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Learning Computer-Mediated Cooperation in 3D Visualization Projects

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Abstract. Project work is becoming an important part of university education aiming at preparing students for team-based activities in a workplace. However, cooperation problems are common in the learning process. The major purpose of this paper is to address these challenges by applying Second Life a as a platform for learning how cooperation can be supported by technology. Three-dimensional Collaborative Virtual Environments (3D CVEs), such as Second Life, have become increasingly popular as a cooperation and learning platform. Such environments provide wide possibilities for collaborative work, interaction, and visualization. In the discussion, we use the results of an explorative case study conducted using Second Life within the Cooperation Technology course at the Norwegian University of Science and Technology. Students were working in small groups on the projects aiming at visualizing major curriculum concepts. We analyze collaboration in student groups that occur on different levels and, as a result, provide a set of implications for using 3D CVEs for learning computer-mediated cooperation and cooperation technology.

Keywords: 3D Collaborative Virtual Environments, collaboration, educational visualizations, Second Life

1 Introduction

Collaboration among learners is a key element of modern university education. A significant part of course assignments and projects is done in groups in order to prepare the students for team-based activities in a workplace. Technology plays a core role in supporting these forms of activities, and therefore, it is important to learn available technologies, their advantages and limitations. Still, cooperation problems are rather common, due to different schedules, attitudes, level of activity, and interest in a specific project. These problems often lead to frustrations and disruptions in the learning process. Therefore, there is a need for better training in this area.

We propose and discuss the use of Second Life as a platform for learning how cooperation can be supported by technology. The reasons behind the selection of this technology are: first – it offers the opportunity to experience different forms of cooperation and mediation, and second – being unfamiliar, it forces discussion on appropriate use of technologies, critical thinking, and reflective learning [1].

The use of three-dimensional Collaborative Virtual Environments (3D CVEs), such as Second Life, for educational purposes has been constantly increasing during the recent years [2]. This technology is known for providing wide opportunities for collaborative work, including manipulations with various types of content [3]. Most 3D CVEs allow collaborative manipulation and sharing of 3D objects and other media. Wide opportunities for simulating environments allows creating the necessary context for conducting meetings, performances, and role playing [4]. In addition, users can interact in a way that conveys a sense of presence lacking in other media [5].

In this paper, we present and discuss data from an explorative case study on collaborative educational visualizations conducted using our virtual campus in Second Life within the Cooperation Technology course at the Norwegian University of Science and Technology (NTNU) in 2011. We analyzed how the students collaborated during the course and derived a set of implications for using 3D CVEs for learning computer-mediated cooperation and cooperation technology. In particular, we discuss how activities in the 3D environment contributed to the process on group and community level, synchronously and asynchronously.

2 Study settings

The study was conducted with 37 students working on projects in small groups (10 groups of 3–4 students in each), in which they were learning collaboration through experiences. They were forced to communicate intensively, cooperate, and collaborate in a technological environment to complete the task. They were required to create 3D visualizations of major curriculum concepts. The resultant constructions were presented to international audience at the joint sessions and seminars (Fig. 1).

Our approach to using educational visualizations in 3D CVEs for learning has been developed in several previous studies [6]. The methodology is based on *constructionism* – an educational philosophy which implies that learning is more effective through the design and building of personally meaningful artifacts than consuming information alone [7]. Constructionism is related to the *social constructivist* approach, which proposes that learners co-construct their environment and understanding together with their peers [8]. In addition, we applied *role-playing*, which is a widely used and effective learning and teaching method. It implies an active behavior in accordance with a specific role [9].

We consider a student group a subject within a learning community. The results of activities performed by students is an artifact, a reification of experience [10] that is shared with other community members, e.g. future generations of students.

Before the students started to work in Second Life, we suggested they should answer a questionnaire. We identified their previous experience in cooperation technol-

ogies and 3D virtual environments as well as their expectations of the forthcoming exercise. Each group was required to create and keep a blog for sharing and discussing proposals, reflecting and documenting the progress, and for the final discussion after the constructions were completed and presented. In addition, each student was required to create and keep an individual blog for weekly reflection.

Upon completion of the exercise, we suggested that students were offered another questionnaire to identify how their experience matched their expectations.

Fig. 1. Visualization project Awareness Lab – student role play

As part of the course, the students participated in the Second International Virtual Summer School on Collaborative Technologies, Serious Games, and Educational Visualizations, organized by two EU projects, TARGET and CoCreat. The goal of the summer school was to demonstrate affordances of the 3D CVE technology and let the participants experience different types of collaborative activities.

Two international events were conducted as part of the summer school. One of them was organized as a seminar on EU projects, which included five presentations and a question-and-answer session. The objective of this event was to demonstrate to the students how international cooperation can be established and supported using modern technologies. Another objective was to expose the students to the novel ideas and technologies behind these projects, such as serious games in corporate learning and collaborative creativity. The second event was organized as a virtual tour to the virtual campus of the College of Education at the University of Hawaii at Manoa and augmented with a feedback sessions with an invited expert. The event was highly interactive, engaging, and fun, but also educational. The visit was followed up by the return visit of the Hawaiian students who evaluated the constructions created by the Norwegian students in the course of the summer school. Both events of the school and the role-play session attracted visitors from Norway, Finland, Estonia, Poland, Russia, and USA.

The data were collected from the direct observation of students' activities online, virtual artifacts, such as chat log and 3D constructions, and users' feedback in the form of group blogs. For data analysis, we use the constant comparative method [11] that was originally developed for the use in grounded theory methodology and is now applied more widely as a method of analysis in qualitative research.

3 Summary of the results

The results of the pre-questionnaire demonstrate that most of the participants had average or good experience in team project work and even better experience with cooperation technologies (92% previously participated in team projects, including university courses and 92% regularly use at least seven types of the Internet cooperation services, such as web-forums, social networking, blogging, and groupware). However, the students had less experience in the work with 3D virtual environments and with 3D graphics or multimedia design (46% regularly use at least one 3D multi-user game, 3D virtual world or a similar platform and 42% completed at least several tasks involving graphics and were able to operate at least one graphics editor). None of the students had previous experience with Second Life.

During the fourth and sixth weeks (the study lasted for 11 weeks in total), we asked the students to reflect individually on the collaboration in the group. The results display that collaboration in most of the groups improved (in the others it remained on the same level) during this period. Direct observation indicates that the students started their visualizations also in this period.

Analyzing the data from direct observation in 3D environment and student discussions in blogs, we discovered that collaboration did not only occur synchronously and asynchronously, but also on the group and community levels. In such a way, we identified four types of collaboration, which are presented and analyzed below.

3.1 Asynchronous collaboration on the group level

Most of the groups preferred asynchronous collaboration in coordination, discussion of the task, reporting, and scheduling synchronous activities. Students explained that they chose asynchronous mode as most efficient, but also as a way of solving coordination problems, such as different time schedules or slow communication.

"One member could at any time go online and add some information, then later some other member could come online and add something else."

A minor part of the 3D visualization activities was done in the asynchronous mode, mostly due to schedule differences and by students who preferred to work from home.

"We performed all the building construction inside of Second Life asynchronously. Some of us created the structure, and others the content, displays and more."

All the groups used additional asynchronous tools at different stages of the project work. Communication via emails and collaborative writing was found most useful, but in addition, some groupware and social networking services were used.

3.2 Synchronous collaboration on the group level

All the groups reported that they met face to face at least once in the beginning of the course to become acquainted with each other and discuss the task. Later, three groups met in the computer class to get assistance from our Second Life expert and use better equipped computers. Two other groups used face-to-face meetings to increase motivation, commitment, and as a convenient way of discussion.

"We found that with setting a time and place to meet, it was easier to get things done, and you felt more obligated to actually show when you were supposed to."

Four groups acknowledged that 3D visualization, being a complex task, stimulated deeper exploration of the chosen topic and learning.

"Whilst we constructed and discussed our ideas we tried to understand the main idea of awareness, how it fits together with collaboration, and how we can represent awareness through our construction."

In addition, more than half of the groups mentioned other motivating factors for using synchronous mode for 3D visualization. These groups preferred the synchronous mode exploiting the advantage of increased workspace awareness as they could follow the development of the group construction in real time, discuss it, and provide immediate feedback to the peers.

"All the Second Life building was done synchronously as we found this very effective. Everyone could see what the others were building and we all had a nice overview of what had been done."

Among the additional synchronous tools were instant messaging, videoconferencing, and mobile phone communication. These tools were mostly used in emergencies.

3.3 Synchronous collaboration on the community level

Synchronous collaboration on the community level occurred during the role-play presentations and virtual seminars. Not all the groups prepared presentations as role plays, stressing the complexity of the task, but those groups who actually did, made much better impression on the audience, according to the feedback. More than half of the groups offered learning through experience with their visualizations, though some of them allowed the audience to try the functionality, while the others just demonstrated it. The rest of the groups prepared more passive presentations, narrating on the topic or offering a virtual tour, which still required a significant effort.

The students identified two most serious challenges for such type of collaborative activity: not enough realistic experience and the amount of effort required to make a play. However, they noted good possibilities for international collaboration and discussion, communication, promotion, corporate training, and emergency simulations.

"There might be some merit in using 3D virtual environments in creating communities across boundaries. As a concrete example, we want to mention the potential of events; one-time happenings where one is able to gather around a common interest at a specified point in time and experience it together with other attendees."

3.4 Asynchronous collaboration on the community level

The students acknowledged the possibilities of 3D CVEs for international collaboration, virtual visits, and knowledge sharing as it was done in the summer school events.

Sharing 3D constructions received a positive feedback. Most of the groups stressed the importance of studying previous students' constructions to have inspiration. Some of the groups stated also that they get additional motivation from exhibiting their construction for other people.

Sharing and exhibiting constructions in the Virtual Gallery is good because it can help newcomers introduce what 3D CVEs are capable of, what is possible to do, what types of collaboration are possible.

Realistic buildings in the campus were recognized as supporting community and providing a sense of place, however, the students wished them to be more functional.

Certain facilities […] are useful in order to support a community development, because people will recognize them and feel connected to the identity of the island.

4 Discussion

The study demonstrated that collaboration took place mostly on the group level during the preparation and the construction phase, which attributed to the nature of the assignment and in line with our the previous research [12]. According to the students' feedback, the collaboration on the community level has a significant potential which was not realized fully due to the limited time frame of the study.

As appears from the students' feedback on their collaboration process and online observations, the intensity in the groups' collaboration increased once they started working in Second Life. This implies that Second Life has a perceived complexity, and a small assignment in the beginning of the course can benefit the whole process.

The presented case study made it possible to explore both synchronous and asynchronous collaborative processes within the 3D virtual environment on two major levels, group and community. We can identify the following major implications.

4.1 Group level collaboration

Synchronous. The fact that the significant part of synchronous collaboration during planning and discussion took place using mechanisms other than Second Life (such as email and face-to face meeting) indicated that the students only to a limited degree used 3D visualization during the collaborative idea development and therefore reverted to other, more user-friendly options. Experimentation with 3D design in Second Life happened mostly on an individual basis. At the same time, when working on the task of developing 3D constructions, synchronous collaboration in group was very important as it provided workspace awareness over activities of the group. This indicates that in order to support different aspects of the synchronous collaboration within the group more efficiently, there is a need for integration of the external cooperative tools with the virtual environment.

Asynchronous. The construction process was to a significant degree characterized by division of labour where different students within a group worked on different tasks, such as constructing the outer building, scripting interactive elements, and designing decorations. At the same time, the requested sharing of property rights of the objects was done to a rather limited degree, which led to problems with reusing them. This indicates that Second Life has certain limitations for supporting asynchronous collaborative construction process. However, these limitations motivated the students to coordinate their building activities carefully and therefore to reflect on the associat-

ed coordination mechanisms that were a part of their curriculum. Also, the fact that synchronous meetings, either in Second Life or face-to-face, were used by the groups which had difficulties coordinating their activities otherwise, indicates that there is a need to improve the asynchronous cooperation mechanisms.

4.2 Community level collaboration

Synchronous. The students identified the advantages of virtual events, as they could learn about different projects in a semi-formal atmosphere, communicate with the speakers in real time, and experience directly how cooperation between distributed partners could be supported in 3D virtual environments. Students' own role plays exploited the 3D aspect to a much greater degree as the audience in most of the cases could actively explore the constructions or observe directly how cooperation mechanisms could be visualized. This implies that organizing regular virtual events for students and coaching them in staging interactive role-plays will contribute to deeper understanding of cooperative technologies and mechanisms, also in relevant contexts such as job-related training. In addition, most of the groups stated that such virtual events contribute to the community development and should be held more often.

Asynchronous. Familiar buildings create "focal points" and a sense of place for both local community members and visiting students or researchers, which was acknowledged as an important factor for sustaining the learning community. However, the functionality of such buildings should also be developed. Availability of 3D constructions from several generations of students was recognized as a positive factor for the community. Student constructions constitute community's "shared repertoire" [13] to promote knowledge sharing across different generations of students and different "communities of interest" [14]. This indicates the need for additional mechanisms in 3D CVEs that support asynchronous cooperation, annotation, evaluation and reuse of constructions, and possibilities for capturing synchronous activities.

5 Conclusions

Reflecting on their experience, most of the students reported that this project allowed them to learn about cooperation methods and identify which of them are suitable for work in 3D CVEs. Apart from being a collaborative tool in its own right, the student feedback shows that a 3D CVE can be used as a platform for learning computer-mediated cooperation. Two main reasons for that were identified.

First, the 3D visualizations of curriculum topics within Cooperative Technologies course the students created and their presentations facilitated in-depth exploration and elaboration of these topics. Second, the construction process forced the students to intensify collaboration, motivating them to explore different tools and methods to facilitate this process and thus learn by experience. Though the 3D technology was generally found unfamiliar and challenging in addition to the complexity of the task, it made the groups collaborate more closely as they needed to consult each other and rely on each other's support to achieve their goals.

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