and prepare
them against future disasters, through collaboration and critical thinking as well as learning
by doing. Teachers will be empowered to adopt novel approaches in teaching.

Based on the aforementioned discussion, the objectives of this work are:

• To educate children in an innovative, highly immersive environment and in an
engaging manner to achieve proper knowledge, skills and attitudes on how to behave
in emergency situations, especially natural disaster related crises.
• To encourage children to help protect their community from natural hazards, through
school activities, so that they can raise public awareness about risks and motivate
others to take protective measures; help them realize that they are a significant part of
the process, for their own safety and sense of empowerment.
• To promote a culture of safety, so in this way, a deep and long-lasting “culture of
prevention” will be established, both through action and new attitudes.
• To create a learning environment that will be attractive to young learners.
• To relate experiential learning to education pioneering a more efficient future
education.
• To strengthen the profile of the teaching professions through supporting teachers’
work to deliver high quality teaching.

3. Method and Findings

During a short period of two months (April and May of 2016) an online survey has been
conducted among students and teachers from the four countries participating in the
FORETELL project, namely at Bulgaria, Greece, Italy and Malta. The aim of this survey was
to determine the level of knowledge and awareness on the safe behavior in case of fires and
floods, as well as the attitude of teachers and students towards the use of 3D simulation
games in the learning process.

A total of 42,745 persons took part in the survey, 3,138 teachers and 39,607 students. The
method included consent-of-use and demographics of the participants and three distinct tools:

A. A short (9 closed 5-point-scale questions) survey to collect opinions from teachers
about their experience in similar environments, their attitude towards using such an
environment in classroom and the appropriateness of the subject in matter (flood and
fire safety).

B. A short (4 closed 5-point-scale questions) survey to collect opinions from children
about their feelings towards such a 3D simulation.

C. A two-part questionnaire (15 multiple choice questions and a short priority list)
aiming for the identification of current level of knowledge and awareness of safe
behavior in case of fires and floods.

The questions on A survey were:

1. Have you ever used 3D simulations in your teaching?
2. Rate from 1 to 5 whether teaching through 3D simulation games is a positive or
negative experience.
3. Do you think that 3D simulation games will increase understanding of protection from
fire and floods?
4. Do you think that 3D simulation games facilitate teaching and learning about
protection from fire and floods?
5. Do you think 3D simulation game can be applied to motivate and retain the activity of students during the learning process?
6. Will such games facilitate acquisition of knowledge and understanding? Will they serve to strengthen learning habits and skills?
7. 3D simulation games are excellent tools for assessing knowledge and skills regarding the topics for disaster protection.
8. Learning through playing increases in short terms knowledge and skills of trainees?
9. On the scale from 1 to 5 how would you rate the statement that games facilitate learning through fun and increase learning by providing positive feedback?

And for the B survey:

1. 3D simulation games increase my interest towards the studied material.
2. I am more interested in playing computer games based on real situations.
3. Through 3D simulation games I can acquire new information and strengthen my existing knowledge.
4. I will play 3D simulation games at home too.

The scales used were color coded (green to positive, yellow for undecided and red for negative) 5-point scale, like the example (with the exception of the yes/no question 1):

*Strongly Agree – Agree – Undecided – Disagree – Strongly Disagree*

The survey had showed that teachers in all countries had used 3D simulation in their teaching in a large percentage (76.7%) and that they believe that such environments are quite useful. The results are summarized at table 1 and figure 1, where the positive attitude of teachers is more than apparent. The table 1 shows the percentiles of the responses in each question (where 5 is the most positive response and 1 the most negative), while figure 1 illustrates the number of responses for each question.

**Table 1. Results from teachers survey in percentiles**

<table>
<thead>
<tr>
<th>Question</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>76.7%</td>
<td>23.3%</td>
<td></td>
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<tr>
<td>Question 2</td>
<td>41.6%</td>
<td>14.6%</td>
<td>18.3%</td>
<td>12.6%</td>
<td>13.0%</td>
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<td>Question 3</td>
<td>46.3%</td>
<td>38.1%</td>
<td>13.1%</td>
<td>1.3%</td>
<td>1.2%</td>
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<tr>
<td>Question 4</td>
<td>48.6%</td>
<td>37.0%</td>
<td>10.4%</td>
<td>1.5%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Question 5</td>
<td>54.8%</td>
<td>32.0%</td>
<td>8.8%</td>
<td>2.7%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Question 6</td>
<td>53.6%</td>
<td>32.2%</td>
<td>9.8%</td>
<td>2.9%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Question 7</td>
<td>51.2%</td>
<td>30.4%</td>
<td>14.1%</td>
<td>1.9%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Question 8</td>
<td>51.3%</td>
<td>33.0%</td>
<td>10.7%</td>
<td>1.9%</td>
<td>3.1%</td>
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<tr>
<td>Question 9</td>
<td>38.2%</td>
<td>18.0%</td>
<td>16.9%</td>
<td>14.0%</td>
<td>12.9%</td>
</tr>
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Figure 1. Teacher’s opinions towards using 3D environments for teaching

Even more promising than the teachers’ survey results, were the results from the children that showed that children are highly in favor of such an environment, as presented at figure 2, which illustrates the total responses for each question.

Figure 2. Students’ opinions towards using 3D environments for learning about flood and fire

Finally, the results from the survey C, showed that only around 69% of the students are able to pass a relatively simple test related to their actions in case of such emergency. A sample of some of such questions is presented at table 2.
Table 2. Sample questions from survey C

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<table>
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<tbody>
<tr>
<td>4. In case the road is flooded, we should:</td>
<td></td>
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<tr>
<td>a) cross it carefully</td>
<td>b) look for an alternative route</td>
</tr>
<tr>
<td>8. Water is used to extinguish:</td>
<td></td>
</tr>
<tr>
<td>a) burning electric appliances</td>
<td>b) burning petrol and oil</td>
</tr>
<tr>
<td>13. In case part of your clothes are burning, you should:</td>
<td></td>
</tr>
<tr>
<td>a) stop, drop to the ground and roll into a ball to protect your face</td>
<td>b) stop, drop your clothes on the floor and run to the shower</td>
</tr>
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</table>

The fact that 69% of the children responded correctly to the questions (regardless of their age), means that children are already familiar with such topics and have already passed some training on the risks in case of floods and fires, the causes for their emergence, prevention measures and correct actions during emergency situations, but there is still a need to develop such an environment to teach them about these hazards through simulation.

4. The FORETELL 3D Virtual World Learning Environment

The development of the FORETELL 3D Virtual World Learning Environment (VWLE) is completely based on free and open-source software tools. The platform of choice is the Opensimulator\(^1\), an open-source client-server architecture which can host massive multiplayer online 3D virtual environments which can be highly interactive and immersive, very similar to those of the proprietary Second Life\(^2\) platform. The Opensimulator fulfills the project's prerequisites for free usage, building and editing, hosting on private servers, catchy graphics and customizable human-like avatars, embedded 3D editor and scripting language to add interactivity, in-world communication channels, expandability, compatibility with the MOODLE Learning Management System\(^3\) and a large supportive community of developers and educators.

Along with the Opensimulator platform, a MOODLE web site has been implemented in order to host the educational multimedia material on floods and fire safety which will be produced during the project. The educational material will be released in English, Greek, Bulgarian and Italian and will be freely available to the educators as additional material for their lessons. Part of this material will be integrated in the 3D VWLE as well, in order to enhance the learning procedure and/or support the game flow.

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1. www.opensimulator.org
2. www.secondlife.com
3. www.moodle.org
Based on the results of the user requirements survey, the following five core scenarios are designed and (some of them) implemented: 1) Fire at Home, 2) Flood at Home, 3) Fire in a Public Building, 4) Flood Outside, 5) Fire Outside. Each scenario consists of sub-scenarios which are small, self-contained situations that present the player with a problem to solve. In general, the sub-scenarios are tied together by a specific kind of danger that the player should be aware of, or by a specific solution. Each sub-scenario is a ‘lesson’ that the player needs to learn, all of which lead to a broader comprehension of the topic that is represented by the core scenario. Some of the scenario-based games are designed as single-player while others as multiplayer.

During the aforementioned five scenario-based games, the children are asked to learn about situations in the real world that they will rarely find themselves in. Therefore a narrative that encourages a sense of realistic make-believe is introduced for the game; The players are welcomed as ‘Trainee Operators’ and are told that the 3D virtual environment is a program that is used to train robots to deal with flood and fire situations, and that robots learn by observing the actions of the player.

On this assumption, the player logs into the 3D VWLE, chooses one of the five scenarios and teleports to the corresponding virtual setting. Each scenario briefly explains the situation that the player is currently in, providing hints about the kind of dangers they will need to look out for. From then on, the player is free to explore the virtual environment, interact with key objects placed in it, receive feedback from the environment and plan their actions in order to either prevent a danger or respond to an emergency situation properly. Their ability to deal with dangerous situations and their overall performance during the game is evaluated by the system and the players earn awards when they complete all tasks successfully.
The development of the 3D VWLE is currently work in progress but it will be made up of five individual virtual regions (figure 3) customized according to the flow and game mechanics of the five core scenarios. There is also an ‘Introductory Area’ (figure 4) which is the entry point of the VWLE. The ‘Introductory Area’ is mainly an area that introduces the players to the basic controls of the environment and explains to them how to start a scenario. It also provides places for avatar customization and familiarization with avatar movement and orientation. Moreover, it includes general tips and best practices on floods and fire safety, as well as access via teleporting to the five regions that host the core scenarios. The textual content of the 3D VWLE will be available in English, Greek, Bulgarian and Italian.

5. Conclusions and Future Work

This paper presented the need (proven by a large survey with over 40 thousand participants) for a 3D virtual world learning environment that is created to facilitate teaching children about floods and fires. The entire work is based on the ‘learning by doing’ concept and it offers an immersive environment suitable for children and their teachers. Future work includes to start using this environment with the participation of children and teachers and evaluate the results. Future plans also include enriching the environment with scenarios proposed by educators or emerged by student's feedback.

Acknowledgment

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