Exploratory and Collaborative Learning Scenarios in Virtual World using Unity-based Technology

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This paper focuses on learning tools developed for the integration in virtual learning worlds that enable instructors to create in-world scenarios more easily. The tools were implemented in consideration of several learning concepts on exploratory, collaborative and challenge-based approaches. It elaborates on the design and development of a virtual world project on two platforms, namely Unity and Open Wonderland which is based on an Egyptian learning world. Users explore the world to find, explore and discard information. Through the process of identification and elimination a story is formed. Users can share information and collaborate with other users in- world and the tasks are supported by tools embedded in the virtual world, such as Textchat, Itemboard and Chatbot. The virtual world in Unity has addressed some of the issues raised in Open Wonderland such as the graphics enhancements, level of interactivities and lessons learned from the first prototype.

Keywords: Games-based Learning, Challenge, Virtual Worlds, Exploratory, Collaboration

Background

There exist countless teaching methods based on various pedagogical concepts. Nonetheless, there are concepts to formulate teaching; for example, the declaration of a few core principles of how teaching can be designed by Strauss (2013). He showed that different amounts of information can be retained by students after a certain time, depending on the activity and teaching method used. This is influenced by factors such as the learning materials and activities, the age of the subjects, or the assessments used for learning. Strauss showed that active learning and completion of tasks when collaborating with one another correlate with increased retention rates. Johnson (1991) affirmed that learning activities that are designed with collaborative work is an effective way to engage students. It is well argued that active learning increased students' knowledge, understanding, and comprehension of the subject matter (Prince, 2004).

Current emphasis of learning approaches lies on technology enhanced learning (TEL), including learning management systems (LMS), personal learning environments (PLEs) and massive open online courses (MOOCs) (Taraghi, Ebner, & Schön, 2013). Computer-supported learning refers to connecting remote students as well as using technologies to improve face-to-face interactions (Balacheff, et al, 2009). It, moreover, allows students to be completely independent while highly connected with others synchronously and also able to communicate asynchronously at any time (Garrison, 2011). The interest and use of virtual worlds for educational purposes has increased in recent years (Berger, 2012; Pirker , 2013). A virtual world differs from traditional course management systems where it includes a three-dimensional graphical setting, the use of avatars to represent participants and the sense of presence with learners in the scene (Calongne, 2008).

Virtual Worlds

According to Kuznik (2009), virtual worlds are also known as immersive environments. According to the definition of OECD (2011, p. 184), virtual worlds are "*persistent virtual environments allowing large numbers of users, who are represented by avatars, to interact in real-time over a computer network such as the Internet"*. Corbit, Wofford and Kolodziej (2011, p. 159) define virtual worlds as "*online 3-D multi-user, avatar-based systems that support the creation of user-generated content"*. Bell (2008) takes into account several definitions that describe the basic characteristics of virtual worlds with a networked of computers and technology needed to create such worlds and the ideas of persistence and synchronous communication with people represented as avatars.

Virtual worlds have great potential for learning and teaching practices (Kuznik, 2009; Duncan, Miller, & Jiang, 2012). Berger (2012) stated that virtual worlds can be used as a tool for group-based learning and collaborative problem solving. Moschini's (2010) explained that the virtual worlds can be effectively used as a communication and social tool. Virtual worlds also offer opportunities for visualisation, simulation, enhanced social networks, and shared learning experiences. The success of educational scenarios in virtual worlds depends on effective learning design, delivery, and assessment (Moschini, 2010). Logging and recording of the user's activities can be built in for analytics. The assessed information can be analysed and used to support the users (Corbit, Wofford, & Kolodziej, 2011). The developed artefacts of learning materials can also be re-used and easily accessible to teachers (Corbit, Wofford and Kolodziej, 2011).

To ensure a stable virtual world learning environment, Calongne (2008) acknowledged that designers, instructors, and IT professionals are challenged to create stimulating content and to be able to deliver virtual worlds reliably. The user interface and navigation are important, as well as the graphics that are chosen to enhance the learning environment. Gigliotti (1995) confirmed that interface, content, perception, and performance are the key factors to create an aesthetic and motivational virtual world.

Immersive learning

A great advantage of virtual worlds over traditional learning environments is the increased perception of immersion (Wasko, Teigland, Leidner, & Jarvenpaa, 2011) and presence, which describes the users' feeling of being in the real setting (Gibson, 2010; Slater, 2009). Although the two concepts are closely related there are some differences, for instance Dalgarno and Lee (2010) define immersion as a measurable characteristic of the world, dependent on technical capabilities to render sensory stimuli, whereas they argue, presence is the subjective reaction of an individual to immersion. Hence, different people can experience a different level of presence but the property of immersion is the same. The level of immersion influences the acceptance of and increased motivation and commitment in a virtual world (Chen, Warden, Wen-Shung Tai, Chen, & Chao, 2011). The more immersed a user is, according to Reiners, Wood and Gregory (2014) the more the user may respond and adapt accordingly. The ability to focus in the world and the feeling of being there are important for successful engagement in virtual learning worlds (McDonald, et al., 2014).

Collaborative and social learning

Closely related to the feeling of presence is the individual perception of social presence (Kreijns, 2003), awareness (De Lucia, 2009; Gütl C. , 2011), or co-presence (Dalgarno & Lee, 2010) in a virtual world. All three terms refer to the feeling of "being there together with others". Collaborative learning refers to a group of students working together in small groups to achieve a common goal. The main focus is on student interaction as opposed to solitary student work (Prince, 2004). This feeling of belonging to a social group is supported by, firstly, the use of avatars as graphical representation of the user, secondly, by providing various communication tools, such as visual channel with text and voice chat (De Lucia, 2009; Gütl, 2011). In world, collaborative learning include starting and ending a conversation, responding to prompts, sharing information, asking for help, asking questions and listening (Herrmann, 2015). The active exchange of ideas, moreover, promotes critical thinking (Gokhale, 1995). The students can have varying levels of knowledge and experience and they are responsible not only for their own learning success but also for one another. Group forming and relationship building occur through active engagement among peers, either in a face-to-face or online environment.

Active, exploratory and problem-based learning

According to Prince's (2004), active learning requires students to engage in meaningful learning activities. The key factors of active learning are student activity and engagement in the learning process. Active learning refers to engaging students with different learning materials and methods, such as reading, listening, discussing concepts with peers or applying the concepts. The learning success lies within the students' responsibility (Bonwell & Eison, 1991). If students are not actively involved in the learning process they will most likely become disengaged and distracted (McDonald, et al., 2014). Bonwell (1991) suggests different ways of promoting active learning, such as using discussions, collaborative group learning or games. Collaborative virtual worlds follow the same line of thinking by actively engaging their participants in learning activities and providing numerous possibilities to collaborate and socialise (Bonwell & Eison, 1991). Moreover, they enable users to explore the world "hands-on" even if it would be too difficult or dangerous in real life (Kuznik, 2009). Thus, virtual worlds are ideally suited to explore a subject of interest. The exploratory learning concept urges learners to explore and experiment to find a path of learning that feels natural to the learner. Only then he or she can come to conclusions (Rieber, 2005). According to de Freitas (2008) virtual worlds can support many scenarios incorporating games or challenge-based learning where students can control their progress through exploratory learning experiences. Problem-based learning is an instructional method that introduces problems in the beginning to provide a motivation and context for the learning cycle (Prince, 2004). As the user is able to make choices on his or her own, and achieve personal learning goals within the environment, virtual worlds lead to greater motivation (De Lucia A. F., 2009; Gütl, 2011). In addition to active participation, game-based approaches can be used to increase the intrinsic motivation of a participant (Garris, Ahlers, & Driskell, 2002). According to Miller (n.d.) it is important to learn through a process of experimentation, trial and error, without fear of failure. Students can explore a scenario that they would not be able to in real life due to geographic, political or content-related boundaries.

McDonald et al. (2014) summarise several other learning theories under the terms constructivism, social constructivism, authentic learning and reflective thinking. Constructivism places the learner at the centre of learning and allows him/her to construct and develop the knowledge, whereas social constructivism also takes the collaborative nature of learning into account. Authentic learning and reflective thinking involve problem solving and consider the complexity of the real world, as well as promote group reflection and collaborative construction of learning (McDonald, et al., 2014). These approaches show related properties as active learning, collaborative learning and problem-based learning which are, well suited for education in virtual worlds, where learning in-world is immersive and socially oriented. McDonald et al. (2014, p. 163) summarises that *"when learning activities are appropriately designed, students assume an active role in learning by constructing, exploring, negotiating and reflecting on their learning within a virtual community of practice"*. These articulations of how theoretical frameworks work with virtual learning worlds were considered during the development of this project.

Related Work

There was a big hype about virtual worlds platforms from 2003 to 2008 (de Freitas, 2008) but interest has stagnated since then (OECD, 2011). The literature agrees that the interest in virtual worlds have decreased between 2010 and 2012 and as shown in the Trough of Disillusionment of Gartner's Hype Cycle (Steinert & Leifer, n.d.). There is, however, an increase in the use of virtual worlds as learning environments in recent years (Dawley & Dede, 2014; Duncan, Miller, & Jiang, 2012). For example, virtual worlds were used to facilitate group work as virtual class rooms; for various kinds of assessment or for bringing geographically dispersed students and educators together (McDonald, Gregory, Farley, Harlim, Sim, & & Newman, 2014). Another example is the work conducted by Ibanez et al. (2011) where situated and collaborative leaning were used in an immersion setting which resembled Madrid for foreign language learning. The 3D virtual environment is also used to teach physics (Pirker, 2013). Other showcases include the historic "Giza 3D" project from Harvard University which aims at combining Giza archives, with numerous data of the Giza pyramids near Cairo, with a realistic 3D visualisations of the site (Manuelian, 2013) or the Egyptian Oracle, a project using a 3D replica of an Egypt temple on screen and actors on and off screen (Jacobson, n.d.), or the Shrine Educational Experience that allows users to learn about the Israeli "Shrine of the Book" in a virtual world environment (Di Blas & Paolini, 2003).

Development of a virtual learning world

The project described in this paper is an extension of a previous prototype that was developed in Open Wonderland (OWL). The goal of this was to create virtual world environments for teachers and use the concept of exploratory and social learning in 3D virtual worlds (Tomes, 2015) to improve student learning.

Objectives

Included in this project is the requirement to develop a set of universally applicable learning tools that can be re-used in any virtual learning environment (VLE) to enhance the learning activities and tasks. It is intended for these tools to be applicable to various learning scenarios. Three main pedagogical objectives were determined for this learning game: (1) knowledge acquisition, (2) enhancement of the conceptual understanding, and (3) measurement of the learning progress. These objectives should be facilitated by the use of certain teaching methods implemented in the VLE, and in the case of this project, the following concepts were used: (1) collaborative learning, (2) exploratory learning, and (3) games-based and challenge-based learning. Several in-world learning modules and activities were implemented based on these pedagogical concepts.

The software Unity was used as the game engine. The decision to use Unity is based on the feedback received from the evaluation of Tomes' (2015) OWL learning environment. The evaluation in OWL revealed general approval of virtual worlds for learning purposes but a number of flaws in graphics, controls and interactivities were highlighted in the game. This led to the decision to adapt the learning environment from OWL and improve the game and learning experience in Unity.

The following sections will describe and compare the OWL and Unity game engines, and the new improved learning tools will be presented.

Selecting a virtual world platform

Although this project is an extension of the work of an earlier prototype, replicating the exact world was not possible given the different game engines. This was attributed to the fact that OWL and Unity offer different pre-installed or add-on tools that facilitate the implementation of key features.

OWL provides ready to use solutions for text chat, voice chat, different kinds of panels and menus (property panel, error panel, context menu), user list, sticky note, as well as, adaptable features, such as, a whiteboard and avatar creation that were used (Tomes, 2015). OWL is built for educational and business contexts to relay key messages, and features such as collaborative tools were limited. OWL has its own advantages such as the modular style that creates extensibility and the easy drag and drop functionality makes it easy to use for non-experienced computer users. There are other useful tools that OWL offers but were not used in the scope of the game development. These include the built-in high-fidelity immersive audio capability that can be used for playback of audio tracks or communication between users, as well as, the functionality of shared applications which allows shared editing of text documents and runs Linux applications, such as Firefox or Open Office, directly in-world (Tomes, 2015).

Unity, on the other hand, has a robust graphics engine platform that allows Unity to detect the best variant for the current video hardware. Unity also provides sharper 3D-objects. Unity can be used across various platform development that includes PC (Windows, Mac, Linux/ Steam OS), consoles (PlayStation, Xbox, Nintendo, Wii), mobile devices (iOS, Android, Windows Phone, Blackberry) and websites (Maratou & Michalis, 2014). Unity does not have built-in tools to support the achievement of this project's objectives, which was the reason why OWL was chosen in the first instance for Tomes' study (2015). However, Unity is an intuitive and has an easier to grasp game engine for beginners as compared to Unreal Engine 4 that requires programming C# and JavaScript coding skills (Masters, 2015). Unity also offers a huge asset repository with free 3D models with great graphics support for both visual and audio effect. Unity has efficient rendering and physics engine that included detailed documentation (Marsh, 2014).

The next section will briefly describe the modules and features of the game and how teaching and learning methods were integrated using Unity.

Story overview

The Egyptian learning world as shown in Figure 1 is based around a game area (see Figure 2) where Egyptian artefacts are located. These items have pieces of information attached that form a story. The first step for students is to explore the world and find the items (Figures 3 and 4) throughout the desert area and pyramids, and this constitutes the exploratory concept of the game. It was developed as a first-person game, which refers to the student's graphical perspective rendered from the viewpoint of the player character (as shown in Figure 3). This facilitates students' immersion into the game.

Figure 1: Egyptian Virtual World

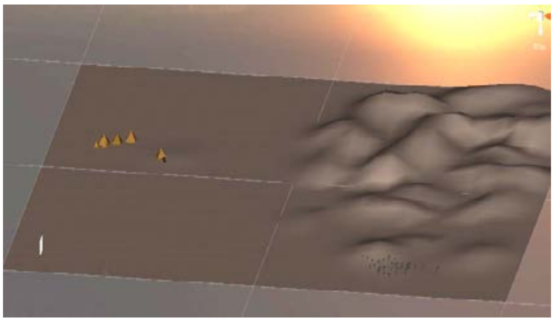

Figure 2: VW Game area

Figure 3: Character with item

Figure 4: Items with information

To make the learning more challenging, items were not just randomly placed in the world but some of the artefacts were hidden. Students were also assigned different roles which, on the one hand, gave hints about the whereabouts of the items but, on the other hand, restricted them from picking up certain items. This meant students had to gather all the information hidden with the items but depending on the role that they were assigned, they might not be able to collect all the items. Moreover, not all items in the world were part of the story; therefore, it is important to identify the artefacts through a process of investigation and elimination. These steps bring forth the important aspect of collaboration. Students had to work together or negotiate by exchanging of information and artefacts in order to master the learning tasks to finish the game. Sharing and discussing the hints provided in the role description may give them some clues with the artefact items and information that they are able to collect. The students must have the knowledge about the items that they require and are able to collect as this is an essential part of the game. The learning activities were designed for students to gain knowledge to unfold a story and be able to practise their communication and negotiation skills. The overall goal for students was to find or enquire all information necessary to understand the whole story. Revision of the acquired knowledge was assessed through a series of quiz. Thus, a vital aspect of solving a problem is for students to choose a path in order to overcome the challenge and be able to watch the story unfold slowly. The aim of the game was for students to find pieces of information and have the ability to link all the details to form a bigger picture.

Exploratory module: Storyline, hints, map

Games usually feature these four characteristics: they have a goal, rules, restrictions, and require acceptance of the rules by the players (Hastie, 2010). As pointed out by Hastie, the goal does not have to be winning but it relates more to a situation where players use their individual skills to reach a certain end point. Rules include the setup of the game and include definitions of what are required of and permitted to players, whereas the restrictions define what are not allowed. This definition can also be applied to this virtual learning world, as it has game-like characteristics.

In this learning world the skills of each player consist of the role-specific information and pick-up restrictions. The game aims to tell students a story about a certain topic. The goal, therefore, is to gather all information necessary to understand the whole storyline. For introduction purposes, there is a beginning statement at the start of the game that teases what the story is about. It, moreover, gives the player a general idea of what he/ she is supposed to do and where to find further information. This should be enough instruction to play the game but there are several helping tools during the game. A menu in the top left corner offers settings, which include user information - referring to the role description, the player's inventory, and buttons to access the chat, a map of the player's environment or hints of what to do (Figures 5 and 6).

Figure 5: Map and Hints of the VW Environment

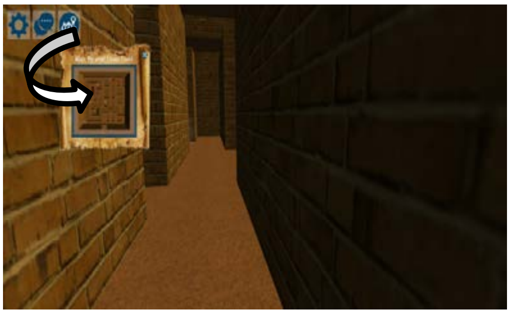

Figure 6: Map and Hints of inside of the Pyramid

Equipped with these skills and knowledge users can explore the desert area and a maze inside a pyramid to find the items. The Egyptian world gives students the opportunity to explore in a safe environment, as proposed by de Freitas (2008). The student can make choices of his/ her own (De Lucia, 2009; Gütl, 2011) and explore and experiment to find a path of learning that feels natural to the learner (Rieber, 2005).

Challenge-based modules: Items, inventory and roles

The main focus of the learning world lies on finding items that are hidden throughout the game environment. Attached to these items are pieces of information that form a part of the story which the game tries to tell. By providing role-dependent hints and pick-up restrictions, players have to work together and negotiate deals to gather all parts of the story. This way, students are engage in learning activities. Not exposing students to vast amounts of new information at once but letting them discover small parts supports the steady evolvement of the students' knowledge. This way of constructing, creating and developing their knowledge and make meaning for their own learning is seen as an important pedagogical theory to engage learners in-world (McDonald, Gregory, Farley, Harlim, Sim, & & Newman, 2014). The teacher's role as administrator of the game allows adding new items to the game, which can easily be done via an interface in the game. This facilitates easier creation and maintenance of the learning environment for teachers with little technical skills.

The inventory is a feature supporting the development of each student's story base. Each individual inventory lists all items of the game but highlights them according to the categories "picked-up already", "not yet picked-up" and "not able to pick-up". This distinction demonstrates students' progress in the game.

Roles were invented to create a distinction between players. The administrator can assign roles to the students. A role consists of some information, usually hints on how or where to find the items or how many there are. As each player starts with different knowledge, the game is highly dependent on the players' ability to collaborate, share and discuss the items. Hence, they are challenged to make a decision about working together and about how much information they are willing to share. It will force them to use their communication skills to get new information in exchange for their own knowledge. Roles, moreover, restrict players from picking up any item. This is indented as another incentive to collaborate with other students. The roles and restrictions are what dDe Freitas (2008, p. 4) calls "*potential for problem – or challenge-based learning"* which then leads to different kinds of collaboration as suggested by Bonwell (1991). Challenging students to collaborate to master the learning goals, moreover, *"promotes group reflection, multiple perspectives and collaborative construction of learning which can be enhanced by using reflection to assist students in framing and reframing the problems"*, according to McDonald et al. (2014, p. 163).

Collaborative modules: Chat, Chatbot, Itemboard

The structure of the game encourages collaboration between the players to a point that they can only finish the game if they have worked and communicated with one another. These interactions between the students can either take place in the Textchat (see Figure 7) or with help of the Itemboard (see Figure 8).

The Textchat is a tool that allows for multiple students to communicate over the server in real-time. It can be accessed via a button at the top left of the screen at any point during the game. All students currently in the game can discuss their findings and questions in one chat. Unity does not provide out-of-the-box chat-modules, therefore, the conversation tool had to be programmed.

The Itemboard is loosely based on the concept of a whiteboard. To prevent the exchange of off-topic information or an overcrowded board full of text, it is not possible to write random text messages on the board. Instead players can simply pin item information to the board in slots, arrange the information slots or delete them. This easy structure provides clarity and a quick overview of the information. The control is very straightforward – there are four slots with add-buttons which, when clicked, draw up a list of items in the player's inventory to choose from. Once an item is selected it is pinned to the Itemboard. Students can rearrange the information pieces by dragging an information box to another slot. Deleting information is done by clicking the delete-button found in the top right of the each information box. If the Itemboard is full, additional board with four spots can easily be added by clicking on the extend-button found on the right side of the board.

Another way to gather information, either of general or item-specific nature, is to use the Chatbot (see Figure 9). Again there are no preconfigured Chatbots offered in Unity's feature set which is why a very simple decision-tree Chatbot was implemented. It offers several possible questions to choose from and gives the answer and a choice of follow-up questions. A help menu is also provided to further guide the user (see Figure 10).

Figure 7: Textchat

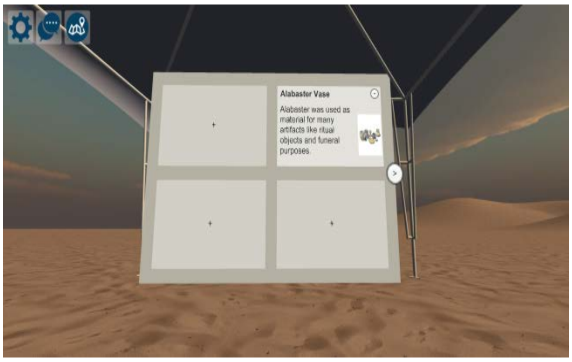

Figure 8: Itemboard

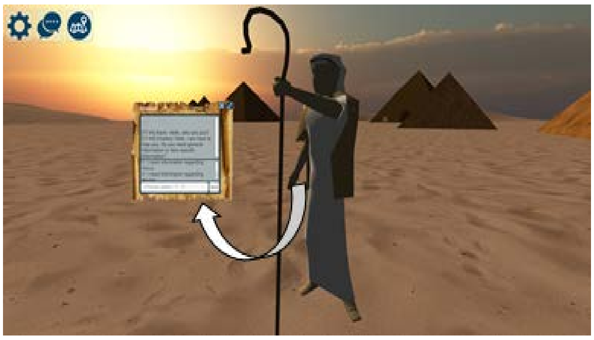

Figure 9: Chatbot

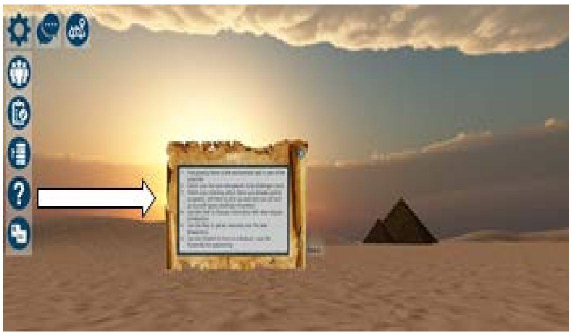

Figure 10: Help menu

These tools are particularly important to the learning game as *"learning is a social activity and learning cannot be uncoupled from the social and cultural context of the learner"* as McDonald et al. (2014, p. 163). Due to collaboration learners are exposed to multiple perspectives and opinions (McDonald, Gregory, Farley, Harlim, Sim, & & Newman, 2014).

Learning module: Quiz

Once students gathered all the information necessary to form the story they can take a quiz, revising all the facts learned. On passing the quiz, the game ends but further development might be use as a starting point for another level. Passing of the quiz gives the student a sense of achievement and the teacher can assess of the knowledge base of each student.

All quiz questions are saved in a XML-document, a software- and hardware-independent document format used for data storage.[1] Teachers can add questions either by editing the XML-file in a standard editor or during gameplay by using the quiz button in the settings menu. There is a pool of questions for each item. When a question is needed for a quiz, the question is randomly picked from a bank of questions.

Analytics Module: Logging

For analytic reasons all user interactions are documented into a log file. The information would include the duration of the game, collaboration tools chosen for communication, interaction with the items, and so on. This can be useful for analytics purposes to see how students gather their information, the means of communication they prefer, how long it takes them to find items and much more.

Improvements over the first prototype

Based on an evaluation of the OWL virtual world (first prototype) implemented by Tomes' (2015), the following issues were raised:

- Use of dated and old-fashioned graphics
- Poor controls and navigation (especially in the pyramid maze)
- Lack of interaction with picked up items
- Limited engagement and reward system
- Itemboard has no intuitive controls, limited space and is not working as expected

The re-design and development of the new world in Unity, moreover, made the following improvements concerning the collaborative tools and challenging nature of the game: In order to oblige to the third and fourth entry in the list, the challenge-based picking-up of items was introduced in order for students to revise the knowledge that they have gained as a result of completing the task of collecting a series of items. In order to pick up certain items and access new information, the players had to answer questions about an item. Thereby, students are forced to learn about the item that they have collected. They also have to consider and figure out if the items collected are part of the story, as not all items in the game area are relevant to the story. Given the negative feedback of the itemboard and the lack of space, this feature was completely revised. An evaluation of the adaptations made to the tool and the improved learning environment in Unity has yet to be done. A comparison between OWL and Unity as game-platforms is useful along with the lessons learned for the implementation of virtual learning worlds.

Conclusion

The virtual worlds described in this paper provided an example of how immersive learning and activity, challenge or game-based learning can be developed. These tools offer many advantages compared to conventional teaching techniques, such as exploring an environment regardless of geographic or content-related constraints, collaborating with people from around the world and offering a more immersive way of learning than ever before. The importance of adapting to new learning technologies and tools is recognised by educational researchers, practitioners, and software designers.

The goal of the project was to revise and redesign educational activities and processes in an immersive, virtual learning environment that incorporates the implementation of a set of learning tools in Unity. The objectives of using the virtual world as an immersive platform is to (1) acquire knowledge (2) enhance the conceptual understanding, (3) assess student learning. In the Egyptian environment, this is done through a series of game-like elements with challenges for students to collect items and their information, assembling the story and gaining an understanding of the subject. The learning was assessed by taking a quiz at the end of the game. The objectives were facilitated by the use collaborative learning, exploratory learning, and challenge-based or game-based learning.

1 http://www.w3schools.com/xml/ 29-06-2015

The collection of items in the Egyptian game area emphasized the exploratory nature of the game, while the roles, restrictions and pick-up questions presented challenges for students.

As discussed, several learning concepts and skills such as exploratory, collaborative, negotiation, problem solving, and decision making have been integrated in this world. Through the process of identification, collaboration, decision making and elimination, users are able to use the collected information to form a story. This design enables each user to learn at his or her own pace and ability. On the other hand, users can also collaborate and seek assistance in-world with the use of Textchat, Itemboard and Chatbot.

This virtual world design can be used to exhibit scenarios as students are actually able to explore the environment they are learning about instead of just reading or hearing about it passively. The Unity virtual world will be tested by students in Graz University of Technology and an evaluation of the environment will be available following the trial.

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References

Balacheff, N., Ludvigsen, S., De Jong, T., Lazonder, A., & Barnes, S. (2009). State of the art in TEL-research. *Technology-Enhanced Learning: Principles and Products.* Springer Science & Business Media.

Beer, M., Fasli, M., & Richards, D. (2011). *Multi-Agent Systems for Education and Interactive Entertainment: Design, Use and Experience.* New York: Information Science Reference (IGI Global).

Bell, M. (2008). Toward a Definition of "Virtual Worlds". *Journal of Virual Worlds Research: Past, Present and Future , 1* (1), 2-5.

Berger, S. (2012). *Virtual 3d world for physics experiments in higher education.* Masterthesis. Graz University of Technology.

Bonwell, C., & Eison, J. (1991). *Active learning: creating excitement in the classroom. aehe-eric higher education report no. 1.* ERIC Clearinghouse on Higher Education, The George Washington University.

Calongne, C. M. (2008). Educational Frontiers: Learning in a Virtual World. *EDUCAUSE Review , 43* (5), 36-48.

Chen, J. F., Warden, C. A., Wen-Shung Tai, D., Chen, F.-S., & Chao, C.-Y. (2011). Level of abstraction and feelings of presence in virtual space: business englishnegotiation in open wonderland. *57* (3), 2126-2134.

Corbit, M., Wofford, J., & Kolodziej, S. (2011). Learning in Virtual Worlds - Assessment Challenges and Opportunities. In M. W. Corbit, *Serious Educational Game Assessment* (pp. 159-174). SensePublishers.

Dalgarno, & Lee. (2010). What are the learning affordances of 3-d virtual environments? *British Journal of Educational Technology , 41* (1), 10-32.

Dawley, L., & Dede, C. (2014). Situated Learning in Virtual Worlds and Immersive Simulations. In M. D. J. Michael Spector, *Handbook of Research on Educational Communications and Technology* (pp. 723-734). Springer.

De Freitas, S. (2008). Serious virtual worlds. *A scoping guide. JISC e-Learning Programme, The Joint Information Systems Committee (JISC)* .

De Lucia, A. F. (2009). Development and evaluation of a virtual campus on second life: the case of seconddmi. *Computers & Education , 52* (1), 220-233.

De Lucia, A., Francese, R., Passero, I., & Tortora, G. (2009). Development and evaluation of a virtual campus on Second Life: The case of SecondDMI. *Computers & Education , 52* (1), 220–233.

Di Blas, N., & Paolini, P. (2003). *Museums and the Web 2003.* Retrieved from The see experience: edutainment in 3d virtual worlds.: http://www.archimuse.com/mw2003/papers/diblas/diblas.html

Duncan, I., Miller, A., & Jiang, S. (2012). A taxonomy of virtual worlds usage in education. *British Journal of Educational Technology , 43* (6), 949-964.

Gütl, C. (2011). The Support of Virtual 3d Worlds for Enhancing Collaboration in Learning Settings. In F. P. Pozzi, *Techniques for Fostering Collaboration in Online Learning Communities: Theoretical and Practical Perspectives.* (pp. 278–299). IGI Global, Hershey.
Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: a research and practice model. *Simulation & Gaming , 33* (4), 441-467.
Garrison, D. R. (2011). *E-learning in the 21st century: a framework for research and practice.* (Second ed.). London: Routledge/ Taylor & Francis.
Gibson, D. (2010). Living Virtually: Researching New Worlds. *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS) , 2* (1), 59-61.
Gigliotti, C. (1995). Aesthetics of a Virtual World. *Leonardo , 28* (4), 289-295.
Gokhale, A. (1995). Collaborative Learning Enhances Critical Thinking. *Journal on Technology Education , 7* (1), pp. 22-30.
Gregory, S., Scutter, S., Jacka, L., McDonald, M., Farley, H., & Newman, C. (2015). Barriers and Enablers to the Use of Virtual Worlds in Higher Education: An Exploration of Educator Perceptions, Attitudes and Experiences. *Educational Technology & Society , 18* (1), 3-12.
Hastie, P. (2010). *humankinetics*. Retrieved from What Characteristics define a Game: http://www.humankinetics.com/excerpts/excerpts/what-characteristics-define-a-game
Herrmann, E. (2015). *The 4 C's of 21st century learning for ELLs: Collaboration*. Retrieved from http://exclusive.multibriefs.com/content/the-4-cs-of-21st-century-learning-for-ells-collaboration/education
Ibanez, M. B. (2011). Design and implementation of a 3d multi-user virtual world for language learning. *Educational Technology & Society , 14* (4), 2-10.
Jacobson, J. &. *The egyptian oracle; religious, recreating egyptian ceremony in mixed reality.* unpublished [online].
Johnson, D. W., Johnson, R. T., & Smith, K. A. (1991). *Active learning: cooperation in the college classroom.* Minnesota: Interaction Book Company.
Kreijns, K. K. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior* , 335-353.
Kuznik, L. (2009). Learning in Virtual Worlds. *US-China Education Review , 6 (9)*, 19-25.
Manuelian, P. D. (2013). Giza 3d: digital archaeology and scholarly access to the giza pyramids: the giza project at harvard university. *2013 digital heritage international congress (digitalheritage 2013).* IEEE.
Maratou, V., & Michalis, X. (2014). *V-ALERT - Virtual World for Awareness and Learning on Information Security. Report on 3D virtual worlds platforms and technologies.* Lifelong Learning Programme, European Commission.
Marsh, J. (2014). *Advantages of the Unity Game Engine – The Ultimate Tool for Game Development*. Retrieved from udemy: https://blog.udemy.com/unity-game-engine/
Masters, M. (2015). *digital-tutors*. Retrieved from Unity, Source 2, Unreal Engine 4, or CryENGINE - Which Game Engine Should I Choose?: http://blog.digitaltutors.com/unity-udk-cryengine-game-engine-choose/
McDonald, M., Gregory, S., Farley, H., Harlim, J., Sim, J., & & Newman, C. (2014). Coming of the third wave: a move toward best practice, user defined tools and mainstream integration for virtual worlds in education. In J. M.-K. B. Hegarty, *Rhetoric and Reality: Critical perspectives on educational technology.* (pp. 161–170). Proceedings ascilite Dunedin 2014.
McDonald, M., Gregory, S., Farley, H., Harlim, J., Sim, J., & & Newman, C. (2014). Coming of the third wave: a move toward best practice, user defined tools and mainstream integration for virtual worlds in education. In J. M.-K. B. Hegarty, *Rhetoric and Reality: Critical perspectives on educational technology.* (pp. 161–170). Proceedings ascilite Dunedin 2014.
Miller, K. (n.d.). *Game based learning at curtin*. Retrieved from http://aliawestbiblia.blogspot.com.au/2015/06/game-based-learning-at-curtin.html
Moschini, E. (2010). The second life researcher toolkit–an exploration of inworld tools, methods and approaches for researching educational projects in second life. In *Researching learning in virtual worlds* (pp. 31 -51). Springer.
OECD. (2011). Virtual worlds. immersive online platforms for collaboration, creativity and learning. *OECD Digital Economy Papers* , 184.
Pirker, J. (2013). *The Virtual TEAL World - An Interactive and Collaborative Virtual World Environment for Physics Education.* MIT, TU Graz.
Prince, M. (2004). Does active learning work? A Review of the Research. *Journal of Engineering Education , 3*, 223-231.

Reiners, T., Wood, L., & Gregory, S. (2014). Experimental study on consumer-technology supported authentic immersion in virtual environments for education and vocational training. In J. M.-K. B. Hegarty, *Rhetoric and Reality: Critical perspectives on educational technology.* (pp. 171–181). Proceedings ascilite Dunedin 2014.

Rieber, L. P. (2005). Multimedia learning in games, simulations, and microworlds. *The Cambridge handbook of multimedia learning* , 549-567.

Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *The Royal Society Publishing , 364* (1535), 3549-3557.

Steinert, M., & Leifer, L. Scrutinizing Gartner's hype cycle approach. In *Technology Management for Global Economic Growth (PICMET)* (pp. 1-13). 2010 Proceedings of PICMET'10. IEEE.

Strauss, V. (2013). *Why the 'learning pyramid' is wrong.* Retrieved from Washington Post: http://www.washingtonpost.com/blogs/answer-sheet/wp/2013/03/0

Taraghi, B., Ebner, M., & Schön, S. (2013). Systeme im einsatz. wbt, lms, eportfolio-systeme, ple und andere. In *L3t. lehrbuch für lernen und lehren mit technologien.*

Tomes, L. (2015). *Exploratory and Social Learning in 3D Virtual Worlds.* Graz University of Technology.

Wasko, M., Teigland, R., Leidner, D., & Jarvenpaa, S. (2011). Stepping into the internet: new ventures in virtual worlds. *MIS Quarterly , 35* (3), pp. 645-652.

Wilding, K., Chang, V., & Gütl, C. (2015). Exploratory and Collaborative Learning Scenarios in Virtual World using Unity-based Technology. In T. Reiners, B.R. von Konsky, D. Gibson, V. Chang, L. Irving, & K. Clarke (Eds.), *Globally connected, digitally enabled*. Proceedings ascilite 2015 in Perth (pp. FP:308-FP:318).

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