GRAZ, UNIVERSITY OF TECHNOLOGY

INSTITUTE FOR INFORMATION SYSTEMS AND COMPUTER MEDIA

(IICM),

GRAZ UNIVERSITY OF TECHNOLOGY

A-8010 GRAZ, AUSTRIA

MASTER'S THESIS

Virtual 3D Worlds for Blended and Distance Learning in Higher Education

Submitted by:

Simone KOPEINIK

Supervisor:

Univ.Doz. Dipl.-Ing. Dr. techn. Christian GÜTL

Graz University of Technology, Austria

Co-Supervisor:

Dr. Vanessa CHANG

Curtin University of Technology, Perth, WA, Australia

August 25, 2010

Technische Universität Graz

Institut für Informationssysteme und Computer Medien

(IICM),

Technische Universität Graz

A-8010 Graz, Österreich

Masterarbeit

Virtuelle 3D Welten für Integriertes Lernen und Fernlernen in Höheren Bildungseinrichtungen

---

Vorgelegt von:

Simone Kopeinik

Betreuer:

Univ.Doz. Dipl.-Ing. Dr. techn. Christian Gütl

Technische Universität Graz, Österreich

Zweitbetreuerin:

Dr. Vanessa Chang

Curtin University of Technology, Perth, WA, Australien

25. August 2010

Abstract

Technology is progressing fast, influencing economy, society and moreover the lifestyle of people. Hence, a new generation of learners has emerged. There are two stereotypes of modern students. Firstly, so called "Digital Natives", i.e. those who grew up using computer and the Internet. And secondly, part time students, who often have families and jobs and are therefore very restricted in time. Opportunities of computer and Internet based systems allow us to better meet this new target groups' requirements.

This document presents the development and evaluation of a virtual learning environment, designed to provide a collaborative group space to work on assignments in geographically dispersed teams. The created environment is separated into multiple areas, consisting of ten private group buildings, two offices to provide consultation hours and various common spaces to enhance social communities. After evaluating several 3D virtual worlds, Second Life was selected as development platform. In the course of a business lecture at "Curtin University of Technology", a first test was performed. Voluntarily participating students tested and evaluated the prototype while completing their final course work. Research results as well as experiences concerning Second Life are outlined and discussed. A subsequent chapter illustrates implemented improvements and extensions, which are based upon evaluation outcomes.

Zusammenfassung

Der Trend zum raschen technologischen Forschritt bringt nicht nur Veränderungen in Gesellschaft und Wirtschaft, sondern auch in der Lebensart der Menschen mit sich. Eine neue Generation von Lernenden ist entstanden: zum einen die so genannten "Digital Natives" und zum anderen Personen, die sich neben Beruf und Familie weiterbilden und dadurch zeitlich oft sehr eingeschränkt sind. Computer- und Internetbasierte Systeme erlauben uns auf die Bedürfnisse dieser neuen Zielgruppen einzugehen.

Diese Arbeit präsentiert die Entwicklung und Evaluierung einer virtuellen Lernumgebung, die entworfen wurde um geographisch verteilten Kleingruppen einen gemeinsamen Raum zur Bearbeitung von Teamprojekten zu bieten. Das digitale Lernumfeld ist in mehrere Bereiche gegliedert. Es besteht aus zehn privaten Gruppenräumen, zwei Büros die für Sprechstunden zur Verfügung stehen und mehreren Gemeinschaftszonen. Basierend auf der Evaluierung verschiedener virtueller 3D Welten wurde Second Life als Entwicklungsumgebung ausgewählt. Im Rahmen einer Wirtschaftvorlesung an der "Curtin University of Technology" wurde eine Evaluierung durchgeführt. Studenten hatten die Möglichkeit die Lernumgebung im Zuge einer Übungsaufgabe zu testen und folglich auch zu bewerten. Ergebnisse der Benutzerstudie sowie mit Second Life gemachte Erfahrungen werden dargestellt und erörtert. Ein nachfolgendes Kapitel beschreibt die darauf basierenden Erweiterungen und Verbesserungen.

Statutory Declaration

I declare that I have authored this thesis independently, that I have not
used other than the declared sources / resources, and that I have explicitly
marked all material which has been quoted either literally or by content
from the used sources.

....

(Place, Date) (Signature)

Eidesstattliche Erklärung

Ich erkläre an Eides statt, dass ich die vorliegende Arbeit selbstständig
verfasst, andere als die angegebenen Quellen/Hilfsmittel nicht benutzt, und
die den benutzten Quellen wörtlich und inhaltlich entnommene Stellen als
solche kenntlich gemacht habe.

....

(Ort, Datum) (Unterschrift)

Acknoledgements

With these words I would like to firstly thank my supervisor Univ.-Doz. Dipl.-Ing. Dr.techn. Christian Gütl, whose support, ideas and positive criticism lead me through the development of this thesis. Also, due to his international relations, I got the chance to complete parts of my work at Curtin, University of Technology in Western Australia. In this context, I need to thank the entire stuff of Curtin Business School and in particular Dr Vanessa Chang, who supervised me during my stay at Curtin. I thank here all of them, for a very welcoming environment, the chance to be part of an international research community and for their unconditional personal as well as professional support.

Furthermore, I have to thank Graz University of Technology for the KUWI scholarship that contributed to the funding of my stay in Australia and moreover the Faculty of Informatics that advanced my research with a "Förderungsstipendium".

Finally, I need to gratefully mention my family and all my close friends, who were encouraging and supporting me over the whole time of my studies. Special thanks is directed at my mum who not only sponsored me, but also inspired me in very many ways.

Contents

Chapter 1

Introduction

Already during the Second World War, instructional design procedures were used systematically. Whereas initially, technologies like radio, video and projectors were popular tools, nowadays, modern technology allows to better meet learners' needs. In the course of technological advancements, computer based learning systems became a widely used education tool. (Reiser, 2001) Kvavik, Caruso, and Morgan (2004) gathered information to evaluate the suitability of computers in higher education. For that reason, a survey concerning students' attitudes towards ICT was conducted with 4374 participating students enrolled in USA universities. Already back then, 93.4 percent stated to own either a desktop computer or a laptop. More than 81 percent of the students had access to broadband Internet. (Kvavik et al., 2004)

Today, a lot of effort is being invested at universities to improve their online learning platforms to attract not only students who are unable to personally attend classes, but to cater for the younger generation of digital natives.

Digital natives, who are known to be very familiar with computer based systems, often prefer to learn on-line for various reasons. (Cabanero-Johnson & Berge, 2009; Chang & Gütl, 2010) Contemporary learning paradigms such as immersive virtual environments provide new possibilities to work collaboratively without being geographically dependent and hence, offer opportunities and flexibilities to attend classes all over the world.

This document focuses on motivation and development of a collaborative learning space, implemented within a 3D virtual environment. The aim of the project is to provide a virtual platform, for learning and working in groups independent of time and location, but also to serve as a social space, pleasant to spend time in.

1.1   Background and Motivation

In present times, the lifestyle of people and hence their needs have changed just as technological achievements did. A new type of learner has emerged, whose expectations demand to be covered. Although there are certainly people who still require distance education for geographical reasons, today's majority of distance students choose this option motivated by a desire for increased flexibility. Asynchronous learning settings unlike face-to-face lectures, allow people to combine an ordinary adult life and the completion of a higher education program. Therefore, distance learning can be seen as a method that expands the availability of education in geographical as well as in social means. (Bates, 2005) Even though today a fairly high number of higher education institutions offer Distance Learning Programs based on

Internet technology, potentials of modern computer programs and networks are usually not fully exploited. Often such platforms are restricted to simple sequences of Web-Pages to navigate through. (Bronack, Riedl, & Tashner, 2006)

In addition to this, Bronack et al. (2008) stated:*"Postsecondary enrollments are rising, and, in response, most colleges and universities offer some form of distance education, which utilizes the Internet and uses asynchronous tools as the primary mode of instruction. However, the most widely available tools offer little support for the formation of web-based learning communities or different kinds of teaching and learning."* Whereas the potentials of Internet based learning systems are by no means contentious, there are various factors that still need to be improved. Dickey (2005) assumed that virtual 3D worlds can be used successfully as supporting learning platforms in asynchronous and synchronous delivery of distance education. Furthermore, Bronack et al. (2006) reported the successful evolution of social communities of distance students, using a virtual learning environment located on an Activeworlds Universe server. No doubt, there is a remarkable number of applications in education that could be supported by 3D virtual worlds. One might think of areas that are unable to be experienced for different reasons, like high costs, security or unfavorable geographical circumstances.

This research project particularly focuses on developing an environment for learners to collaboratively work on group projects like essays and presentations. The main object is to offer virtual working spaces for individual groups to work in, as well as social communication and recreation areas. Such places may be equipped with tools encouraging creative building processes.

The concept is intended to serve regular distance students, but also enables projects across universities and even countries.

1.2 Structure

Reading this thesis, one is guided through the evolution of a virtual collaborative learning space. It opens with knowledge and thoughts concerning ICT supported education, leading to the design and implementation of the prototypal environment and concludes with the discussion of findings, improvements and experiences.

More precisely, Chapter 2 starts with a glimpse on distance learning and talks about its relation to blended learning. After a short explanation of pedagogical terms, arguments for the importance of technology in education are presented. The chapter concludes with an overview of the current situation of e-Learning. Chapter 3 defines 3D virtual worlds and explains assigned terminologies. Then, three important 3D modeling frameworks are introduced and compared. Finally, positive and negative aspects of 3D worlds in education are outlined. In Chapter 4 a small selection of examples of research projects in the field of 3D virtual worlds for collaborative as well as distance learning is outlined. The introduction of previous work is completed with a discussion of positive and negative conclusions. Influenced by the presented information, the subsequent Chapter 5 describes the basic ideas and requirements of this research project. Then, an illustration of the evaluation settings and the research project's objectives is provided. Chapter 6 gives details to design and implementation of the first prototype. Also, the experiment setup is

explained and completed, summarizing the findings. Approaches for improvements were derived from experiences that were made while developing and using the learning environment. Their realization is reported in Chapter 7. Descriptions of the enhancement of tools, the expansion of the environment and of an added Web-Interface for on-line configuration are given. Chapter 8 particularizes experiences, gained during the project's progression. Lessons learned concerning the collaboration with a foreign university as well as the handling of a project, are presented. Chapter 9 sums up former presented information and presents some reflections on the future of 3D virtual worlds in education.

Appended are two questionnaires, that where completed by research participants. Transcribed evaluation results of each questionnaire can be found subsequently.

Chapter 2

ICT-supported Education

"On-line courses are becoming ubiquitous at many universities. The ability to complete entire degrees without actually being present on a college campus is becoming popular with adult students. The ability to attend classes while eliminating long commutes or taking classes at a time more convenient to the student is creating an entirely new genre of student: one neither the instructor nor the other students in the class ever meets in person." (Childress & Braswell, 2006)

Information and Communication Technology (ICT) provides a great basis for distance education, creating independence of time and location. With this technology, learning is not only possible staying at distance to the teacher but also within geographically dispersed groups. (Pöysä, Lowyck, & Häkkinen, 2005) To start out, consider the following short introduction into the term e-Learning and its social relevance. Zhang and Nunamaker (2003) define: *"E-learning refers to any type of learning situation when instructional content is delivered electronically via the Internet when and where people need it."* Life-

long-learning is no longer only a matter of professional development, hence more and more people attend different educational programs out of personal interest. Furthermore, the evolution of our social, economical and political structures suggests an increasing value of knowledge and thus also knowledge management and transfer in our society. E-Learning offers an accommodating access to education, especially to people who are not likely to attend university classes or courses otherwise. (Graf, 2005; Gütl & Chang, 2008) To ensure quality standards in ICT supported education, a lot of research was done in order to specify guidelines and standards. One example for such an attempt was discussed in Seok, Meyen, Aust, Fitzpatrick, and Newberry (2006) and Seok (2008). Hereinafter, three dimensions of e-Learning worth to consider while designing and evaluating an on-line education system are outlined:

1. **Accessibility**

   Concerns mainly technical properties of the platform that may influence the ease complexity to access learning content. For instance, the level of usability the interface provides, but also how clearly the learning content is structured.

2. **Adaptability**

   Addresses the possibility of a user to adjust an environment's learning structure to its individual needs. This might affect the presentation of learning content, the relation of pictures, formulas or text to each other or the need of a summarizing section at the end of a topic.

3. **Clarity of Communication**

   References to the quality of educational content and the suitability of its preparation. Hence, it influences how good a learner understands what and how to learn and therefore rates the quality of information itself.

The potential of e-Learning to support individual learning processes and even life-long-learning need not to be investigated anymore. Nowadays, the issue is to find pedagogical concepts and application domains that tap the provided potential fully. This does not only call for high quality structured information but also for a modification of the traditional teacher and student roles to the roles of assistant and knowledge seeker. (Graf, 2005)

2.1 Beginnings and Development of Distance Education

Information outlined in this section is based on B. Holmberg (2005). The beginnings of distance education were based on the assumption that teaching could work without direct contact and supervision. Even though teaching through written instructions might have existed for a long time, the first approach of distance education, defined by two way communication, was documented in Boston in the year 1728. In 1833 and 1840 in Sweden and England, two other appearances of distance education were reported. As the University of London in the year 1836 starts to offer their service as an examining body also to university external students, it allows distance

education students to achieve university degrees for the first time. During the following decades in the UK a couple of distance education providers arose, specialized in preparing distance students for external university exams but also offering other courses. Documented American correspondence courses can first be found at about 1880. Australia, which started a little later in the year 1911, was not only offering correspondence courses for adults but also entire primary and secondary school educations for children who never had face-to-face contact with a real teacher. During the first half of the 20th century the value of knowledge became more important to ordinary people. It was identified as an opportunity to work one's way out of badly paid insecure jobs and therefore seen as a chance to get out or stay out of poverty. Also, in times of war, distance education played an important role, serving regular schools to supply school children via correspondence teaching. They still solely worked with written material. Later on, high quality correspondence institutions were adapting their teaching material according to technological progress. When in the 1960s and 1970s the first governmental approved full degree distance education programs emerged, correspondence teaching obtained a whole new image. Finally, it was recognized as a serious and significant new alternative in education. Since then, governments began to support the evolution of distance learning. After a new educational target group, characterized by adult part-time students, was identified, distance courses were promoted to make the access to university education easier and hence increase the amount of graduates. Also companies, that needed their employees to attend on-the-job training, motivated by economical benefits as well as a constant need of learning, benefited from this trend. (B. Holmberg,

2005)

Nowadays, we can find many universities that offer courses over distance in various countries. Mainly it is provided as an additional service for those who cannot attend traditional classroom lectures for different reasons. A few however exist, which provide their students only with correspondence teaching (e.g. Open University UK or University Oberta de Catalunya, Spain). Enhanced by modern technology (e.g. video conference tools, electronic mail, discussion forums, etc.) the target groups of today's distance learning are expanded. With the focus still clearly on adults, today's distance learning tends to serve different stereotypes of learners. (B. Holmberg, 2005) Those are divided into the following groups:

1. **Students having a family and a job**
   Students, that mainly do not interact with other students and are focused on completing their assignments individually. Main targets are the acquirement of specific skills (needed for the job), to achieve entrance to higher education or sometimes just to learn something new, for instance a language out of intrinsic motivation.

2. **Students at traditional universities**
   Learners who decide to attend some of their classes on-line.

3. **Students happy to use modern computer programs**
   Mostly people who prefer to stay at home doing their coursework. Modern e-Learning offers a wide range of tools for maintaining social contacts and possibilities to work in groups and communicate without noticeable delay.

4. **Supervised under-aged students**

   Concerned are school kids living in areas where appropriately educated teaching staff isn't available. They are typically advised by some adults but instructed over distance learning.

To fulfill a modern learner's needs, synchronous and asynchronous distance education is offered. Additionally it might be enhanced by video material, forums, etc. but can also be completed through supplementary face-to-face lectures or meetings.

2.2   Blended and Distance Education

Blended Learning aims at a well-balanced combination of face-to-face and on-line learning. In this context, on-line learning may also refer to a computer-aided classroom situation, where the respective strengths of each concept can be optimally exploited. Therefore, success in blended learning demands new and different teaching approaches. (Garrison & Vaughan, 2008) Common tools like on-line Discussion Forums, Wikis, Web-logs used for blended learning are further described in (Garrison & Vaughan, 2008). These interactive platforms are frequently used to complement traditional classroom teaching, providing a neutral area to share knowledge in a relatively anonymous fashion.

Distance education itself is a very wide ranged understanding of teaching somebody without meeting face to face. The comfortable use of computers and Internet cannot enhance the content of subjects but is able to improve its presentation and communication widely. Basically all kinds of media can

be used: letters, video and audio materials, telephone and CDs, etc. After an era of using letters and videos to transport teaching material, one can easily imagine the simplification coming along with the potential of on-line systems, especially when it comes to interaction or collaborative group activities. (B. Holmberg, 2005) However, it is still necessary to find a replacement for the face-to-face part as well as other concerns in Blended Learning, which are further discussed in Section 2.6.2. 3D worlds might have potential to close parts of this gap, substituting the student-student or student-teacher contact through meetings with virtual representations of oneself.

2.3   Relevant Forms of Learning

The here described schemes of learning are relevant to the subject, since they are frequently used in combination with e-Learning theories (Dickey, 2005). This section aims to provide an overview of how the following terms can be understood in context of ICT supported learning.

Synchronous vs. Asynchronous Learning

The distinction of synchronous and asynchronous learning indicates whether educational communication takes place in real-time or with time shift. Both terms are frequently used in the context of e-Learning and distance learning. An example for synchronous e-Learning would be videoconferencing or chat, whereas asynchronous e-Learning refers to the use of blogs, discussion forums, e-mail or the download of learning materials. Thus, one of asynchronous learning's benefits is the upcoming flexibility in time which makes

it an indispensable part of modern education. (Zhang & Nunamaker, 2003)

Social Constructivist Learning

Social constructivist learning is popularly used for education in virtual worlds. Hereby the learner is taking an active role, collecting information and knowledge with other peers in order to reach a common target. The two characterizing factors are firstly, that the process happens in a group and therefore includes some kind of collaboration and secondly, that there is an active participation of the peers in order to achieve the desired outcome. (K. Holmberg & Huvila, 2008)

Distributed Learning

Distributed learning provides a learner with various tools to use, giving the choice to select the most adequate one. That can be meant in terms of using a Learning Management System, a virtual world and face-to-face lecturer or seen in a smaller context also deciding between different forms of communication (text-based or voice over IP). Nowadays, virtual learning environments usually supply synchronous and asynchronous communication services. Thus, one is able to vary between text chat and VOIP as well as Wikis, blogs or forums (whatever currently fits best) to share and increase one's knowledge. (K. Holmberg & Huvila, 2008)

Learner-Centric Learning

In contrast to face-to-face learning, where the teacher typically dictates every detail of the course program, when, what and how to learn, e-Learning and in particular asynchronous learning supports another scheme which is described as learner-centered learning. Here, it is a students' responsibility to organize learning sequences as required. According to (Zhang & Nunamaker, 2003): *"A transition is occurring from "teaching by telling" to "learning-on-demand" or "learning by asking or doing".* This also refers to factors like time and place. In contrast to traditional classroom learning, ICT supported learning settings are typically available around the clock. (Zhang & Nunamaker, 2003)

Flexible Learning

Describes a method of educational structure. It is built around the students' needs in various respects. Such might be time, place, disabilities, etc. to ease their access to learning material. Although one can often find this label in relation to distance education, the terms do not imply one another. Distance education however can be applied as a part of flexible learning. (Bates, 2005)

2.4 Pedagogical Aspects - How Technology supports Learning

E-Learning, especially in combination with Internet technology, expands the range of ways to access information. Logs, Wikis, Voice over IP and Instant Messenger are only some of the available tools being used today. Given this

technology, e-Learning is able to support interaction between several learners, learner and content as well as learner and teacher. (Chou, 2003)

Different aspects arise when applying altered teaching approaches. Virtual worlds are successfully used as supporting learning platforms not only in asynchronous but also in synchronous distance learning. According to literature research, through a learning activity several procedures seem to support learners not only to remember but actually to understand what was learned. These were identified as the active contact of a learner with information, tools and materials in addition to a collaborative working and learning part. (Dickey, 2005)

Virtual Learning Environments usually possess some kind of social space where students might discuss learning issues. According to Graf (2005), this interaction helps to acquire new findings and points of view. Students benefit from each others knowledge and competencies and learn more effectively in the virtual group situation than they could individually. Also, it is argued that acquiring knowledge within a group is more stimulating and motivating because of emerging discussions and different opinions of group members. Moreover, nowadays technology, in particular the Internet, advances the collaboration of versatile teams with parties different in social, cultural and/or educational background. Such an environment not only increases professional competencies but also social skills and media literacy.

2.5 Technological Terms

One has to distinguish between different technological approaches. In the following, some of the most common terms are described.

2.5.1 Virtual Learning Environment

A virtual learning environment (VLE) represents a computer program that is intended for educational aims. Although the term is sometimes used with levity, it does not include every simple, static Web-Page that comes with instructional or pedagogical content, neither is it restricted to some kind of three dimensional virtual interface. In literature, one can find exact specifications which define properties, a so called VLE has to fulfill. (Dillenbourg, Daniel, & Paraskevi, 2002) In Dillenbourg et al. (2002) some factors are discussed elaborately, following a survey of the most important issues:

- *Designed information*

  Information might not only be lines of text offered to read but information stored in databases, that allows to generate answers to appearing questions dynamically. Also it is necessary to provide technology permitting multiple participants to add and manipulate content, so the knowledge is not of a static nature.

- *Social interaction*

  Contrary to a traditional on-line learning program or a simple Web-Page, where a learner is studying alone in front of a desktop computer, a VLE is supposed to offer tools that motivate social interaction between

several participants. This can be any platform, used to discuss the relevant content. Here it is important that learners are aware of the presence and availability of other learners.

- *Representation*

  Virtual learning environments are not restricted to any kind of representation. Every thoughtfully designed interactive interface, whether it is simply text-based or is provided with high standard 3d technology, is able to transfer information satisfyingly. However, a pleasant interface is known to raise the motivation of a user and conversely, a user-interface that is below a learners' accustomed standards, might cause frustration and lack of interest. It is important that navigation through the environment is not a challenge on its own. Also devices that visualize the attendance of others might affect collaborative work and communication positively.

- *Interaction with the system*

  There is a wide range of possibilities to let students/learners be part of the content building process. In order to tap the full potential of the learning space the range of applications reaches from evaluating each others assignments publicly to large constructivist learning projects, like building up companies or environments.

- *Scope*

  Virtual learning environments are, although often associated with it, definitely not bound to distance education. They may enhance traditional classroom learning as well as serve as a tool in blended learning.

In fact, due to a high flexibility in time that comes along with distance education, a lot of people choose this option even though living close to the offering institution. Thus it is common to provide students with complementary face-to-face meeting options to counteract typical problems arising with virtual learning environments.

According to Witmer and Singer (1998): *"The effectiveness of virtual environments (VEs) has often been linked to the sense of presence reported by users of those VEs."* Furthermore they defined the term presence in the given context as: *"the subjective experience of being in one place or environment, even when one is physically situated in another."*

2.5.2 Learning Management System (LMS)

A Learning Management System is an on-line learning platform, for learner and instructor to access various on-line education services. Also supported by such a system is the coordination of provided learning contents. WebCt, Blackboard and Moodle are three noteworthy representatives among many others. Typical features of an LMS are administrative tasks like access control and the creation of learning content by multiple sources. Tools to communicate like discussion forums or chats are offered as well. (Paulsen, 2002) An LMS is a virtual learning environment but does not fit the specification of Virtual Reality.

2.5.3 Virtual Reality

Virtual Reality (VR) names virtual environments that allow real-time interaction. One can distinguish between three different types of VR's (Moore, 1995):

- *Text-based*

  A users' communication and interaction is managed through text input and text output. The environment is textually described and might be completed with static two-dimensional graphics.

- *Desktop-based*

  User communication and interaction is expanded through joystick and head phones/speakers. The environment comes with 3d animated graphics and multimedia-based features. It does not immerse the user - the user is still interacting with the environment from outside.

- *Sensory-Immersive*

  It is characterized through complex hardware tools such as head-mounted-displays, sensory data-gloves or suits, etc. Supportingly, this equipment provides a feeling of immersion and iteration within the virtual environment rather than with the VE.

2.6   Current Situation of E-Learning

Living in an age of globalization, where international dialog becomes a daily routine and multinational corporations require high qualified human resources,

knowledge sharing and transfer is more than ever essential to economical success. Governments, companies and research boards support the development of e-Learning for various reasons. One good reason is to assure a high standard of education. E-Learning combined with the amenities of the Internet provides a broad base, offering access to information at any time and place. Even though traditional classroom education can never be equally substituted, it does not always fit the needs of our current life-long-learning society best. Technology progress forces employees to steadily train and renew their skills to keep pace with the state of the art. Motivated by the growing impact of human resource development on economical competitiveness, companies spend large amounts of money on training and education programs. In 1999 American companies have already spent three billion American dollars on technology supported personnel education. Also, open access to education is nowadays frequently under discussion. Well known suppliers of open and distance education in Europe are for instance the "Open University of the Netherlands" or the "Open University of Catalunya", that are also part of a committee, organizing "The Seventh Annual Open Education Conference" (*The Seventh Annual Open Education Conference*, 2010). In order to offer equal future prospects to young people, independent of their remoteness, ethnics or health condition, modern technology has already been used to facilitate access to education. (Zhang & Nunamaker, 2003)

2.6.1 The Significance of E-Learning

The necessity of e-Learning can be explained from different perspectives. Primarily, the value of knowledge is changing from a more vocational training into a lifelong learning process. Consequently also the age, needs and time flexibility of the target group varies significantly. Due to this changing stereotype of learners, e-Learning is gaining more and more in popularity. A high percentage of today's students are only part time students, sometimes even having families at home. Supported by these days' technological options, self centered education opportunities can be offered as a portable, flexible and cost saving alternative to traditional classroom education. Blended learning as well as pure e-Learning, currently also referred to as distance learning, are playing a fundamental role in present and future learning applications. (Varnava-Marouchou, 2004; Zhang & Nunamaker, 2003) In Duan and Jiang (2008) it is additionally argued that e-Learning is boosting a students' creativity and activity level by adjusting educational routines into a student centered rather than an instructor centered process.

In the article Zhang, Zhao, Zhou, and Nunamaker (2004) the following Table 2.1, comparing e-Learning and traditional learning methods is presented:

2.6.2 Problems and Limitations

Social Aspects

Nowadays e-Learning is used commonly as an enhancement of traditional classroom learning. Offering additional access to learning material, literature

and discussion platforms, it is still limited in terms of awareness of other participators. Consequently, a lot of this information exchange tends to be asynchronous. This seems to be perceived as a problem particularly in distance education programs, which offer a high percentage of classes and learning materials exclusively on-line. Discussed shortcomings are (Sheehy, Ferguson, & Clough, 2007; Monahan, McArdle, & Bertolotto, 2008; Chittaro & Ranon, 2007):

- *Little personal contact*
  Motivation lacks caused by technical or educational issues lead to high drop out rates. Often there is no contact person when problems appear. Instructors are often overwhelmed with work.

- *Very high drop out rates*
  Due to a lack of social contact with other students as well as tutors students often experience motivation problems, while not perceiving to be part of something. Also, little teacher's feedback and missing support with technological issues may lead to students' getting lost and being over-challenged.

- *Missing Benefit*
  Students can't recognize the added value using e-Learning components

- *Exclusion through information gaps*
  Nowadays, we are living in an era in which, for a majority of people, all day Internet access goes without saying. Thus a new disadvantaged group is coming up, out of financial or infrastructural limitations.

- *Little synchronous teacher contact*

  Underestimation of expenditure of time often leads to disproportional high working loads for available staff members, that they are no longer able to cope with.

- *Usability of Interfaces*

  Insufficient instructions combined with inexperienced computer users often lead to a rejection of the environment.

Security

Apart from all the positive aspects and enhancements technology brings along, gaps and error sources are probably unavoidable. In the following a selection of security problems in e-Learning (Warren & Hutchinson, 2003; Sheehy et al., 2007) are presented:

- *Privacy*

  Mechanisms to ensure data security are needed to be taken into consideration. On-line accessibility of personal student data like grades or identity, not only ask for awareness on the system developer side, but also for an elaborate user guidance through the emerging risks according to data security.

- *Fraud*

  Is there a key to identify a virtual user positively? This is not only an issue in terms of learning (taking exams) but also in terms of harassment committed through unauthorized persons. Some environments have rules and restrictions to protect specifically minor users. The

question remains, whether and how it might be possible to ensure a user's identity to one hundred percent.

- *Reliability*

  An on-line system can never be as reliable as personal contact. Problems concerning download and upload of documents and the fail of file sending may arise, especially towards the end of a project time line.

2.7 Discussion

First approaches of distance learning can already be found in the 18th century. These, only based on the presumption that distance education might work, were applied through correspondence between instructor and learner. Nowadays researchers all over the world try to backup and enhance theories and practices of distance learning usually provided as some kind of e-Learning. (B. Holmberg, 2005)

According to K. Holmberg and Huvila (2008) the difference of learners in time and place are still major factors for dropout rates in distance learning. Some simply caused by technological difficulties where no assistance is found and others triggered through the perception of social isolation.

Sheehy et al. (2007) amongst others states that virtual 3D worlds are able to solve some of e-Learnings constraints or problems corresponding to social awareness. The main difference is explained by the visual attendance of a virtual persona. During a research project concluded in K. Holmberg and Huvila (2008) participants stated that virtual worlds would represent a more pleasant and fun to work with alternative to other web-based learning

environments. Also it could not replace face-to-face education but for those who would not have a chance to physically participate, like in pure distance learning, virtual worlds could bring one closer to a face-to-face learning experience than previous e-Learning approaches. A virtual campus pervades a certain atmosphere which is generated by the abstraction of a real world environment and makes an operator perceive it as somehow real.

	Learning	E-Learning
Advantages	Immediate feedback	Learner-centered and self paced
	Being familiar to instructors and students	Time and location flexibility
	Motivating students	Cost-effective for learners
	Cultivation of a social community	Potentially available to global audience
		Unlimited access to knowledge
		Archival capability for knowledge reuse and sharing
Disadvantages	Time and location constraints	Increased preparation time for the instructor
	More expensive to deliver	Not comfortable to some people
		Potentially more frustration, anxiety, and confusion

Table 2.1: Pros and Cons of E-Learning vs. traditional learning Methods (Zhang et al., 2004)

Chapter 3

3D Worlds in Social Learning Settings

"[...] thoughtful application of VW technology will significantly enhance the experience and transfer of learning."(Cross, O'Driscoll, & Trondsen, 2007)

This chapter introduces the concept of 3D worlds and its relation to Collaborative- and Distance Learning. After giving a definition and introducing common terminology, the relevance of 3D worlds for e-Learning is discussed. Arguments are brought forward that explain the importance of collaborative learning in distance education. The chapter concludes with a discussion listing advantages but also potential problems that may arise using 3D worlds in collaborative learning settings.

3.1 Introducing Virtual 3D Worlds

A Multi User Virtual Environment (MUVE) is defined as a computer program, simulating an environment usually aligned to physical forces. Often it is tried to emulate real world atmosphere, by reconstructing buildings and sometimes even whole areas. The user's virtual representation can move around and look at objects from different angles. To develop a relation to the environment and other participants, each user has its own virtual identity. Whenever such an identity is on-line, it can be perceived by other users. MUVEs support asynchronous and also synchronous communication. Being aware of other users' presence, one can use text chat and sometimes also VOIP to communicate with others. Facial expressions and body language might be provided as well. (Maher, Skow, & Cicognani, 1999) Now, one may have noticed that this notation provides no constraints in regard to an output format and according to that, covers all sorts of interfaces. Therefore, a 3D virtual world can be seen as a specialization of a MUVE.

One can find reams of definitions for 3D worlds. The following is taken from Boulos, Hetherington, and Wheeler (2007): *"A virtual world is a computer based, simulated multi-media environment, usually running over the Web, and designed so that users can 'inhabit' and interact via their own graphical self representations known as avatars."*

In accordance with Dickey (2005), three dimensional virtual worlds are one of the new emerging technologies, that are currently challenging and greatly enriching learning and teaching. Furthermore, a 3D virtual world in Dickey (2005) is defined as:"*networked desktop virtual reality in which users*

move and interact in simulated 3D spaces." Also, it comes with the following three characteristics (Dickey, 2005; Berge, 2008):

- *Interactivity*

  A 3D environment which allows participants to interact with virtual objects as well as each other.

- *Embodiment*

  An avatar can be explained as a user's visual representation within a 3D virtual environment. It allows one to communicate with other participants' individually invented characters, to move freely within the environment and to interact with existing objects. The camera is usually linked to the avatar.

- *Supporting Communication*

  Necessarily provided are synchronous applications like text chat or voice over IP. Asynchronous tools might also be available.

Through a browser or via standalone client application accessible virtual 3D worlds are based on Web3D standards. According to Nigel (2007) Web3D is defined as: "*the generic term commonly used to refer to any three dimensional (3D) graphics technology supported by the World Wide Web (WWW).*" Examples for such technologies are the Virtual Reality Modeling Language (VRML), eXtensible 3D (X3D) and Java3D. (Nigel, 2007) Chittaro and Ranon (2007) found that Virtual Reality VRML and X3D are the most common open standards (ISO) in Web3D.

3.2 Existing 3D Virtual Environments

Frameworks presented in this section are only a very little selection of a constantly growing set of 3D virtual applications. However, those three are commonly used for research in virtual education and therefore interesting for this research.

3.2.1 Second Life

The on-line 3D virtual world called Second Life was founded by Linden Labs in 1999. It offers residents the opportunity to move freely, designing and creating their own reality. Nowadays, it is used by people amongst others in the fields of communication, education, economy and advertisement. Through the easy to handle access it is available for a broad audience. Basic user accounts are free of charge. Only a single download of the client program followed by its execution are necessary to get started. A new user starts out placed on a so called orientation island, in order to fulfill some easy assignments before continuing. Generally the virtual environment is divided in mainland and islands. User holding premium accounts are qualified to buy and sell land at mainland or may even purchase whole islands. Like in real life monthly costs for the land (fees) have to be paid. On exchange the owner of land gets certain rights like building and planting but also to restrict the access for other residents. The existence of an intern currency called Linden Dollars (L$), allows to emulate economical simulations. (*Second Life Wiki 1*, n.d.) Inspired by the structure of Second Life an open source, 3D application server that is called OpenSimulator came into existence. Not only a

similarity in features exists, but also the SL viewer, amongst others can be used to access the so called Open Grid environment. Although, a number of projects and research using OpenSimulator already exists, the application is still considered to be alpha software. (*OpenSimulator Wiki*, n.d.)

Interface

Image 3.1 shows version 2.0.1 of the Second Life's client interface. Please note that Second Life's client interfaces change repeatedly and may differ depending on the operating system.
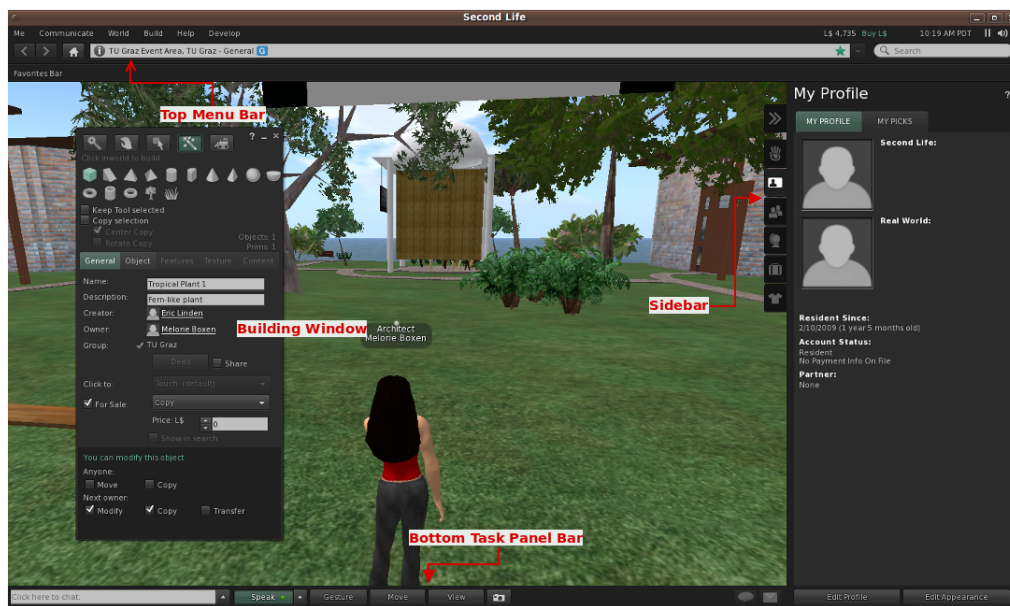
Figure 3.1: Second Life - Client Application Interface

Top Menu Bar

The top menu contains within its sub menus the most of options, tools and features the SL viewer offers. These include windows to configure parameters of land and the viewer itself. The bar below contains data

37

about the avatars location and movement behavior.

Bottom Task Panel Bar

This menu bar includes controls relevant for interacting within the environment. Basically it serves for communication, movement and view. Moving is also enabled by using the arrow keys.

Sidebar

Includes all items concerning the personal and social data of the avatar. Examples for such are registered friends, a personal profile, an inventory for saving objects, etc.

Building Window

The Building Window is an essential tool for creating content in Second Life. It allows to not only create objects, but also to move, rotate, resize them, amongst other features like scripting behavior or changing surfaces by adding textures.

(*Second Life Wiki 3*, n.d.; *Second Life Wiki 4*, n.d.)

Critical System Requirements

Although, a Second Life client application is available for Windows, Linux and MacOs the here presented data matches the minimal system requirements of Windows PCs. A complete listing can be found at *Second Life Wiki 2* (n.d.).

System Requirements - Overview	
Operating System	XP Vista Linux Mac OS
Computer Memory	512 Mb
Computer Processor	800 MHz Pentium III or Athlon
Internet	Cable DSL
Graphics Card	NVIDIA GeForce 6600 ATI Radeon 8500, 9250 Intel 945 chipset

Table 3.1: Second Life's minimal System Requirements
Second Life Wiki 2 (n.d.)

Relevant Constraints

Second Life runs on Linden Lab's company server with Linden Script Language (LSL) as provided programming language. For the advanced usage of Second Life one has to learn a new and to this environment restricted programming language. Also, only a limited scope for design is provided, as it is not possible to change code of the server application. Thus, the integration of other software applications is fairly hard to realize. In education the financial aspect might also be an issue. Firstly, one has to pay for land and secondly for some essential functions to work in-world.

3.2.2 Open Wonderland

Till February 2010 Open Wonderland was a project lead by Sun Microsystems. Then it was passed over to a non-profit organization named Open Wonderland Foundation. The open source framework is usable free of charge

and licensed under GNU General Public License version 2.0. Available for downloads are a server application and a client viewer. Both is based upon java code and not labeled as products but is to be seen as future- and research-oriented technology. Everyone, mastering the Java programming language, might be able to create and adapt virtual worlds to their needs. Therefore, the extension of the server framework is supported. Some changes can also be realized with system administration skills, since the server comes with a Web-Administration-Interface. The Open Wonderland framework works with modules that can be added to individualize the server application. An administrator can write and share its own modules, just as well as obtaining it from the "Module Warehouse". There are some standard applets already available within the system. Through the handling of simple menu controls, single and multi-user 2D programs can be assigned, including Open Office tools, Firefox or even a white board implementation. Such are called shared applications. According to *Open Wonderland 1* (n.d.) the target of this project is to provide a framework for the end user which is functional, secure, scalable and reliable enough to serve as a serious platform for educational as well as commercial activities. (*Open Wonderland 1*, n.d.; *Open Wonderland 2*, n.d.)

Interface

Worth to be mentioned is the user-friendly installation of the client application. Since an application is offered, that downloads and launches the client application automatically, primary users only need to push the button and wait until the client is installed. The only precondition is an installed java

version. Figure 3.2 illustrates the Open Wonderland client application.
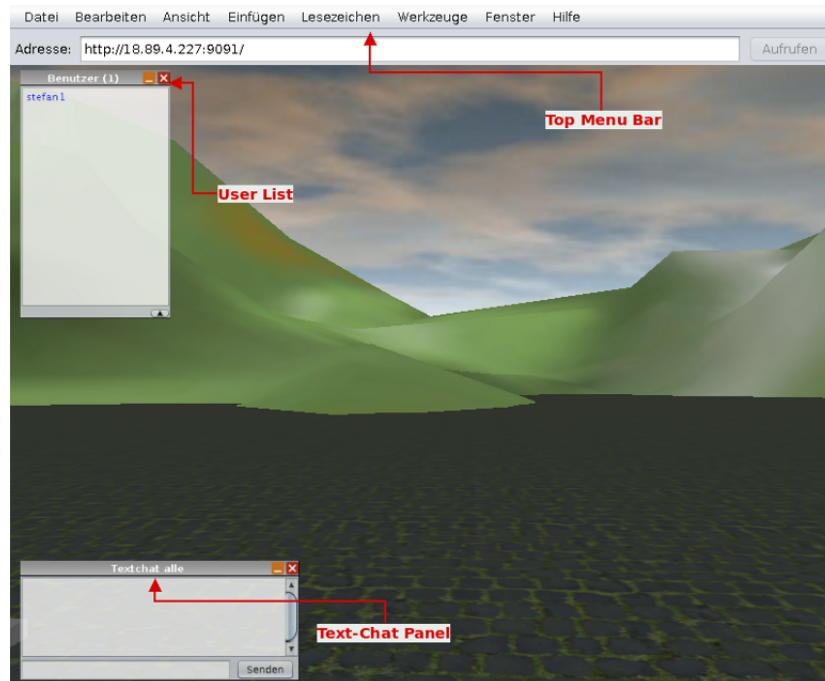
Figure 3.2: Open Wonderland - Client Application Interface

Top Menu Bar

At the top of the frame the main menu is located. It offers a wide range of features, starting with an adaptation of the client interface by adding other option windows to the view, up to the insertion of objects and modules.

User List

All users being on-line in the same Wonderland world are listed in this window. For a selected avatar, settings like volume of voice chat amongst others, can be adjusted.

Test-Chat Panel

In this window, chat interactions of all avatars located in the Wonderland world are displayed. To participate in the communication, one has to type a text into the bottom text field and press send.

(*Open Wonderland 3*, n.d.)

Critical System Requirements

System Requirements - Overview	
Operating System	Windows Mac OS X Linux Solaris
Computer Memory	1 GB
Computer Processor	1,5 GHz
Internet Connection	DSL-speed link needs to be a wired Ethernet connection
Graphics Card	NVIDIA with at least 128 MB 256 MB for proper performance

Table 3.2: Open Wonderland's recommended System Requirements
(*Open Wonderland 2*, n.d.)

The viewer of the virtual environment will run at all operating systems, since it is based on java. Nevertheless, for the server application a Linux or Solaris machine is needed. (*Open Wonderland 2*, n.d.)

Relevant Constraints

System requirements demand 1GB computer memory. This already asks for a notebook not older than two years. Testing the viewer showed that at least 2GB should be available to work with the environment in a satisfying

speed. Also, a graphic card of NVIDIA is highly recommended to use. Such requirements reduce the amount of potential end-users. Running and administrating the server application brings great autonomy but just as much responsibility. Especially if the system is used within a big organization one has to consider the cost-benefit relation.

3.2.3 Activeworlds

The Activeworlds Corporation owns the 3D virtual framework, that is currently used in business, entertainment and education. Currently, the companies server hosts more than 1000 virtual 3D worlds. Depending on the amount of money one is happy to spend, the quality of the package varies. A customer may choose between different products. Some extended solutions even allow the importation of 3D objects, created with 3D modeling tools. Also, the programming and assignment of applets is possible, although the programming language is restricted to C. The range starts with single rooms and goes up to whole universes. While VOIP is not a standard feature, a world's host can enable it, purchasing it as an extra tool. End-users have two different options to visit Activeworlds. Firstly, with a guest account and secondly as a citizen. Guests only have restricted permissions, but a citizenship comes along with utilization fees. In-world, an end-user has typical options available, like to fly, run, jump and dance or also teleport from one place to another. Additionally, creating and moving around objects is supported. Due to the interest of educational facilities, an Education Universe emerged. The company offers reduced fees for virtual space, located within

this area. (*Activeworlds 1*, n.d.)

Interface

Figure 3.3 provides a glimpse at the client application of Activeworlds, followed by a short explanation of some displayed menu items.
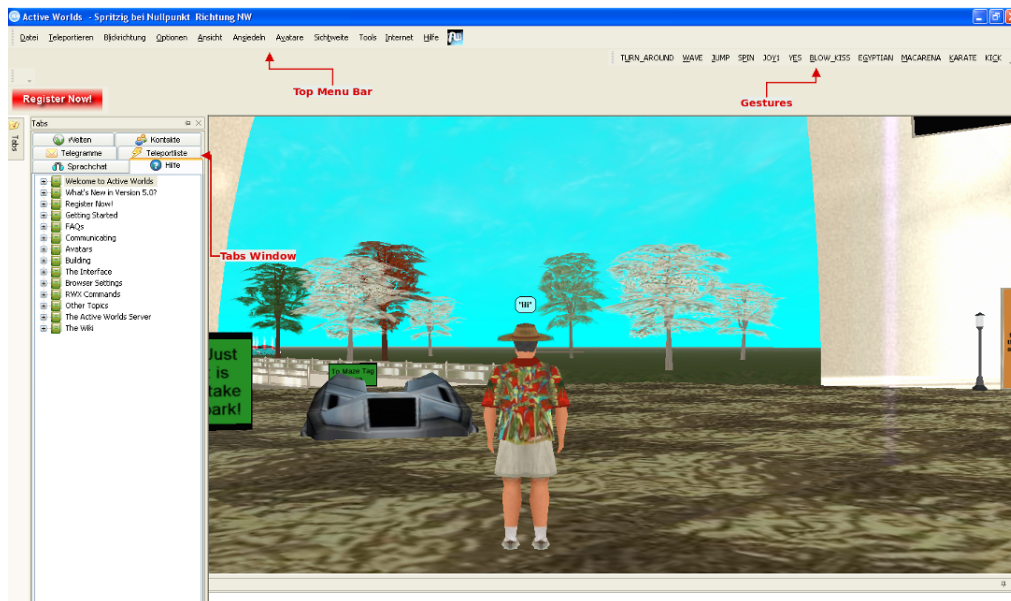
Figure 3.3: Activeworlds - Client Application Interface

Top Menu Bar

> The menu offers access to adaptable parameters of the client application as well as features to communicate and generally interact in the virtual world.

Tabs Window

> This window can be enabled using the Menu Bar's Show Menu (Ansicht). It provides a quick view on different serviceable information arranged through tabs.

Gesture Bar

> Also the gesture bar is not displayed by default. After turning it on in the Show Menu, an avatar can be animated by a simple click on one of these buttons.

(*Activeworlds 3*, n.d.)

Critical System Requirements

Here presented system requirements specifically apply to the Active World Education Universe (AWEU) (*Activeworlds 2*, n.d.).

System Requirements - Overview	
Operating System	Windows 98 ... Windows Vista
Computer Memory	128 MB
Computer Processor	800 MHz
Internet Connection	not reported
Graphics Card	3D accelerated video card (>= 64MB)

Table 3.3: Activeworlds' recommended System Requirements (*Activeworlds 2*, n.d.)

Relevant Constraints

The use of the framework is subject to a charge in two aspects. For one thing, administration rights for virtual environment are brought into account and for another thing utilization fees for avatars apply. Additionally, the number of avatars allowed to be on-line simultaneously is restricted. The server space is hosted by the company and therefore it is necessary to trust their privacy policies as well as their quality standards. Also, the system's restriction to Windows operating systems is unfavorable.

3.2.4 Comparison of selected Frameworks

The former presented 3D virtual worlds are commonly used in educational research and were therefore the options to choose from for this project. Various aspects were illustrated and considered, in order to select the most appropriate framework. The three most crucial factors formed:

1. **Access**

   As this is a research project, as many learners as possible should be able to use the environment. Access might be restricted due to high system requirements or the compatibility of the client application. If one looks at the three presented frameworks one will see that the requested system requirements for Activeworlds are by far the lowest. However, since it is only available for windows operating systems, Second Life was ranked first in this characteristic.

2. **Financial Aspects**

   Two of three frameworks come with substantial costs. Only the Open Wonderland server is freely available to use. Also, there is no need to provide students working in an Open Wonderland world with additional money. Therefore, Open Wonderland is ranked first and Second Life take the second position. Activeworlds is placed last, as Graz University of Technology already has a Second Life island at command.

3. **Server Handling**

   The first test run was conducted at Curtin University of Technology in Perth, Western Australia. To host a publicly accessible virtual world

server would have been combined with a huge administration effort. Also, it wasn't planned to deal with any kind of sensitive data in-world. Thus, a virtual world hosted by the providing company was preferred.

Mainly based on the presented aspects, Second Life was selected as framework for this research project. But also interest in particular use of Second Life as technology was drawn, caused by statements like the following: *"Linden Lab's Second Life is perhaps the most popular virtual world platform in use today, with an emphasis on social interaction."*(Boulos et al., 2007)

3.3 How E-Learning benefits from 3D Worlds

Generally speaking, 3D virtual worlds facilitate learning throughout demanding situations. This could be the degree of difficulty, heavy research costs or great distance between participating parties (Chittaro & Ranon, 2007). Virtual 3D worlds can also improve learning for people suffering from certain handicaps, such as reading difficulties. The broad spectrum of visualization techniques for learning content alongside the possibility to interact with the environment may reduce the knowledge acquisition gap for affected groups. (Moore, 1995) Furthermore, in contrast to traditional face to face education, 3D-VE's are a welcome platform for constructivist learning schemes which supposedly are less time consuming in knowledge acquisition and provide a more enduring learning effect (Chittaro & Ranon, 2007).

Below, some arguments found in Dalgarno and Hedberg (2001) and Cross et al. (2007) describing positive affects that arise using 3D worlds are pre-

sented:

- *Ease of Communication*

  Currently used VWs usually offer embedded VOIP which facilitates the communication between students and teachers and also amongst students. It makes it easier to ask questions, to give lectures or simply communicate with each other.

- *Sense of Community*

  A student develops an emotional connection to his/her virtual representation, called avatar, and is able to communicate with other avatars. That leads to a learner's perception of being part of a community.

- *Combination of Computer Applications*

  Integrating existing Learning Management Systems into VWs offers the advantages of both technologies. An example of such an implementation is the Moodle-Interface used in the 3D-VW Second Life.

- *Simulation*

  There are areas in all kinds of research fields (e.g. economics, physics, chemical engineering, etc) where the practical training of knowledge may be difficult. The reasons can be financial and/or security related. Without the need of hazarding any real consequences learners are able to gain experience in their field by practicing up to a point where they are completely satisfied with their performance. Also, it is easier to apply knowledge in the same or a similar environment it was acquired in.

- *Viewing Angles*

  Building and observing objects and their behavior from all different angles can be used to facilitate and improve the understanding of complex structures, for example geometric or physical objects.

- *Independence of Place and Time*

  The reconstruction of buildings, landscapes or maybe even whole geographical areas as well as an avatar's ability to teleport from one place to another, makes it possible to travel virtually through time and space. Certainly, this offers meaningful improvements not only in teaching subjects such as history, geography or architecture, but also in language, cultural education and others.

- *Knowledge Sharing*

  Watching other learners create spectacular objects such as buildings or vehicles, often animates students to share knowledge collaboratively to achieve higher goals. Sometimes they are also animated by an emerged community spirit.

Also, Ang and Wang (2006) argue that ICT and in particular virtual worlds increase the dedication of learners. They tested their argument by letting badly performing students try to complete learning tasks in a 3D virtual world. The idea was to let them visualize abstract content (in this case planets) that is otherwise intangible and/or difficult to look at/examine. The research showed a positive outcome, evaluated through students performance, observation and interviews.

Sanders and McKeown (2007) present advantages of a virtual social space, which learners experienced using their 3D Action Environment: *"Students know and can see when their colleagues are logged into the world. They can walk up to another and talk to them about life, work, or the latest news. Through these interactions, both planned and serendipitous, students begin to create knowledge together. They talk about the work they are doing in class, they share ideas, processes, and resources with one another and contribute to the base of knowledge that exists in their field."*

In the research work K. Holmberg and Huvila (2008) it was stated that: *"Second Life produces a more realistic feel of presence than discussion forums or chat rooms."* Whereby in this case, Second Life is representative for any 3D virtual world and thus it can be concluded that virtual worlds might enhance distance learning since the lacking sense of presence is a fairly known issue in distance education.

3.4 Discussion

In this chapter positive arguments as well as limitations of 3D worlds in social learning settings were presented. Advantages are for instance the easy use of simulations in demanding learning situations, the possibility to visualize learning material for handicapped students, a new level of knowledge sharing among learners or an envolved feeling of presence which might act contrary to drop out rates in distance learning. Moreover, virtual environments offer a completely new opportunity to collaborate, independent of a team's geographical dispersion. They run on server based applications which often can

be accessed through simple Internet Browsers, extended with appropriate plug-ins or easy to install client applications. (Chittaro & Ranon, 2007) This offers great new possibilities, for instance to support collaborative research, language teaching or teaching in general. Imagine an on-line university with students all over the world attending classes only held by leading experts in their field.

Although such perspectives sound amazing, lets take a look at some potential problems:

1. **Proof of identity:**

   It is not only a problem to identify students and their work, also the identity of teaching staff can be critical.

2. **Data security:**

   Since data that is used in the 3D world is usually stored at the provider, one needs to trust their security and discretion policies. The same holds for intellectual property created inside a 3D world.

3. **Group dynamic:**

   Although many papers label anonymity as an advantage of virtual 3D worlds, in Sheehy et al. (2007) some students complained about not knowing other participants in person. This even caused frustration. Nevertheless, being aware of the existence of other users can be seen as a big improvement for e-Learning. Supposedly it leads to a virtual formation of groups.

4. **Learning difficulties:**

   Learning problems may arise if text chat is the only available communication device. Little typing skills or already low quality Internet connections might lead to restrictions in asking questions or in simple communication. (Dickey, 2005) Contrary, it was mentioned that constructivist learning and the visualization of learning material may help handicapped learners.

In conclusion it remains to say, that besides all advantages and drawbacks technology can only be as good as it is used. Like stated before, Chittaro and Ranon (2007) name the often poor preparation of teaching staff as one of 3D worlds major problems. Sometimes, this surfaces in illustrations of lecture material unsuitable for e-Learning but it can also appear as negative attitudes. The latter phenomenon is explained in literature not only by the educators' missing knowledge, but also by the unavoidable extra work caused by restructuring of approved sequences and by a general reluctance to new technologies. Thus, even the best e-Learning system is likely to fail if it is used badly. In the end a lot depends on pedagogical preparation and support work in the background.

To provide an idea of previous research, the next chapter presents a selection of e-Learning projects that use virtual 3D worlds in order to enhance blended- and distance education.

Chapter 4

Existing Work on Blended- and Distance Education within virtual 3D Worlds

When it comes to the integration of ICT into a well attuned environment, participants often have a rather negative attitude towards resulting changes. Berge (2008) reasoned that there has to be a reasonable educational benefit for learners and teachers to legitimate an implicated additional time investment for familiarization. The number of hours a beginner needs to operate comfortably and efficiently inside a virtual world (especially referring to Second Life) is usually in a double-digit range. (Berge, 2008)

The challenge is to find teaching scenarios that cannot be realized effectively in traditional classrooms, but are likely to improve through the use of 3D virtual reality. An easily comprehensible example, amongst many other areas, represents the field of distance education.

This chapter presents exemplary a small selection of research works in this field.

4.1 Constructive Learning with Activeworlds

Dickey (2003) provides an informative review of the three 3D virtual worlds "Activeworlds", "OnLive! Traveler" and "Adobe Atmosphere". A discussion, questioning each world's ability to enhance learning in positive ways, is performed and concludes in the prediction that 3D virtual worlds are not only able to offer new promising opportunities in traditional classroom education but also in the field of distance learning.

The author's subsequent research addresses concrete projects, using the Activeworlds framework. Details of the paper Dickey (2005), discussing two different projects, are outlined hereinafter. Both samples intended to teach under the concept of constructivist learning, which is generally known to be supported by 3D worlds. In the first project a virtual environment, simulating a campus with different houses, and places to meet and stay was constructed. Students had to successfully complete individual tasks and also group projects. For the collaborative assignments, several patios (common areas), see Figure 4.1, that allowed students to chat and meet were offered. Also, links leading to relevant task information were provided.
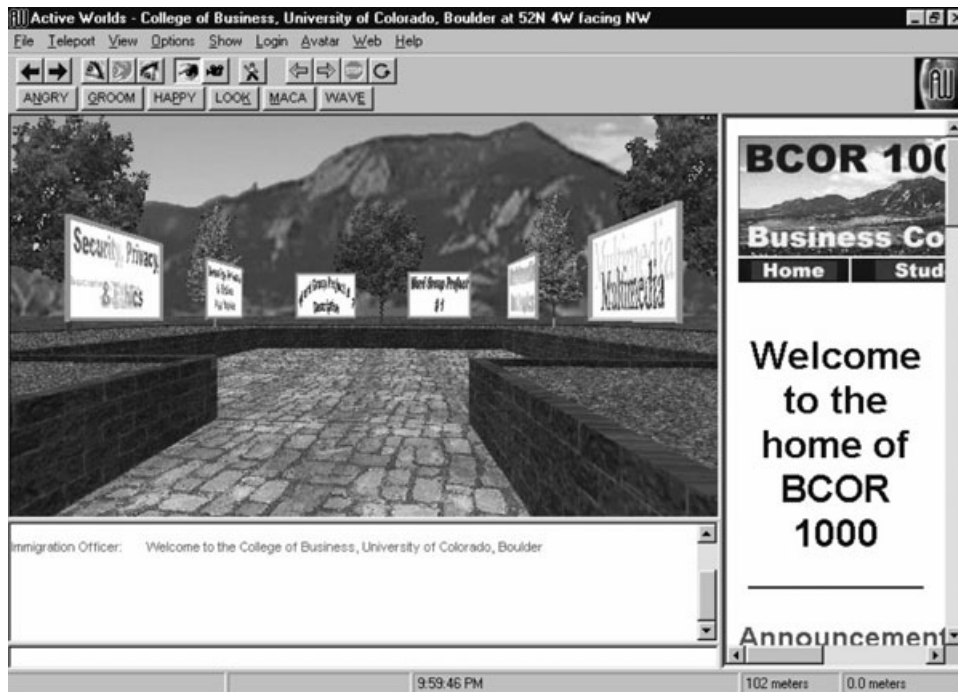
Figure 4.1: Common Learning Space to complete Collaborative Group Work (Dickey, 2005)

An evaluation resulted in mainly positive feedback. Some of the advantages perceived by students are the liberation from obligatory physical classroom attendance and a more relaxed working atmosphere caused by the anonymity of ICT.

The second experiment is an example for blended learning and thus, does not fit the definition of distance learning. It was performed as a lecture, teaching 3D object modeling, which is an application field not so far to seek. Students were trained during units of two hour classroom sessions. The lectures were discussion based and supported by 3D-illustrations, see Figure 4.2.
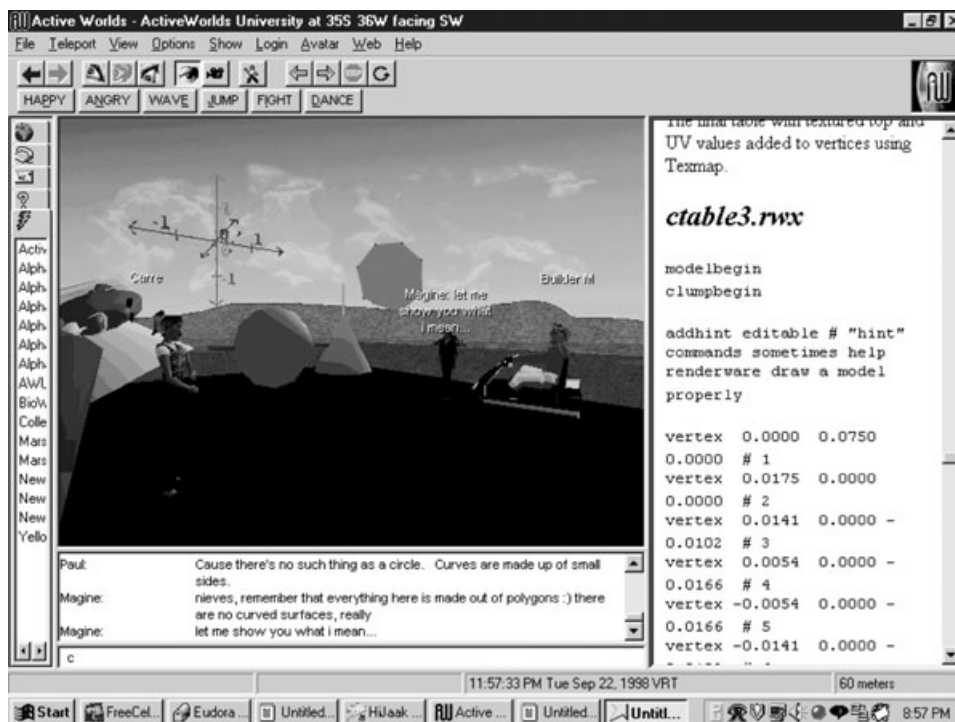
Figure 4.2: Environment during a 3D Modeling Class
(Dickey, 2005)

A main advantage was found in the visualization of objects as well as the opportunity to look at them from different perspectives. Even though the general feedback was positive, problems were reported, due to the restrictions of communication channels to text chat. Hence, each student's participation in discussions strongly depended on typing abilities.

Finally, two conclusions of the research work are outlined (Dickey, 2005):

1. Like in every teaching situation, a teacher's education and attitude play a significant role. Using ICT, one could even say the quality of learning material depends strongly on an educators IT knowledge and his/her degree of familiarization with the specific tool. Another crucial requirement is the adjustment of the learning material's presentation

to a particular learning environment or equipment.

2. Students mentioned the relaxed working atmosphere as an advantage. However, it is questionable whether the loss of interpersonal distance could turn into a disadvantage, leading to abusive behavior in long term use.

Another example for constructive learning with Activeworlds can be found in Bronack et al. (2006). This paper reports about a project initiated by professors of Appalachian Sate University which is called Appalachian Education Technology (AET) Zone. Motivated by the demand to build up a stronger sense of community between different parties, involved in a distance learning program, the AET Zone arose. The virtual learning space is based on the Activeworlds Universe Server application, that is hosted at a university server by university internal technicians. Beside various class areas, a space for orientation and common interest was created. Figure 4.3 presents an overview of this region including a library, a service center, common areas and a teleport station. Classes were given in separate zones, each arranged to fit the necessities of a destined learning scope, while also considering a lecturer's teaching preferences. The setup of a hypermedia class serves as an example. To let the students experience the functionality of hypermedia a labyrinth consisting of hyperlinks was created. The target of the class was to find a way through this maze. (Bronack et al., 2006)
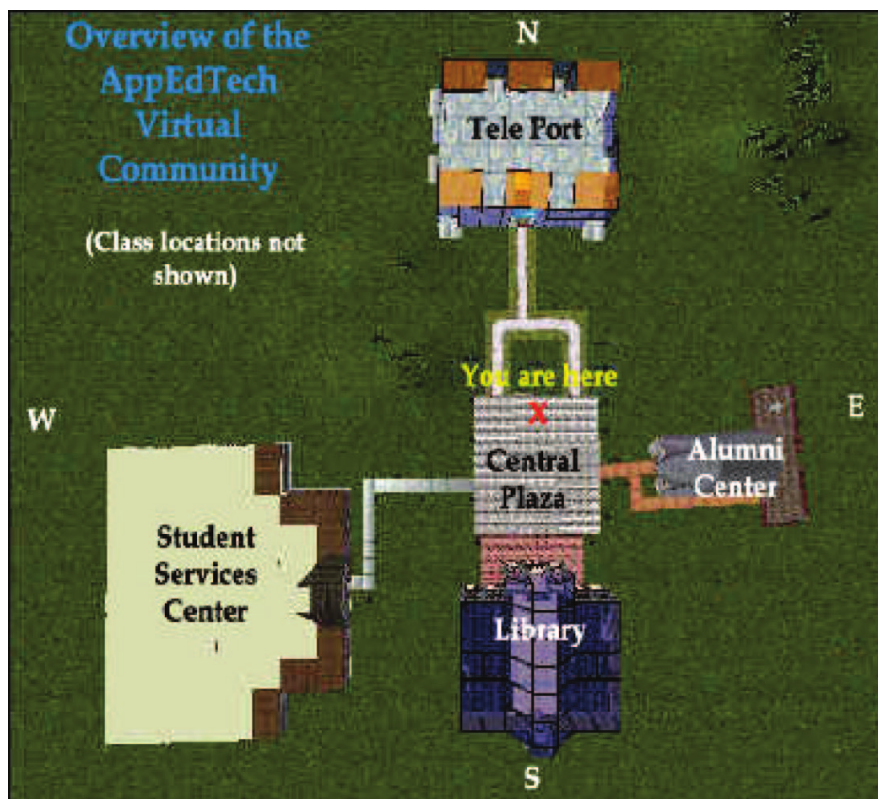
Figure 4.3: Learning Environment - Overview
(Bronack et al., 2006)

The response of students using the program was predominately positive. Even though some starting difficulties were reported, after a certain familiarization period advantages dominated. Students with jobs or family benefit the most from virtual learning properties. This is explained by more flexibility in time and no need to move to a particular place. University attendants however, described a modification of their own understanding of student-teacher relationship as well as in their teaching approaches. The virtual learning environment provoked a learning and discussion culture across class domains. Thus, a community arose, where learner and instructor interact with other participants, regardless which course or year they belong

to. (*Appalachian's 3-D virtual campus receives Campus Technology Innovators Award*, 2006; Bronack et al., 2006)

4.2 Collaborative Learning Environment with Virtual Reality (CLEV-R)

This section is based on information that is presented in McArdle, Monahan, Bertolotto, and Mangina (2004). At the University College Dublin a prototype of an e-Learning platform called CLEV-R was created in 2004. The environment based on a virtual reality framework imitates the real world university. Teaching takes place within different buildings like lecture halls and collaboration rooms. Students and lecturer are embodied as avatars and able to communicate using gestures, text or voice. In order to allow an adequate presentation of learning content, the use of multiple media types like audio, video and picture formats is supported. Figure 4.4 shows a screen shot of the environment, accessible through a simple Internet browser. The graphical user interface is split into two parts, displaying the 3D virtual environment on the upper section and available controls to interact with the system right below. If we look at the picture we can see a teacher giving a lesson in a lecture room equipped with a slide board. Learners may use the lower part to communicate with others, change their status or look for avatars being on-line at the same time.
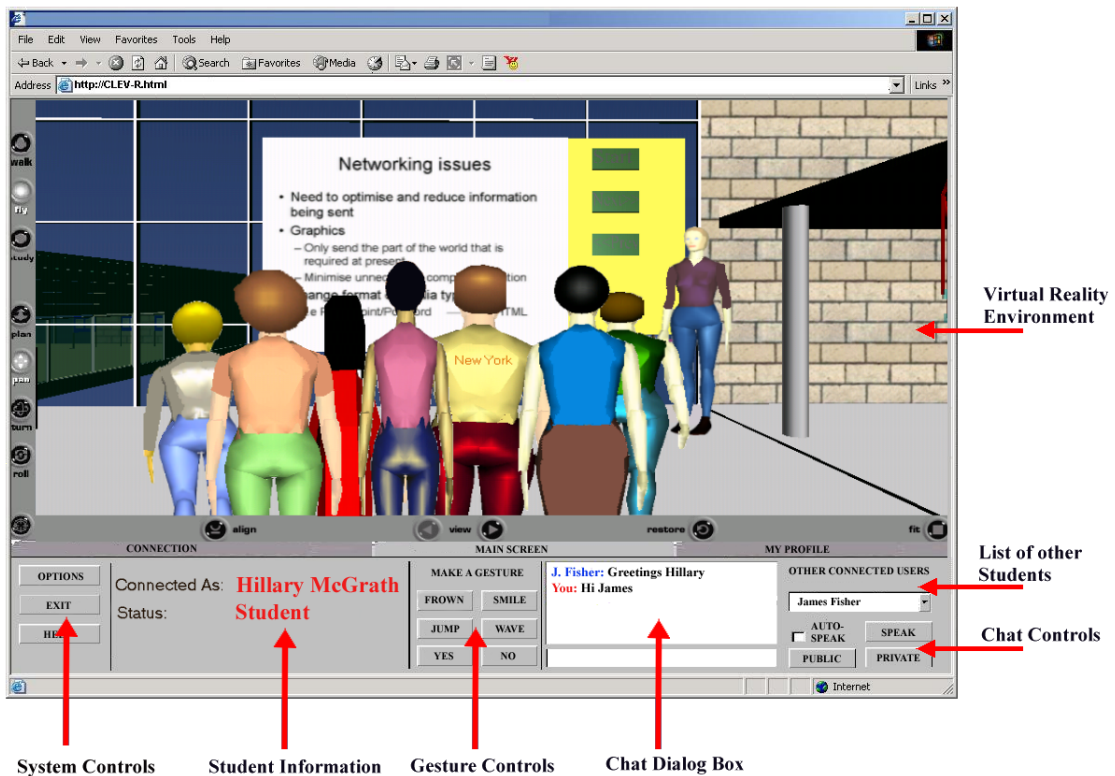
Figure 4.4: CLEVR
(McArdle et al., 2004)

The overall idea is to provide students with a virtual space not only for learning but also to socialize with like-minded people. Therefore, the environment offers non-formal areas to upload media and enjoy it with others. Providing a list of on-line participants might be conducive to build social contacts and thus, to arouse some kind of group dynamics. Unfortunately, there is only very little information about the user evaluation of the prototype. Only two major problems are discussed. The first one is dealing with the learning environment's representation in real-time. As the 3D graphics took too much time to load, this was influencing the user satisfaction negatively. The second one is concerning orientation issues. To solve the latter

problem, the use of a 2D map as a navigation guide, enhanced by a feature to find other avatars in-world, is recommended and also part of the project groups future work. (McArdle et al., 2004)

4.3 Second Life - Research of the University of Salerno

During the last few years, researcher of the Mathematics and Informatics Department of the University of Salerno (Dipartimento di Matematica e Informatica, Universita degli Studi di Salerno) examined various experiments in the field of teaching using Second Life, with particular interest in collaborative worlds (e.g. Lucia, Francese, Passero, and Tortora (2008a) or Lucia, Fasano, Francese, and Passero (2008)).

Lucia, Francese, Passero, and Tortora (2008b) describe a project not particularly aimed for education but to work collaboratively within Second Life. The environment, that is explained subsequently, should provide a useful, easily accessible virtual space for group meetings. It is intended to facilitate work related interaction within geographically dispersed teams. To meet the requirements of such a working situation, tools shown in Figure 4.5 and user roles were specifically developed. The screen shot presents avatars, sitting at a round table during a meeting. Right above them one can see three of the available tools, which are a board displaying the sessions agenda, one that records participants' chat activities and the third tool, showing a so called booking list, which gives information about the chronology of speak-

ers. Meeting participants also have a command panel, that allows to influence the meeting sequence, at their disposal.

Figure 4.5: Meeting Setup in Second Life
(Lucia et al., 2008b)

A test-run, including a following evaluation, was conducted by fifteen master students, divided into three groups. Each of them got an assignment to complete that required the use of the virtual application to analyze the problem and design a solution they had to implement afterwards. As stated in Lucia et al. (2008b), the concluding evaluation came out very positively. Participants did not complain about technical issues or additional workload through familiarization time. They scored the environment as generally convenient to work in and the usage of the tools as clear. This results are not as astonishing, considering the fact that test persons were last year master

students of the university's computer science program. One can only assume how the evaluation's outcome would change, having less trained computer user employed. Just sporadically, in one sentence of the conclusion, it is mentioned that SL asks for work arounds to cover lacks in asynchronous communication.

4.4 Discussion

Although e-Learning was all along a popular Web-Application, the amount of suppliers is constantly growing covering all sorts of application areas. In higher education e-Learning is not merely a tool for distance learning, but rather utilized as a complement to traditional classroom learning. Despite the growing assortment, text-based learning platforms often lack in usability and still miss to address social demands of students. Enriched by nowadays high-speed Internet connections, virtual worlds may fill the gaps of text-based interfaces, offering more intuitive handling and by using avatars awareness of a social community (McArdle et al., 2004). Within this chapter examples of different teaching approaches using 3D virtual environments were presented. Factors like the independence of time or the get away from traditional learning methods were proved as positive factors. Also, constructivist learning methods and the easy way to collaborate are factors engaging the use of 3D virtual environments. Furthermore, it was confirmed that the use of virtual identities allow social interactions to become informal. In one example the boundaries between different classes and age groups partly disappeared and a communication beyond this alignments came into existence. To allow this

kind of communication, publicly accessible recreation areas are usually provided. But also negative aspects were discussed. Some instructors expressed concerns regarding the casual way of behaving, since there are no long-term studies on further evolution. Also, the exclusion of particular user groups needs to be avoided. For instance, students with low typing capabilities were reported to ask fewer questions. Therefore, not only text chat but also the use of VOIP is recommended to overcome participation gaps. Even though it seems that proficient IT user might have an easy time working with 3D virtual worlds, problems may arise when people who are not specialized in the field of IT use the same resource. Consequently, the quality of an introduction class might highly influence teaching and learning within the environment. If it is too hard for a learner to get used to the interface he/she might get lost already at the beginning of a learning session. The first step hereby is to properly navigate. In the project elaborated in Section 4.2 the missing 2D map to ease the navigation was discussed. Luckily, modern 3D virtual world frameworks, such as Second Life, already provide this as a standard feature. A last facet to discuss is the quality of presentation of a virtual environment. User generally might not like it if one object appears after another with a time delay of half a second or more. To avoid unsatisfactory system performance, the requirements on a end-user system should be kept in a low and realistic scope.

Information introduced in this chapter, amongst other things, served as a basis for the creation of a 3D virtual collaborative learning environment. The following part of the document gives details according to design and implementation of this environment.

Chapter 5

Design of a 3D World for Geographically Dispersed Learning

Immersive virtual reality (VR), currently deployed in the form of on-line virtual worlds (VWs) is a rapidly developing set of technologies which may become the standard interface to the informational universe of the Web, and profoundly change the way humans interact with information constructs and with each other. (Djorgovski et al., 2009)

Nowadays' generation of learners, commonly referred to as "Digital Natives" or also the "Net Generation" was born after 1980 and therefore raised and educated with a steadily enhancing access to information and communication technology. As a consequence, those enjoy the use of ICT to retrieve information quickly, to comfortably interact over distance and are known to be keen to work in teams of different race and culture. Although, not all stu-

dents fit the profile of a "Digital Native", a change from instructor-centered to learner-centered education, motivated by their demands, is predicted and partly already happening. (Gütl & Chang, 2008; Chang & Gütl, 2010) However, education needs to slowly adapt to current technological options and learner preferences. Thus, it is suggested to concentrate on social networking technology (Jones & Ramanau, 2009). International, scientific communities based on 3D virtual platforms already exist. One successful as well as impressive example is the Meta Institute for Computational Astrophysics (MICA) which is currently located in Second Life. Scientist from the United States, Canada, but also Europe and Asia are working together. Aims of this groups are amongst others to improve international collaboration and to find new teaching approaches enabled through virtual worlds. This non profit organization provides geographically independent and free of cost access to talks and workshops and therefore knowledge, presented by experts in their field (*Meta Institute for Computational Astrophysics - Exploring Astrophysics in Virtual Worlds*, n.d.). That is how the future of higher education might adjust through the use of virtual reality. In this respect, our research project is an approach to enrich teaching, making knowledge acquisition independent from location, time and nationality and meanwhile adapt to current students' generation expectations of learning.

Parts of the information illustrated in this chapter has already been published and can be found in Chang, Gütl, Kopeinik, and Williams (2009) and Gütl, Chang, Kopeinik, and Williams (2009).

5.1 Project Idea

Aim of this project are design and creation of an on-line 3D-virtual learning environment, providing a comfortable and useful space for collaborative group work. More precisely, the completion of tasks by small groups should be supported. In addition, the emerging prototype has to meet the needs of distance learning students enrolled in higher education classes. According to literature, some critical factors were identified in previous projects, as influencing factors on students' drop out rates in distance education. Those include, having a contact person when issues appear and perceiving to be part of a social community. Components, promising to support called demands, have to be integrated.

Also significant is to provide a virtual learning environment, which is convenient to operate even for students without a background in computer science or a related field of application. Also, access needs to be ensured for a preferably wide range of users. Therefore, the system requirements to run the client-application of a selected 3D virtual framework need to be as low as possible.

With this in mind, a virtual learning environment is developed focusing on the following:

- Making the environment a pleasant place to spend time in

- Enabling and facilitating communication among users

- Providing useful tools for collaboration

The result should be an area for group members to work on shared projects

67

within a productive, but also enjoyable, collaboration environment.

5.2 Requirements on a Framework adequate to the Definition of this Project

Based on the project idea, following requirements were identified:

1. **Readily accessible and personalizeable virtual identities for both teachers and students**
   An avatar is the virtual representation of oneself. Thus, it is important to enable customization of appearance to strengthen the personal connection to the digital identity.

2. **Communication between different peers**
   There should be an option for verbal as well as text-based communication. Both options should be available since their services imply different benefits. Giving an example: Text chat can be used to ask questions without interrupting the instructor that currently uses VOIP to lecture. After finishing his/her talk, the lecturer has the chance to answer former inquiries.

3. **Office for consultation hours**
   Virtual 3D-worlds offer the possibility to improve the teacher-student relationship by entering a new social level of communication. The office should serve as a location where an instructor can be found and contacted if required.

4. **Outside break area to get in contact and chat with other students**

   Encouraging social contacts and awareness, the outside area might be a central place, that everyone has to cross entering their private buildings.

5. **Private learning/collaboration rooms with access restrictions**

   One room per group necessary to allow private and undisturbed team work. Since participating groups are supposed to complete assignment tasks in the environment, it is necessary to control access to their private rooms in order to protect students' intellectual property.

6. **Collaboration and learning tools**

   To provide a useful collaborative workspace, the need of supportive tools is not far to seek. Therefore, the private group rooms as the environment's major workplaces, need to be equipped with resources.

   - *Document sharing*

     Communicating with each other while working collaboratively on a document is an important requirement. Its realization can influence the quality of a learning environment deeply. For this project a tool to create and edit a formatted text document, such as a word file, is demanded.

   - *Presentation*

     In higher education an assignment is very likely to conclude with a final presentation. This is why the environment is firstly, asked

to provide a possibility to create and discuss slides and secondly, some tool to conduct a presentation.

- *Swapping ideas*

  sharing of ideas within a team is necessary. Supporting tools for brainstorming or simply to note or point out important facts are desired.

5.3   The Setting

The first prototype will be developed and evaluated at Curtin University of Technology in Perth, Western Australia. Students enrolled in a course at Curtin Business School (CBS), are going to complete an assignment with the assistance of the learning environment. Such an assignment in any case includes the creation of a formatted text file as well as a final presentation. Based on the students' age class, it is assumed that general computer skills and a certain familiarity with 3D virtual environments, is preexisting. Users are not supposed to work at university and therefore have to configure and use their own work stations. Consequently, they can not be expected to possess state of the art, high-end equipment. Complying with the university's internal network security policy is also an issue. Installing a virtual 3D world server application would bring about the need to access this application through the university's virtual private network, that is accessible by university associates only. Thus, installing a virtual world server application on the university server, means to create a 3D virtual space cut off from the world outside the university's campus. Also, such a project would ask for a lot of

technical and administrative effort to cover data security concerns, adapt the firewall and do other adjustments. However, one main advantage of on-line virtual 3D worlds is the possibility to connect and collaborate easily with people all over the world and therefore a framework is preferred, working as a separate instance, outside the university's field of responsibility. A last but critical factor is the project's tight time schedule, conditioned by the user group and their semester timetable, the prototype needs to be available for disposal shortly after midterm. Consequently, a time line of three month is resulting.

5.4 Scope Objectives

Combining the project settings (5.3) with the in Section 5.2 identified requirements, Second Life was chosen as the most adequate framework. The decision is mainly justified by the framework's low hardware requirements and easy to install client application, but also favored because it is running at Linden Lab's publicly accessible server that avoids potential issues with the university network.

Therefore, the objective is the creation of a virtual learning space in Second Life. For the first version of the program, a collaborative work place should be set up, offering room for four groups consisting of three to four students, each. Per team one room or building, equipped with former identified tools (5.2) has to be available. In particular, this tool set includes a brainstorming board, a white board, a slide presentation board and a document sharing facility. In order to establish a spot in the room where an avatar

is able to observe all four boards' contents, it is asked for a well-structured room layout. Additionally, one room for the lecturer is required to offer a place for consultation and assistance. Furniture, as a place to sit and communicate will be necessary for the student rooms, the consultation office and also an outside break area. This remote space should be a comfortable recreation place to support discussion between the different working groups but also to advance the come about of social contacts. Once the learning space is utilized, an evaluation will take place. Students, teachers and administrators are asked to answer questions concerning their perception and satisfaction, gathered while working immersed in the virtual environment. Given that the collected feedback concludes positively, the prototype is planned to be improved and expanded to a higher amount of group and teacher rooms. In further consequence, it is aimed to use this educational application in the course of teaching at Graz, University of Technology.

5.5   Discussion

In this chapter we initially talked about reasons and motivation to build a collaborative learning environment and discussed the primary concept and evolution of the project framework. Then, requirements derived from the first project ideas were listed. Out of this, a basis design was extracted. Finally, we talked about the expected boundary conditions in order to explain some final design decisions.

In the following, some comments reviewing the chapter's most important aspects:

Motivation

Internet based technologies offer a wide and modern range of tools to enhance teaching and learning. Supported by the MICA example, it is not far to seek that virtual 3D environments could not only be a useful complement to traditional education but also a great chance for new international and therefore intercultural knowledge transfer.

Tools

The tools described in this chapter are just a basic course for the system developer to lean on. One still has to consider, that the implementation and functionality is highly depending on the selected 3D virtual environment, its possibilities and restrictions.

Second Life

Although there are several 3D virtual environments suitable or even better fitting to create a collaborative learning space, Second Life scores through its very easy to handle user client. Likewise, there is no need to take care of the server application since its running at Linden Lab's company server. Of course, the outsourcing of server application implicates both advantages and disadvantages. One negative aspect would be the complete loss of influence in various significant parameters like the reliability of the system or even data security. However, since the resources of this project are very limited, the effort to run a server application is not a subject under discussion.

A greater insight into the realization of the here introduced design is given in the next chapter. First an overview of the created tools and the environment in general (6.1.2), then some details to the technical implementation (6.1.2), followed by a survey and description of the prototypes evaluation (6.1.6, 6.2) are presented. Finally, key aspects of implemented improvements (7) are outlined.

Chapter 6

A first Prototype

Information according to implementation and evaluation of this project has already been published and can be found in Chang et al. (2009) and Gütl et al. (2009).

6.1 Implementation of the Prototype

Proximate subsections summarize ideas and areas of applications we kept in mind, while creating the here introduced collaborative virtual learning environment. In the following, a glimpse at our environment, focusing on a brief description of integrated tools, is presented.

6.1.1 Approach

This research project concentrates on 3D virtual worlds used for collaborative work in higher education. A prototype was built, that meets former analyzed demands of a collaborative group space (5.2). The prototype was tested and

evaluated by voluntarily participating students. Given the pre-conditions, Second Life was selected as the most adequate virtual environment to conduct the project. Our prototype offers tools to support collaborative work in groups by providing a private room for each group, an office for consultation hours and a public area designed as a casual meeting point. Students were invited to participate in the experiment, using the environment to complete an assignment within the scope of a university subject.

By means of a pre-questionnaire, information was collected in order to identify those who are potentially interested in virtual 3D environments and are also willing to use such an environment while completing collaborative tasks. After a test run, participants were required to complete a post-questionnaire that gave insights into user satisfaction and provided recommendations for improvements.

6.1.2 Environment

To create a sustainable environment in Second Life, it is indispensable to rent or buy a piece of land. Graz University of Technology provided us kindly with a suitable property located on their island. Right there, a first prototype of our virtual learning space came into existence. It consists of four collaboration buildings, a teachers' office and an outside recreation area (Fig. 6.1). The collaboration buildings are stand-alone houses, equally equipped with a hand of former identified tools (6.1.3). Each one of those is assigned to exactly one group, as a private team work space. The outside area (6.1.5) is an open space accessible to all visitors. Thus, social interaction can take place

in a casual environment. Also it serves as a zone, free from learning material, to recreate between exhausting learning sessions. The last component is an office (6.1.4), meant as a location where on one hand every learner knows to find the instructor and on the other hand an instructor has his/her own work space, to hold meetings and to offer consultation hours.
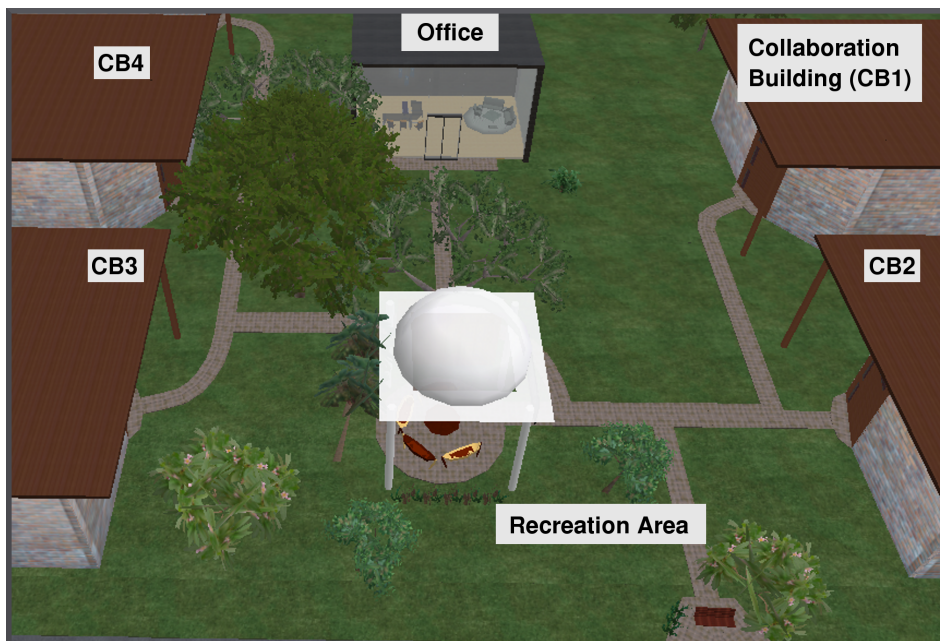
Figure 6.1: Collaborative Learning Environment - Version 1

Implementation Details

The learning environment's three dimensional content, was exclusively created via Second Life's in-world building tool set. In the following, a short description, in order to introduce general building functionality.

Building Simple Objects in Second Life Basis for all items created in-world, is a provided selection of standard shapes, also called prims or

primitive objects (Fig. 6.2).

Figure 6.2: Standard Shapes

Adjustable parameters allow to change an objects' appearance (Fig. 6.3b), standard physical behavior (Fig. 6.3c) and user permissions (Fig. 6.3a). In order to obtain more complex items, affected prims need to be linked together. This is how a new object, including it's own configurable properties, emerges. Consequently, by changing a new item's properties, the properties of all combined objects change similarly. In the course of linking objects together, also a hierarchical structure arises that determines the last selected prim as root. Thus, all other included shapes are child prims. This comes into consideration when creating interactive tools, where the different parts need to communicate with each other, further explained subsequently in Section (6.1.2).
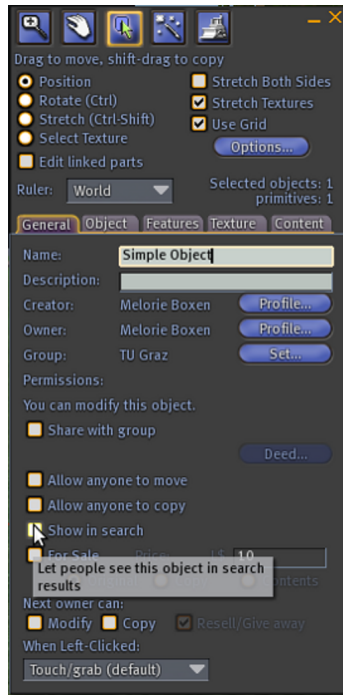
(a) General Properties and Object Rights
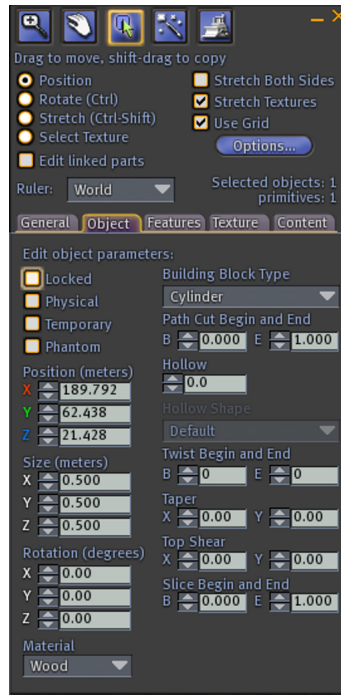
(b) Appearance Setting
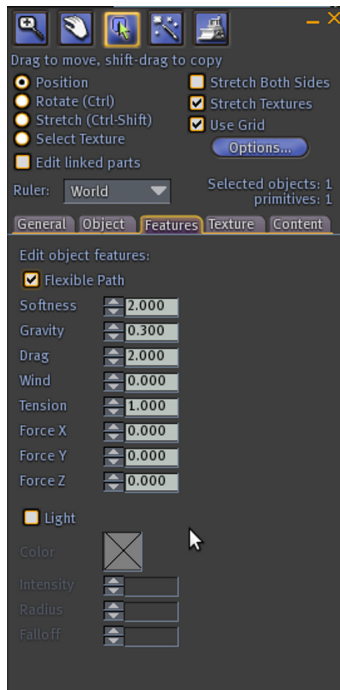
(c) Physical Properties

Figure 6.3: In-world Build Window

To modify the look of a prepared figure, textures and colors can be selected in order to put on the surface. Therefore, a standard library of textures (basically simple image files) exists. Individual images can also be uploaded via the file upload option of the main menu or bought in-world. Another item of the building menu is landscaping. It is possible to rearrange the composition of the ground by flattening, raising or lowering it. Assigning so called terrain textures, determines the design of the surface. This is how meadows, beaches or snowy mountains are formed. "Terrain textures" are not subject of the building menu, but have to be edited using the estate tool shown in Figure 6.4. As the name suggests, this is an adjustment tool, configuring parameters of a whole region/estate. Unfortunately, our project only possesses a limited piece of land the island on an island owned by University of Technology, Graz. This island is used by various research groups, working on multiple different projects. Although changing the terrain texture is not feasible, we still wanted to obtain a nice ground layer looking like grass or sand. Covering our land with thin, flat prims turned out to be the most satisfying solution to this concern, since those objects' textures can be modified individually to be sand, stone, grass or any other.
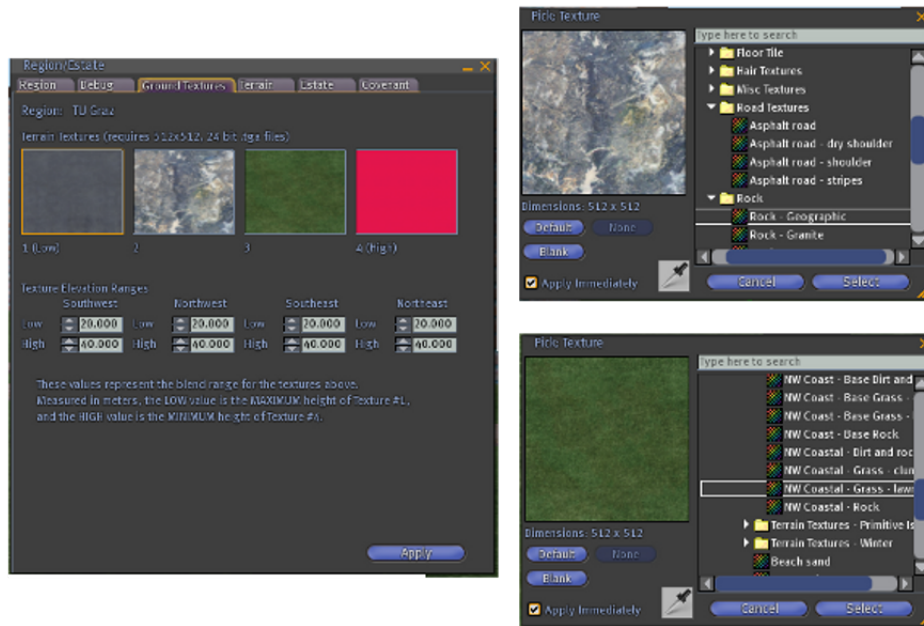
Figure 6.4: Region/Estate Manager

Scripting in Second Life Once an object is built, appended scripts allow it to interact and perform in certain ways. Second Life has its own programming or, strictly speaking, scripting language named "Linden Script Language (LSL)". New scripts are created using the in-world scripting editor (Fig. 6.5b). Scripts created in external editors still have to be copied into the in-world editor, in order to compile it. Each objects' content offers a "new Script - button" (Fig. 6.5a) to create an LSL file.
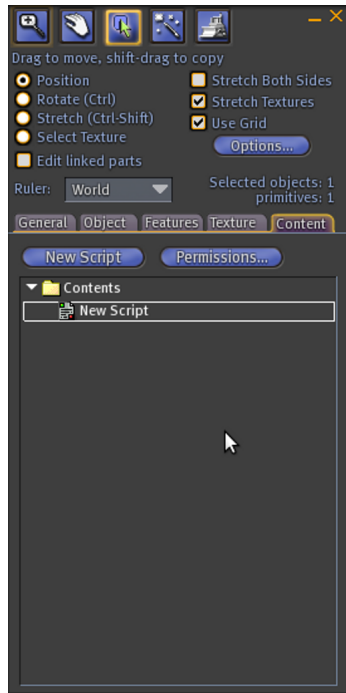
(a) Object Menu: Content   (b) LSL in-world Editor
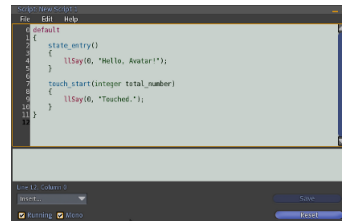
Figure 6.5: Creating a Script

A documentation of predefined functions and constants can be looked up on various Wikis such as *LSL Portal* (n.d.) or *LSL Wiki* (n.d.). The interaction between objects and avatars is based on event handlers, that are also listed at the above mentioned Wiki pages. Events are queued up when triggered parallel or while another event still is in progress, in order to dispatch them sequentially. However, this only happens for the current state of the object. Also, the queue is reset whenever the object changes its' state. Most important events, used during the first implementation of the environment's prototype are:

State_entry

This event is triggered, every time an object enters a state. A function

to catch the event, has to be defined separately for each state.

State_exit

Works equivalent to state_entry but is triggered, as the name implies, at the time an object leaves a state.

Touch_start

It is triggered whenever an avatar touches an object. Due to this event it is possible to let an avatar influence an objects' behavior.

Listen

The event has to be enabled using the llListen command. Once enabled the event is triggered by any input on a text channel. To sort out irrelevant data, the llListen command has 4 parameter to adjust. According to them the data transfer can be cut down to a specific channel, an avatar, an object or even a predefined message.

Link_message

When various prims are linked together, forming a single object, the function llMessageLinked can be used for object internal interaction. Using this event it is possible for a prim to communicate with its own scripts, all scripts in the object, all child prims' scripts or the root prim's scripts. Again this is determined through a parameter in the calling function (llMessageLinked).

Timer

The parameter of the function "llSetTimer" defines the range of time till the event is initiated.

Changed

> The Event is triggered every time certain changes happen to a prim. This might concern a prims properties, location or content.

Dataserver

> If asynchronous information is required, a script is able to request it using the Dataserver event. Supplied functions support the reading of notecards, scanning of agent data, inventory data and inquiries of simulator status information.

As already mentioned, triggered events are only taken into account if related event handlers are implemented in the current state of the object. Optional states can be defined in the script. An object might change between different states, but the so called "default state" is always an object's initial state. From an Avatar's point of view the options to interact with an object are touching, communicating via chat channel, buying it or pulling it out of one's inventory.

6.1.3 Tools

Every collaboration room was equipped with one instance of each tool described in this subsection. The next paragraph will give a brief review of technical details being a matter of interest for the implementation of this tools.

Building Multi-User Tools To enable the multiple use of all tools, the land needed to be divided in as many parcels as instances of tool sets.

Parcels are subdivisions of land. Each parcel has its separate configuration parameters (Fig. 6.6).
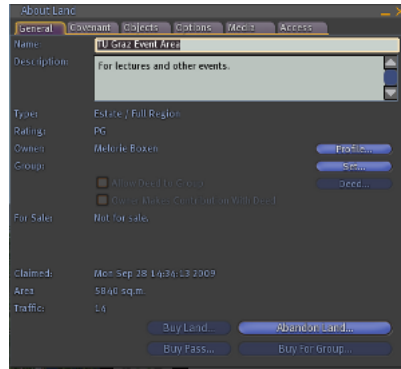
(a) About Land Menu: Content
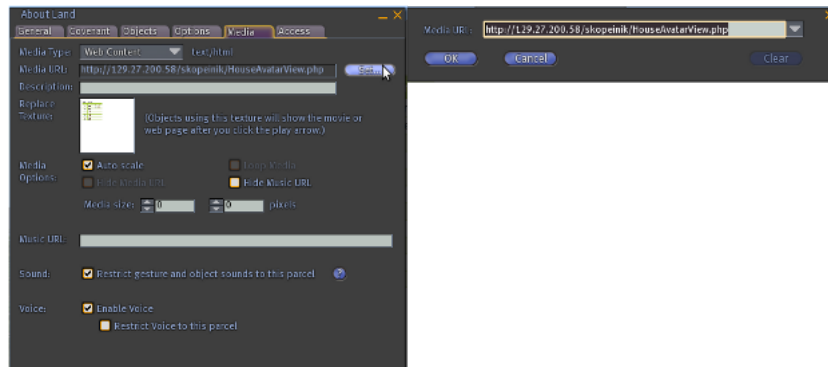
(b) About Land Menu:

Figure 6.6: About Land - Preferences

Consequently, it makes perfectly sense to split land into smaller entities, if determining factors differ. In this project, the land is divided into five units. One for each collaboration room and another one containing the lecturer's office and the common area. This structure emerged during the implementation phase, as we decided to use Google documents to overcome our document sharing issues. The document is supposed to be visible permanently, so everyone in the room can follow eventual changes of the document.

Therefore, first a Google document needs to be published on the Web, to then integrate it's link into the environment. In order to show HTML content inside Second Life, functions for media streaming are available. However, only one media stream per parcel is executable at the time. Also it is worth mentioning that Second Life does not offer an easy possibility to write text on a board or prim and neither it does for file sharing. The only provided file format are simple text files called notecards. Those are typically used to pass information about land or a tools functions to an avatar or as configuration files assigned to objects or more exactly lying in an object's content. Since the actual writing on a board is not possible, there are two options to implement white boards or note boards. One can create prims that are equipped with specific textures which are able to display up to ten characters by changing their structure. These prepared prims might either be stored in the content of an object to be pulled out on demand or already placed and linked in a row on it's surface, waiting to change. Affected by the lack of file or program integration support, although in different aspects, are the Media Wall (6.1.3), the Slide Presenter (6.1.3), the Brainstorming Board (6.1.3) and the White Board (6.1.3). How the above named issues influence the creation of interactive tools is described in the following subsections.

Media Wall with Google Docs

The board (Fig. 6.7) is able to display four kinds of different media types, that are segmented into web content, audio, video and images. A configuration file is available to define both, source and media type. So, the walls' content can vary in the amount of available pages and types. As it is so far not

possible to share documents inside Second Life, this wall is intended to serve as a workaround, presenting an interface for a relatively comfortable access to Google documents without leaving the virtual environment. Features of the tool are:

- Setup the wall with individual content

- Sift through adjusted media pages using the boards' arrow keys

- Update the walls' content by clicking on the surface

- Set a timer that periodically updates the currently displayed content

- Opening the currently shown media page within the in-world browser

Using the described properties, one can for instance enter the Web-Address of a Google document and open the in-world browser to edit it. Meanwhile all other group members that are staying in the room are able to follow the document changes without any additional effort.
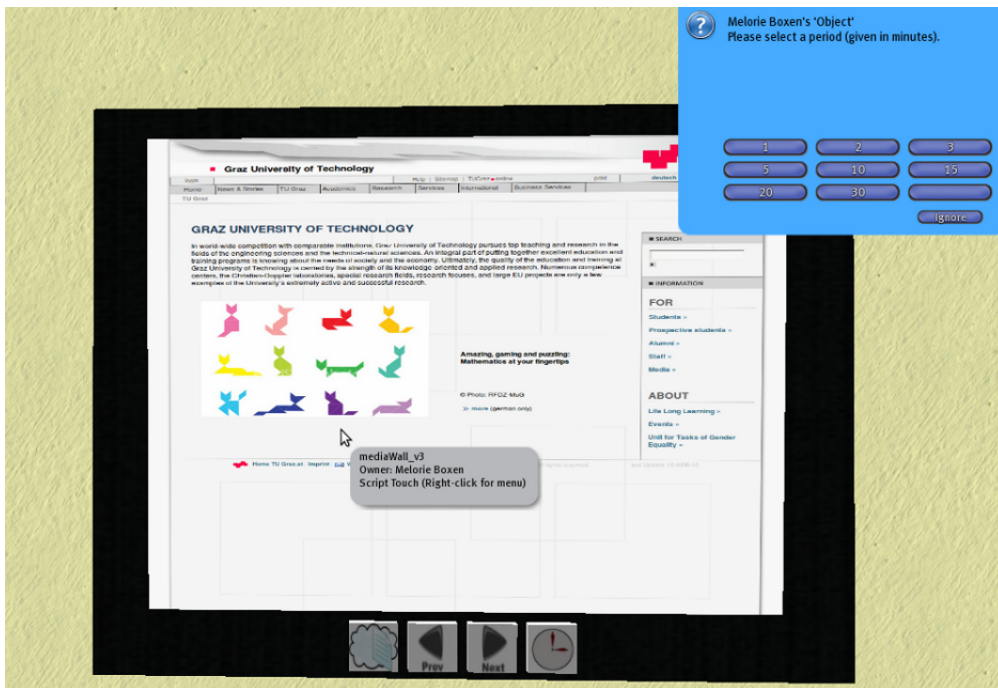
(a) Media Wall with time configuration dialog
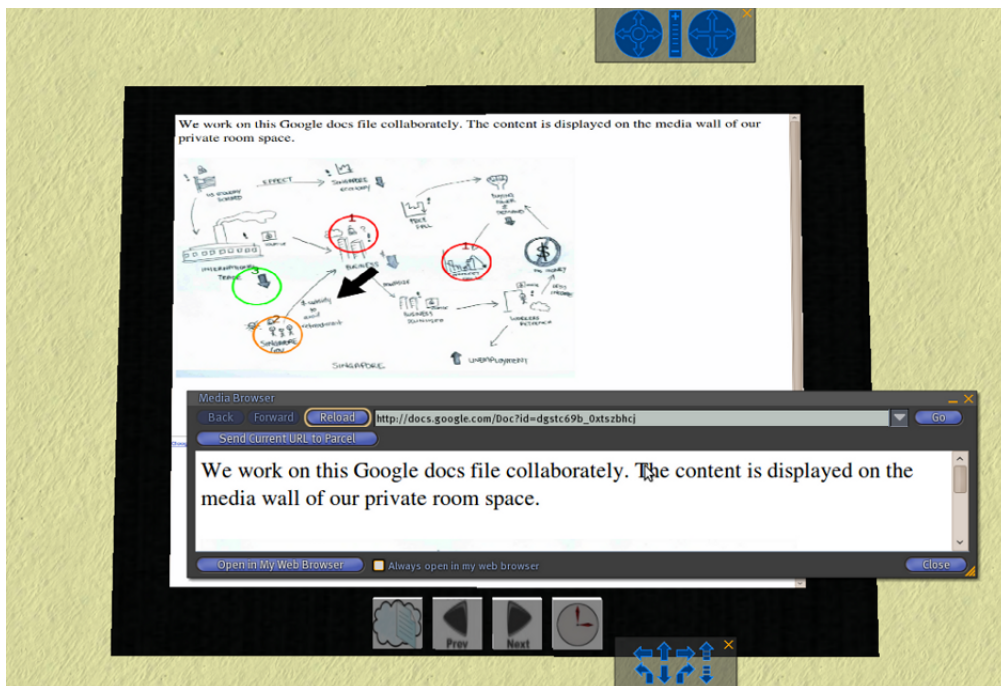
(b) Media Wall displaying Google docs

Figure 6.7: Media Wall

Implementation Details: To get around Second Life's missing document editing possibility, the Media Wall was created. A notecard stored in the content of the object defines the presentable Web-Pages. The object consists of six prims. Four are used as buttons, one as a display and another one as background. All six are linked together, with the display prim acting as root element and therefore also containing a sort of business engine, controlling the object's functionality. Different parts interact through the link_message event. In order to implement this behavior, the prim acting as display is equipped with the "*Default Media Texture" on one face. This texture is provided in the standard library of every avatars inventory and is already arranged to present media. This assigned texture needs to be identical with the texture set in the About Land menu's Media tab (Fig. 6.6b). Additionally, there is a script that adapts the parcel's media properties using the function llParcelMediaCommandList. An extra preparation is necessary to present a Google document for collaborative use on the Media Wall. These are:

1. Creating a Google document

2. Inviting all editors

3. Publishing the document on the Web

4. Adding the obtained in the Media Wall's notecard

Now, to keep up with changes, there is a button implemented that opens a user dialog to set a timer period. This timer updates the display's content periodically or whenever an avatar touches it. The built-in function llSetTimer

89

is used for that purpose.

Restrictions: Entire pages can solely be displayed, if there is no scrolling necessary. Otherwise only the upper part of the web content is shown. Since the configuration takes place in a text file (notecard) and Second Life restricts their access, only the owner of the object is allowed to change the setting. The media configuration works for the whole parcel, that means only one media can be streamed at one piece of land. Also, an avatar only sees the media applied to the parcel they are located on.

Slide Presenter

Final presentations are very likely to be part of a project. For this purpose, a tool (Fig. 6.8) that displays images was created. Such might include items of a common interest, like slides of a presentation, images to discuss, lecture material, etc. An authorized user could upload images, drop them on the wall to use it as a shared item and delete it whenever the information becomes useless.

Therefore the tool is able to:

- Add new images to its content

- Update the content on demand

- Sift through all uploaded images using arrow keys

- Delete unused items
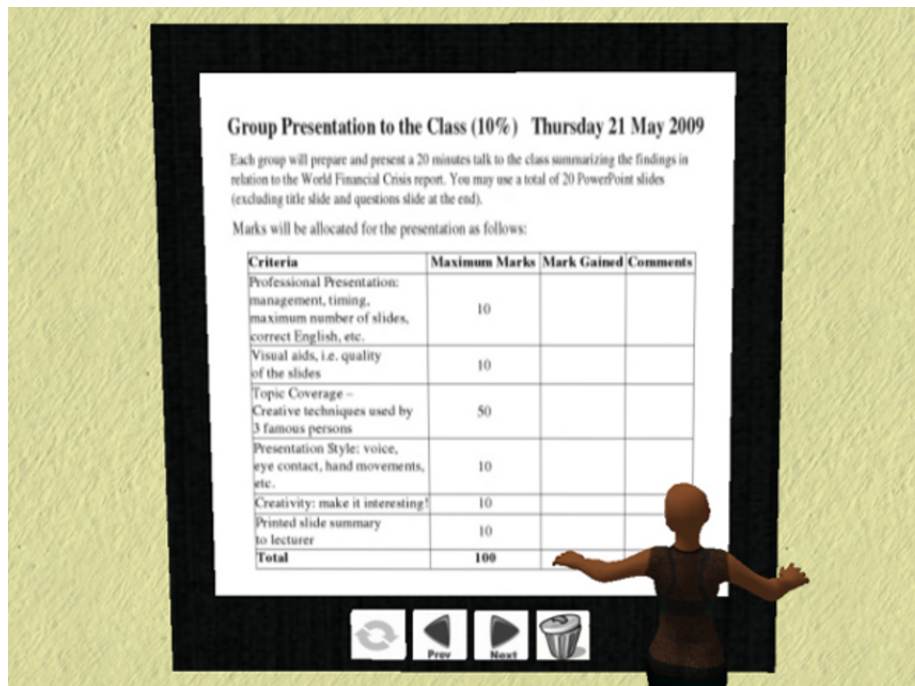
Figure 6.8: Slide Presenter

Implementation Details: The tool consists of six prims. The display is the root object containing the control part. The communication takes place through the built-in event "link_message". All textures that are supposed to be presented with the tool, have to be located in the object's inventory. Whenever an avatar drops or deletes a texture, it is detected through the change event handler. This allows to adapt the presentation items by reloading the object's content. Four buttons are located on the bottom of the board. They serve to navigate through the slides, to refresh the slides and their sequence and to delete images from the object's content. To navigate through the images, a texture has to be loaded from the content to be set on the presenting face of the prim. As the loading takes a reasonable amount of time, which is perceived as inconvenient, additional to the displayed texture,

five other textures are loaded and displayed invisibly at the other faces of the prim. Thus, with every back or forward the texture of the visible face changes to one of the other faces. Of course there is one face that still has to load it's texture from inventory, but since it is hidden nobody will notice.

Restrictions: Already existing slides need to be transformed into image files as well as uploaded by using Second Life's standard menu. This procedure asks for additional costs in relation to time and money. Further on, regardless of the order of dropping the images at the wall, they will always be displayed in an alphabetical order based on their filenames. One has to consider this fact, before assigning the files to the wall.

Appointment Setter

The Appointment Setter (Fig. 6.9) acts as an e-mail sender, primarily to inform group members about upcoming meetings. Composed messages are automatically sent to all listed group members. Those messages standardly include the avatar name of the creator, a text and an appointment. Features to realize this behavior are:

- A user dialog to enter an appointment (Fig. 6.9b)

- A date checker to verify the validity of the appointment

- The possibility to enter a message via text chat

- An implemented process canceling function that resets all values
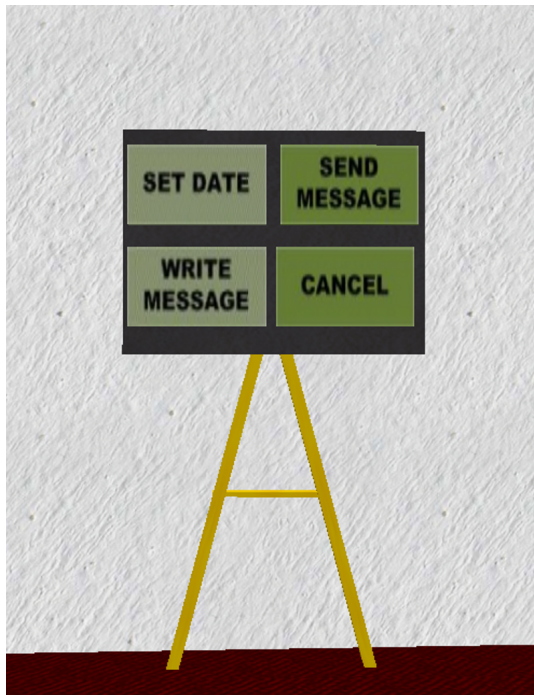
(a) Appointment Setter Tool
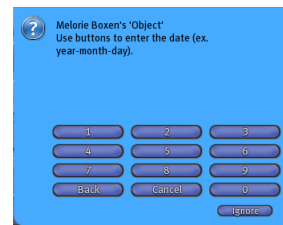
(b) Input Dialog

Figure 6.9: Appointment Setter

Implementation Details: Like the former explained tools, the Appointment Setter also consists of various linked prims interacting via the "message_linked" event. The two mentionable built-in functions used by this tool are llDialog and llEmail. In order to ease the correct input of time and date, a user dialog, realized with llDialog, is employed. As with every user input a dialog event is triggered and the user dialog disappears again, the function needs to be called periodically till the input is complete. For the input of a text message the text chat channel was selected. Before every user input a new channel number is generated. To avoid misdirected data traffic the object is only listening at the specified channel that is also advised to the current avatar to allow the text input. When an avatar pushes the

send button, the llEmail function is called, sending the entered data to all e-mail addresses that are stored in a notecard in the objects content.

Restrictions: All members' email addresses have to be added to the configuration file (notecard). Like mentioned before, Second Life restricts the access to this kind of file and therefore only the object owner is allowed to change its content. This might cause inconvenience, as the owner has always to be available to perform adjustments.

Brainstorming Board

At the beginning of every creative process, it is necessary to generate and collect ideas. The board (Fig. 6.10) offers assistance in this early conception phase. This is a free educational tool, placed at the disposal by Dudeney Ge (n.d.). Users are able to:

- *Start a new brainstorming session*
  Whenever a new session is started, the board deletes all its' former content and defines a new chat channel. This channel is determined to listen to upcoming user input.

- *Create items on the board*
  Using the SL-text chat at the specified channel a new item can be created. Every new term is put on a randomly generated place on the board.

- *Move and organize created items*
  Operators might like to display their created items in a different struc-

ture. To reorganize generated tokens, one can use Second Life's building menu.

- *Delete items*

  Created items can be deleted separately by selecting them performing a left mouse click or all together by using the "X" button on the board.

Figure 6.10: Brainstorming Board

Restrictions: To change the position of words, a user has to be familiar with Second Life's editing menu. Also the selection of the item is likely to cause trouble, as it has to be hit the middle of the item almost exactly. A second limitation is the inability to save a brainstorming before triggering a new one. The text objects are static and therefor they have to be deleted to clear the board whenever initializing a new brainstorm. In case the informa-

tion of an old brainstorm is further needed, it might be advisable to take a snapshot, save it to disk, upload it to the SL again and put it on some other tool inside the room (e.g. White Board, Slide Presenter).

White Board

The "White Board" (Fig. 6.11) was bought as part of an education package inside Second Life (AngryBeth Shortbread, n.d.). It can be used during a document- or product creation process to

- Upload images

- Draw small mind maps

- Present ideas via uploaded slides

- Use a tool set of different objects to write, highlight and point out stuff on an existing image

- Perform private group votes
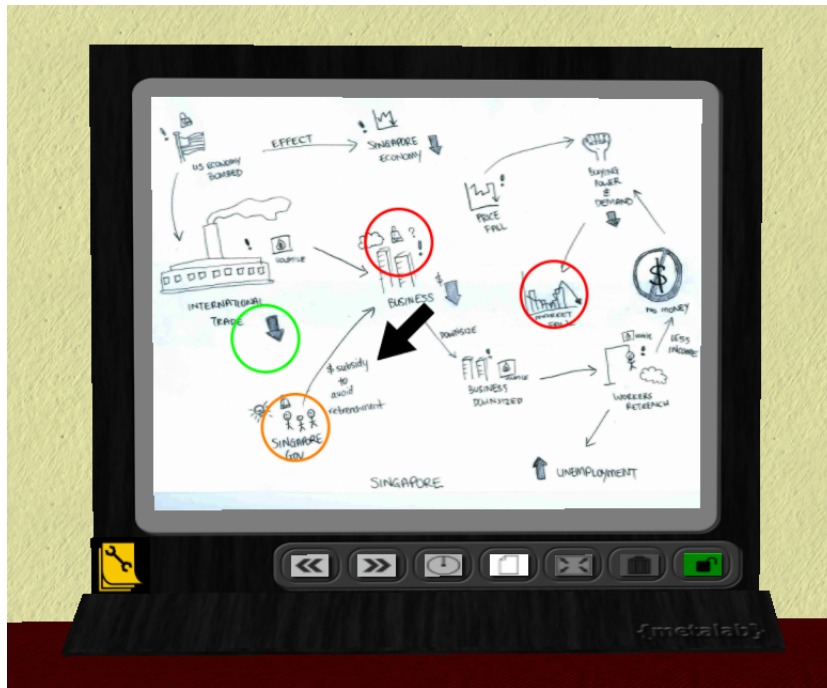
Figure 6.11: White Board displaying a former uploaded Image

Restrictions: It is not possible to save changes that are performed on a specific image or slide on the media wall, back to the original file. The added objects are simple Second Life prims, they stay permanently wherever they have been put. This might cause trouble, as the prims obstruct further work with subsequent pictures. To get around this constraint all prims have to be deleted whenever the displayed image is changing. In order to store modifications anyways, the author suggests to take a snapshot, save it to the disk and to later upload and put it on the wall again.

6.1.4 Office

This room provides an area for consultation hours. The front walls are slightly transparent, which allows every on-line learner to recognize whenever the instructor is present and also if he/she is currently occupied with another group or user. Further on, the office is divided into a formal area on the left side and a comfortable, casual meeting area on the right side of the room. Thus, the involved parties can choose the most appropriate environment. A summary of identified aspects in offering a lecturer room follows:

- A virtual environment facilitates consultation hours - one could easily sit at home in their pajamas and still attend a previously arranged consultation hour. Especially shortly before a project deadline it would be an advantage to ask an instructor for advice without even having to leave the workplace.

- Virtual worlds are less personal than real world situations - therefore students might overcome their inhibitions easier.

- Interacting in form of avatars brings up a whole new level of instructor-learner relationships - resulting in a comparatively flat hierarchy, it might reduce social distance between the two participants.

(a) Formal Area
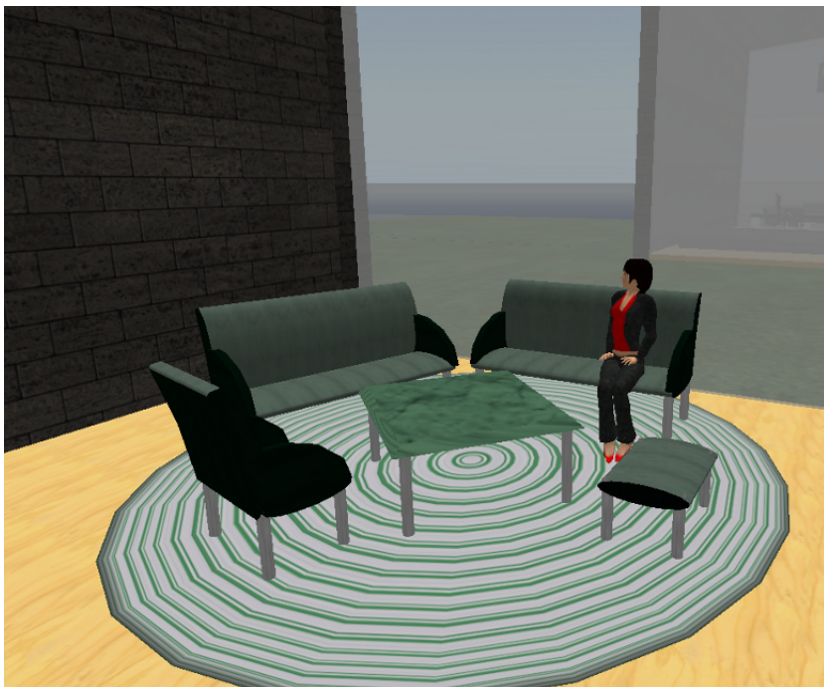
(b) Casual Area

Figure 6.12: Consultation Office

6.1.5 Recreation Area

Like many real world environments, our virtual space (Fig. 6.13) offers a location for casual social interaction. Replacing the traditional coffee kitchen of a company, the commonly accessible area is a platform to relax, to chat, to meet learners of other groups and to build up relationships. Those activities might increase social awareness and the degree of involvement. Also, informal interaction often stimulates knowledge exchange.

(a) Common Space

Figure 6.13

(b) Quiet Area

Figure 6.13: Recreation Area

6.1.6 User Study

Experiment setup

To evaluate the group learning space, students of Curtin University of Technology, enrolled in the course titled BPA 300, were asked to participate voluntarily in the research project. Sixteen of them agreed on doing a pre questionnaire which was aimed at finding out whether there are student groups that are more motivated to use a virtual environment than others. For this purpose questions about their general attitude towards on-line virtual worlds, about demographic data, about computer skills and computer experience were asked. Six people out of the initial sixteen, decided to complete a

course assignment using the created environment for their team meetings. As the principal task participants had to write an essay, including rich pictures and charts. The experiment was constrained by the following:

- One group consists of three students

- Group members work at the same time on-line

- On-line consultation hours, provided by the lecturer, offer assistance

Upon completion of their assignment, the six test persons were required to fill out a post questionnaire. Through this evaluation our research team tried to get constructive feedback useful for subsequent improvements of the collaboration area and the provided tools. Another part of the form contained queries covering students' impressions and thoughts about Second Life as well as on-line virtual worlds.

6.2   Findings

Within this section, information about the prototype evaluation is presented. Pros and cons concerning the learning environment itself but also the use of Second Life, are discussed. It is intended to cover different points of view by interviewing various participating roles. Please note that this evaluation was conducted with Second Life's viewer version 1.23. Due to Linden Lab's fast development the current viewer version 2.1.1 was already able to solve several of here discussed issues.

6.2.1 Developers Point of View

Hereinafter, observations made with Second Life as a platform and an implementation environment are discussed. Second Life is an on-line framework that offers the possibility to create interactive 3D environments relatively quickly. The dedicated programming language (Linden Script Language) is easy to become acquainted with, particularly for people who are already experienced in the field of software engineering. Although the documentation of LSL's functions is not always satisfactory, there is a great variety of on-line tutorials, Wikis and forums that provide support, by answering questions quickly as well as professionally. We have experienced the very engaged user community as a big benefit coming along with the platform. Also the creation of 3D content out of standard objects is guided very well. Depending on how imposing the outcome needs to be, Second Life's in-world building tools might present a comfortable and fast alternative to regular 3D modeling tools like Blender. Besides that, it can take quite an effort to integrate objects (often measurements and textures need to be adapted) created outside the platform. Coming to the system's drawbacks, it is worth mentioning that Linden Labs charges for uploading images, sounds and animations. Unfortunately, when working with Second Life, the upload feature is absolutely essential. Anyway, the amount of money needed for uploads, is comparably small in relation to the costs one has to devote for land and ownership. The biggest issues while creating a learning environment, which also influenced our design, arose out of LSL's functionality restrictions. A selection is listed hereinafter:

There is no option to ban avatars from looking into closed buildings or rooms   In order to protect users' intellectual property and to control plagiarism it is necessary to screen certain objects from unauthorized access. Creating walls and scripting doors seems to be pointless, as long as every random avatar is able to sneak in undetected. Even though walls forbid to walk in a room, it is not possible to ban someone from using the camera angle to zoom in or even from using a special acceleration script to run through walls.

Writing can only be realized by creating textures, that display characters   On account of this, in-world document sharing is currently not possible. Since we built an environment meant for collaborative work on essays, it turned out to be a very unfortunate shortcoming of SL as a platform.

Only one media per parcel at the time is supported   As explained in Section 6.1.2, a workaround using Google docs was implemented to substitute in-world document sharing. Therefore, we stream one media inside each collaboration room. Attention should also be paid to the restricted visibility of media. Media is only displayed for avatars who are located at the same parcel as the streamed media. Avatars standing outside the parcel can only see a blank screen. Accordingly, the here described restrictions need to be coordinated with the design of buildings and work places.

The amount of allowed prims per parcel is limited   The limit of prims is quickly exceeded. In order to fall below the boundary value, it is

advisable to design objects using standard shapes sparingly.

It is very hard to provide user-friendly collaboration tools User dialogs are not very comfortable to work with. Even though there is a built-in function "llDialog", that generates dialog boxes with a text and buttons to select, it takes too much time between the action of pushing a button till a reaction is performed. Moreover, after each selection the dialog box needs to be recreated, resulting in a behavior that appears very unsettled, when it comes to number pads or similar artifacts. Alternatively, the text chat can be used, but often this is perceived just as inconvenient.

Time-consuming configuration of Tools Some in-world tools might need properties and parameters like avatar names, URLs, etc. It is common to use note cards, as some kind of data container to allow scripts to readout required information. This solution was experienced as inconvenient. Firstly, because only the owner of an object is allowed to change a note card and secondly, it can become a good deal of work to setup configuration files for multiple tools, one by one.

6.2.2 Findings from Students' Point of View

This section is based on the outcome of two questionnaires we conducted to complete our research. Sixteen students responded to the pre questionnaire which is divided into the categories demographic data, general information and e-Learning, computer games and Second Life (Appendix A), whereas the post questionnaires' main sections asked about students experience with

105

Second Life and using a 3D virtual environment in general (Appendix B). For the post questionnaire only six responses were collected. This equals the amount of students, volunteering to use the collaborative virtual environment while completing their assignment. The class in which we were looking for participants comprised eight female and eight male students between eighteen and thirty. Most of them described themselves as experienced computer users, mainly working with MS-Office products. A few had further knowledge in C# and HTML. Table 6.1 gives an overview of users' demographic data and general IT experience.

Demographic Data		Computer/IT Experience	
Age Group		Level of IT Experience	
18-24	14	Highly Experienced	13
25-30	2	Little Experienced	3
Gender		Level of e-Learning experience	
Male	8	Experienced	16
Female	8	Not Experienced	0
Student Type		Computer meets SL requirements	
Australian	3	Yes	14
Non-Australian	13	No	2
Student Type		Participating in this experiment	
Part-Time	1	Yes	6
Full-Time	15	No	10

Table 6.1: Pre-Survey - Demographic Data and IT Experience
(Chang et al., 2009)

Even though nine students indicated an interest in the particular environment, only six of them, which amounts to two working groups, decided to volunteer for this research project. Also, most of them called themselves eager to use new technologies and stated to use the computer frequently for

106

playing. An interesting fact is, that five of six research volunteers, claimed not to play computer games regularly. A more structured view of important pre- questionnaire results can be found in Table 6.2 and Table 6.3.

Students' Technology Adoption and Life Styles	
Usage of computer per week	
Less than 30 hours	7
30 hours or more	9
Willing to use new technology in my learning task	
Yes	15
No	1
Willing to use new technology in my work task	
Yes	16
No	0
Familiar with on-line role playing games	
Yes	9
No	7
On-line role playing games are entertaining	
Yes	11
No	5
Playing computer games regularly	
Yes	11
No	5

Table 6.2: Pre-Survey - Students' Technology Adaption
(Chang et al., 2009)

Students who decided not to participate in the research gave mainly three reasons for a refusal:

1. **Increased workload through familiarization**
   A great majority of the students did not have any experience with Second Life. On top of that, it takes a certain time to become trained in using the environment's particular equipment.

2. **Stability concerns**

   As the development of the prototype was only just completed, there was no prior test run performed. Because of that students felt insecure of the stability and reliability of the environment and its tools.

3. **Pressure of time**

   Students expect an additional workload, caused by problems explained in point one and two. This is an issue, as most of them already have serious time pressure to complete their course work.

Four of them also noted to prefer face to face communication for its simplicity. One of the respondent's answers included: *"It takes a lot of time to get familiar with the game and it seems face to face is more direct and easy to understand."* The declarations in favor were based on interest in new technologies. The following statement as an example: *"I would like to try out anything new. I am a bit hesitant but there is no harm in trying. I know I will learn a lot from using it."*

Familiarity with 3D Virtual Worlds Learning Environment	
Currently using 3D/VW environment	
Yes	7
No	9
Currently using Second Life	
Yes	1
No	15
Interested in using Second Life	
Yes	9
No	7
Perception of VW/SL as a collaborative learning environment	
Useful	10
Not Useful	3
Don't Know	3

Table 6.3: Pre-Survey - Familiarity of 3D Virtual Worlds
(Chang et al., 2009)

Table 6.3 presents information about the learners' experience with 3D-virtual worlds as well as their attitude towards it. Contrary to our concerns, meeting the system requirement and download rate were not crucial factors. Only two out of sixteen students claimed insufficient technical equipment as a problem. Surprising was the relation between gender and voluntarily participating test persons. According to literature (Griffiths & Hunt, 1995) males are not only more likely to occupy themselves with computer games but also easier to motivate to play than females. Thus, the target group was expected to be predominantly male. Astonishingly enough, five out of six volunteers turned out to be female.

After the two collaboration groups, consisting of three students each, finished their assignments, the post-questionnaire (Appendix B) was completed. Only one student had used Second Life before. Thus, some of the negative

experiences were an increased workload that lead to time pressure, missing know-how of 3D virtual worlds in general as well as the in-world collaboration tools. Students felt distracted by bad usability. It seems to be hard to provide an intuitive and easy to handle user interface for collaboration tools. The missing document sharing feature was claimed by students at Curtin, University of Technology as one of the major downsides, but Google documents was stated to be well appreciated. Problems also appeared because some group members needed more time to get familiar with the technology than others. This influenced the working atmosphere negatively. In addition, issues with the independence of working space and time came up. Some group members were working on campus and claimed to have a hard time finding a PC to use. Furthermore, the university had a strict limitation for downloads that was easy to exceed. Others, who worked at home, named the sometimes slow and unstable Internet connection as a drawback. In terms of communication, one found it hard to explain thoughts and concepts in a virtual environment especially because the user client's VOIP function was neither easy to handle nor very reliable. The missing possibility to express emotions like in real life was also mentioned negatively. In spite of everything, five participants are planning to further use Second Life to work on collaborative tasks and to get together with friends. Those mainly liked the implicated flexibility in respect to time and location and the arising possibilities of asynchronous teamwork. A selection of students' answers is listed in Table 6.4.

110

"Even though with our different schedules I believe Second Life made it easier for our group to meet"
"easier to work around group members other commitments"
"Solves the problem of transportation issues "
" Time saving in regard to traveling time; working at home"
"Flexible:meet group members even during night time"
"Easier to put documents together because they are on-line and we can each add to the document"
" Meeting minutes through chatting"
"Environment provides media to leave messages or ideas for other group members"
"Only a single environment"
"Helped organizing the group"
"Whatever work done by a group member can be continued by another group member later on"

Table 6.4: Post-Survey - Statements Students' issued according to their Learning Experiences

(Chang et al., 2009)

The last part of the post-questionnaire deals with the provided tools and the collaboration environment generally. Although, students were explicitly asked to name suggestions for improvement, only two changes were recommended:

1. Learners should be able to add and remove URLs displayed on their collaboration room's Media Wall

2. To avoid confusion during a presentation, the Slide Presenter should display the page number and the number of pages

6.2.3 Findings from Tutor's Point of View

Assistance was offered for the installation of the Second Life client in combination with a short introduction to the particular environment. Participants

also had a contact person for upcoming difficulties, while completing their assignments. Even though most of the participants complained about too little supervision during familiarization time, only one of them used the offered support service. Our technical assistants suggested additional tutoring lessons, held in computer labs, in order to shorten familiarization times and therefore increase students' working abilities. Also a problem is to share the use of rooms or rather tools among multiple working groups. Content on slide presenters, brainstorming boards and white boards, remains statically on the equipment.

6.2.4 Lecturer's Point of View

The lecturer, being a participant of the research project, answered questions according to following fields of interest:

1. **Second Life familiarization in respect of Navigation**

   I have not had much experience with Second Life and it took me some time to get used to moving the Avatar around the island. It was also difficult to know which building I should go into first-perhaps names could be placed on the buildings describing their functions.

2. **The learning environment in general**

   I am not a big fan of using on-line learning to actually set up the site seems to me to take a lot of effort that could be used for more productive activities

3. **Second Life consultation hours**

   Benefits: *Allows students to work remotely*

Disadvantages: *It is difficult to know who you are really interacting with because of the use of avatar names Waiting for everyone to sign on is problematic*

4. **Ideas for further improvement**

   Name buildings[1]

5. **Second Life as a learning platform in regard to on-line teaching and collaborative learning**

   I do not like teaching over the web. IT takes up too much time in comparison with physical classes. If students miss a session, then you have to go through the on-line process all over again when they are ready. With physical classes, you can simply refer them to the blackboard materials.

6. **Students learning outcome/experience with Second Life**

   The students were not very familiar with the application, and the time we spent on-line was not very productive. If it is to be used again, it would be necessary to provide extensive training to the staff and students.

Although an introduction was given, the lecturer felt lost and had a hard time getting familiar with Second Life itself as well as the environment. Also, his answers show a generally negative attitude towards using new, experimental technology in teaching.

---

[1]The interviewed person refers to a lack of unique identifiers like for instance door plates, to view and distinguish provided buildings easily.

6.3 Discussion

The evaluation of the first test run pointed out preparation gaps as well as predominantly expected positive results. Students for instance, had in general a positive attitude towards the project idea, but felt over-challenged, due to unpleasant boundary conditions like tight time limits and pressure to perform. Also, by letting students volunteer to use the system, unequal competition positions were created. Accordingly, students were afraid to perform worse than there non participating colleagues. These concerns were caused by the conceivable additional time investment, which was necessary to familiarize with the environment. In order to avoid these issues in further research, we recommend to integrate the use of such an environment as a regular task of coursework. Moreover, we think participants would definitely profit from introducing tutorials guiding through installation and basic functionality. Optimally, those classes take place in computer labs, so everyone is able to practice and try out in person. More concrete information was extracted out of a technical view. Based on the data presented here, the following extension possibilities were identified:

1. **Enhancement**

   As the content on tools like the Brainstorming Board (6.1.3) or the Media Wall (6.1.3) remains static, it is not possible to use one collaboration room for more than one student group for the duration of an assignment. Thus, to use the environment for whole classes it is reasonable to increase the number of collaboration rooms.

2. **Orientation Aids**

   Even though only the lecturer, who appeared to be sparsely familiar with 3D virtual environments, stated to have trouble navigating withing the learning space, it seems helpful to add some kind of labeling to prevent orientation problems. As the environment will be larger than before, it is reasonable to label houses and to create destination panels.

3. **Configuration**

   It might become quite time consuming to reconfigure all tools of all houses every time the assigned group changes (6.2.1). Also, access rights are a critical factor, as the configuration is implemented through notecards which are only changeable by an object's owner. Thus, some kind of configuration interface might ease the process.

4. **Tool Improvement**

   Besides general problems with the environment students claimed two missing features. Firstly, the possibility to add new and remove URLs at the media wall. This is not possible, since the URLs are read out from a notecard. And secondly, it was conceived as disturbing that the Slide Presenter would neither show the current slide number nor the total number of slides.

The next chapter is dedicated to the description of the changes and enhancements, mainly motivated through the results of the first evaluation.

Chapter 7

Implemented Improvements

After performing an initial test run of the prototype, an evaluation was completed in order to identify perceived problems and therefore to collect ideas for further improvements of the learning environment. During this process we came up with three different approaches. Firstly, Second Life brings along restricted access rights for objects. That, in our case, causes difficulties while configuring the in-world collaboration tools. To deal with this issue and also to increase usability, a Web-Interface described in Section 7.2 was implemented. The consequential adaption of in-world objects and extensions is discussed in Section 7.1. Due to the predominantly positive feedback of students using the prototype it was decided to expand the environment to provide space for ten user-groups and two lecturers, see Section 7.3.

7.1 Tool Enhancements

The three tools Slide Presenter (6.1.3), Appointment Setter (6.1.3) and Media Wall (6.1.3) got adapted to be configurable through a Web-Interface (7.2). Additionally, the Slide Presenter and the Media Wall were enhanced with two functions as missing reported in Section 6.2.2. In order to improve the Slide Presenter tool, students suggested to add some kind of informative output, that displays the current slide number as well as the number of slides assigned to the board, see Figure 7.1. This was realized using the SL built-in function llWhisper on chat channel 0, so every avatar located next to the board would be able to see it.
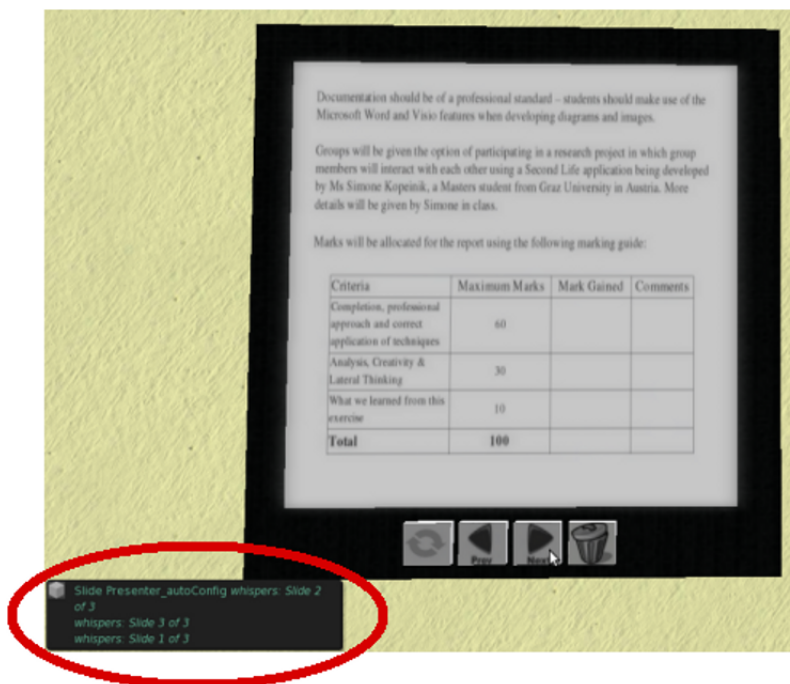
Figure 7.1: Slide Presenter Board that displays Number of Slides

In our initial implementation, the URLs represented on the board were

specified at a notecard. Since this turned out to be relatively inflexible and consequently was perceived as inconvenient, we decided to improve the tool by changing the source of configuration. Now there are two different approaches to complete the Web-Configuration setup. Firstly, Web-Pages can be added by administrators using the Web-Interface. Secondly, authorized learners have the possibility to add URLs via chat-channel in-world. Therefore, the Media Wall was enhanced by two extra buttons. One to add displayable URLs to the board and the other one to delete URLs that already exist within the board's configuration.

Figure 7.2: Media Wall improved by new Functions

7.2 Web-Interface

This section gives insights into motivation, design and implementation of the created Web-Interface. Caused by lacking in-world options to implement a user friendly configuration interface, a Web-Interface using PHP and java script combined with a SQL database was created. In summary, it can be stated that the configuration platform serves to provide the in-world tools with changeable parameters to allow the reuse of collaboration buildings by variable groups and avatars. Affected by customization processes are for one thing the collaboration tools inside the buildings and for another thing their entrance doors to make it harder for unauthorized avatars to access. Hereinafter, a short description of purpose and usage of the interface's different elements.

7.2.1 Access

A log-in window (Fig. 7.3) restricts the access to the menu options of the interface. The application is created to be used exclusively by system administrators. Ordinary user of the environment (learner), have no entitlement to change any kind of system parameters. Once a qualified user has logged in, the authorization is verified using sessions. Figure 7.3 shows the configuration manager's start frame.

Figure 7.3: Lo-gin Window

7.2.2 User

As shown in Figure 7.4 the section User enables to create and change a record of a Second Life user. Real persons' first name and last name are solely to track the identity of an avatar and not relevant for the configuration. The entered id forms the primary key of the data set, in order to prevent potential problems caused by name conflicts. Maintaining an e-mail address is optional, but necessary in case the Appointment Setter tool (6.1.3) is desired to perform properly. Although a user can be created without avatar information, this data is essential, since the avatar name is used to set user rights on Second Life objects.

Figure 7.4: Editing an existing User Profile

7.2.3 Second Life Learning Groups

A Second Life learning group consists of two or more students meant to work collaboratively on a project. In Figure 7.5 one can see the form which allows an administrator to easily create a group by assigning user and URLs to an groupname. Once a group exists, parameters like members or URLs can be changed. Associated URLs will be displayed at the Media Wall (6.1.3) of an assigned collaboration room.

Figure 7.5: Creating a new Group

Every group should have a private working space. Therefore, they are placed in one collaboration building, each. Buildings are labeled from A1 to A5 and B1 to B5, depending on the section they are located in. In-world the houses are marked with door plates right above their front doors. Three forms are provided assist the house configuration:

1. **Edit**

   This form does the actual work. It displays the current state of the house in the second column, so that the operator is at all times aware whether a resource is empty or occupied. The combo-box in the third slot serves to select a new group or as well to reset a house to empty (see also Fig. 7.6a).

2. **Avatar View**

   Avatar View is the first of two representations of the house configuration. It supplies a fast overview of where a group is located and which

avatar belongs to it. The user information of this view is restricted to the avatar data, in order to preserve users' privacy. This makes sense, hence the table is also displayed at the Update Wall (Fig. 7.12) in the learning environment's casual area (see also Fig. 7.6b).

3. **Extended View**

The second, more complete view, includes users' ids and full names and is only accessible over the Web-Interface and should assist the admin tasks (see also Fig. 7.6c).

(a) Assigning Groups to Houses

Figure 7.6

(b) Table showing avatars, having access to a house

(c) Table showing avatars and actual user information

Figure 7.6: House Settings

7.2.4   System Administrator

Once an user record is created, this account can be enhanced by admin rights. An administrator has access to the Web-Interface and is therefore authorized to add and edit other users, create and edit groups of users and also to grant and revoke admin rights for existing user. Figure 7.7 displays the two responsible pages.

(a) Form to grant admin rights

(b) Form to revoke admin rights

Figure 7.7: Admin Status

After the registration of an administrator, password and username can only be changed by him-/herself. This is restricted by the interface, since it automatically changes the data of the user which is currently logged in. Using the frame shown in Figure 7.8, an admin can change their own password.

Figure 7.8: Changing an Admin's Password

As visible in the left frame, there is another form available to change the username of the administrator. There is no screenshot of this frame included, since it is very similar to the password change formular.

In Section 7.4 some details according to the technical realization and interaction with other components, are illustrated.

7.3 Expansion

Motivated by the evaluation of the first test-run, the here introduced elements were designed. Based on various factors like availability of land and minimal needs for an actual employment in lectures, the environment was enlarged to serve for ten groups of learners and two teaching instructors. In Figure 7.9, one can see the main part of the renewed setting. In order to provide an pleasant atmosphere, also two additional common areas came up.

126

Figure 7.9: Enhanced Environment - Top View

The teacher's office itself was not discussed as a part of the evaluation results. Nevertheless, based on the request of future instructors, two tools were added. Figure 7.10 illustrates the left section of the office, that is equipped with a desk and thus forms the rather formal space. A tool called Media Wall (6.1.3), is placed as a new element on the left wall. To obtain the transparent walls, it can be switched on and off when required. On the second picture (Fig. 7.10b) one can see the active Media Wall, whereas the first one (Fig. 7.10b) shows the wall in its off-state .

127

(a) Glass Wall

(b) Media Wall

Figure 7.10: Office - Formal Area

As described in Section 6.1.4, the instructor room has two differently equipped sections. Figure 7.11 is an image of the casual side of the office building. A Noticeboard was added on the right wall, so participants can write down important things during meetings. Three different buttons are implemented to operate the board:

1. **Reset**

   Enables the input chat channel and deletes the content of the board entirely.

2. **Speaking Tube**

   Generates and writes out a new input channel number. Text written on this channel will be displayed on the board.

3. **Line Arrow**

   Deletes the according row and puts the cursor on its first digit. The next entered text will start with this digit.

Figure 7.11: Office - Casual Area

The Update Wall, shown in Figure 7.12, is located in the most central common area of our property. It displays the occupancy of the buildings, see Figure 7.6b, configured through the Web-Interface. The central display lists all collaboration rooms with assigned groups and their group members represented as avatar names. Thus, if someone feels lost, he/she can easily find the correct room by reading the chart. On the board's right and left edge one control panel each is located. As the learning environment is split into two sectors with house numbers A and B, so are the boards panels. Left handed buttons control houses in sector A and right handed those placed in sector B. Pushing the top button one can update the configuration of a whole section, while the remaining five buttons trigger single house configuration

updates. What exactly happens, is explained more detailed in Section 7.4.

Figure 7.12: Common Area with Wall to Update the Configuration

Finally, Figure 7.13 shows the last part of the settings enlargement. This is an additional recreation area for users of the environment, to chill out and relax after or during an exhausting learning session.

Figure 7.13: Beach Recreation

The following section describes the environment's enhancement from a technical point of view. It is explained how various items outlined in this chapter interact with each other.

7.4 Technical Implementation

This section is separated into two subsections. One gives insights into the realization of the Web-Interface, while the second explains how the configuration is passed on to specific Second Life objects.

7.4.1 Web-Interface

Presentation and applications of the platform are already described in Section 7.2. In the following, a brief introduction into the implementation is given. At first, Figure 7.14 visualizes the system components. PHP5 was selected for the implementation of the main parts of the program. Java script plays only a complementing role, executing a few run-time operations. As an interface between PHP code and the SQL database, the class "mysqli" provided by PHP, was used.
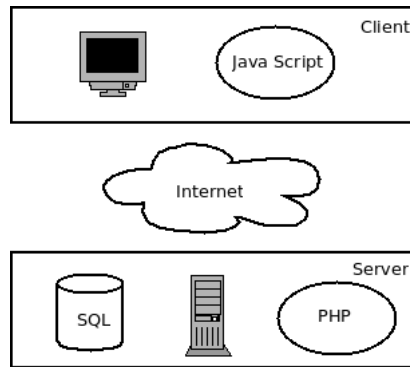
Figure 7.14: Structure of the Web-Interface

Hereinafter a detailed representation of the created database tables, completed through explanations of design choices.

The first Table 7.1 stores user information. The column id identifies the data set and therefore has to be unique in this table. This number might be a student number or a social security number. Since names are rarely unique, this identification number was added to prevent potential problems.

133

Field	Type	Null	Default
id	int(10)	No	
first_name	varchar(20)	No	
last_name	varchar(20)	No	
email	varchar(30)	Yes	NULL

Table 7.1: DB-Table: User

An extra table saving avatar information exists (see Table 7.2), to allow multiple avatars assigned to one user. Here, the combination of first name and last name can be used as primary key, since Second Life also uses this pair as unique identification.

Field	Type	Null	Default
first_name	varchar(20)	No	
last_name	varchar(20)	No	
user_id	int(10)	Yes	NULL

Table 7.2: DB-Table: Avatar

As below shown in Table 7.3 the administrator table includes the column user_id, that refers to Table 7.1, which implies that an administrator is a privileged type of user. However, to allow quick creations of admin accounts directly at the database, the field need not be filled in. This is not possible using the Web-Interface. In general, admin rights might only be granted to already existing users.

Field	Type	Null	Default
user	varchar(20)	No	
pwd	varchar(20)	No	
user_id	int(10)	Yes	NULL

Table 7.3: DB-Table: Admin

In order to obtain group information, independent from particular members, relevant information is split into two tables. One (see Table 7.4) only saves the groupname with according identification number. Thereby, the ID represents an automatic index used as primary key. The second Table 7.5 maps users to specific groups. Here, the pairing of user and group_id forms the primary key, so a user can participate in various groups. This is relevant for teaching assistance which might supervise multiple groups or even for students, if two different lectures take place in the environment at the same time.

Field	Type	Null	Default
id	int(10)	No	
name	varchar(20)	No	

Table 7.4: DB-Table: AGroup

Field	Type	Null	Default
group_id	int(10)	No	
user_id	int(10)	No	0

Table 7.5: DB-Table: SLGroup

Every URL in Table 7.6 is assigned to a group. Thus, each group can have its individual Web-Pages, which will be displayed on their private collaboration room's Media Wall (6.1.3). Hence, every group owns a list with URLs.

Field	Type	Null	Default
url	varchar(30)	No	
group_id	int(10)	No	

Table 7.6: DB-Table: WebTable

The last Table 7.7 is provided to store a current occupancy of houses. As a constant parameter the house number is the primary key of the data set. Groups can be assigned and reassigned through their group_id.

Field	Type	Null	Default
house_nr	varchar(2)	No	
asigned_group	int(10)	Yes	NULL

Table 7.7: DB-Table: House

Image 7.15 exposes the relation between different data tables serving as

a complement to already illustrated information.
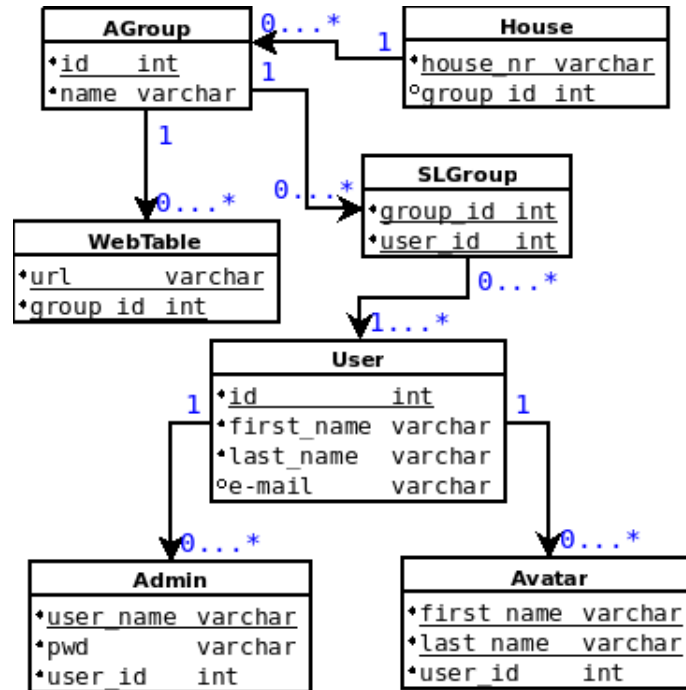
Figure 7.15: Database Structure

Within this subsection information about the configuration Web-Interface is given. The following will explain how the Web-Interface interacts with a Second Life script.

7.4.2 Interaction

This subsection gives more details about how the system operates. First the configuration has to be completed using the Web-Interface. Assuming this is done, three scenarios may trigger a configuration process:

1. **A button on the Update Wall (Fig. 7.16a) was pushed**

   This tool enables the avatar of an instructor to trigger a configuration

request, whenever changes in the configuration were performed.

2. **A door plate (Fig. 7.16b) was just reset**

   Each door plate stores the configuration of the building it is attached to. Whenever a door plate is reset, it loses the information and therefore automatically retrieves the data. The obtained data is then sent to configurable tools in the building.

3. **A door plate (Fig. 7.16b) is not able to provide configuration parameters**

   Every time a tool is touched it checks the authorization of the touching avatar. If there is no authorization data, the tool will realize it and will subsequently ask the door plate to provide the missing information. Most likely the door plate will be able to provide the configuration data, but in some cases (e.g. the last reset of the door plate happened before a configuration was available) it has to request the data from the Web-Interface.

(a) Update Wall   (b) House with Number Plate
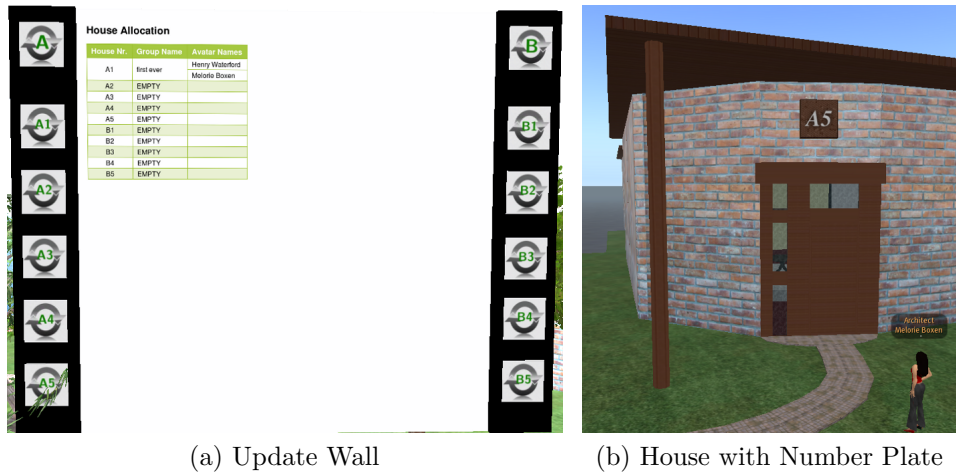
Figure 7.16: SL - Configuration Components

As all named events result in very similar job streams, only one case was picked to be introduced exemplarily. For a better understanding the course of events is complementary to the following description also visualized in Figure 7.17. The process is triggered by an administrator's avatar touching a button of the Update Wall (Fig. 7.16a). Depending on the affected button, either a whole section (A or B) or a specific house will be addressed. Therefore, the door plates of those buildings receive a message, that is sent over a predefined chat channel. To that end, each door plate (Fig. 7.16b) listens on a different allocated channel. If a door plate receives an order to update its configuration, an HTTP request with parameters identifying the concrete building, is sent to a PHP enabled page, which is part of our Web-Interface. This applet retrieves relevant data and sends it back to the in-world object. Now, the door plate that is already waiting for a response, receives the data and stores it after editing its format. Before setting up the tools with the new configuration, a message is sent in order to inform affected tools. Hereafter,

the door plate sends relevant parameters to all configurable objects of the building.
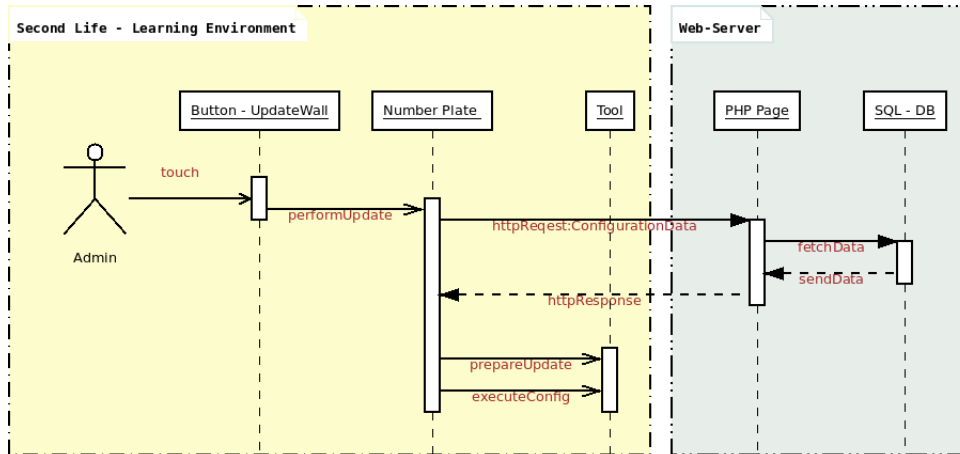
Figure 7.17: Configuration: Sequence Diagram

7.5 Discussion

In the course of this chapter, adjustments performed on the introduced prototype were documented, pictures of the extended environment showing new tools and facilities were presented and a developed Web-Interface was characterized. Some details according the technical implementation conclude the chapter. The first section starts with a brief description of the now extrinsically configurable tools. One might have noticed that only three out of five tools were enhanced by an interface to allow automatic configuration. This is because the Brainstorming Board and the White Board are not created by our project group and thus we have no access rights to read or change the source codes. Although there was a discussion going on whether to recreate this tools, we decided to compromise at this state of the research, choos-

ing economy of time over range of functions. However, if the environments next test-run is successful, the tools will be replaced. For the configuration, the concept of the Update Wall interacting with door plates was generated. Hereby, the door plates serve as a configuration node, no less than as orientation assistance. This is worth mentioning, as during the prototype evaluation orientation difficulties were documented. Also, the Update Wall refers to the numbers written on the door plates. As stated in Section 7.3 the door plate is located in the most central common area, with the intention to be visible from the entire environment. Unfortunately this is not realizable, because the displayed information is categorized as a media and SL restricts the visibility of medias to specific parcels. For this very reason, the information table displayed on the Update Wall's screen is only visible for avatars who are currently located on the same piece of land.

This chapter concludes with some comments about general design decisions. Firstly, we are aware of certain imperfections in the structure of the environment. Size and shape of collaborative buildings are only two to mention. Nevertheless, we were restricted by different aspects, like Second Life induced restrictions as well as available property. Under consideration of relevant aspects, we tried to make the best decisions possible.

Chapter 8

Lessons Learned

Since there is a fairly high amount of subjects I would like to describe, the chapter is divided into four different fragments. Those deal with aspects of the collaboration with an abroad university (8.1), issues while reviewing literature (8.2), experience gained in Second Life (8.3) and general organizational concerns (8.4).

8.1 Collaborating with Curtin, University of Technology

Completing the research-project within a foreign culture and environment has broadened my horizon enormously. At the beginning different start barriers had to be overcome, such as language difficulties or a long lasting jet-lag. However, Curtin University of Technology was providing a very warm and welcoming as well as scientifically competent and organized environment. We were a group of three students from Graz, University of Technology vis-

iting the Curtin Business School (CBS) at the same time. The university supplied fully equipped workplaces that were 24 hours accessible through a chip card-key, research seminars, an English language course and supervision in our research. At the same time, our colleagues and supervisor assisted us with organizational issues, arrival problems, settling in and furthermore introduced us to local customs. Reconsidering the differences between Australian and Austrian university education, out of my personal experience I would point out two prominent items. Firstly, the relation between student and supervisor. In Australia it seems to be common for students attending a master course, to have a far closer relationship to their teachers and thesis supervisor. A supervisor has more of a leading and motivating than examining character. Secondly, research work is taken very seriously and well integrated into university curriculum. Not knowing how to prepare a questionnaire appropriately, cost me some trouble at the beginning of my research. Anyhow, my supervisor showed a lot of patience and understanding and after reading various instructional papers and completing a couple of correction cycles, two satisfactory questionnaires were resulted. After the creation of the questionnaires, there was a bulk of paperwork to fill out. Every research project involving living participants has to be approved by an ethic committee. The university is very strict about this policy, supposed to protect potential research victims. Summarizing, it can be said that the exchange at Curtin UoT not only strongly improved my English skills and inter-cultural (social) competencies, but moreover, it gave me a short but imposing glimpse into how international research might work.

8.2 Literature Research

Autonomously starting to work in a field, asks for a lot of reading and reviewing. In the first couple of weeks, there was no concrete definition of the research project, the thesis finally resulted in. This made it even harder to figure out whether information/knowledge was supposedly important or not. The first attempts to find suitable literature became frustrating, since most of state of the art papers are not freely available and buying them could quickly become, extremely cost intensive. Of course, the University provides access to some research resources, but this service is also very restricted. Thus, after a short period of time one has to accept those formal restrictions and settle for using papers that are not just recently published but are the best available ones. Besides the lack of access to research material, my two biggest issues to overcome, while looking for literature, were time management and motivation. First, as mentioned before, it was not easy to evaluate the importance of located material, caused by an initial non-knowledgeableness in the field of distance learning and also 3D virtual worlds. Nevertheless, after a few weeks a basis knowledge was built up and the investigation became more concrete. The temporary move to Perth to stay at Curtin UoT involved some great benefits, especially in terms of knowledge acquisition. Not only talks, held by various international researchers but also a discussion group called the Virtual World players took place every week. This, and a great variety of licenses for research journals were stimulating progress and triggering new attempts. After a period of introduction the project was defined and a project plan for the first prototype, including very strict deadlines was set up. During

the prototype creation phase, literature was used very aim-oriented to solve appearing problems. Due to the time pressure, there was a lot of reading and researching that I did not make notes of. In retrospect I am able to say, that already elementary minutes would have saved a lot of time for subsequent literature work. The results of the first literature review served as basis for a more detailed project definition. Once the pressure of project deadlines and milestones is gone, it might become hard to still focus on essential facts to advance properly. Also, it cost quite an effort to not deviate from the subject, while reading all these papers with different approaches and sources that potentially include interesting and useful information. Sometimes one just ends up searching for new papers instead of making use of sources that have already been found. Only in the last few weeks, I started to work efficiently, immediately copying useful information into an extra file and adding the source to the bibliography file before starting to read another related paper, so I would not loose or forget the already discovered data.

8.3   Working in and with Second Life

As easy it is to install and access Second Life's user client in first place, as complicated it can be to solve upcoming issues while creating in-world content. Me, already being in Western Australia and the responsible administrator staying in Graz, led to a bunch misunderstandings and therefore waiting times, not least because the assignment of permissions can be quite a piece of work. In addition I have not had any experience with the environment an thus did not exactly know what I was asking for. By trial and error,

we worked out the required settings eventually. An over and above existing time difference of eight hours did not speedup the process. Bottom line, while configuring a system it is highly recommended to have all involved parties on site. Then, a wise next step would have been to attend a building lecture in Second Life. Well, for the simple reason that the nearest lecture was offered with a latency of two weeks, I decided to train myself independently, consulting tutorials, Wikis and other random material. Although, it worked out all right, a well instructed lesson that summarizes the most important matters, would certainly facilitate every user's first steps. Not having a Second Life expert available to consult, I wasted a huge amount of time trying to solve issues assigned to scripting tasks, that were not even realizable within this framework. To avoid such a waste of time I kindly recommend a frequent use of Second Life's on-line forums (*Second Life Forums*, n.d.), where mainly experienced user give fast and competent answers.

8.4 Project handling

After doing the initial literature research and the familiarization with the selected 3D-VW (Open Wonderland), a more detailed project outline was drawn up. At this specific point, the objective was to build a prototype in an already determined 3D virtual world, allowing educatees to work over distance collaboratively. A group of students were asked to complete an assignment while using our model. The requirements of the test group brought up new aspects that led to a slight reorientation of the project assessment.

Taking into account the test groups' technological limitations, Project Wonderland did not seem to be the most appropriate VW anymore. In a short time decision Second Life was selected as the new working space. Thereby arising an unfortunate situation, since Second Life was never particularly considered and therefore examined, before. Firstly, at least sixty hours of work, used for familiarization with Project Wonderland were wasted and secondly there was no existing knowledge base regarding Second Life and its exact features. The resultant lack of skills led on to problems and insecurity during the design phase and worse, scepsis by the professor who was tutoring our test group. With the wisdom of hindsight, one can reason that it is not advisable to select an implementation environment and much less invest time into it, unless a definite choice is made, validated by all facts and needs of the project scope. Rather, it might be beneficial to devote this time to creating a telling overview of on-hand development options. Now, the next step of the practical research part was the preparation of the questionnaires. This needed to be done in an early stage, because the pre-questionnaire had to be approved by Curtin university's ethic committee, before the test users first came in contact with the virtual prototype. Although the outcome of the questionnaires were fairly satisfying, I am convinced the findings could have been even more advantageous having a mostly concrete concept of the learning space and its tools, at first. Then, driven by time pressure, it was necessary to list the requirements and order them according to their degree of importance. Creating the collaboration tools obtained high priority, the setup of buildings and surroundings was postponed to the last four weeks. Hence, some of this time could still be used to finish the programming, if

147

required. This structure worked out very well, since I mostly took myself the chance to lollygag with superficiality. Yet still, I managed to spend a couple of days on learning how to use the 3D content creation suite Blender (*Blender*, n.d.), just to finally find out that Second Life's in-world content creation tools are firstly easier to handle and secondly more than sufficient for my needs. That is why it certainly makes sense to first think about a project's emphasis and only thereafter select an appropriate program, not going beyond, but still complying with the true requirements.

8.5 Discussion

To sum up the section, one could say it is helpful to schedule some extra time for initial literature research, in particular if it happens to be written in any other than the reader's mother tongue. Also, it is worth to take into account, that a detailed basis knowledge about existing theories just as in contemplable development frameworks, could speed up ensuing tasks significantly. Coming to a conclusion, a detailed initial planning phase is essential for a positive project result and can hardly be overrated.

Chapter 9

Summary and Outlook

Aim of this project was the creation of a collaborative learning space implemented within a 3D virtual world. The application should provide a pleasant as well as convenient place to complete university assignments, working together in small groups.

This document provides an overview of the formation of a 3D virtual learning environment. It was described why computer based learning is essential in today's education and how technology like Internet communities may enrich learning experiences. Insights into the evolution of distance learning and the changes of student profiles, were given. Arguments, like the perceived feeling of presence, or possibility to combine different forms of communication were presented to explain the advantages of 3D virtual environments compared to simpler two dimensional e-Learning applications. After presenting a hand of exemplary research projects, outcomes which influenced our project design were discussed. The design of the resulting learning space is a product of requirements derived from literature based knowledge,

ideas of project team members and conditions aroused from project settings. Chapter 5 introduced the project idea, setting and objectives and also represented a passage between the theoretical and practical parts of this thesis. In subsequent chapters insights about the realization were illustrated. For the implementation of our prototype Second Life was selected, as it met our research project's requirements best. One of our most critical concerns was to find a 3D virtual world, usable by as many students as possible. Therefore, the client needed to be easy to install and operate as well as low in technical requirements. In Section 3.2 arguments reasoning the choice were outlined. Still, in literature problems with Second Life's client interface are documented. For instance in K. Holmberg and Huvila (2008): *"Six students stated that they had some technical difficulties that hindered them from participating in the lectures in-world. Most of the problems appeared to be related to computer graphics cards that did not meet the technical requirements of Second Life client software.* Luckily our test persons were able to work effortlessly with the virtual world's client application. The originated collaborative learning environment was documented by various screen-shots of tools and facilities, completed through explanations of features and restrictions. Moreover, a conducted evaluation of the application was analyzed and presented. Based on experiences and problems that appeared during utilization and administration, suggestions for improvements were discussed. Even though it was possible to eradicate some flaws, Second Life's virtual world interface and its assigned scripting languages highly restrict the options of in-world development and thus improvements of usability were often not implementable. However, a couple of changes and extensions were real-

150

ized and described. In the penultimate chapter, lessons learned which apply to various areas, were illustrated.

This work concludes with a few thoughts about Second Life, the use of 3D virtual worlds for education and desirable future developments in this area. In the field of virtual 3D worlds for education a lot of research has already been done, but only comparatively few research groups point out the restrictions and problems that still come along using such an immature technology and its requirements. Related to Second Life, one needs to expect significant restrictions due to missing document sharing possibilities and deficient in-world features[2]. Some restrictions also occur due to Linden Labs user guidelines. A problem that might appear in various countries, is caused by Second Life's age policy, according to which users under the age of eighteen are only allowed to use a so called Teen Grid, whereas users at the age of eighteen and older don't have access to it. This precaution is necessary due to appearing content including pornography and violence. For institutions where first semester students are often under age, that might lead to a barrier for the employment of virtual learning environments.

Although, it is out of question that in the area of virtual worlds there is still a lot of work to do, it needs to be identified as a technology that is able to reform the future of education in various means. Given the motivation to invest resources and moreover the willingness to share knowledge, 3D virtual worlds could serve as a great platform for international communities of expertise and also as a framework to provide similar high education standards

---

[2]Information illustrated in this document refers to Second Life's viewer version 1.23 and might not be accurate for the current version 2.1.1.

worldwide, completely independent from local teachers' qualifications. The perceived additional value of 3D virtual learning systems also highly depends on operational areas. Thus, a mentionable aim is to optimally exhaust the potentials of used frameworks, when designing education material.

To sum up, it is necessary to say that the challenge is to create a virtual environment, flexible in the creation of learning settings, easy to access, low in requirements and overall simple and intuitive in operation. In order to converge to this functionality requirements, future research will continue with work on dynamically changeable learning rooms.

Bibliography

Activeworlds 1. (n.d.). (`http://www.activeworlds.com/`)

Activeworlds 2. (n.d.). (`http://www.activeworlds.com/edu/awedu_download.asp`)

Activeworlds 3. (n.d.). (`http://www.activeworlds.com/help/aw50/index.html`)

Ang, K. H., Wang, Q. (2006, December). A case study of engaging primary school students in learning science by using active worlds. In (pp. 5–14). Sydney, Australia.

AngryBeth Shortbread, S. L. (n.d.). *Metalabs communal whiteboard.* (`http://slurl.com/secondlife/Gourdneck/194/236/67;http://metalab.blogspot.com/2006/06/communal-whiteboard.html`)

Appalachian's 3-d virtual campus receives campus technology innovators award. (2006, Sept). Online. (`http://www.news.appstate.edu/2006/09/05/virtual-campus/`)

Bates, T. (2005). *Technology, e-learning and distance education.* Routledge.

Berge, Z. L. (2008, May–June). Multi-user virtual environments for education and training? a critical review of second life. *Educational Technology Magazine: The Magazine for Managers of Change in Education, 48*(3), 27–31.

Blender. (n.d.). (`http://www.blender.org/`)

Boulos, M. N. K., Hetherington, L., Wheeler, S. (2007). Second life: an overview of the potential of 3-d virtual worlds in medical and health education. *Health Information & Libraries Journal, 24*(4), 233–245.

Bronack, S., Riedl, R., Tashner, J. (2006). Learning in the zone: A social constructivist framework for distance education in a 3-dimensional

virtual world. *Interactive Learning Environments*, *14*, 290–297.

Bronack, S., Sanders, R., Cheney, A., Riedl, R., Tashner, J., Matzen, N. (2008). Presence pedagogy: Teaching and learning in a 3d virtual immersive world. *International Journal of Teaching and Learning in Higher Education*, *20*(1), 59–69.

Cabanero-Johnson, P. S., Berge, Z. (2009). Digital natives: Back to the future of microworlds in a corporate learning organization. *The Learning Organization*, *16*(4), 290–297.

Chang, V., Gütl, C. (2010, May). Generation y learning in the 21st century: Integration of virtual worlds and cloud computing services. In Z. W. Abas, I. Jung, J. Luca (Eds.), *Proceedings of global learn asia pacific 2010* (pp. 1888–1897). Penang, Malaysia.

Chang, V., Gütl, C., Kopeinik, S., Williams, R. (2009). Evaluation of collaborative learning settings in 3d virtual worlds. *International Journal of Emerging Technologies in Learning (iJET)*, *4*, 6–17. (`http://online-journals.org/i-jet/article/view/1112/1163`)

Childress, M. D., Braswell, R. (2006, August). Using massively multiplayer online role-playing games for online learning. *Distance Education*, *27*(2), 187–196.

Chittaro, L., Ranon, R. (2007). Web3d technologies in learning, education and training: motivations, issues, opportunities. *Computers & Education*, *49*, 3–18.

Chou, C. (2003). Interactivity and interactive functions in web-based learning systems: A technical framework for designers. *British Journal of Educational Technology*, *34*(3), 265–279.

Cross, J., O'Driscoll, T., Trondsen, E. (2007, March). Another life: virtual worlds as tools for learning. *eLearn Magazine*(3), 2.

Dalgarno, B., Hedberg, J. (2001). 3d learning environments in tertiary education. In *Ascilite'01: Meeting at the crossroads* (pp. 33–36). Melbourne, Victoria.

Dickey, M. D. (2003). 3d virtual worlds: An emerging technology for traditional and distance learning. Ohio, USA.

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learn-

ing: two case studies of active worlds as a medium for distance education. *British Journal of Educational Technology*, *36*(3), 439-451.

Dillenbourg, P., Daniel, D. S., Paraskevi, S. (2002). Virtual learning environments. (`http://hal.archives-ouvertes.fr/hal-00190701/en/`)

Djorgovski, S. G., Hut, P., Mcmillan, S., Vesperini, E., Knop, R., Farr, W., et al. (2009, July 21). Exploring the use of virtual worlds as a scientific research platform: The meta-institute for computational astrophysics (mica). (`http://arxiv.org/abs/0907.3520`)

Duan, X., Jiang, P. (2008). Research of a virtual 3d study pattern based on constructive theory in e-learning. In *e-forensics '08: Proceedings of the 1st international conference on forensic applications and techniques in telecommunications, information, and multimedia and workshop* (pp. 1–5). ICST, Brussels, Belgium, Belgium: ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering).

Dudeney Ge, S. L. (n.d.). *Brainboard v4.0 - international character set [boxed].*

Garrison, D. R., Vaughan, N. D. (2008). *Blended learning in higher education.* Jossey-Bass.

Graf, C. (2005). *E-learning.* LinkPhysica–Verlag Heidelberg.

Griffiths, M. D., Hunt, N. (1995). Computer game playing in adolescence: Prevalence and demographic indicators. *Journal of Community & Applied Social Psychology*, *5*(3), 189–193.

Gütl, C., Chang, V. (2008). Ecosystem-based theoretical models for learning in environments of the 21st century. *International. Journal of Emerging Technologies in Learning (iJET), Vol*, 5060.

Gütl, C., Chang, V., Kopeinik, S., Williams, R. (2009, September). 3d virtual worlds as a tool for collaborative learning settings in geographically dispersed environments. In (pp. 310–323).

Holmberg, B. (2005). *The evolution, principles and practices of distance education.* Bibliotheks und Informationssystem der Universität Oldenburg.

Holmberg, K., Huvila, I. (2008, October). Learning together apart: Distance education in a virtual world. *First Monday*, *13*(10). (`http://journals.`

`uic.edu/fm/article/view/2178/2033`)

Jones, C., Ramanau, R. (2009). Collaboration and the net generation: the changing characteristics of first year university students. In *Cscl'09: Proceedings of the 9th international conference on computer supported collaborative learning* (pp. 237–241). International Society of the Learning Sciences.

Kvavik, R. B., Caruso, J. B., Morgan, G. (2004). Ecar study of students and information technology, 2004: Convenience, connection, and control. *5*.

Lsl portal. (n.d.). (`http://wiki.secondlife.com/wiki/LSL_Portal`)

Lsl wiki. (n.d.). (`http://lslwiki.net/lslwiki/wakka.php?wakka=HomePage`)

Lucia, A. D., Fasano, F., Francese, R., Passero, I. (2008). Enhancing rationale management with second life meetings. In *Dms* (p. 118-123). Knowledge Systems Institute. (`http://dblp.uni-trier.de/db/conf/dms/dms2008.html#LuciaFFP08`)

Lucia, A. D., Francese, R., Passero, I., Tortora, G. (2008a). Synchronous distance lectures in second life: Teaching fundamentals of informatics. In *Proceedings of the 14th international conference on distributed multimedia systems, dms* (pp. 384–389). Knowledge Systems Institute.

Lucia, A. D., Francese, R., Passero, I., Tortora, G. (2008b). Slmeeting: supporting collaborative work in second life. In *Avi* (p. 301-304).

Maher, M. L., Skow, B., Cicognani, A. (1999). Designing the virtual campus. *Design Studies, 20*(4), 319 – 342. (`http://www.sciencedirect.com/science/article/B6V2K-3WM5K9T-1/2/f866066534fe80541829a6686c7bb2a2`)

McArdle, G., Monahan, T., Bertolotto, M., Mangina, E. (2004). *A web-based multimedia virtual reality environment for e-learning.*

Meta institute for computational astrophysics - exploring astrophysics in virtual worlds. (n.d.). (`http://www.mica-vw.org/wiki/index.php/Meta_Institute_for_Computational_Astrophysics`)

Monahan, T., McArdle, G., Bertolotto, M. (2008). Virtual reality for collaborative e-learning. *Computers and Education, 50*(4), 1339–1353.

Moore, P. (1995). Learning and teaching in virtual worlds: Implications of virtual reality for education. *Australian Journal of Educational Tech-*

nology, 11, 91–102.

Nigel, J. W. (2007). The impact of web3d technologies on medical education and training. *Computers & Education, 49*(1), 19 – 31. (`http://www.sciencedirect.com/science/article/B6VCJ-4GNTFHN-1/2/038248c7a389ba900e10bef7249450da`)

Opensimulator wiki. (n.d.). (`http://opensimulator.org/wiki/Main_Page`)

Open wonderland 1. (n.d.). (`http://www.openwonderland.org/about/about-project-wonderland`)

Open wonderland 2. (n.d.). (`http://www.openwonderland.org/about/faq`)

Open wonderland 3. (n.d.). (`http://sites.google.com/site/openwonderland/tutorials/learning-the-basics-tutorial`)

Paulsen, M. F. (2002). *Online education systems:discussion and definition of terms.* (`http://nettskolen.nki.no`)

Pöysä, J., Lowyck, J., Häkkinen, P. (2005). Learning together there-hybrid place as a conceptual vantage point for understanding virtual learning communities in higher education context. *PsychNology Journal, 3*(2), 162-180.

Reiser, R. A. (2001). A history of instructional design and technology: Part ii: A history of instructional design. *Educational Technology Research and Development, 49*(2), 57–67. (`http://www.springerlink.com/content/t84v161740422678/`)

Sanders, R., McKeown, L. (2007). Promoting reflection through action learning in a 3d virtual world. *International Journal of Social Sciences, 2*(1), 50–56.

Second life forums. (n.d.). (`http://blogs.secondlife.com/community/forums/?f=54`)

Second life wiki 1. (n.d.). (`http://wiki.secondlife.com/`)

Second life wiki 2. (n.d.). (`http://secondlife.com/support/sysreqs.php`)

Second life wiki 3. (n.d.). (`http://wiki.secondlife.com/wiki/Viewer_2_Quick_Start_Guide/Interface_overview`)

Second life wiki 4. (n.d.). (`http://wiki.secondlife.com/wiki/How_do_I_build_objects%3F`)

Seok, S. (2008). Teaching aspects of e-learning. *International Journal on*

E-Learning, *7*(4), 725–741. (`http://go.editlib.org/p/24323`)

Seok, S., Meyen, E., Aust, R., Fitzpatrick, M., Newberry, B. (2006, October). *Three dimensions of the online course evaluation instrument in postsecondary education.*

The seventh annual open education conference. (2010). (`http://openedconference.org/2010/`)

Sheehy, K., Ferguson, R., Clough, G. (2007). Learning and teaching in the panopticon: Ethical and social issues in creating a virtual educational environment. *International Journal of Social Sciences*, *2*(2), 89–96.

Varnava-Marouchou, D. (2004). 21st century trends in education: implications for learning and teaching in higher education. *Information Technology Based Higher Education and Training, 2004. ITHET 2004. Proceedings of the Fifth International Conference on*, 443-448.

Warren, M. J., Hutchinson, W. (2003). Information security - an e-learning problem. In W. Zhou, P. Nicholson, B. J. Corbitt, J. Fong (Eds.), *Advances in web-based learning - icwl 2003* (Vol. 2783, pp. 21–26). Berlin, Heidelberg: Springer-Verlag.

Witmer, B. G., Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, *7*, 225–240.

Zhang, D., Nunamaker, J. F. (2003). Powering e-learning in the new millennium: An overview of e-learning and enabling technology. *Information Systems Frontiers*, *5*.

Zhang, D., Zhao, J. L., Zhou, L., Nunamaker, J. F. (2004). Can e-learning replace classroom learning? *Commun. ACM*, *47*(5), 75–79.

List of Figures

List of Tables

Appendix A

PRE-Questionnaire

The appended pre-questionnaire was completed by sixteen students at Curtin, University of Technology. All of them were assisting a business related class called BPA 300. A cove page, informs potential participants about the project aims, intentions of the research and its conditions. This survey was performed before the start of the application's test-run. Questions were geared towards gathering information about students demographic data, their learning and working preferences, their general attitude towards virtual worlds and computer games as well as already existing experience. Also questioned was whether a respondent would participate in the research or not. This information was meant to derive a relation between a persons characteristics and their propensity for working with technologies like 3D virtual worlds. In Section 6.2.2 one can find information about evaluation results.

Information Sheet

Research Study: 3D-Worlds for Learning in Higher Education

To Whom It May Concern

My name is Simone Kopeinik. I am a Master student of Graz University of Technology, Austria with a major in software development. I am currently working on a research project at Curtin University of Technology investigating the usefulness of collaborative learning environments in 3D worlds. As part of my study I have constructed a virtual collaboration environment (VCE) in the 3D world of Second Life. This environment is provided to fit with the requirements for students to work on assignments collaboratively in Second Life. Students who complete an assignment using the VCE will be asked to identify the strengths and weaknesses of the learning collaboration in the VCE space.

There are two parts to the survey, a pre questionnaire and a post-questionnaire. The pre questionnaire will include data about the participants and their interests related to Virtual Worlds specifically about 3D Worlds, Second Life and other VCE in general. I am also interested to find out why the participants are interested to participate in this experiment. The post-questionnaire will be handed out to each participant at the end of the experiment. For this questionnaire I am interested to find out about the participant's learning experiences in VCE.

The pre-questionnaire will take approximately 15 minutes. There are no "right" or "wrong" answers to the questions. Your opinion is what I am asking for. Please be sure that you give a well thought answer to all questions. In case you change your mind, just cross it out and mark the appropriate box with an "x". If the space provided for written answers is too limited, feel free to comment on the reverse side.

Your participation in this experiment is voluntary, and you may withdraw at any time without prejudice or negative consequences. This research has been reviewed and approved by the Curtin University's Ethics Coordinator, and is compliant with the University's ethical standards.

In case you have any queries and concerns regarding this project, please do not hesitate to contact my supervisor or myself.

Thank you very much for your time.

Simone Kopeinik   Dr. Vanessa Chang
University Associate   Research Supervisor
Curtin University of Technology   Curtin University of Technology
Email: s.kopeinik@cbs.curtin.edu.au   vanessa.chang@curtin.edu.au

Pseudo name: _____
(please provide a pseudo name for yourself and this
name will also be used for the post-questionnaire)

Part A: Demographic data

1. Age:
   ☐ < 18   ☐ 18- 24   ☐ 25-30   ☐ > 30

2. Home country: _____

3. Gender:
   ☐ male   ☐ female

4. How many days per week are you normally on campus?   _____

5. Distance between main place of living and university (one way):
   ☐ living on campus (eg. Erica Underwood House, Japan House, etc)
   ☐ 3- 5 km   ☐ 6-10 km   ☐ 11- 20km   ☐ 21- 30km   ☐ > 30 km

6. I have an Internet connection at home.
   ☐ yes   ☐ no

7. My download is restricted to _____ MB per month.

8. Do you work?
   ☐ no   ☐ part time   ☐ full time

   a. If you work part time, please specify the number of hours you work per week.
      _____

Part B: General information and E- learning

9. How many units are you enrolled in this semester?   _____

10. I usually attend lectures:
    ☐ frequently (>10)
    ☐ mostly (6- 9)
    ☐ seldom (2- 5)
    ☐ hardly ever (1)
    ☐ never

11. I attend BPA 300 lectures
    ☐ frequently (>10)
    ☐ mostly (6- 9)
    ☐ seldom (2- 5)
    ☐ hardly ever (1)
    ☐ never

12. How do you describe your level of IT experience?
    ☐ very experienced   ☐ experienced   ☐ less experienced   ☐ inexperienced

13. Describe your experience of using the computer (programming, using MS-Office, etc).
_____
_____
_____
_____

14. How many hours per week do you use the computer? _____

15. At what age did you start using computers? _____

16. When completing work assignments (eg tasks assigned by your employer) I prefer to work ......
☐ at home ☐ at work ☐ other _____

17. When completing university assignments (eg learning tasks assigned in a unit) I prefer to study ...
☐ at home ☐ at university ☐ other _____

18. My computer meets the minimum requirement for Second Life (please find attached a list outlining the minimum requirement).
☐ yes ☐ no

If you answered 'no' above, list the problems you encounter:
_____
_____
_____
_____

19. Have you used e-learning frameworks (Learning Management Systems such as Blackboard, WebCT, etc)?
☐ yes (go to 19a) ☐ no (go to 19b)

   a. List the frameworks that you have used.
   _____
   _____
   _____
   _____
   _____

   b. Evaluate the following e-learning framework tools using a scale from 1 (very useful) to 4 (not useful).
   - unit outline   ☐1 ☐2 ☐3 ☐4
   - discussion board   ☐1 ☐2 ☐3 ☐4
   - collaboration with peers   ☐1 ☐2 ☐3 ☐4
   - learning centred lecture material   ☐1 ☐2 ☐3 ☐4
   - other _____   ☐1 ☐2 ☐3 ☐4
   - other _____   ☐1 ☐2 ☐3 ☐4

20. Whenever a new technology is released I ......
☐ cannot wait to try it out.
☐ use it as soon as I have the time.
☐ use it when I see a main benefit in it.
☐ just use it if I really have to.

a. What new technologies have you recently used?

_____
_____
_____
_____
_____

b. As an employee, I am willing to apply new technologies in my work task.
☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

c. As a student, I am willing to apply new technologies in my learning task.
☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

Part C: Computer Games and Second Life

21. I play computer based games (incl. Playstation, Wii, etc) regularly.
☐ yes (go to 21.a) ☐ no (go to 22)

a. How many hours a week do you play? _____

b. List 3 of your favourite games.

_____
_____
_____

22. I am familiar with Online (Role Playing) Games.
☐ yes (go to 22a) ☐ no (go to 23)

a. How many hours a week do you play? _____

b. List 3 of your favourite games.

_____
_____
_____

23. Playing Online Role Playing Games is entertaining.
☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

24. Have you used 3D virtual worlds / 3D environments?
☐ yes (go to 24a) ☐ no (go to 25)

a. Which ones?

_____
_____
_____

b. For what purpose?

_____
_____
_____

25. Are you currently using Second Life?
☐ yes (go to 25a) ☐ no (go to 26)

a. I have enough time to get familiar with Second Life.
☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

26. Are you interested in Second Life?
    ☐ yes   ☐ no

27. I am participating in the Second Life experiment in BPA 300.
    ☐ Yes (if 'yes', go to 27a)   ☐ no (if 'no', go to 27a)

    a. Explain your decision.
        _____
        _____
        _____
        _____
        _____

28. Virtual 3D worlds (eg Second Life, Java Wonderland, etc) are useful for collaboration.
    ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree ☐ don't know

    a. Give reasons for your answer.
        _____
        _____
        _____
        _____
        _____

Thank you for your participation.

Appendix B

POST-Questionnaire

Following the survey, that was completed by students at Curtin, University of Technology, in order to evaluate the prototype of the here introduced collaborative virtual learning environment. It is divided into two main sections. The first one is asking about the general impressions and experiences students have gathered working with Second Life. Whereby, the second passage is concerned with working in a virtual environment and terminates with questions about the usage of the concrete learning environment The questionnaire was completed by six students, after using the learning space to complete an assignment of a business lecture. Essential parts of Section 7 rely on the this survey's evaluation results. A résumé can be found in Section 6.2.2.

Pseudo name: _____

Part A: Second Life

1. I had difficulties setting up Second Life.
   ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

   a. Explain the main problems.
   _____
   _____
   _____
   _____
   _____
   _____

2. Have you used Second Life before working on this project?
   ☐ yes (go to 3) ☐ no (go to 2a)

   a. I had enough time to get familiar with Second Life.
   ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

   b. How many hours did you spend on setup and familiarization with Second
   Life before you were able to work on your assignment in Second Life?
   _____

3. I describe my experiences with Second Life as positive.
   ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

4. Based on your experiences in this experiment, Second Life can improve
   business collaboration over distance.
   ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

5. I prefer to use Second Life over other technologies / tools to perform
   collaboration over distance.
   ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

   a. If you disagree or strongly disagree, name at least one technology / tool
   that you would use.
   _____
   _____
   _____
   _____
   _____

6. As a result of this experiment, I am going to use Second Life for ......
   a. learning.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   b. communicating with people from other countries.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   c. playing games, sports, etc.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   d. getting together with friends.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   e. completing collaborative tasks.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   f. other
      _____

Part B: Using a 3D virtual environment

7. I like to use a similar tool for further projects.
   ☐ yes   ☐ no

   a. Why?
      _____
      _____
      _____
      _____
      _____

   b. For what kind of project (application area)?
      _____
      _____
      _____

8. It is easier to meet in virtual than in physical environments.
   ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree

9. Using 3D virtual worlds ......
   a. is easier to collaborate.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   b. raises my motivation to learn.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   c. saves travelling time.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   d. offers flexibility in respect to time.
      ☐ strongly agree ☐ agree ☐ disagree ☐ strongly disagree
   e. other
      _____

10. I am distracted by the high amount of information in 3D virtual world.
   ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree

11. List the main advantages you have experienced with using virtual worlds as a collaborative environment.

   _____
   _____
   _____
   _____
   _____
   _____
   _____

12. List the main disadvantages you have experienced with using virtual worlds as a collaborative environment.

   _____
   _____
   _____
   _____
   _____
   _____
   _____

13. I appreciate using _____ in virtual worlds.
   a. white board
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   b. brainstorming board
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   c. media wall (wall that displays the google docs document)
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   d. slide presenter
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   e. google docs to write an essay
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   f. google docs to prepare a presentation
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   g. text chat
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
   h. voice over IP
       ☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree
       i.   other
       _____

14. Make suggestions for improving the quality of tools mentioned in question 13.

   _____
   _____
   _____
   _____
   _____
   _____

15. Name functionalities you were missing.

_____
_____
_____
_____
_____
_____

16. I appreciate attending online consultation hours.
☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree

17. I appreciate to chat/relax in the recreation area.
☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree

18. The virtual learning environment enhanced the outcome of our project
☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree

     a. Give reasons for your answer.

_____
_____
_____
_____
_____

19. I describe my experience with this particular learning environment as positive.
☐ strongly agree   ☐ agree   ☐ disagree   ☐ strongly disagree

     a. If you disagree or strongly disagree, what would you change in the learning environment to improve it to a satisfactory level?

_____
_____
_____
_____
_____

20. To complete the assignment task I used the learning environment for .....
(multiple options possible)
☐ the first _____ number group meetings.
☐ the last _____ number group meetings.
☐ all group meetings.

21. To complete the assignment task I used the learning environment .....
☐ at home   ☐ at university   ☐ other _____

Thank you for your participation.

Appendix C

Transcription of Questionnaire Results

(*) Some parts of the evaluation was asked to assess with numbers from one to four. Hereby, one signifies very useful and four stands for not useful at all. Whenever a field holds the value zero, the participant didn't provide an answer.

Within the Post-questionnaire results, one will find the term P-Nbr which abbreviates the term Participation Number. It might cause confusion that the participation numbers in the first post-questionnaire table consist of two numbers separated through an underline character. This is because the first number is the participation number assigned to the second questionnaire and the first number was identifying the same participant at the pre-questionnaire. Both are stated to give the reader a chance to relate the results of pre- and post-questionnaire to each other.

Pre-Questionnaire (Check Boxes)

	Question		Σ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Age	18-24	14		1	1	1	1	1	1		1	1	1	1	1	1	1	1
		25-30	2	1							1								
2	Home country	South Korea	1	1															
		Malaysia	2		1						1								
		China	5			1	1	1		1	1								
		Indonesia	4						1					1				1	1
		Australia	3										1		1		1		
		Zimbabwe	1													1			
3	Gender	female	8	1		1	1				1			1	1	1	1		
		male	8		1			1	1	1		1	1					1	1
4	Days per week on campus	?	2										1		1				
		1day	1													1			
		2 days	1			1													
		3 days	6		1		1	1	1	1							1		
		4 days	3	1							1							1	
		5 days	3										1		1				1
5	Distance: home - campus	on campus	3		1							1					1		
		3-5km	2					1	1										
		6-10km	6			1				1	1			1		1			1
		11-20km	5	1			1						1		1		1		
		21-30km	0																
		>30km	0																
6	Internet connection at home	yes	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		no																	
7	Download/month	10MB	1			1													
		12-15MB	1		1														
		40MB	1					1											
		60Mb	1				1												
		400MB	1																1
		2500MB	1														1		
		3000MB	3	1						1		1							
		10000MB	1						1										
		15000MB	1													1			
		20000MB	1								1								
		25000MB	1											1					
		unlimited	3										1		1			1	
8	Work	no	6				1		1	1	1	1				1			
		part time	10	1	1	1		1					1	1	1		1	1	1
		full time	0																
8. a	Working hours/week	8	1															1	
		15	3			1			1										1
		16	1						1										
		20h	4	1	1	1										1			
		25h	1													1			

Page 1

9	# of enrolled units this semester		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		3	2	1													1		
		4	13		1	1	1	1	1	1	1	1	1	1				1	1
		5	1												1				

10	Usual attendance of lectures		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		Frequently = >10	9				1	1			1	1	1	1		1		1	1
		Mostly = 6 to 9	6	1		1			1	1					1		1		
		Seldom = 2 to 5	1		1														

11	Attendance of BPA 300		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		Frequently = >10	8				1	1			1	1		1		1		1	1
		Mostly = 6 to 9	7	1		1			1	1			1		1		1		
		Seldom = 2 to 5	1		1														

12	Described it experience		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		very experienced	1	1															
		experienced	12				1	1	1	1	1	1	1	1	1	1		1	1
		less experienced	3		1	1											1		
		inexperienced	0																

14	Use of computers in hours/week		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		15h	2									1					1		
		20h	3				1									1		1	
		25h	2						1										1
		30h	4	1		1		1		1									
		40h	2		1									1					
		60h	2										1		1				
		>100	1								1								

15	Start using computers at the age of		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		<10	4						1				1	1	1				
		10	2	1													1		
		11	2													1			1
		12	3			1	1			1									
		13	1															1	
		15	1					1											
		16	2								1	1							
		18	1		1														

16	Prefer to complete work assignments		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		at home	5			1	1		1			1			1				
		at work	9	1				1		1	1		1			1	1	1	1
		at university	1		1														
		any place I am	1											1					

17	Prefer to complete assignments		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		at home	8	1			1	1		1						1	1	1	1
		at university	9		1	1			1		1	1	1	1	1	1			

18	Computer meets minimum requirements		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		yes	14	1	1	1	1	1	1		1	1	1	1		1	1	1	1
		no	2							1					1				

19	Use of e-learning platforms		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		yes	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		no	0																
19.b	Evaluation of e-learning frameworks (*)	unit outline	13	1	1	0	1	0	0	1	1	3	1	1	0	1	1	0	1
		discussion board	27	3	4	0	3	0	0	3	3	1	3	2	0	1	2	0	2
		collaboration with peers	25	2	2	0	3	0	0	3	2	1	4	1	0	1	3	0	3
		learnig centered lecture material	17	2	2	0	1	0	0	1	1	3	1	2	0	2	1	0	1

20	New technology:		Total	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
		can not wait to try	2	1											1				

		Total																
	as soon as I have time	3											1	1		1			
	I see a main benefit	11		1	1	1	1	1	1	1						1	1	1	1
	use it if I really have to	0																	
20.b Willing to apply n. techn. in my work task	strongly agree	3											1	1		1			
	agree	13	1	1	1	1	1	1	1			1		1	1	1	1	1	
	disagree	0																	
	strongly disagree	0																	
20.c Willing to apply n. techn. in my learning task	strongly agree	6										1	1	1	1		1	1	
	agree	9	1	1	1	1	1	1						1				1	1
	disagree	1								1									
	strongly disagree	0																	

		Total																	
21 Playing computer games regularly	yes	11	1	1		1	1		1	1	1	1	1			1		1
	no	5			1			1						1	1		1	
21.a Play x hours/week	<5	1								1		0				0		
	5	4	1				1						1					1
	10	1		1														
	20	2					1				1							
	48	1						1										

		Total																	
22 Familiar with online role playing games	yes	9	1	1					1	1	1	1		1				1	1
	no	7			1	1	1						1		1	1	1		
22.a Play x hours/week	<5	2								1	0		0			1		
	5	1																1
	6	1	1															
	10	2		1				1										
	48	1						1										

		Total																	
23 Online role playing games are entertaining	strongly agree	5	1						1	1			1						1
	agree	6		1	1			1								1	1	1	
	disagree	5			1	1					1	1		1					
	strongly disagree	0																	

		Total																	
24 Have you used 3d virtual worlds/env.	yes	7		1		1			1	1						1	1	1
	no	9	1		1		1	1			1	1	1	1	1			

		Total																	
25 Are you currently using second life	yes	1													1			
	no	15	1	1	1	1	1	1	1	1	1	1	1	1		1	1	
I have enough time to get familiar with?	strongly agree	0																
	agree	5							1			1			1	1	1	
	disagree	4	1	1	1					1								
	strongly disagree	0																
	no answer	7			1	1	1			1		1	1					1

		Total																	
26 Interested in Second Life	yes	9			1			1			1		1	1	1	1	1	1
	no	7	1	1		1	1		1	1		1						

		Total																	
27 Participate on project	yes	6								1	1		1	1	1	1		
	no	10	1	1	1	1	1	1	1			1					1	1

28	Virt. 3d worlds are useful for collaboration	strongly agree	1													1			
		agree	9	1		1			1		1			1	1		1	1	1
		disagree	3		1		1	1											
		strongly disagree	0																
		don't know	3							1		1	1						

P – Nbr	Questions and Responses

	13	Describe your experience of using the computer
1		mayor in development and visual design / part time job
2		no programming skills
3		
4		photo shop, MS - office
5		MS - office
6		limited skills in C#, MS - office
7		
8		office 2007, C#, Internet, online games
9		MS - office, no programming skills
10		
11		Visual studio.net, MS - word/excel, photoshop, corel draw
12		MS - office, e-mail
13		limited skills in C#, MS - office
14		C#, html, sql, limited skills using unix
15		
16		C#, sql, MS - office

	19.a	List e-learning frameworks you have used				
		others	**Blackboard**	**Web CT**	**Capsim**	**Oasis**
1		online lectures in Korea	1			
2			1	1		
3		"ppt from lectures"	1			
4			1		1	
5			1			
6			1			
7			1			
8			1	1		1
9			1			
10			1			
11			1			
12			1	1		
13		Ross (at University in South Africa)	1			
14			1	1		
15			1			
16		"Web paint, yahoo group"	1			

	20.a	What new technologies have you recently used?
		others
1		game consoles, touch phone
2		Full hd lcd tv
3		
4		
5		

6	Windows 7, Windows Presentation Form
7	
8	iMAC
9	Bluetooth remote, Web base flash presentation application
10	
11	Blackberry smartphones
12	i-phone
13	
14	second life, i-phone, i-pod nano
15	Windows 7
16	Windows Vista

	21.b	**List 3 of your favourite computer based games**
		others
1		Diabolo 2, Sims, WII sports
2		Warcraft, FIFA 2009, Wonny 2
3		
4		Wii
5		Warcraft, PES
6		
7		
8		Wii fit, Playstation, Sims 2
9		Call of Duty 4, Starcraft, Command and Conquer 3
10		
11		Sims, Need for speed
12		
13		
14		
15		
16		Counter strike, Cabal online, Playstation, Wii

	22.b	**List 3 of your favourite online role playing games**	
		others	*World of Warcraft*
1		korean games	1
2			1
3			
4			
5			1
6		Viwawa, Cabal online, Ran online	
7			1
8			1
9			
10			
11		Chapsa online	1
12			
13			

14	
15	Ragnarok online, Cabal online, RF online
16	Ragnarok online, Cabal online, Counter strike

24.a.b. Which 3D-VW have you used?

	name	none	For what purpose?
1		1	
2	Sims		?
3		1	
4	"e magazines"		Presentation
5		1	
6		1	
7	World of warcraft		
8	Cant remember		
9		1	
10		1	
11		1	
12		1	
13		1	
14	Second Life, Sims		For IS project, playing
15	Second Life		Trying it out
16	Online game		playing

27.a Why I do (not) participate in the experiment

		Yes	No
1	I have to have more time to investigate Second Life		1
2	Too new and I can not see the good of using it / afraid the system could not be stable enough		1
3	My computer is not very good, and I need to many times for work and other units. I'm afraid I can't spend that much time on this essay in second life.		1
4	I can't take so much time to do it. More clear in face to face discussion. Can see my group members all the time.		1
5	It takes a lot of time to get familiar with the game and it seem that it is not very helpful to my assignment -face to face is more direct and easy to understand		1
6	We need more time to learn about Second Life. I am not familiar with the system		1
7	I think Second Life is not related to BPA 300. not convenient to communicate with our group members		1
8	x	1	
9	x		1
10	x		1
11	Because it is something new for me and basically I love playing games, so why not doing assignment as it like I am playing the games	1	
12	Trying something new, it sounds interesting	1	

13	I would like to try out anything new. I am a bit hesitant but there is no harm in trying. I know I will learn a lot from using it.	1	
14	I have unlimited download at home. It would be interesting to try. If not working I can stop it. I like working from home.	1	
15	Its good for meetings	1	
16	To use second life will increase the work to adapt with second life and even to do a normal meeting is already hard to finish the assignment.		1

	28.a	Why are virtual 3D worlds good for collaboration	
1			
2		I prefer to work on something simple. Too complicated will make the person tired. Prefer MS word	
3		I do think the Second Life technology not only use in the gaming. It is good to know we are trying to make it works in learning.	
4		It's difficult to discuss and analyse the problem for using the worlds. Otherwise, if I have enough time to do so, I will try the 3D worlds for collaboration. Thank you all the same!	
5		face to face is more direct and easy to understand each other (group mates)	
6		People could meet other people in their home	
7			
8		Yes Second Life will be useful in the future for students	
9		I haven't tried it yet.	
10		unfamiliar/haven't used any virtual 3D-worlds to judge its usefulness	
11		For instance if one of the group members house is far from the others, so they can just meet up using Second Life.	
12			
13		It allows you to explore other opportunities, expand their use	
14		They are good when everyone can't get to the one place. But they still have to make time to spend on Second Life. I think we already do a lot of work on the net. I think one on one contact is important and meetings are usually helpful face to face.	
15		All group members could meet disregard our physical location	
16		If the people in a team don't have time to meet in a person the this will be useful	

Post-Questionnaire (Check Boxes)

Question		Σ	1_13	2_12	3_8	4_14	5_11	6_9
Question		**Σ**	**Participation Number**					
1 Difficulties setting up Second Life	strongly agree	0						
	agree	0						
	disagree	3	1	1			1	
	strongly disagree	3			1	1		1
2 Used Second Life before.	Yes	1				1		
	No	5	1	1	1		1	1
2. a Had enough time to familiarize	strongly agree	1				0		1
	agree	1					1	
	disagree	3	1	1	1			
	strongly disagree	0						
2. b # hours for setup and familiarization		11	1	4	2 to 3	0	1	5
3 Positive experience using SL	strongly agree	1						1
	agree	3			1	1	1	
	disagree	2	1	1				
	strongly disagree	0						
4 SL can improve business collaboration over distance	strongly agree	1				1		
	agree	3	1		1		1	
	disagree	2		1				1
	strongly disagree	0						
5 Prefer to use SL for collaboration	strongly agree	0						
	agree	2	1				1	
	disagree	4		1	1	1		1
	strongly disagree	0						
6 I'm going to use SL for …								
6. a learning	strongly agree	0						
	agree	4			1	1	1	1
	disagree	1		1				
	strongly disagree	1	1					
6. b communication with people from other countries	strongly agree	0						
	agree	4	1	1			1	1
	disagree	1			1			
	strongly disagree	1				1		
6. c playing games, sports, …	strongly agree	0						
	agree	4	1	1	1		1	
	disagree	1						1
	strongly disagree	1				1		
6. d getting together with friends	strongly agree	1						1
	agree	4	1	1	1		1	
	disagree	0						
	strongly disagree	1				1		

Post-Questionnaire (Check Boxes)

6. e — collaborative tasks	Count						
strongly agree	0						
agree	5	1		1	1	1	1
disagree	1		1				
strongly disagree	0						

7 Using a similar tool for further projects	Count						
YES	3			1	1	1	
NO	3	1	1				1

8 It is easier to meet in virtual than in physical environments	Count						
strongly agree	3	1			1		1
agree	1			1			
disagree	2		1			1	
strongly disagree	0						

9 Using 3D virtual worlds …

9. a is easy to collaborate	Count						
strongly agree	0						
agree	4	1		1	1		1
disagree	2		1			1	
strongly disagree	0						

9. b raises my motivation to learn	Count						
strongly agree	0						
agree	4	1		1		1	1
disagree	2		1		1		
strongly disagree	0						

9. c saves traveling time	Count						
strongly agree	4	1			1	1	1
agree	1			1			
disagree	1		1				
strongly disagree	0						

9. d offers flexibility in respect to time	Count						
strongly agree	2	1			1		
agree	3			1		1	1
disagree	1		1				
strongly disagree	0						

10 Distracted by high amount of information in 3D worlds	Count						
strongly agree	0						
agree	2		1		1		
disagree	3	1		1		1	
strongly disagree	1						1

13 I appreciate using …

13. a white board	Count						
strongly agree	1						1
agree	3		1		1	1	
disagree	1			1			
strongly disagree	1	1					

13. b brainstorming board	Count						
strongly agree	2				1		1
agree	1					1	
disagree	3	1	1	1			
strongly disagree	0						

			Total	1	2	3	4	5	6	7
13. c	media wall	strongly agree	1							1
		agree	2	1	1					
		disagree	3			1	1	1		
		strongly disagree	0							
13. d	slide presenter	strongly agree	1							1
		agree	1			1				
		disagree	4	1	1		1	1		
		strongly disagree	0							
13. e	google docs to write an essay	strongly agree	2					1		1
		agree	4	1	1	1		1		
		disagree	0							
		strongly disagree	0							
13. f	google docs to prepare a presentation	strongly agree	2					1		1
		agree	2	1		1				
		disagree	2		1			1		
		strongly disagree	0							
13. g	text chat	strongly agree	2	1						1
		agree	3			1	1	1		
		disagree	1		1					
		strongly disagree	0							
13. g	voice over IP	strongly agree	2	1						1
		agree	2			1		1		
		disagree	2		1		1			
		strongly disagree	0							

			Total	1	2	3	4	5	6	7
16	Appreciate on-line consultation hours	strongly agree	1							1
		agree	1			1				
		disagree	4	1	1		1	1		
		strongly disagree	0							

			Total	1	2	3	4	5	6	7
17	Appreciate chat/relax in the recreation area	strongly agree	1							1
		agree	4	1	1	1		1		
		disagree	1				1			
		strongly disagree	0							

			Total	1	2	3	4	5	6	7
18	The virtual learning environment enhanced the outcome of our project	strongly agree	1							1
		agree	2	1		1				
		disagree	2		1			1		
		strongly disagree	1				1			

			Total	1	2	3	4	5	6	7
19	Describe the experience with this particular learning environment as positive	strongly agree	1							1
		agree	3			1	1	1		
		disagree	2	1	1					
		strongly disagree	0							

20	Used the environment for …				0				
		the first x	1		0	0.5			0.5
		the last x	1		0	0.5			0.5
		all group meetings	3	1	0		1	1	

21	To complete the assignment task I used the learning environment …	at home	3	0.5		0.5	0.5	1	0.5
		at uni	3	0.5	1	0.5	0.5		0.5
		other	0						

P-Nbr	Questions and Responses

	1. a Explain the main problems
1	x
2	Simone assisted with creating an account; Setting up was not a problem
3	x
4	x
5	x
6	I didn't face any problems on setting up Second Life. I rather find it very straight forward.

	5. a Preferred technology to use (over SL)
1	Google Docs + IM program
2	Skype
3	Skype and MSN
4	MSN
5	x
6	MSN, Yahoo Messenger, Email

	7. a Reasons (not) to use SL further projects
1	I am not familiar with 3D virtual environments
2	Unless I'm very familiar with a software I wouldn't use it for any further projects. The reason is the time consuming factor when discovering new software.
3	It is fun and convenient
4	Because it made meeting group members a lot easier. Even though with our different schedules I believe SL made it easier for our group to meet. It also saves time to travel.
5	Because sometimes it is hard for uni students to manage their time regarding all unit project that they should do, especially with transportation condition. So, second life pretty much help to solve the problem.
6	I may find Second Life is easy to use, but others may not think so. Thus, it may be potentially causing communication breakdown and project may takes longer time to be accomplished. But from my perspective, I would really like to use virtual environment as an alternate meeting venue so that the project can progress to a further milestone within a day.

	7. b	Using SL for
1		x
2		x
3		For assignments and other team works
4		For any group project
5		group project
6		Group projects on programming, web building, brain storming and decision making (not classified), academic assignments, and other real time communication intensive projects.

	11	Main advantages experienced using SL for collaboration
1		time saving, flexible, fast
2		x
3		saves traveling time; meet group members even during night time
4		saves traveling time; easier to work around group members other commitments; easier to put documents together because they are on-line and we can each add to the document; when chatting you have a minutes for your meeting without having to retype, which is handy if you ever have to revisit the meeting
5		I definitely learn something new from this experienced; I save my time because I can do it at home
6		Time flexibility; Solving parking and transportation problem – Ease of meeting; Looks more realistic than messenger – more comfy feel; Provides better ways to generates idea – brainstorming; Provides medium to leave notes or information for group members to share on an idea; Provides services to issue notes or messages to all group members at once; Provides services that all can be achieved in a single environment (no need to change programs or websites for different tasks)

	12	Main disadvantages experienced using SL for collaboration
1		having to find a PC at uni with the program on it, if I don't carry my laptop. Limited to the amount of download.
2		not user friendly
3		not familiar with the functions in SL; e.g. the whiteboard and the brainstorming board
4		sometimes face to face meetings are easier to communicate in; hard to explain some concepts in the virtual world; internet troubles (won't allow you to log on); people can be distracted and surf the web instead of concentrating
5		It is hard to express my thought especially when the best way to explain it is by drawing. There is also problem when the internet connection is lagging.
6		Cost of internet quota; Discourage multi-tasking as the computing power will be devoted to virtual environment engine; People may easily get distracted; Need an internet accessible environment to meet; Heavily rely on the speed of internet or ISP services

	13i	I appreciate using in Second Life
6		I also appreciate the furniture created in the virtual world as it makes the environment looks more realistic and exciting. The security features on creating each group a room is very well appreciated as well as it provides each group privacy and security on the assignments (the work, ideas and information on brainstorming board, white board and media board) can only be shared with the authorized personnel

	14	Suggestions to improve the quality of tools
1		white board is to complicated - even just to draw a circle -> fo time consuming
2		x
3		more instructions in SL
4		write extensive manuals for the tools; have sessions on how to use them; be able to save the slides on the brainstorming board
5		There were a problem where my group member had a meeting and someone else can see what happened inside the room by scrolling the camera even though that person can't enter the room. This maybe need an improvement in the future.
6		The white board and the media board should include a scrolling feature like a web browser so that the content can be viewed completely. The brainstorming board should include the button on "clear or erase" to avoid accidents on erase the previous work accidentally. An "Undo" button can be very helpful as well. Brainstorming board should include confirmation notification prior to erase the previous work. Security features may need to improve as well. Although the door only grant access to authorize personnel but the walls and the doors of the rooms do not block the access of the camera. One still can spin the camera around to get into the room and can see and listen to the conversation while peek on the white board, media board and brainstorming board.

	15	Missing functionalities
1		separate toolbars for each board (drawing options / display options)
2		x
3		x
4		be good if there was a tool like Google docs but in the virtual world. So you were able to upload documents within SL.
5		emoticons list
6		The current features have been very complete; It only needs some improvements as suggested to make it perfect.

	18. a	Why the virtual learning environment enhanced the project outcome
1		We were able to work faster
2		x
3		x
4		I think the outcome would have been the same, as we would have still been meeting and collaborating. But I do believe it helped in the organization of our group.
5		I don't really understand with the meaning of the outcome of our project, but I think the outcome is not as good as if we meet physically. This is because there are still some limitations occurs with virtual learning tools.
6		Virtual learning does help in improving the outcome our project in terms of whatever work done by a group member can be continue by another group member later on when they get on-line without being left out as one can view the note left by the group member who last edit the work. However, in my opinion, I won't agree that the outcome of the project is totally laid on the virtual environment, other factors like team work plays a more important role

	19. a	Suggestions for improvement
1		Provide face-to-face how to use guides
2		extra time to get used to Second Life
3		Give more instructions for using functions
4		x
5		x
6		x