This is a preprint of the paper to be published at the 1st Global Conference on Learning and Technology (Global Learn Asia Pacific). The final version is available in AACE Digital Library http://www.editlib.org/p/34441.

Virtual Campus of NTNU as a place for 3D Educational Visualizations

Ekaterina Prasolova-Førland[1], Mikhail Fominykh[2], Theodor G. Wyeld[3]

[1, 2] Program for learning with ICT, Norwegian University of Science and Technology, Norway

[3]Screen and Media, Flinders University, Australia

ekaterip@idi.ntnu.no, mikhail.fominykh@svt.ntnu.no, twyeld@gmail.com

Abstract: This paper focuses on two case studies conducted in a Virtual Campus of Norwegian University of Science and Technology (NTNU). In these case studies the Virtual Campus acted as a venue for guest lectures and as a place for collaborative 3D educational visualizations and cross-cultural interaction. The data collected during the studies is analyzed to explore the technological, social and other issues using virtual worlds in educational settings, focusing on visualization of educational content. The paper concludes with some recommendations for future development of the Virtual Campus.

Introduction

3D virtual worlds support a variety of activities and their use has increased in recent years. The design of educational virtual worlds often follows Vygotsky's social constructivist approach (Vygotsky, 1978), allowing learners to co-construct their environment and understanding together with their peers (Bryceson, 2007). There are a number of reasons for choosing 3D virtual worlds for educational activities. 3D virtual worlds offer new opportunities for learning (de Freitas, 2008) and allow people to interact in a way that conveys a sense of presence lacking in other media (Kelton, 2007). In addition, 3D visualization is a powerful tool for supporting understanding and memorization of complex concepts as well as information retrieval and is widely used in educational contexts (Czerwinski, van Dantzich, Robertson, & Hoffman, 1999). Another important motivation behind the choice of this technology is its potential for supporting cross-cultural understandings and collaboration (Wyeld & Prasolova-Førland, 2006). This suggests that 3D virtual worlds can create a stimulating atmosphere around a collaborative creative learning process, also building on a pre-existing common interest by students in the international multi-user 3D computer game culture. Examples of successful 3D virtual world applications include Second Life (www.secondlife.com), Active Worlds (www.activeworlds.com) and Wonderland (https://lg3d-wonderland.dev.java.net).

A growing number of universities have introduced virtual representations in the form of virtual campuses for supporting a wide range of educational activities. 3D virtual campuses are created using different types of platforms and technological solutions, the most widely used one at the moment is Second Life (SL). Education is one of the major application domains in Second Life and, despite some criticism, it is a good example of this type of platforms. Educational projects in Second Life vary broadly, from full-scale, highly realistic campuses to individual classes taught in common areas. Over 500 universities and colleges have a presence in Second Life since it opened to the public in 2003. Major universities already using SL include California State University, Harvard University, Ohio State University, University of Hertfordshire and University of Sussex, just to mention a few. Other educational organizations that have a presence in Second Life include research organizations (for example, Biomedicine Research Labs), libraries (Alliance Library System), and museums (International Spaceflight Museum). There are also numerous examples of virtual representations of educational institutions in Active Worlds, such as iUni (http://iuni.slis.indiana.edu).

Another popular category of virtual worlds is virtual museums. This metaphor is popular because it is well-known from everyday life. A modern age virtual museum is a complex system with a wide range of possibilities for learners. They are used to facilitate educational process in different ways, such as presenting their exhibitions online and serving as a place for educational activities. Virtual museums have proved effective in a number of educational

projects (Hawkey, 2004; Prasolova-Førland, 2005). As emphasized in (Tanikawa, Ando, Yoshida, Kuzuoka, & Hirose, 2004), in a virtual museum we can provide users with the same opportunities as they would have during a guided tour in a real exhibition, including communication and collaboration with peers.

It is common for both virtual campuses and virtual museums to attempt creating a 'familiar' atmosphere for their users. However, a virtual campus is not only a 3D realistic model of the physical campus. In our previous work we discussed the idea of a virtual campus as a framework around educational and social activities and a set of tools and resources to support those activities (Fominykh, Prasolova-Førland, Morozov, & Gerasimov, 2008). One of these tools was Collaborative Virtual Workshop (CVW) that was introduced as an innovative resource in the context of a virtual campus, supporting collaborative work on 3D educational content as well as sharing and reusing such content. In CVW we seek to combine features from both virtual campuses and virtual museums, taking advantages from both approaches.

NTNU is now in the process of building a virtual campus in Second Life. The Second Life platform was chosen as it is the most common technology of choice for such educational projects, including other pre-existing Norwegian Second Life projects, such as Second Norway. The paper is structured as follows: the next section outlines the two case studies that were conducted in the Virtual Campus of Norwegian University of Science and Technology (NTNU). The following section presents a discussion on the case study results and implications for developing the Virtual Campus and CVW as an integral part of it. The last section concludes the paper and outlines future work.

Two case studies in the Virtual Campus of NTNU

The Virtual Campus of NTNU is a joint project created in cooperation between the Program for learning with ICT (LIKT), NTNU Library (UBIT) and the Department of Computer and Information Science (IDI). The work on the Virtual Campus of NTNU is based on previous work on creative visualization of educational content and cross-cultural collaborative work in 3D virtual environments (Fominykh, Prasolova-Førland, Morozov, et al., 2008; Prasolova-Førland, 2007). In the following, 2 case studies of using the Virtual Campus for educational activities are presented.

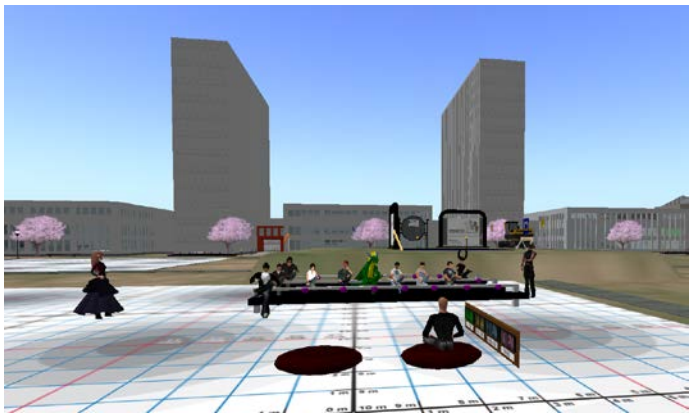

Fig. 1. Virtual Campus of NTNU in Second Life

Case study I: Virtual Campus constructing and a virtual lecture

The development of the NTNU Virtual Campus began in Second Life during the spring semester of 2009. A group of 4 students created an interpreted model of one of the university's buildings – Sentralbygget (Fig. 1) as part of a project course (IT2901 – Informatics Project II). The building has a set of rooms and auditoriums, informational resources and other tools. The students were given a significant degree of freedom in developing the requirements for the project in order to create a design that was as much as possible in the accordance with their needs as NTNU students.

The students decided to focus mostly on the representative function of the Virtual Campus. They have generally achieved two main goals of the project: making the construction recognizable and providing informational resources

about the university. The students noted in their report that they learned a lot about both project work and modeling buildings in a 3D virtual world.

When the construction was finished, the NTNU Virtual Campus was used as a venue for a lecture for students from Flinders University, Adelaide, Australia. About 15 students (the amount varied during the session) attended a lecture on educational use of 3D educational worlds. The lecture took place in a virtual auditorium using voice-feed and an in-world slide-show. To avoid some technical problems and due to the fact that not all the students had access to sound, everybody except the lecturer used text chat for communication. In addition to attending the lecture, the Australian students evaluated and discussed the work of the Norwegian group (who also attended the session and presented their project) on the Virtual Campus. They provided feedback and discussed in general the possibilities and potential for using the Virtual Campus for educational activities.

The session and associated discussion allowed us to highlight a number of issues related to the use of the Virtual Campus for education. The Australian students pointed out the opportunities it presented, such as the possibility to attend lectures from different parts of the world and learn from other cultures. The students mentioned a number of areas where they believed a Virtual Campus would be useful. These included: “group work and social activities”, “networking with students and industry people”, “learning and making contacts with people and hearing what they are doing”, etc.

The Australian students also pointed out some drawbacks such as anonymity issues. For example, saying that people can “use avatars to distance themselves from responsibility for their actions”, which is a known problem of online open spaces. The students have also mentioned possible difficulties recognizing people and grading class participation in particular. They also pointed out that it was rather chaotic during the lecture and sometimes difficult to understand who said what (using online chat).

When asked for improvement suggestions, the students mentioned that the campus needed a private discussion place and more efficient virtual classrooms. Another suggestion was to provide better support for 3D content manipulation. At the end of the session, one of the Australian students proposed that “…we could create a campus together”.

Case study II: Collaborative 3D educational visualizations and cross-cultural interaction

In the autumn of 2009, the Virtual Campus of NTNU was used for one of the practical exercises in a course TDT4245 – Cooperation Technology. The exercise was carried out in 6 groups, 3-4 students in each. In this exercise, the students were asked to build a visualization/construction representing one of the research areas or a course taught at NTNU. The students were asked to consider how their constructions could be used in educational activities on the Virtual Campus and for promotion of NTNU.

Students had a tutorial on Second Life (in classroom). Following this they met online in Second Life. Students presented their project proposals, were assigned a building area and received additional training in Second Life building. The total building period was approximately 6-7 weeks. One week before the deadline, a joint session with students from Flinders University was organized, Australia (7 students + 1 teacher), Mari State Technical University, Russia (5 students + 1 teacher), and 1 teacher from Molde, Norway. The visitors were guided through the building sites and asked to give their comments and feedback to the Norwegian students’ work-in-progress. The meeting was delayed as the Australians had some technical problems with updating Second Life to a new version since the last time they had visited SL; they also had some bandwidth problems during the session. In their presentations, the students used different elements: pre-made and specially designed buildings, text ‘notecards’ with information, 2D pictures and 3D models, videos, sounds, and other elements.

Assessment was based on participation in the construction effort and on a group essay where the students were asked to discuss different aspects of collaborative work and learning in the context of a virtual campus, collaborative work on 3D educational content as well as future trends and possibilities. The students were also asked to discuss potential use of their constructions and possible directions for development and improvements for the Virtual Campus as a whole. Students evaluated each other’s constructions and received evaluations from the visitors. The following provides an overview of the session.

Group 1 decided to present the history of NTNU as the university turns 100 in 2010. Using a museum metaphor, the group showed a timeline of the history, including information in the form of text, images and video. The presentation was conducted as a guided tour. The presenters sometimes became silent and as coordinators we had to supplement. This however unexpectedly led to some confusion among the guests, doubting who was saying what. During the presentation, students got suggestions for improvement (mostly how to make the construction more interactive and fun).

Group 2 developed a presentation of the student project of making the most fuel efficient vehicle "DNV Fuel Fighter" that received first place in an annual competition for European high schools and universities. The group had an exhibition with posters, pictures, video and a 3D model of the car, allowing visitors to drive it themselves (Fig. 2). Before the group started the presentation it took about 4 minutes to gather people at the right place. The confusion about who was saying what had increased as the presenters had also changed. Several people missed some messages and were still at the previous construction hence out of the next presenters' chat range. During this presentation some lag problems also appeared that made some people unable to move and speak. An important suggestion was made – to start 'rezing' and 'de-rezing' buildings. 'Rezing' means making 3D objects appear in the world. During the case study navigating from one student project to another was a problem even if constructions were in close proximity. In our case 'rezing' constructions when needed and 'de-rezing' not needed ones can matter since it can solve navigation problems during presentations and clear more space on the island.

Figure 2. DNV Fuel Fighter construction

Group 3 created a virtual "Health Care Division", responsible for training and creating awareness related to the medical field. The project was at a very early stage and not presented by the students.

Groups 4 and 5 decided to go with the areas of Architecture and Design and Fine Arts and Music. Group 5 recreated one of the major landmarks in the city of Trondheim – Studentersamfundet. This building houses various student organizations and is an important social meeting place for students in Trondheim, where one could go dancing, attend concerts and participate in debates. Group 4 presented different forms of art, music and dancing inside Studentersamfundet, with videos, pictures and interactive elements such as musical instruments. During the presentation an importance of both real and unreal in 3D virtual environments was stressed. Since the construction was a recreation of a real building, several people suggested showing what is going on in real life in Studentersamfundet, placing announcements and links to various events. There was also a suggestion to show a Twitter feed in this place to keep people up to date. Additionally, several suggestions on building were expressed by the visitors. The Norwegian authors of the project expressed a need for more constructing support.

Group 6 created a virtual museum of Arts and Music. Students had the idea of allowing talented people, especially NTNU students, share their fine arts learning with each other, as well as displaying their work and attracting potential sponsors (Fig. 3). During the presentation, it was agreed that such a virtual museum can exhibit not only images, but sculptures, installations and other forms of art. Students should be able to contribute with their art works and university project works.

Figure 3. NTNU Museum of Modern Art

After the project presentations, the visitors and NTNU students took a tour of the central building of the university – Sentralbygget that was constructed during the first case study (Fig. 1). Towards the end of the session we had some suggestions for improvements, mostly from the visiting teacher, such as providing facilities for easy storing and retrieving of student projects, information in virtual rooms about their real counterparts and more interactivity. Several visitors mentioned the difficulty in navigating in such a large building and the need for an additional map with teleports. One of the NTNU students was critical that the Virtual Campus of NTNU was not commonly known to its students and employees and suggested advertizing on the university's website to make the Campus more available for teaching, student projects and social activities. Finally it was proposed to link the Virtual Campus in Second Life and the local LMS "It's learning".

All visitors were also asked to take a short survey. The survey provided general feedback on the Virtual Campus and vote for the best students' project. The survey showed that the campus was relatively suitable for social activities, while the support for educational activities was minimal and the campus in general needed improvement. The negative evaluation of the educational facilities at the campus by the visitors could be partly explained by the fact that no existing facilities (such as the lecturing ones) were explicitly demonstrated during the session.

After the Norwegian students completed the course they were asked to answer a questionnaire. The questionnaire had totally 4 questions with a set of sub-questions stressing specific issues, such as which activities and facilities/tools are suitable or not for a virtual campus (Figs. 4-5). In addition, the questionnaire contained a short description and 2 questions concerning a new tool/framework with a tentative name "Project gallery" (Figs 6-7). This was initially defined as simple as "a special tool/framework for constructing, storing and presenting content in a 3D environment". In particular, the Project gallery is intended for assisting constructing, presenting and storing student projects, similar to those that were created in the case study. The idea of such a tool/framework originally appeared in one of the authors' earlier works (Fominykh, Prasolova-Førland, & Morozov, 2008) and was reinforced during the case study in response to several problems (as reported by the students during the online sessions in Second life and their essays). For example, participants needed more support for the constructing process. Many students noted that a library of pre-made 3D objects and university related textures could allow them to concentrate more on the creativity. Case study constructions took a lot of space in the Virtual Campus. This space should be cleaned for future projects and the constructions themselves could be saved for later use. Presentation of constructions proved to be not an easy task and also needed support. Therefore, to find solutions to these problems, we introduced the concept of a Project gallery and included corresponding questions into the questionnaire.

When answering the questionnaire, the students were asked to position their answer on a Likert scale, with 5 alternatives varying from "to a very little extent" to "to a great extent". During the subsequent analysis, 5 different alternatives were assigned the following weights: -2, -1, 0, 1 and 2, correspondingly. For each question, the weighted answers were summed up. The results are presented in Figs. 4-7 below.

Among the suggested activities in the Virtual Campus, the students prioritized virtual lectures. An activity that students were involved in – 3D visualization, constructing installations and sharing content – received an equal amount of positive and negative votes. Other activities were less popular (Fig. 4). Among the tools and facilities in the Virtual Campus a library with educational resources was considered the most necessary. Recreation of the main university building – a major landmark – was considered less important than recreation of departments with administrative information and tools. Private and group rooms were considered not important. Socializing place was

almost equally supported. Realistic auditoriums were supported less than abstract auditoriums with unrealistic features (Fig. 5).

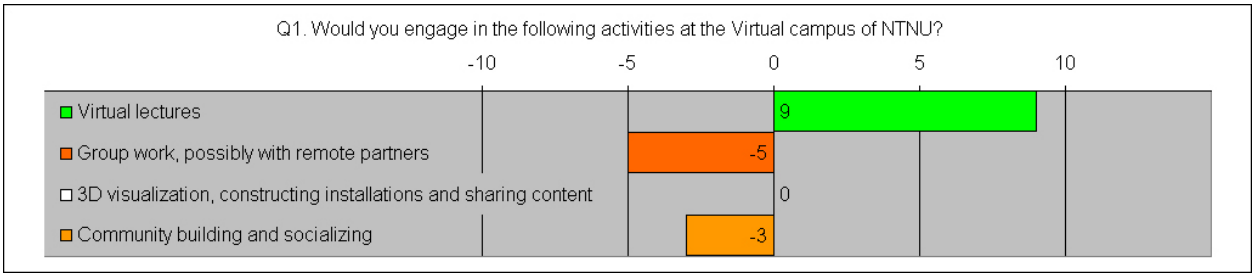

Figure 4. Questionnaire results. Question 1: Activities at the Virtual Campus

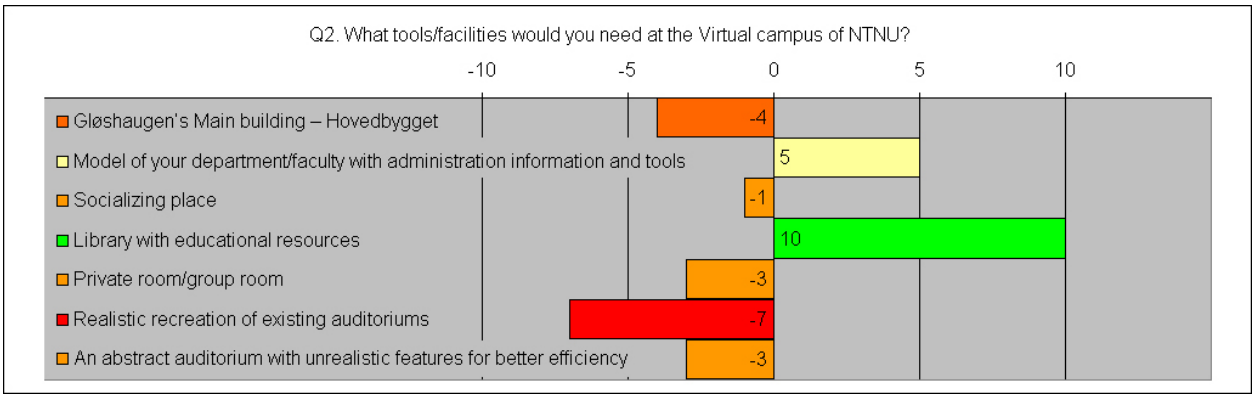

Figure 5. Questionnaire results. Question 2: Tools/facilities at the Virtual Campus

According to the results of the questionnaire the Project gallery was mostly seen as an information place, with the library of resources a main feature. Generally, the proposal was considered useful and almost all the points got more positive votes than negative. In addition to an information place, the project gallery should combine a meeting place, elements of a museum and a workshop as well as being a social place. The responses show that all the proposed roles of the Project gallery should be supported (Fig. 6). The students supported all the facilities and tools that were offered as a part of the Project gallery. Besides the library of university related 3D objects, textures and templates for constructing, there should be a creative and fun atmosphere, possibilities for learning more about projects and a stage for presenting. The idea of creating the Project gallery in any recognizable building was also supported by most students (Fig. 7).

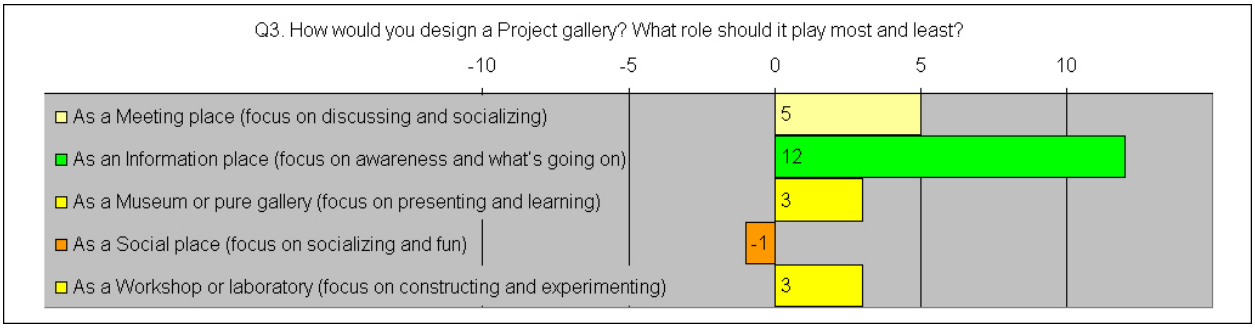

Figure 6. Questionnaire results. Question 3: Designing Project gallery

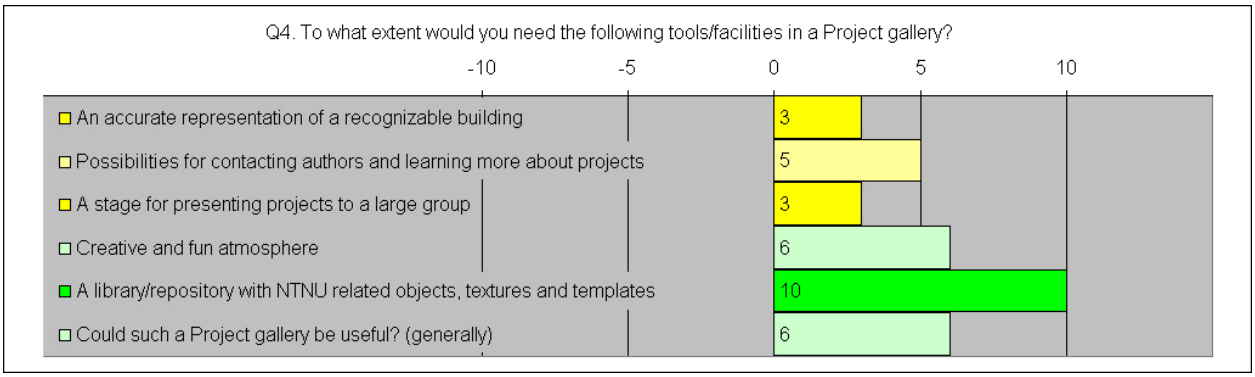

Figure 7. Questionnaire results. Question 4: Tools/facilities at the Project gallery

Discussion

This section summarizes the major implications for further design and development of the NTNU Virtual Campus based on feedback from the case studies and previous research. Among other things, the Virtual Campus will be improved by developing a special tool supporting collaborative work on 3d educational content – Creative Virtual Workshop (CVW). The initial idea of such a tool was presented in our previous work (Fominykh, Prasolova-Førland, & Morozov, 2008). CVW was introduced as an innovative resource in the context of a virtual campus, supporting collaborative learning, creativity expression and resource sharing for a wide range of educational contexts. The recent case studies allowed us to specify its design for the support of creation, demonstration, storing and retrieval of student projects. According to the questionnaire results, case study participants supported the idea of a Project gallery that we now consider as a part of the CVW.

As we have already mentioned in the Introduction, a virtual campus is not only a space, but most importantly a framework around educational content, learning activities and associated tools and resources. In this context, based on the students' feedbacks, the CVW is meant to be one of the main tools of the NTNU Virtual Campus. The following provides the major requirements for the Creative Virtual Workshop in the context of the Virtual Campus.

Appearance: The Virtual Campus of NTNU should have some realistic buildings to convey the spirit of NTNU, but at the same time it should be engaging, user-friendly and have unrealistic features/designs where it is necessary for an enhanced and more efficient educational experience. Similarly, while discussing the proposal of the Project gallery/CVW and how it should appear, the students mentioned support for information sharing and meetings as well as a creative and fun atmosphere as important. Since some realistic designs (such as small rooms and auditoriums) were criticized as being not very user friendly, the CVW's exterior should preferably resemble an existing university building, while the interior may have an unrealistic appearance for best possible performance.

Structure: The overall structure of the NTNU Virtual Campus should be well-organized and to a certain degree resemble the structure of the physical campus. The structure should have a varying degree of flexibility to allow modifications form the users, but at the same time keeping the overall structure consistent. Realistic buildings and places should be better used for social activities and as representative areas holding various informational resources about the university and its life. At the same time, there should be workplaces where educational activities can be conducted. The CVW is considered a tool in a virtual campus context with a complex structure, integrating several places in one framework. The design of the CVW is based on the previous research and on three main suggestions from the participants of the case studies: firstly, more support for constructing processes, secondly, support for presenting projects and awareness and finally, provision of a library of resources. Accordingly, the CVW will have a virtual workplace equipped with building tutorials and tools. This workplace must also be linked to a library with ready to use objects, textures and scripts as well as university related resources. To provide support for presenting projects, there should be a virtual stage, equipped with corresponding facilities, such as a slide-show screen, a place for presenting 3D constructions and seats for the public. This stage should be surrounded with a virtual gallery that must be able to store and exhibit student constructions (such as those were made in the second case study). Gallery exhibits can be implemented as posters with the possibility for extracting any project to the virtual stage.

Role: The Virtual Campus of NTNU in general should be an arena for working and learning in a 3D virtual environment. Various virtual places in the campus should play a number of secondary roles, such as providing support for specific educational or social activities, providing information about the university, attracting

prospective students and so on. In the context of the Virtual Campus, the CVW will play several different roles, since it has several functions. These roles are: providing support for constructing (via workplace and library), providing support for presenting (via stage) and providing awareness (via gallery). Among these roles, the CVW can also be used as a meeting place and as a socializing place.

Conclusions and future work

In this paper we present and describe two case studies that were conducted in the Virtual Campus of NTNU. The paper describes the settings and the initial results of these case studies. Gathered empirical data and the students' direct feedback allowed us to analyze how effective virtual worlds are for supporting educational and social activities. Participants' comments and suggestions were discussed in light of how to develop and improve the campus. Future work will include further development and extension of the Virtual Campus of NTNU. The major directions of the development will be recreation of several recognizable buildings of the physical campus and setting up facilities for lecturing and other educational activities. This includes in particular designing a Project gallery/CVW for supporting creation, demonstration, storing and retrieval of student projects as well as for supporting collaborative work on 3D educational content in general. In addition to using the Virtual Campus for exercises and lectures for students at NTNU and cooperating universities, we plan to use the Campus as a venue for an international Summer School as a part of EU FP7 TARGET project.

References

Bryceson, K. (2007). The online learning environment - A new model using social constructivism and the concept of 'Ba' as a theoretical framework. Learning Environments Research, 10(3), 189–206.

Czerwinski, M., van Dantzich, M., Robertson, G. G., & Hoffman, H. (1999). The contribution of thumbnail image, mouse-over text and spatial location memory to web page retrieval in 3D. Paper presented at the Interact, Edinburgh, Scotland, 163–170.

de Freitas, S. (2008). Serious Virtual Worlds report. Bristol / London, UK: Joint Information Systems Committee.

Fominykh, M., Prasolova-Førland, E., & Morozov, M. (2008). From 3D Virtual Museum to 3D Collaborative Virtual Workshop. Paper presented at the 8th International Conference on Advanced Learning Technologies (ICALT), Santander, Spain, 443–445.

Fominykh, M., Prasolova-Førland, E., Morozov, M., & Gerasimov, A. (2008). Virtual Campus as a Framework for Educational and Social Activities. Paper presented at the 11th International Conference on Computers and Advanced Technology in Education (CATE), Crete, Greece, 32–37.

Hawkey, R. (2004). Learning with Digital Technologies in Museums, Science Centres and Galleries. London: Futurelab.

Kelton, A. J. (2007). Second Life: Reaching into the Virtual World for Real-World Learning. ECAR Research Bulletin, 2007(17).

Prasolova-Førland, E. (2005). Place Metaphors in Educational CVEs: An Extended Characterization. Paper presented at the 4th Conference on Web-based Education (WBE), Switzerland, 349–354.

Prasolova-Førland, E. (2007). Creative Curriculum Visualization in a 3D CVE. Journal of Advanced Technology for Learning, 4(3), 154–159.

Tanikawa, T., Ando, M., Yoshida, K., Kuzuoka, H., & Hirose, M. (2004). Virtual Gallery Talk in Museum Exhibition. Paper presented at the 4th International Conference on Advanced Learning Technologies (ICALT), Finland, 369–376.

Vygotsky, L. S. (1978). Mind in society: the development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wyeld, T. G., & Prasolova-Førland, E. (2006). Online 3D CVE performance of T.S. Elliot's coctail party: an example of virtual stage. Paper presented at the 5th International Conference on Web-Based Education (WBE), Puerto Vallarta, Mexico, 31–36.