This is a preprint of the paper to be published at the 5th International Conference e-Learning (EL). The final version is available in IADIS press proceedings.

COLLABORATIVE WORK ON 3D CONTENT IN VIRTUAL ENVIRONMENTS: METHODOLOGY AND RECOMMENDATIONS

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ABSTRACT

In this paper, we present an explorative case study that aimed at studying how to support collaborative work on 3D educational content. Collaborative virtual environments have become increasingly popular in educational settings and the role of 3D content is becoming more and more important. In the paper, we introduce and apply an original methodology for work with 3D content. Using this methodology, we analyze the results of the case study in comparison with the one previously conducted in similar settings. In both case studies, groups of students were asked to build a creative visualization of a research- or education-related project and present the construction to the public. We explore the change in the experience that users had to investigate, the effect of the improvements that we made in the learning environment and the task. Based on the comparison results and the discussion, we present a set of recommendations for supporting collaborative work on 3D educational content.

KEYWORDS

3D collaborative virtual environments, 3D content, educational visualizations, Second Life

1. INTRODUCTION

The use of 3D Collaborative Virtual Environments (CVEs) such as Second Life for educational purposes has been constantly increasing during the recent years (de Freitas et al. 2009). One of the reasons is the potential and capability of such environments for supporting collaborative work with various types of content, as discussed in several studies (Arreguin 2007; Nederveen 2007; Atkins 2008; Hwang et al. 2008). Most CVEs allow advanced content manipulation, uploading, creating and sharing 3D objects and other media, such as text, graphics, sound and video. The term ‘content’ can be understood more widely than media objects, as we have discussed in (Prasolova-Førland et al. 2010). As it is noted in (Bessière et al. 2009), content can be ‘objects, places, activities’ or any valuable information or experience.

Another important reason is the opportunity for participants to interact in a way that conveys a sense of presence lacking in other media (Kelton 2007; Park et al. 2009). Users are represented by avatars and act in a shared 3D space that gives them awareness of each other’s actions. Wide opportunities for communication make CVEs suitable for conducting meetings, performances and role-playing (Sant 2009).

A growing number of education- and research-intensive institutions have started using CVEs for presentations and promotions, conferencing, sketching, training and other purposes. Second Life is one of the most successful CVEs at the moment (www.secondlife.com) and remains one of the most stable, developed and populated, though there are without doubt certain limitations. In this paper, we present an explorative case study on the use of CVEs for collaborative work with 3D content, using Second Life platform.

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2. COLLABORATIVE VISUALIZATION EXERCISES

2.1 Background

In the autumn of 2010, we conducted a regular practical exercise in the Cooperation Technology course. The exercise was preceded by several earlier exercises where we were exploring various aspects of collaborative work and learning in 3D CVEs. Since 2009, we have been using a virtual campus of Norwegian University of Science and Technology (NTNU) in Second Life for these exercises.

In this paper, we particularly focus on comparing this study with the one conducted in 2009. In the 2009 exercise, 6 groups of students (3-4 students in each) were asked to build a visualization representing one of the research areas or a course taught at NTNU. Resulted constructions were presented to the international audience at a joint session. Analyzing the results of the study, we have identified a number of problems related to the learning approach and the work in a 3D environment. To solve the problems, we have proposed a framework called ‘Creative Virtual Workshop’ that provides support for constructing (virtual workplace and library), support for presenting (virtual stage) and awareness (virtual gallery). The details of the study are presented in (Prasolova-Førland et al. 2010).

In both studies, we used the same environment and gave a similar task to the students. However, for the latest study, we have improved the environment and the task. Besides that, this year the exercise was conducted in conjunction with an International Summer School on Collaborative Technologies, Serious Games and Educational Visualizations, organized by the EU TARGET project (http://www.reachyourtarget.org/). Almost finished student constructions were available in the Virtual Campus during the Norwegian Science Week festival and demonstrated on the virtual science fair. Considering these facts, in this paper we explore the change in the experience that users had with 2 case studies: before the learning environment and the task were improved and after.

2.2 Case study settings

The exercise in 2010 was carried out with 25 students in 7 groups, 2-4 students in each. None of the students had previous experience in Second Life, however most of them were familiar with 3D virtual environments from gaming. The students were asked to build a visualization representing any research project and present it at a joint session by role-playing. After the joint sessions, the students had 2 weeks for reflecting on their activities in group essays. We provided a guideline for this task in the form of a set of questions to discuss and aspects to consider. In the first part of the essays, the students discussed their collaborative process, design choices, role-playing and reflected on the learning method. The second part of essays was devoted to the Virtual Research Arena’s role and design, which is out of the scope of this paper.

This method is based on ‘constructionism’ (Harel and Papert 1991) – an educational philosophy which implies that learning is more effective through the design and building of personally meaningful artefacts than consuming information alone (Papert 1986; Harel and Papert 1991; Bessière et al. 2009). Constructionism is related to the social constructivist approach (Vygotsky 1978), where the main idea is that learners co-construct their environment and understanding together with their peers. We also applied role-playing, which is a widely used and effective learning and teaching method. It implies an active behaviour in accordance with a specific role (McSharry and Jones 2000; Craciun 2010).

For describing and evaluating student constructions, we use an original methodology that is based on the analysis of our previous studies on collaborative work with 3D content presented in (Prasolova-Førland et al. 2010). The methodology suggests describing a 3D construction along 2 dimensions: virtual exhibits (types of content) and visual shell (content presentation form). Virtual exhibits have 3 main categories: text, 2D graphics and multimedia, and 3D visual symbols. An additional dynamic category considers how the virtual exhibits are presented to the viewer, for example, by role-playing. A visual shell in its turn can be described using 3 dimensions: aesthetics, functionality and expressed meaning. According to the methodology, a successful construction provides a harmony between the visual shell and the virtual exhibits. At the same time, a balance between the dimensions of the visual shell and different ways of displaying virtual exhibits should be found. The methodology can be used for describing and evaluating 3D educational visualizations and 3D educational content.

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2.3 Student constructions

In the following, we provide an overview of the student constructions (Fig. 1). We summarize the analysis of the constructions describing virtual exhibits and visual shells (Table 1).

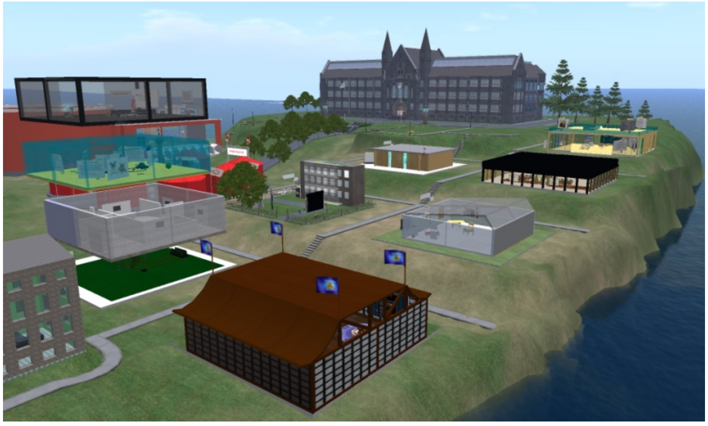

Figure 1. Student visualizations of research projects in the Virtual Campus of NTNU

Group 1 created a programming history museum. The group constructed 4 floating platforms symbolizing eras of programming. Each platform has interactive schemes or challenging quests.

Group 2 visualized the effect of Kung-Fu training on health. The group created a very realistic and authentic Chinese-inspired environment that impressed the public, including Chinese visitors.

Group 3 visualized BP Solar Energy research project – the biggest solar skin in Norway. The students constructed a piece of wall with an interactive virtual solar skin, showing conversion of the solar energy.

Group 4 presented the work of the designer Enzo Mari known for using simple pieces of wood for constructing furniture. The group built several pieces of furniture and placed them in a workshop.

Group 5 decided to try and visualize the idea of proposing prototypes and selecting the best solution. The construction included a room with a set of random interactive objects and a half-working voting system.

Group 6 visualized a concurrent design methodology. The students sought to re-create real-life design facilities and built a room with a few tables and large screens on the walls for different expert groups.

Group 7 visualized a project called "ArTeNTNU" that aimed at increasing knowledge about the intersection between digital art and software technology. The students built a virtual gallery filling it with information about the artefacts created within the project.

Table 1. Student constructions analysis

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Text	basic info, details	basic info	details	details	basic info	basic info	basic info, details
Multimedia	slideshow	slideshow, graphics, web links	slideshow, graphics	slideshow, video	no	graphics,	slideshow, web links
3D symbols	functional, real-life	decorative	functional, real-life	real-life	functional	real-life	real-life
Presentation	excursion, avatars	excursion, avatars	role-play, avatars, audience	role-play, avatars	discussion	role-play, discussion, audience	excursion
Aesthetics	elements	atmosphere, elements	elements	elements	no	elements	atmosphere
Functionality	interactivity, simulation	navigation	interactivity, simulation, navigation	navigation	navigation	navigation	navigation
Expressed meaning	visual symbols, metaphors	visual symbols	visual symbols	metaphors	no	metaphors	metaphors

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3. CASE STUDY RESULTS

All the groups noticed that the project was interesting and their knowledge in the area cooperation technologies has increased. Most of the students noted that they became aware of when it is appropriate to use CVEs and when to use other tools instead.

3.1 Collaborative process

Describing the collaborative process, 5 groups reported that they worked mostly asynchronously due to the different time schedules. Still 2 other groups preferred a synchronous mode, exploiting the advantage of increased workspace awareness as they could follow the development of the group construction in real-time. All the groups used many other communication and cooperation tools at different stages of the project work, including e-mail, instant messaging, file-sharing and video conferencing. Real-life meeting were also used by all the groups to a varying degree and for different purposes. Reflecting on their experience, most of the students reported that this allowed them to learn more about cooperation methods and identify which of them are suitable for work in CVEs, for their group and for their task.

3.2 Design choices and role-playing

The students were very different reflecting on their inspiration by other constructions in the Virtual Campus or elsewhere in Second Life. The feedback varied from stressing the importance of studying other constructions to mentioning a minor effect of this kind of studying for inexperienced users. One of the groups criticized all the constructions presented in the campus in terms of presentation means and tools, while another group was very positive exactly about this, stressing that they were inspired by the constructions on the island for the building and the tools contained inside.

The other constructions on the island were useful to get an idea of what was possible and a sense of how things were done, especially in the first stages and on interactive objects.

For us, the other projects on NTNU Island only had a minor effect on our inspiration. Because we didn't know Second Life from before, we had no clue about how hard it would be to make something equally cool/fancy.

To mediate their understanding of the presented projects, the students used various design choices (see Table 1). The groups exploited different place metaphors from a very simple “room” to museums, galleries and conventional places. According to the student feedback, choosing metaphors was in some cases related to the nature of presented project, for example museum metaphor for the programming history museum (group 1), convention building for the art project (group 7). In other constructions, this choice was defined by the reality, for example, recreating a part of a building with a solar panel for the solar energy project (group 3). Creating impressive authentic atmosphere was the key factor, for example, in a project representing Asian martial arts (group 2).

To present information, the students used various means (Table 1). The most common tools were slide shows and posters, which were used by all groups except just one, however, in different settings. In 3 of the constructions, slides and posters played the role of the main sources of information, while in 3 others they were just complementing information, presented by visual symbols and interactive elements or simulations. Interactive simulations were used a lot by 2 groups, attracting interest and evoking positive feedbacks. At the same time, one of the groups emphatically refused to use interactive elements in favour of easy navigation (group 7). The use of visual symbols made some of the constructions highly appealing, intensively exploiting advantages of the technology. In addition to the above, 2 of the groups used links to web pages with further information and one of the groups used a video screen with a short clip.

Decorations are beautification elements and usually do not comprise meaning. Such elements were used in the constructions also to a different degree (Table 1). One of the groups spent much of the effort elaborating the aesthetics of the construction (group 2), and only 1 did not use decorations at all (group 5).

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All the constructions were presented at the joint session. Although the students were given a task to prepare presentations as role-plays, most of the groups cut it to simply describing constructions (Table 1). Nevertheless, those groups who actually performed role-plays made a better impression on the audience, according to the feedbacks. Role-playings had another advantage in terms of explaining the details of the projects, since the audience was to a different degree involved in the play. Interactive simulations were also attracting audience by the possibility to try or test presented topic or system. Few groups or individual students prepared authentic avatars that were appealing and appreciated by the audience.

3.3 Visualization and increased understanding

The students provided feedbacks on how their understanding of the group's own research topic improved during the visualization effort. All the groups except one claimed that they became more aware of the presented topic and their understanding (subjectively) increased. At the same time, 3 groups described the pre-phase to the actual construction as the most 'learning-intensive', since during this phase they had to discuss how to present their projects in the best possible way, e.g. "how to implement the concept into something concrete". Groups that recreated real-life items in their presentations appeared to be the ones that benefited from the actual construction, though mentioning that the experience was not as rich as in reality.

During the research each of the group members learned much. In order to visualize the construction we arrange a series of field trips took pictures and made sketches which also provided a better understanding of the construction.

Some team member never built a piece in real life. But they also reported that they became more aware of the construction method while building in SL.

Most of the actual learning part took place outside of SL, during the brainstorming and start-up phase. While creating the 3D visualization we almost didn't learn anything.

Reflecting on the understanding of the projects presented by other groups, the students emphasized the importance of interactive elements as experience-enhancing and giving a practical idea of the presented topic. Some additional comments (both positive and negative) were related to exploiting the unique advantages of the technology, stressing the value of creating something that is impossible (or expensive) in the real world and criticizing extensive use of 2D graphics and slideshows in particular. Engaging the audience in presentations and role-plays was considered an important factor for increasing understanding of the topic. Using voice chat or, in some cases, both voice and text chats was recommended to make presentations appealing and easy to follow. Authentic avatars and the overall atmosphere of a construction as well as recreating real-life buildings were also considered to be important for enhancing the learning experience.

The winner means of presentation must be the constructions with their functionality. To be able to interact with "something" in a presentation makes the crowd feel excited, focused and eager to learn. The use of [authentic] avatars also helped clarify who gave the presentation and was writing or talking.

Using a 3D representation of a real object (the solar panels) was interesting. But sadly it fell short of its goal. It seems the really crucial point was the combination of insulation and power generation but also the user satisfaction. The aesthetic change to the building as well as the reduction in day light is available to the inhabitants. Engaging the audience in a concurrent design process was an interesting idea and a good choice given the subject.

Comparing experience of creating a project presentation using a 3D CVE technology to a 'traditional' slideshow presentation, all the groups acknowledged superiority of CVEs in terms of interactivity, flexibility and innovativeness. Most of the students noted that presentations in a 3D environment are more comprehensive and provide more complete experience. At the same time, the number of critique comments was significant. According to the feedback, the main disadvantage of a CVE technology is its complexity resulted in a "tremendously increased" time and effort required for preparing a presentation and moreover –

special skills. The second important disadvantage of CVEs arises from their advantage. Exciting functionality and advanced graphics often draw the focus from the topic away. The third disadvantage is the lack of feedback from the audience. The students doubted the usefulness of 3D CVEs, since it is impossible to "have full control over a group" and "force the students to pay attention". Few balanced opinions were given supposing that there are some tasks and topics that are more suitable for each technology. Only 1 group mentioned higher system resources requirements for running CVEs. This point was considered less important, since all the students had powerful enough personal computers and additionally a computer class equipped with up-to-date hardware. In it interesting to note that only 1 group put a single point describing an advantage of a 'traditional' slideshow presentation, while everybody criticized CVEs.

4. DISCUSSION

In this section, we discuss the change in the experience that users had before the learning environment and the task were improved and after. Based on the student feedback and the discussion, we present a set of recommendations for supporting collaborative work on 3D educational content in CVEs.

4.1 Collaborative work on 3D content

Collaborative process in both case studies included synchronous and asynchronous activities with the use of various additional tools and face-to-face meetings. From this perspective, we have not discovered any significant difference between case studies.

Design choices that the students applied in their constructions indicate the level of engagement and understanding how to use CVE technology with its advantages and disadvantages. The constructions from the exercise in 2009 were available on the island and demonstrated during the welcome meeting. In such a manner, this year students could study features and designs of the same exercise right on the Virtual Campus, while last year students were advised to explore other virtual campuses and research-related places in Second Life. Besides that, this year the students could study and get inspired by the constructions on the Virtual Science Fair, which was located nearby. Library of resources that had been proposed by the students in 2009 was available in 2010. It includes free 3D objects, textures, scripts, clothes, simple tools such as a slideshow screen and teleportation links to other regions. Even though the library was small, all the groups except just one used provided objects in their constructions.

Students' constructions have changed at least partly as a result of the described improvements in the learning environment and case study settings. This change can be explored by the original methodology that was presented earlier in the paper and used for describing student constructions (Table 1). In this respect, constructions in the recent case study appeared more elaborated than in the previous one. While in 2009 the students paid attention to 1 or rarer 2 of the visual shell aspects, in 2010, most of the groups paid attention to at least 2 aspects (Table 1). The variety and relevance of the virtual exhibits have also visibly increased. All the groups except just one used different types of content to present different types of information in the recent study. Appropriate use of visual symbols was established at least in 3 constructions out of 7 (Table 1).

Asking the students to present their constructions by *role-playing* encouraged them to pay more attention to this part of the task. The students tried to make their presentations engaging and often involved the public into the play. This resulted in much more focused attention of the public and much less amount of people lost. The public did not have any trouble identifying presenters, since their avatars often appeared correspondingly to the constructions. In addition to the text chat, this year most conscientious students used a voice chat that was advisable according to the task. The role-plays, in which presenters succeeded in synchronous texting, speaking, moving avatars and interacting with the elements of the constructions, were very much appreciated by the public.

In the essays, many groups noted that their *understanding of the topics* visualized by other groups depended on few key factors, such as appropriate use of interactive elements, clearly presented information, overall atmosphere and engaging presentation. As follows from the study results and discussion above, in the recent case study, the topics were presented with more attention to important details and factors. The task of comparing experience of creating a project presentation using 3D CVE technology to a 'traditional' slideshow presentation led to much deeper analysis of advantages and disadvantages of CVEs in the essays.

Based on the feedback from the students and other participants of the past year case study, we have identified *that recreating real places and buildings* in the Virtual Campus is important for an engaging and appealing atmosphere. This is especially relevant for the main easily recognizable places and landmarks. In the period between two studies, we constructed the main university building 'Hovedbygget' with library facilities inside and the student community building 'Studentersamfundet' with lecturing facilities and resource library inside. The exterior of the buildings resembles reality, while the interior is done differently in order to better suit their functions in the Virtual Campus. In the recent case study, many students noted in their essays that the buildings play an important and positive role in the Virtual Campus environment, even though the interiors and functionality were still in progress.

Supporting learning communities was continually stressed in the essays as an important engaging and motivating factor. In both case studies, the students recognized the global nature of Second Life, stressing the importance of involving international visitors and the general public. For the recent case study, we enhanced the community factor with the international summer school and the Virtual Science Fair, organizing seminars, inviting experts, exhibiting project visualizations made by researchers and attracting the general public. Besides that, the availability of the past year student constructions in the Virtual Campus provides the continuity of the study and the feeling of belonging. In such a way, supporting learning communities is important for students' experience on collaborative work with 3D content.

4.2 Recommendations for collaborative work on 3D Content in CVEs

In the following, we provide a set of recommendations for organizing collaborative work with 3D content, based on the discussion above. The recommendations are developed for teachers, instructors and technicians working in 3D CVEs.

Content level:

- Encourage participants to consider different types of *virtual exhibits* for different types of information. Using only text and posters is not usually justifiable in 3D space, while the purpose of interactive elements and the meaning of visual symbols can be unclear without explanation.
- Encourage participants to elaborate aesthetics, functionality and expressed meaning of the *visual shell*.
- Consider *dynamics* of the content and use it for the benefit of the participants. Organize live performances around the content, such as role-playing.

Service level:

- Organize *tutorials*, introducing technology basics for participants. Provide additional materials and be available for questions during the work.
- Provide basic *building resources*, allowing the participants to start early composing structures from ready-to-use blocks.

Community level:

- Define the *domain* and engaging issues for the members (Wenger et al. 2002), such as research projects at a university.
- Support *connections between different communities* such as students and teachers, external experts and the general public.
- Create dedicated *community spaces* with corresponding initial community events, such as Virtual Science Fairs and seminars.
- Provide initial *boundary objects* and introduce shared artefacts as catalysts of collaboration, such as an infrastructure supporting interactive communication and "points of focus" around which the interaction and collaboration will be structured (Thompson 2005).
- Create *community repository* (Wenger et al. 2002), such as a virtual gallery, exhibiting 3D constructions.

5. CONCLUSIONS AND FUTURE WORK

In this paper, we explore how to support collaborative work on 3D educational content. The main contributions of the paper are based on the results of explorative qualitative case studies conducted in the

Virtual Campus of NTNU in Second Life. We provide a set of recommendations for teachers, instructors and technicians helping to organize collaborative work with 3D content. In addition, we introduce and apply an original methodology for work with 3D content that is especially relevant for describing and analyzing educational visualizations. Our future work will include further research into the use of CVEs in educational settings, improvement of the Virtual Campus environment and conducting new projects and studies.

ACKNOWLEDGEMENTS

The research presented in this paper is financed by Program for Learning with ICT, Department of Computer and Information Science, NTNU and EU FP7 TARGET project (grant agreement N° 231717). The authors wish to thank Rune Aunøien, Albena Antonova, Judith Molka Danielsen as well as all the students and researchers participating in the project.

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