HELSINKI UNIVERSITY OF TECHNOLOGY
Faculty of Information and Natural Sciences
Degree Programme in Industrial Engineering and Management

Eero Palomäki

APPLYING 3D VIRTUAL WORLDS TO HIGHER EDUCATION

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science (Technology)

Espoo, December 8, 2009

Supervisor: Professor Matti Vartiainen
Instructor: Professor Matti Vartiainen

HELSINKI UNIVERSITY OF TECHNOLOGY ABSTRACT OF THE MASTER´S THESIS
Faculty of Information and Natural Sciences
Industrial Engineering and Management

Author: Eero Palomäki

Subject of the thesis: Applying 3D Virtual Worlds to Higher Education

Number of pages: 110+5 | Date: December 8, 2009 | Library location: TU

Professorship: TU-53 Work Psychology and Leadership

Supervisor: Professor Matti Vartiainen | Instructor: Professor Matti Vartiainen

Increasing interest in 3D virtual worlds has lead to the creation of hundreds of such environments and to an expansion in the scale of their application. A considerable amount of research has focused on reporting experiences of using virtual worlds in education. However, less attention has been paid to the production process of a course that utilizes 3D virtual worlds. The aim of this research was to identify important themes related to such production process based on experiences of educators that have used virtual worlds. A process model for producing a course utilizing 3D virtual worlds was created as a product of this research.

Literature review was conducted to find advantages and problems related to virtual world usage in education. Reported advantages included conducting activities in a risk-free environment, enchanting collaboration and communication, increasing engagement, enabling an alternative space for instruction and tasks, and the visualization of difficult content. Respectively, reported problems included the difficulty to find appropriate value-added educational applications; the inability to read "natural" physical cues; technological issues; costs; behavioural, health and safety issues; the lack of standards; and user adoption problems. The electronic mailing list of a Second Life educator community was analyzed for focus themes that should have an impact on the production process. Found themes included the importance of virtual community support, technical problems, and using ready-made resources. Based on existing models of course production process, one was created taking into consideration issues specific for virtual worlds and found focus themes from the community analysis. The model describes the environment, different phases, roles, provides ideas for creativity, and advices to avoid problems. It can be used as a starting point for or as a checklist in planning and producing a university course. With a few modifications, the process model can be used in other environments as well. The introduction of new technology to teaching states new requirements for the organization, such as requirements for IT infrastructure, education planning, teaching, flexibility, new customer service view, and organizational learning. The strategic level view and practical implications were considered in the discussion section.

Keywords: Virtual worlds, Second Life, Education | Publishing language: English

TEKNILLINEN KORKEAKOULU DIPLOMITYÖN TIIVISTELMÄ

Informaatio- ja luonnontieteiden tiedekunta

Tuotantotalouden tutkinto-ohjelma

Tekijä: Eero Palomäki

Työn nimi: 3D-virtuaalimaailmojen käyttö yliopisto-opetuksen tukena

Sivumäärä: 110+5	Päiväys: 8.12.2009	Työn sijainti: TU

Professuuri: TU-53 Työpsykologia ja johtaminen

Työn valvoja: Professori Matti Vartiainen	Työn ohjaaja: Professori Matti Vartiainen

Kiinnostus 3D-virtuaalimaailmoja kohtaan on kasvanut jatkuvasti. Maailmoja on satoja ja niitä syntyy jatkuvasti lisää. Myös maailmojen käyttötarkoitukset kehittyvät. 3D-virtuaalimaailmojen opetuskäytön kokemuksista on raportoitu paljon, mutta niitä käyttävän kurssin tuotantoprosessi on jäänyt vähemmälle huomiolle. Tässä tutkimuksessa etsittiin tärkeitä teemoja tätä prosessia ajatellen perustuen 3D-virtuaalimaailmoja käyttäneiden opettajien kokemuksiin. Tuloksena esitettiin tuotantoprosessin malli kurssille, jolla hyödynnetään 3D-virtuaalimaailmoja.

Kirjallisuusanalyysiä käytettiin etsiessä raportoituja etuja ja ongelmia 3D-virtuaalimaailmojen käytössä opetuksessa. Raportoidut edut sisälsivät toimimisen riskittömässä ympäristössä, yhteistyön ja viestinnän tehostumisen, kasvaneen sitoutumisen, vaihtoehtoisen tilan tarjoamisen toiminnalle sekä vaikean sisällön visualisoinnin. Raportoituja ongelmia olivat vaikeus löytää opetuksellista lisäarvoa tuottavat käyttötavat, kehon kielen puuttuminen, teknologiset ongelmat, kulut, käyttäytymiseen, terveyteen ja turvallisuuteen liittyvät ongelmat, standardien puute sekä käyttäjien sopeutumisen vaikeudet. Lisäksi virtuaalimaailma Second Lifessä toimivien opettajien yhteisön viestintää analysoitiin. Analyysin pohjalta eriteltiin tärkeitä teemoja, joita olisi syytä huomioida tuotantoprosessissa. Löydettyjä teemoja olivat mm. virtuaaliyhteisön tuen merkitys, tekniset ongelmat sekä valmiiden resurssien hyödyntäminen. Käyttäen pohjana olemassa olevia tuotantoprosesseja kursseille, luotiin prosessi ottaen huomioon virtuaalimaailmojen asettamat erityisvaatimukset sekä viestintäanalyysissä löydetyt keskeiset teemat. Luotu malli tuotantoprosessista kuvaa kurssin ympäristön, prosessin eri vaiheet ja tarvittavat roolit. Lisäksi se antaa ideoita luoviin ratkaisuihin ja neuvoja ongelmien välttämiseksi. Sitä voidaan käyttää lähtökohtana tai tarkistuslistana virtuaalimaailmoja käyttävän kurssin tuottamisessa. Uuden teknologian tuominen opetukseen asettaa vaatimuksia myös organisaatiolle, kuten vaatimukset IT-infrastruktuurille, koulutuksen suunnittelulle, opetukselle, joustavuudelle, uudenlaiselle asiakaspalvelunäkemykselle sekä organisaation oppimiselle. Lopuksi käsiteltiin virtuaalimaailmojen käytön strategista tasoa yliopistossa ja käytännön merkityksiä.

Asiasanat: Virtuaalimaailmat, Second Life, Opetus	Julkaisukieli: Englanti

Acknowledgements

This master's thesis was an education development project conducted for the study committee of Helsinki University of Technology. I want to thank the study committee for enabling me to research this fascinating topic. Without your funding, this research would not have been possible.

I am also thankful to my supervisor and instructor professor Matti Vartiainen. Thank you Matti for suggesting this interesting topic and for all the guidance, advice, and feedback you have given me.

I would also like to thank my family and dear friends for all the support and help you have given me during my studies and this project. I would not be me without you.

Espoo, December 2009

Eero Palomäki

Table of contents

Glossary

Term	Definition
Active Worlds	A virtual world created by Activeworlds Inc.
Asynchronous	Not synchronous; occurring at different times.
Avatar	Avatar is a representation of the user in a virtual world.
Blended learning	A combination of learning methods.
Character	User's avatar.
Distance education	Education that takes place when the instructor and participant are separated by space and/or time.
Faceted classification method	A faceted classification method allows the assignment of multiple classifications to an object, enabling the classifications to be ordered in multiple ways, rather than in a single, pre-determined, taxonomic order.
Focus theme	An important theme in producing a course that utilizes 3D virtual worlds.
Interreality	A hybrid of two worlds (the real world and a virtual world) and the integration of user's experiences in them.
In-world	Inside a virtual world.
Island	An area inside Second Life.
Learning environment	The learning environment refers to the entirety of the learning related physical environment, psychological factors and social relationships. In this setting, study and learning take place.
Linden Labs	American Internet company that has created

	virtual world called Second Life.
Machinima	Short film created by recording video of a 3D virtual world.
Main grid	The main version of Second Life (for ages 18+).
Message category	Message categories are used in the email analysis of this research. They show that a message has certain kind of content. The messages were divided into 21 different categories.
Message type	Messages in the email analysis were divided into four types: "question," "comment," "link," and "other."
Out-world	Outside virtual worlds, in the real life.
Player	A term used in games that means the user.
Real-world	Outside virtual worlds, in the real life.
Resident	Second Life user inside the virtual world.
Scripting	Programming inside a virtual world. Can be used for example to implement functionalities to objects.
Second Life	A virtual world created by Linden Labs.
Simulation	An imitation of an environment or situation. Can be used for example in training or research.
Skype	Skype is a software application that allows users to make telephone calls over the Internet.
SL Educators/SLED-list	An electronic mailing list of a Second Life educator community.
Synchronous	Occurring at the same time.
Virtual learning environment	A software system designed to support teaching and learning in an educational setting

Virtual reality	An immersive and interactive simulation of either reality-based or imaginary images and scenes.
Virtual world	A synchronous, persistent network of people, represented as avatars, facilitated by networked computers.

1 Introduction

Increasing interest in 3D virtual worlds has lead to the creation of hundreds of such environments and to an expansion in the scale of their application. These environments enable a wide variety of options for educators. They open the possibility to improved educational results, and allow the use of teaching strategies not available without the technology.

3D virtual worlds allow interaction that resembles face-to-face interaction. Thus, they are suitable for individual study guidance, teaching events, group work, problem solving, and presenting course assignment results. In more traditional learning environments (i.e., Optima), the interaction is less intense and more vulnerable to interferences.

3D virtual worlds can be used to support distance learning and teaching in an interactive way. The user can change his appearance (avatar) to his liking. These environments provide means to more dynamic role use than normally. Different kind of materials and presentations can be brought to these environments.

Erickson and Siau (2003) have noticed the continuous exploration of new opportunities to bring the classroom experience online as technology becomes more sophisticated and capable. There are two different goals for this endeavor. Firstly, some seek to use these opportunities to provide better distance education. Secondly, more sophisticated virtual realities or virtual worlds are created in order to expand the interaction among students as well as their instructors. (Eschenbrenner, Nah, & Siau, 2008) Lombardo (2007) has argued that future brings educational approaches that allow more holistic

understanding of knowledge and development of interpretative skills and deep understanding, compared to the past where focus has been in memorization, drill, and mechanical learning.

Example uses

Dickey (2005a) has conducted case studies of educational institutions. In one of the studies, she used the Active World environment in an undergraduate business-computing course, and in another in an object-modeling course. From these case studies, she concluded that 3D virtual worlds offer various opportunities for students and instructors. In the business-computing course, the students used the virtual world to complete and submit assignments, review their grades, locate web-linked resources, collaborate with other students, and communicate with a chat tool. In the object-modeling course, the instructor used chat tools in order to promote discussion, and presented examples of 3D objects. (Eschenbrenner et al., 2008) It could be summarized that these opportunities included promoting collaborative and cooperative learning (Siau, 2003), self-defining the learning context, creating interactive experiences with materials or models that may not be replicable in a traditional classroom (Siau, Sheng, & Nah, 2006), and providing engaging, constructivist activities (Eschenbrenner et al., 2008).

Virtual worlds can also increase awareness of real world phenomena. For example, a simulation of a toddler's initial cognitive experience has been used to improve caregiver's awareness of these experiences when joining a daycare. (Passig, Klein, & Noyman, 2001) Other cited applications are health care related learning applications including creating simulations for emergency training, mental health training (e.g., experience hallucinations of schizophrenia patients), brain and body interactivity training, and telesurgical training (Mantovani, Castelnuovo, Gaggioli, & Riva, 2003).

Jennings and Collins (2007, p. 182) listed some capabilities associated with one of the virtual world environments, Second Life:

- accenting site with logos, maps, welcome signs, and various forms of greetings
- offering promotional materials to visitors (e.g., free t-shirts for avatar)
- sidewalks, pathways/footpaths, bridges, and elevators for avatar to navigate within site
- links to other Internet websites and teleports to other Second Life locations
- communication tools – text or audio
- space for classrooms, auditoriums (includes podium, video screen, chalkboard, and seating for avatars), libraries, theater, offices (includes chairs and desk), research labs, sandbox (for building), role-playing, student projects, assignment distribution and submission, apartments/housing, art galleries, visitor centers, resource centers, meetings for campus organizations, and socializing (e.g., bars, restaurants, dance clubs, beaches, gardens, game rooms, coffee shops)
- creating sense of openness (e.g., buildings with mesh ceilings and no walls, bubbles floating in the air, pane glass windows looking at ocean/patios/vegetation)
- replication of real-world environment and building connections with real-world (e.g., animal life, natural vegetation, historic buildings, campus layout)
- social accommodations (e.g., offering beverages, listening to radio, vending machines)
- simulations of events, games etc.

Virtual worlds come both from open sources projects and from proprietary vendors. Many of the virtual worlds are used in educational contexts. Active

Worlds Educational Universe, launched in 1999, is a browser-based virtual environment consisting of user-created 3D worlds inhabited by avatars. (Dickey, 2005a; Peterson, 2006) Adobe Atmosphere, launched 2001, is a virtual environment that allows avatars to navigate and interact with one another (Dickey, 2005a). Linden Lab opened Second Life in 2003 (Joly, 2007). Some other examples of these environments are Croquet Consortium, OpenSim, Project Wonderland, Twinity, There, Moove online, Entropia Universe, Qwak and Olive. These worlds differ in a variety of ways such as communality, openness to everyone, business features, game-like environments, user base, technologies used, user interface, and building tools.

A considerable amount of research has focused on reporting experiences of courses using second life and describing the opportunities and possibilities of virtual worlds. However, less attention has been paid to the production process of a course that uses 3D virtual worlds as a tool.

Research objective

The objective of this research is to study and evaluate to what extent the use of 3D virtual worlds is appropriate to higher education teaching and how it could be implemented. Based on this analysis, a process model is developed that describes the process of producing a course that uses 3D virtual worlds as a tool. The model covers the stages before, during, and after the course. The model describes the environment, different phases, roles, provides ideas for creativity, and advices to avoid problems.

Research questions

1. What are the advantages and problems in applying 3D virtual worlds to higher education?

2. What are the focus themes in producing a university course that uses a 3D virtual world as a tool?
3. What kind of process is suitable for producing a university course that uses a 3D virtual world as a tool?

Scope and limitations

The focus of this research is on higher education. The problems, advantages, and focus themes are searched from experiences. The technology, environments, and solutions considered are to be current, not forthcoming, even as technology improves all the time at a fast phase. Teaching in a virtual world is a global phenomenon, and there exists many international educational communities. Literature and the messages from one of these global communities are used as sources.

Research structure

Experiences from using virtual worlds in teaching will be searched from literature. Specific topics include the technology of virtual worlds, knowledge and experiences accounted about the environments, and how people act in virtual worlds. In addition, suitable pedagogical models are examined. This material is used to build understanding, to seek the advantages and problems related to virtual world usage in education, to identify focus themes in the production process and usage, and to provide outlines and content for the model developed.

The empirical data consists of the messages from an electronic mailing list. The list members are educators using or being interested in education in the virtual world Second Life. Messages from two months are collected and categorized. This gives understanding about the topics educators discuss in a peer community and focus themes to be considered when applying 3D virtual worlds to education. Finding repeating topics can help to improve

understanding about problems, and to give focus to themes that should receive attention in the course production process.

2 Literature review

This chapter first discusses the history of virtual worlds and pedagogical approaches. Then a virtual world is defined, and some relating terms explained. Later, a method for comparing different virtual worlds is presented. Finally, the advantages and problems of using virtual worlds in education reported in literature are described. This answers the research question 1. The end of the chapter lists applications reported in literature, and ways to approach planning education for virtual worlds. These can be used as tools in the production process of a course that uses 3D virtual worlds, that is presented in chapter 4.

2.1 History of virtual environments

Virtual worlds as such are not a new phenomenon. Their earliest ancestors are Multi-User Dimensions/Dungeons (MUDs) and Multi-Object Orientated MUDs (MOOs) from the 1980s. These multiplayer environments were text-based, but already showed the characteristics of the modern virtual worlds. Similarity was present especially in the dialogic dimensions. Already inside these environments communities were formed. (de Freitas, 2008)

Another important step was the 1985 released game Habitat for the Commodore 64 computer. The game included graphics and avatars, and it used modem to take connection to a central server, that hosted a state of the virtual world, and distributed information to the client computers connected

to it. The game world was a platform for all kind of social interaction, and was even self-governed by its citizenry. (de Freitas, 2008)

The idea of joining oneself inside a virtual world has been outlined also in science fiction. Gibson's Neuromancer (1995, first published 1984) and Stephenson's Snow Crash (1993, first published 1992) use the idea of moving between the spaces of real and virtual realities.

The technology available has developed radically from the 1980s. The broadband capability has increased, access to web services widened, interoperability of web-based software expanded, and higher specification personal computers and graphics capabilities become available. This has led to a boom in the use of virtual worlds. (de Freitas, 2008)

2.2 Pedagogy and didactics

Planning of a learning environment is always based on a conception of learning and teaching. The conception can be conscious or unconscious one. It is more sophisticated to use a conscious idea of learning and teaching. Here so-called didactic approaches are central. (Manninen et al., 2007) Didactics studies include curriculum theory (what to teach) and the theory of teaching methods (how to teach) (Engeström, 1981, pp. 1-5; Reusser, 1995, p. 83).

There are three approaches in curriculum theory: subject-centered, problem-centered, and student-centered. Subject-centered approach starts from the content under study, and its logical structure. Problem-centered approach investigates a situation, where the content is needed. Student-centered approach is planned from the needs and wishes of the student. All three approaches have different requirements for the learning environment. The subject-centered approach needs traditional teacher centered classroom lectures. The problem-centered approach needs a supporting environment

for group work and active, exploratory learning done by students. The student-centered approach has requirements for the social and psychological aspects of the learning environment. (Manninen et al., 2007)

The didactic approach chosen defines the form, structure, and processes of the learning environment. The approach should be chosen based on what best suits the teaching situation, subject and students. Today, it seems to be common to follow the principles of constructivism. Unfortunately, often the implementation of these principles is left on the level of trendy and easily assimilated buzzwords such as openness, individuality, self-direction, cooperation, and constructiveness. (Manninen et al., 2007)

The various didactic approaches differ from each other in their concept of learning and teaching, and their philosophical background. Which one is best, depends on the situation. Learning goals and the target group of the course have effect on the decision. Behaviouristic, cognitive, and constructivist approaches suit learners of all ages, but humanistic and radical humanistic approaches are best suited for adults. Table 1 presents a summary of the main differences of the different approaches. From these approaches often used in teaching in a 3D virtual world is the constructivist approach, as virtual worlds support it with social and immersive experiences (Bronack, Riedl, & Tashner, 2006; Dede, Brown-L'Bahy, & Whitehouse, 2002; Dickey, 2005a, 2005b). That approach is described next.

Table 1: Didactic approaches in relation to the environment (Manninen et al., 2007, p. 111).

Didactic approach	**Role of the environment in learning**	**Relationship with the environment**
Behaviouristic	Stimuli provided by the environment shape behavior, i.e., learning.	Context for defining needs, assessment of application and effectiveness.
Cognitive	Learner's orientation base (understanding, competence) is modified by interaction with the environment.	Context for learning motivation, learning needs, application and assessment.
Constructivist Social constructivism	Social interaction and collective construction of information gained from the environment.	Learner's active exploratory relationship to the environment and the group, social interaction.
Cognitive constructivism	Active construction of information gained from the environment on various phenomena.	Phenomena and challenges of the environment as a source of learning.
Humanistic	The environment as a source of experiences, learning as reflection on sharing of experiences.	Focus mainly on the mental and physical environment of the learning situation.

Radical humanistic	Focus on the rightness of a socially constructed world view (meaning perspective); distorted world view as a source of learning.	Focus exclusively on the social environment and communication, the individual reflects his or her own meaning perspective (attitudes, values, practices) on the community.

Constructivism is an approach that collects several different phenomena of today under one concept (Tella, 1996, p. 40). For example, the following paradigms belong to constructivism:

- social constructivism
- radical constructivism
- information processing constructivism
- the socio-cultural approach
- social constructionism.

Despite of the differences, all the paradigms see learning as an active process of construction, which teaching should support (Duffy & Cunningham, 1996, pp. 170-177). However, the features of each paradigm imply a different approach to learning environment design. For example, in cognitive constructivist approach the emphasis is in the interaction between the learner and the environment, while in socio-cultural approach, it is on the learner's possibility to participate in social interaction, and the usage of cultural tools.

There are some challenges in using the constructivism approach. First, the educators should consider students' everyday reality and previous knowledge when planning the course. Second, the transfer effect should be

considered, that is, how the student could apply the knowledge and skills acquired in new contexts. Third, different approaches to the same subject are possible, for example historical and economical approaches to a historical event. (von Wright, 1993a)

Von Wright (1993b, pp. 19-31) has listed some features of the constructivist view of learning. He defines learning largely as doing – experimentation, problem solving, and understanding. In addition, social interaction has a central role through shared responsibility and social support. The features also take a stand to the assessment. The assessment should take various forms, metacognitive skills and the reflective capacity of the learner are central. Flexible teaching methods and recording only the key objectives and ideas in the curriculum are noted to be important. A constructivism-based learning environment should rise questions in the learner and help him construct answers.

2.3 Learning environments

Virtual worlds are usually a part of a larger entity, the learning environment. Here are two definitions for a learning environment.

"The learning environment refers to the entirety of the learning related physical environment, psychological factors and social relationships. In this setting study and learning take place" (Finnish National Board of Education, 2005).

"A learning environment is a place or community where people can draw upon resources to make sense out of things and construct meaningful solutions to problems" (Wilson, 1996).

Both of these definitions make it clear that a learning environment is more than just a classroom. In fact, based on these definitions, it seems that 3D virtual worlds suit well as a part of a learning environment, as they allow the

gathering of resources, social interactions, and offer the possibility to construct solutions to problems.

2.4 Distance education

Already in 1980, Keegan (1980) noted that distance education is becoming common in higher education. This has become especially true with the advancement of technology and tools available. The possibility to transfer the traditional classroom education to online to be independent of time and physical distance has received researchers' attention (Bates, 2005; Holmberg, 1995). In addition, the effect of the distance and online tools to learning outcomes and satisfaction has been studied. Grosky and Caspi (2005) report that comparative studies between classroom education and distance education have found no significant differences in outcomes or satisfaction. However, Paquette-Frenette (2006) reports that when some group of students are present in classroom setting and others at a distance, the emotional and social distance between these groups increase.

An existing trend according to Dickey (2005a) is to create interactive learning environments. The increasing shift towards constructivism supports this trend (Eschenbrenner et al., 2008). Virtual worlds support constructive learning well as they open up many possibilities for educators to use. Another trend in learning environments according to Barab et al. (2000) is collaborative learning environments. 3D virtual worlds offer a good tool for accomplishing these both goals. The environments have a wide variety of means to communicate and collaborate with others in a shared virtual space. In addition, many of these environments are built by users, so they offer a place for creativity and experimentation.

2.5 Synchronous versus asynchronous

Interactive media usage can be divided to synchronous and asynchronous usage. When all the students are able to interact with each other at the same time online, this is called synchronous usage. On the other hand, asynchronous usage means usage when everyone takes part when it is best for them. Examples include forums, blogs and wikis. Internet-based asynchronous technologies are the primary mode of instruction in the distance education courses of today. (Jones, 2008) Dede et al. (2002) conducted a research with 30 students. Students reported that interacting online outside classroom affected positively to their learning experience and increased their engagement with the class-related material. More interestingly, using synchronous media helped the students better to know and interact with their classmates.

2.6 Virtual worlds

2.6.1 Definition of a virtual world

Currently, no agreed-upon definition of a virtual world exists. Academics, industry professionals and the media use the term differently at different times. (Bell, 2008)

Richard Bartle has been working with virtual worlds since the 1970s. Bartle (2003) presents five conventions for virtual worlds that distinguish them from related non-real spaces:

1. The world has underlying, automated rules that enable players to effect changes to it (although not to the rules that grant them this ability). This is the world's physics.

2. Players represent individuals "in" the world. They may wield partial or total influence over an army, crew, or party, but there is only one game entity that represents them in the world and with which they strongly identify. This is their character. All interaction with the world and other players is channeled through characters.
3. Interaction with the world takes place in real time. When you do something in the world, you can expect feedback almost immediately.
4. The world is shared.
5. The world is (at least to some degree) persistent.

Virtual world researcher Castronova (2004) adds technology to this mix defining a virtual world as: "crafted places inside computers that are designed to accommodate large numbers of people."

Bell (2008, p. 2) suggests a common basic definition for a virtual world for research purposes. He combines the other definitions, and defines a virtual world as:

"a synchronous, persistent network of people, represented as avatars, facilitated by networked computers."

Other noted features and characteristics of 3D virtual worlds include the illusion of 3D space that allows real-time interaction/interactive capabilities, avatars that are digital representations of users, chat tools facilitating communication, first person viewpoints, navigation freedom, and abilities of participants to share space as well as time and to design their own spaces (Dickey, 2005a, 2005b; Mikropoulos, 2001; Ondrejka, 2008).

2.6.2 Avatar

One shared thing between the virtual worlds is the use of avatars. Avatar is a representation of the user in the virtual world. Usually it is possible to customize the avatar to your liking. The emotional bond between the user

and the avatar is surprisingly strong. The sense of presence is very high in these worlds. Residents are aware of their own avatars and of the presence of others. (Gilman, Tashner, Bronack, Riedl, & Cheney, 2007). Avatars are digital personas used to represent a person's identity in a virtual world environment (Conway, 2007). An avatar usually is a caricature, a full body, or just an image of a head. The environment Active Worlds offers customization of avatars to registered users. Nonregistered users can pick avatar from a standardized set. Avatars can walk, run, slide, and fly in the virtual world. (Dickey, 2005a; Peterson, 2006) Tashner, Riedl, and Bronack (2005) conclude that users transfer their social behavior, social skills and own personalities to Second Life. Also the usage of avatars can give students a comfortable level of anonymity (Dickey, 2005a), that can be advantageous for example when using virtual worlds as a tool to learn new languages and the students need to discuss using voice chat to students in other countries.

Dickey (2005a) says that the use of unique names with avatars increases trust and aid recognition. The avatar can share some features with the real life person, such as jewelry or clothes. For example, a teacher has bought apple earrings after her avatar had used them while teaching in Second Life for some time (Svärd, 2009). This can help the students to recognize the instructor.

2.6.3 Separation from games

Because 3D virtual worlds have evolved from, and the most advanced virtual worlds still tend to be, computer games, the vocabulary in use is mainly game-based. This is one reason why 3D virtual worlds are sometimes incorrectly thought to be games. Problems can arise, as the concept of a game can easily be associated being neither useful nor educational. It is reasonable to go through the argument of separating 3D virtual worlds from games, as it

can also be necessary when arguing for the use of such environments in an organization.

Schultze and Rennecker (2007) present a two-axis framework to classify virtual worlds. The framework is presented in Figure 1. The x-axis represents the rule structure of the game, and the y-axis the correspondence to material reality. The game rules are differentiated to two approaches by Juul (2005): progression and emergence. The former one is highly scripted. Players have goals and narrative is typically quest-driven. These goals can be collecting objects or points in worlds (Ermi & Mäyrä, 2005). The latter one only enforces a small amount of rules that allow a wide range of behaviors and play variations. This x-axis differentiates games from virtual worlds. In addition, the terms used differ, as for example Second Life calls the users as residents, not as players or characters. These non-game virtual environments are better called as multi-user virtual environments (MUVE) or simply virtual environments rather than games. (Holmberg & Huvila, 2008) Bartle (1996) describes game-like worlds to more conducive to players interested in "acting," while the emergent worlds are more conducive to "interacting." The y-axis picture the degree how these worlds correspond to reality. The axis differentiates "realistic" and "fantasy" worlds.

2.6.4 Separation from virtual reality

The terms virtual world and virtual reality (VR) should also be separated. Virtual reality has more focus in the mechanics that humans use to interact with computer simulations. It is not especially interested in the content of the simulations. (Bartle, 2003)

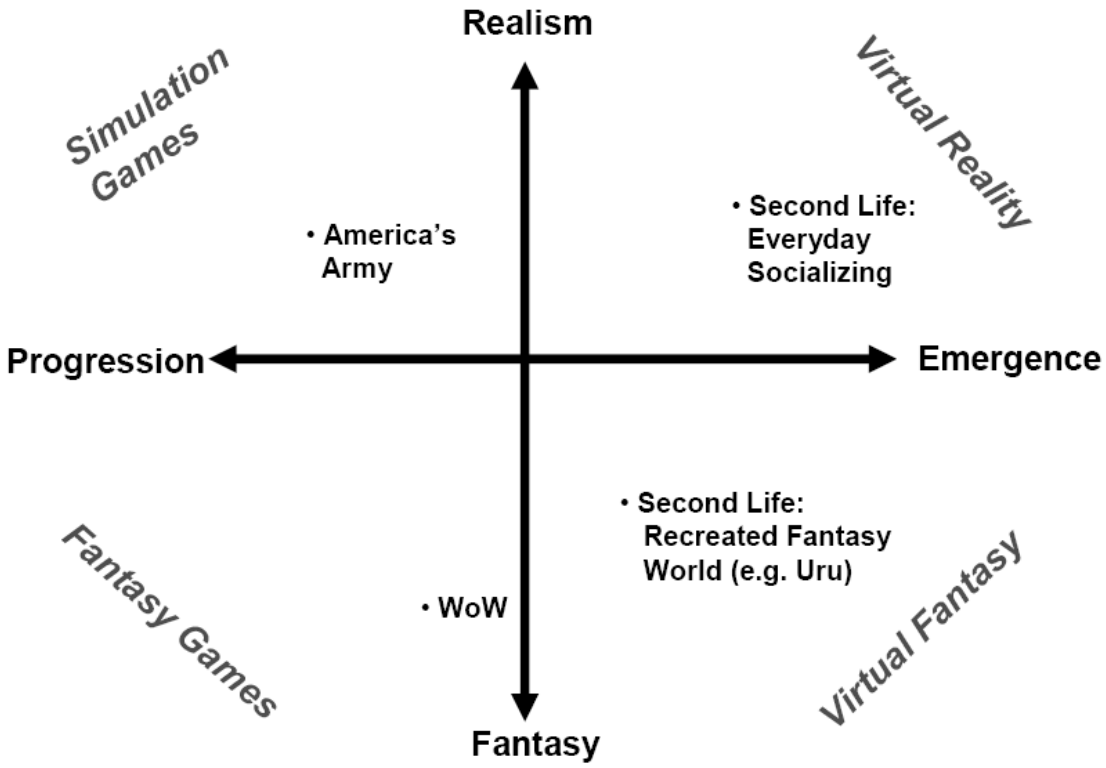

Figure 1: Virtual Worlds Classification Scheme (Schultze & Rennecker, 2007, pp. 335-351). Second Life, America's Army and World of Warcraft (WoW) are three different virtual worlds used as examples.

2.6.5 Interreality

The interreality described by van Kokswijk (2003) means a hybrid of two worlds and the integration of user's experiences in them. Users are in both worlds at the same time, but not completely in either. This describes one way to use 3D virtual worlds in teaching, for a mixed reality experience or to support local teaching. Other possibilities are to use the technology completely virtual or in distance education. Combining face-to-face instruction with computer mediated instruction can also be called to be blended learning. (Graham, 2006) Dede et al. (2002) note that limiting the students only to a classroom setting instead of using multiple media

undercuts the full range of students' learning styles. In general, distributed learning also provides more opportunities for engagement and means for interaction with more individuals, and this has been proved beneficial to the learning experiences of students. (Dede et al., 2002; Dickey, 2005a; Gilman et al., 2007; Riedl, Bronack, & Tashner, 2005)

2.7 Comparing different virtual worlds

Mennecke et al. (2008) state that hundreds of publicly accessible and countless number of private virtual worlds exist. They have been planned for a variety of functions targeting a diverse set of target markets.

Delwiche (2006) used Everquest and Second Life in courses that were part of a study. Because he found the learning curve of Everquest to be quite deep, he suggests that accessibility should be a deciding factor when choosing between different MUVEs to use in education. According to him, other factors should be the genre and extensibility of the MUVE. The virtual worlds differ also in the capabilities that are available for use. Eschenbrenner et al. (2008, p. 100) report differences for example in available communication methods, the building process and the skill-requirements of the process. However, these are only some sides of a virtual world. If the world is chosen solely based on these factors, it might be inaccurate solution to the specific scenario at hand. There is a need for a systematic way to compare the different virtual worlds.

Robbins (2009a) uses the faceted classification method developed by Herring (2007) to compare and analyze different virtual worlds. The method is based on the early text classification system developed by library scientist Ranganathan (1933). In faceted classification method, the subject domain is first analyzed into component facets, and then the relevant facets are combined to characterize items of interest. These facets are similar to tags

used to describe objects in Web2.0. Facets classification enables easy categorizing, analyzing, sorting, comparison, and differentiation of all kind of objects.

Robbins has gathered a list of more than 75 virtual world environments with varied user demographics, genres, and geographic regions of development. Based on analysis done on these environments she formed ten facets that can be used to describe virtual worlds. Next, these facets and their sub-categories are presented and described. The comparison done by Robbins about the 75 worlds based on their facets, can be found online (Robbins, 2009b).

Dominant content form

Only a few of modern virtual worlds are text-based, but the difference to visual ones is so important that it is necessary to categorize worlds based on this trait.

Subcategories

- Text dominant environment: Text is the primary form of content. Some images or icons can exist, but their meaning is limited without text.
- Image dominant environment: Graphic environment where image is the dominant content form. Text can be present, but image is the primary content type.

User-to-user communication

The environment can offer multiple ways for users to communicate. Most used are text, visual, and voice based communication. This facet describes which one or many of these communication ways are dominant between users.

Subcategories

- Text
- Voice
- Combination

Stigmergy

Stigmergy was developed to describe the indirect communication among termites in an insect colony. Stigmergy is an ability, which enables manipulation of environment to communicate with others in the space. (Bonabeau, Dorigo, & Theraulaz, 1999) In virtual world context, stigmergy means the ability to create lasting content into the world.

Subcategories

- Stigmergic
- Non-stigmergic
- Limited stigmergy

Object ownership

Objects in a virtual world can be publicly owned like wikis, or having private ownership. Private ownership can be achieved via a payment, creation, or achieving a goal. The ownership affects for example the communication type between the users.

Subcategories

- Private ownership
- No ownership
- Shared

User identity formation

Users form identity based on how they are represented in the virtual world. Some environments offer more options for users to customize their look, for example. In graphical environments, even the custom avatar is a

way of communicating to other users. In this context, more freedom means more ways to communicate.

Subcategories

- Static: The environment defines the user's identity, and that cannot be changed. For example, the users could be addressed as "Player 1" and "Player 2."
- Custom: The environment allows easy avatar customization. This can be achieved through clothing, objects, and persistent profiles.
- Conditional: In some environments, the user's appearance can be tightly related to the user's status or level of achievement of goals. Only more experienced characters can reach some clothes or body features.

Environmental access

Sometimes there is a need to limit the access to the environment. This facet describes if the environment has open access. Some environments offer the feature to limit access to certain areas inside the environment based on user identity.

Subcategories

- Public: The access to the environment is not limited. Anyone willing to pay the possible usage fee is free to create an account and enter the environment.
- Fee: Open to everyone, but a monthly fee required.
- Private: Environment offers a way to limit access based on a certain procedure.

User's relationship with other users

This facet describes the relationship type between the users.

Subcategories

- Collaborative: There is no competition between the users. The communication and relationships are collaborative in nature. Some environments where both parties must agree aggressive type of competition belong to this category.
- Competitive: There is competition between the users. The competition is a required element of the environment's goals.
- Conditional: In these environments, there are situations where users are collaborative and other situations where users are antagonistic. For example in World of Warcraft, players can attack other players only on specific areas.

User's relationship with the environment

This facet describes the relationship between the user and the environment. Here is a big difference between game-type environments and non-games.

Subcategories

- Collaborative: Here the environment offers no danger to the user. The user collaborates with the environment.
- Competitive: The environment presents dangers and challenges to the users. The users compete against the environment. Most games belong to this subcategory.
- Conditional: The role of the environment changes depending on the area or situation. In some parts of the world the environment can be friendly, and in others, hostile. The relationship can also change based on the achievements of the user.

Access to Groups

This facet describes the process of joining a group.

Subcategories

- Private: Groups can be joined only by invitation or after earning the access in some certain way.
- Public: Joining groups is not restricted.
- None: The environment does not offer group functionality.

Number of groups

This facet describes the ability of the user to join multiple groups.

Subcategories

- None: Groups are not available.
- One: Users can join a single group at a time.
- Many: Users can belong to multiple groups at the same time.

2.8 Advantages of using virtual worlds in education

Holmberg and Huvila (2008) report that the use of Second Life has advantages especially in teamwork in comparison to lectures. They noted following advantages: the physical presence of avatars, real time communication, and the existence of a shared local space. These features lead Second Life creating a more realistic feel of presence than discussion forums or chat rooms. This is in line with Jones, Morales, and Knezek (2005) who noted that Second Life brings distance education closer to face-to-face education. These advantages apply to other virtual worlds as well.

Graham (2006) defines a term blended learning systems to mean combination of face-to-face instruction with computer mediated instruction. The term seems relevant as well to the use of 3D virtual worlds in education. The reported advantages are that blended learning allows more effective

pedagogical practices, greater flexibility (i.e., adult students), and the possibility to achieve of cost-effectiveness (Graham, Allen, & Ure, 2003). Eschenbrenner et al. (2008) identified benefits in using 3D virtual worlds in education. Identified benefits include conducting educational activities in a risk-free environment, enhancements in collaboration and communication, engaging learners, being able to utilize an alternative space for conducting courses and associated tasks, and visualization of difficult content. The following paragraphs explain these benefits more thoroughly.

Conducting activities in a risk-free environment

The learner can execute many activities in 3D virtual worlds with less risk. Graves (2008, p. 50) cites the benefits of Second Life to include providing "a social laboratory where role-playing, simulations, exploration, and experimentation can be tried out in a relatively risk-free environment." Dickey (2005a) demonstrates the benefits with the opportunity to experiment without concern for "real-world repercussions" and being able to "learn by doing." The risk-free might also translate to a feeling of safety as Ondrejka (2008) states that some students have cited a greater level of comfort in asking questions, and are able to develop a sense of shared learning. In addition, Second Life has been seen as a good place for exploring new domains of interest and innovation (Goral, 2008). Conway (2007) states that the use of avatars can attune students that are interested in on-line courses, as it can create more opportunities to introduce more creativity into the classroom.

Collaboration and communication

The second benefit is enhancing collaboration and communication. Peterson (2006) achieved results supporting that the creation of an avatar increased the individual user's sense of telepresence or copresence, which

has been suggested to improve communication, as well as social and educational experiences in virtual worlds. Many of the virtual worlds allow non-verbal communication cues and emotions to be shown in real time by one's avatar. This adds non-verbal communication for example in comparison to text-based communication. Bronack, Riedl, and Tashner (2006, p. 220) list the benefits of virtual worlds in education to be "a sense of presence, immediacy, movement, artifacts, and communications unavailable within traditional Internet-based learning environments." They also describe that they were able to interact with students in "more fluid and natural ways" (p. 230), allowing students to select their own paths of learning, resources, and activities, and are "encouraging cross-class collaboration" (p. 230). The students themselves reported the interactions with other students to be stimulating and the experience to be enriching. These chat tools and communication capabilities of virtual worlds provide a platform for collaborative and cooperative learning that is valued in the socio-constructivist paradigm. (Dickey, 2005a, 2005b)

Collaboration and communication is also important in distant learning. Graves (2008) sites the ability to interact with individuals located around the world. Avatar customization to look like almost identically oneself can help to enhance on-line communication (Foster, 2007a). Second Life is argued to offer "a very rich form of communication, and the main task of education is communication" (Goral, 2008, p. 62). Forster (2007b) supports that Second Life provides a culturally diverse experience and a livelier communication in distance education courses.

Engagement

One benefit attached to virtual worlds in education is increased engagement. Mikropoulos (2001) conducted a research where brain activity was measured for tasks performed in real as well as in virtual reality

environments. Findings demonstrated that subject were more attentive, responsive, and utilized less mental effort in the virtual world, demonstrating that knowledge transfer of information gained in one world to the other world is possible. Other studies support increased engagement. According to Mason (2007) students are more engaged in learning tasks and spend more time thinking and discussing the subject material. Richter, Anderson-Inman, and Frisbee (2007) note perceptions of immersion into another world and engaging in learning in the first person, which is more interactive and experiential. As learners are allowed to interact with information in the first person, this facilitates constructivist-based learning activities (Dickey, 2005b). Dickey states that the interaction with virtual objects can be helpful in developing a stronger conceptual understanding, depending on the content. Engagement experiences are also present; Foster (2007b) states that using virtual worlds can increase enthusiasm for learning and introduces some to an experience, in virtual worlds, that they may have never realized.

Alternative space for instruction and tasks

Graves (2008) cites some educational professionals see opportunities to conduct courses or related activities in places other than the classroom, for example visiting simulations of places that no longer exist in real life. Some living in more risky locations find Second Life a safer place to arrange field research projects (Foster, 2007b). One suggestion by Conway (2007) is freeing up instructor's time to be spent on spontaneous and productive interactions in form of group work or class discussions in the real world. This time could be freed by conducting teaching through an academic avatar that follows traditional classroom instructional methods in a virtual environment. In a virtual environment, it is possible to personalize the learning space (Dickey, 2005a).

Visualization for difficult content

3D virtual worlds are a good tool to build simulations. Such simulations are better suited in teaching certain kind of materials than plain static format. For example, difficult dynamic 3D concepts, such as "lines of nodes" and the variety of scales and sizes, are typically disregarded in introductory astronomy courses. The use of a 3D virtual world could offer the students a tool to learn these concepts more easily. (Barab et al., 2000)

2.9 Problems of using virtual worlds in education

In addition to the benefits, there are also issues present when using virtual worlds in education. The reported issues about the usage of Second Life in education can be categorized to eight broad categories (Warburton, 2008a, 2008b; Warburton & Perez-Garcia, 2009). Table 2 describes these categories.

Table 2: Eight problem categories of using Second Life in education (Warburton, 2009, pp. 422-423).

Problem category	**Description**
Technical	Both client and server side issues, such as bandwidth, hardware, firewalls, down time and lag. Also human or user related issues including managing the client interface and developing basic in-world competences, such as navigation, creating objects, manipulating one's avatar and developing a visual 3D grammar. Because of these issues, the experienced in-world experience can vary between users.
Identity	There are problems with fluidity and playfulness inherent in Second Life identity construction, as it can

	become confusing and disconcerting. Social relationships can be problematic to build and fraught, when identities are not fixed. The freedom to play with identity and manage reputation can be an issue of concern. The accountability for actions can be displaced.
Culture	Second Life can be an isolating experience. Communities are not always easy to find, and can be demanding to participate in. Second Life has its own set of codes, norms and etiquette (Meadows, 2008), and these are not always straightforward to read. Second Life can even feel destabilizing and outside – the "safety zone" – a place of no limits, no boundaries and no restrictions on behavior.
Collaboration	Cooperation and co-construction demand scaffolding. Successful group activities need trust and authenticity. If effective dialogue needs to be present, considered use of the in-world presence layers and possibly external services, such as wikis, blogs or a virtual learning environment (VLE).
Time	Even simple things can need a considerable amount of time. Designing, validating and running teaching activities requires time to address issues such as intellectual property rights, object permissions, and accessibility. Second Life requires educators to develop multiple skills to deal with issues when designing, implementing and practicing education.
Economic	The platforms available differ in their economic model in use. Some are hosted locally, some outsourced. Some

	have open code base, some proprietary. Some have subscription options; some can be bought and owned. Second Life is hosted by Linden Labs on their servers. The client can be downloaded freely. Basic usage is free, but anything over that costs real money. The land for teaching spaces have to be bought or rented, uploading images and textures costs, in-world tools used in education cost, and script and building expertise have to be bought.
Standards	The current state of virtual worlds is lacking standards and interoperability norms. Choosing one of the worlds locks time and economic investment. Lack of standardization hinders the integration of other technologies and resources to enhancing the in-world experience.
Scaffolding persistence and social discovery	There are problems related to social discovery of others in-world. The avatars have profiles, but no such egocentric social networking services, such as Facebook and LinkedIn. The avatars can describe their first and second life, but the social network of a friend is hidden. This means that each avatar is trapped at the centre of its own community. The in-world environment is always present, but avatars exist only when they are in-world. A new way used to some extent overcome this problem is to use an out-world service for build social identities of avatars. For example, Flickr photo sharing groups are used in avatar construction and fleshing out identity.

Eschenbrenner et al. (2008) included the following issues from their literature study about issues in utilizing 3D virtual worlds in an educational context: identifying value-added educational applications; being able to read people's natural physical cues; technological issues; costs; behavioral, health and safety issues; and user adoption. Following paragraphs discuss these issues.

Appropriate value-added educational applications

A major question in using virtual worlds in education is finding appropriate value-added educational applications. Two challenges have been identified. First, determining situations in which virtual world learning presents value beyond what traditional education can provide. Second, determining how to effectively utilize and adapt these worlds to support learning. (Mantovani et al., 2003)

Foster (2007a) notes that promoting games in learning environments is degrading to education, even though 3D virtual worlds could be utilized to host educational games. Schultze, Hiltz, Nardi, Rennecker, and Stucky (2008) state that existing virtual worlds may not have been designed with educational goals in mind.

Inability to read "natural" physical cues

When using virtual worlds there is a lack of non-verbal communication. The avatars can show some facial expressions, but one professor states these forced expressions to be meaningless and not providing sound evidence of a student's attentiveness or boredom. (Graves, 2008) According to Dickey (2005a) the traditional classroom setting provides a broader range of non-verbal communication.

Technological issues

Mantovani et al. (2003) state that possible technological issues include proprietary applications with limited adaptability to other contexts as well as system usability.

Other virtual reality issues include the re-invention of interfaces that accommodate the three-dimensional versus traditional two-dimensional designs and requiring exceptionally high system performance in order for the virtual-reality effect to be experienced (Bryson, 1996). Schultze et al. (2008) have reported some learners not having enough hardware power or bandwidth to utilize properly Second Life and most of the discussion focusing on the features of Second Life and not the educational topic.

Costs

There are concerns over costs (Dickey, 2005a; Mantovani et al., 2003). Actually, a common concern for any implementation of technology for education is costs (Schultze et al., 2008). Costs include the purchasing and maintaining of own virtual space, building, training, etc.

Behavioral, health and safety issues

Mantovani et al. (2003) note health and safety issues, such as simulator sickness and ocular problems. When considering the playful nature of virtual worlds, activities can become more playful than educational. This can lead to challenges in monitoring behavior. (Graves, 2008) For example, there has been a virtual shooting on the Second Life campus of Ohio University, and some students from Woodbury University have been engaging in "disruptive and hostile behavior" (Graves, 2008, p. 50).

According to Bugeja (2007) the two most common violations in Second Life are assault and harassment. He continues that in cases, such as violence, some issues might exist, if the terms of service agreements of the company

conflict with academic. Bugeja poses the following questions: Has the professor included warnings if she required an exercise to be performed in a virtual world? Is your university aware of harassment issues in virtual worlds, and has it issued guidelines?

Bugeja (2007) also states there might be some issues because students are required to agree to virtual world company's terms of service. For example, Second Life main grid has an age restriction of 18 years.

User adoption

Both teachers (Dickey, 2005a; Mantovani et al., 2003) and students (Dickey, 2005a) can have issues using virtual worlds because lack of experience. To use the world one needs a basic set of in-world skills, such as teleporting and using basic communication tools (Graves, 2008). If only form of communication is text, individuals not having adequate typing or written language skills may suffer (Dickey, 2005a). Mennecke et al. (2008) note that virtual worlds do not scale well when too many avatars are participating to the teaching. Additional issue listed is trust (Siau, Sheng, Nah, & Davis, 2004; Siau & Shen, 2003). Can the participants trust the technology, the environments, and the people they meet in the virtual worlds?

Schultze et al. (2008) report experiences from a single session class in Second Life to include learners (age 25-50) encountering navigational problems and experiencing disorientation and confusion. On the other hand, a four-week set of sessions of learners with online gaming background (average age 20) got comments that Second Life was simple, but graphics appeared outdated. Barab et al. (2000) noted that learners spent a significant amount of time learning the software of the virtual world. Because of this, there was a delay before they started to study the actual subject. However, the learners stated that this could be avoided using a scaffolding approach in acquiring technical skills and subject-matter concepts.

2.10 Reported applications of virtual worlds in education

One often-addressed example of the benefits of virtual worlds in education is the demonstration of Yellowlees and Cook (2006). They built a house in Second Life that features some of the hallucinations of individuals with schizophrenia. The experience uses naturally graphics and audio, and the user is able to explore the house with her avatar. A major share of visitors (75 %, n=549) answered that the visit increased their understanding about schizophrenia.

Another area where the possibilities of Second Life have been considered is health education (Boulos, Hetherington, & Wheeler, 2007). The result was that Second Life provides a safety environment for students to practice medical skills without danger of serious consequences. These simulations in Second Life are quite realistic because of the immersive nature of the virtual world. Boulos et al. conclude that Second Life may be an ideal place for simulation and practice.

Eschenbrenner et al. (2008) categorize applications for higher education in three groups based on their purpose: (i) replicating reality and existing activities, (ii) developing novel spaces and conducting activities unique to the virtual world environment, (iii) those focusing on accomplishing both of the above. Table 3 provides various applications of 3D virtual worlds in higher education divided into these three categories.

Table 3: Reported uses of 3D virtual worlds in higher education (Eschenbrenner et al., 2008, pp. 96-98).

Organization	Application	Source
1. Replicating Reality – Utilizing Alternative Space for Existing Activities		
Appalachian State University and Clemson University	3D virtual world created to improve online learning for master's degree students.	("ASU partners with Clemson to create virtual world technology," 2008)
Ball State University – Middletown Island	Intellagirl conducts freshman English-composition class.	(Foster, 2007b)
Duke University's Fuqua School of Business	Partnering with ProtonMedia to create 3D spaces for education or "telepresence portal."	(Bisoux, 2008)
INSEAD - France and Singapore	School/library is open-air building with auditorium seating 36. Clickable computer screens provide access to other web pages and library offers hot tea. Research lab provides notecards to describe research and request consent. Public space/beach	(Jennings & Collins, 2007)

	provides clickable kiosks to obtain more information about INSEAD, space for reflecting and conversing, bar with drinks available, and listening to radio.	
Princeton University	Created island that includes lecture hall, art museum, and performance location.	(Graves, 2008)
2. Developing Novel Space – Conducting Activities Unique to Virtual World		
Immersive Education project - Boston College, Harvard University, Amherst College, Columbia University, Massachusetts Institute of Technology, Sweden's Royal Institute of Technology, Japan's University of Aizu, the Israeli Association of Grid Technologies,	Created tours inside Egyptian tomb, created interactive lessons (Croquet and Project Wonderland), developed park and replica of Boston's subway system to tour city's neighborhoods, developed Restaurant Game to help waiters/waitresses acquire skills/training through simulations of	(Foster, 2007a)

National Aeronautics and Space Administration (NASA), Sun Microsystems, the City of Boston, and the New Media Consortium	restaurant experiences.	
Indiana University	Created a Virtual Solar System project for astronomy undergraduate course.	(Barab et al., 2000)
Lehigh Carbon Community College and adjunct at DeSales University (professor at both)	Professor created Literature Alive – provides guided tours of famous literary locations (e.g., Dante's Inferno).	(Foster, 2007b)
Vassar College – Vassar Island	Re-creation of Sistine Chapel – visitors can fly to ceiling or view tapestries designed for the walls.	(Foster, 2007a)
3. Replicating Reality and Developing Novel Space		
Boise State University	EDTech island utilized for teaching educational games and providing students testing area (building own objects),	(Goral, 2008)

	includes information center, and condominium.	
Bowling Green State, Ohio	Use virtual campus for teaching, research, office hours (space pods situated into mountain sides), exhibiting art and music, and presentations by guest speakers. In process of creating a writing center ran by graduate students.	(Goral, 2008)
Bradley University	Students have conducted analyses of avatar fans of musicians that conduct performances in Second Life, as well as other topics, such as online hackers.	(Foster, 2007b)
Georgia Institute of Technology	Augmented Reality lab created software to associate actual physical spaces with virtual – creating ability to combine video feeds from the real world with Second Life avatars.	(Goral, 2008)

Johnson & Wales University	Created a Virtual Morocco in conjunction with Ministry of Tourism of Morocco. Includes monuments and opportunities to learn about Moroccan culture. Students created and developed plans and prototypes, and worked with individuals from other countries on project. Virtual BLAST (Balloon-borne Large-Aperture Submillimeter Telescope) brought attention to scientific ballooning projects by flying over the Second Life main grid and stopping to visit various educational and scientific locations. Entrepreneurship students create business plans and develop prototypes in Second	(Mason, 2007)

	Life.	
Massachusetts Institute of Technology	75% of island dedicated to student projects, remainder replicates physical campus (including outdoor theater area). Avatars can address a crowd with a megaphone and determine average viewpoint by avatars moving to right or left of line on platform. Sponsored contest for students to design dormitories.	(Foster, 2007b)
Montclair State University	Use mountainsides for displaying syllabus and spheres for deadlines, Literature Alive spots include Willow Springs and encountering evil in Young Goodman Brown, and provide sunbathing area as well as covered deck near lake.	(Foster, 2007b)
Ohio University or	Entry way provides	(Goral, 2008; Jennings

Ohio University Without Boundaries	historical information and historic replicas of campus (along with Standards and Privacy Statement). Locations include Welcome Center (video display of learning initiatives), Art and Music Center, Classroom and Meeting Center (with seating capacity of 25), Learning Center (displaying e-learning activities), Student Center (coffee shop, stage which includes microphone, pool tables, kiosk publicizing real-world entertainment activities, student video lounge, vending machines, and reading space), Featured Games (simulation of fast food restaurant – avatar selects food to learn nutritional value),	& Collins, 2007)

	Stocker Center and Sandbox (building objects by permission). Collaborated with The Princeton Review for SAT preparation.	
Simon Fraser University	Professor produced films for posting on YouTube and created cartoons for first-year calculus students.	(Conway, 2007)

Kay and Fitzgerald (2008) present a set of categories representing in their opinion the current educational activities of Second Life:

- self-paced tutorials
- displays and exhibits
- immersive exhibits
- role plays and simulations
- data visualizations and simulations
- historical recreations and re-enactments
- living and immersive archaeology
- machinima construction (short film created by recording video of a 3D virtual world)
- treasure hunts and quests
- language and cultural immersion
- creative writing.

To sum up, a variety of educational activities have already been reported in literature, and it is possible that many more not reported exist.

2.11 Planning education for virtual worlds

Lim (2009) has presented six lenses that he calls "the six learnings." These lenses are helpful when planning and implementing courses in virtual worlds. Lim delivers this framework after more than sixteen months in-world experience. He suggests that having an equal and mutually respectful multi-partite relationship between school management, content developers, service provides, and curriculum designers raises the probability of effectively meeting learning goals.

Lim has experiences about Second Life, but suggests that the lessons could as well be applied to other virtual worlds. The six lenses should already be used in early planning stages of the course. The lenses are not meant to be used all at the same time; rather each curricular intervention should utilize one or two of them. The lenses used should be chosen based on the mission and values of the school, and the learning objectives of the course.

Learning by exploring

Exploring the virtual world itself offers many learning possibilities. The subject can be for example an installation, landscape, or community. The tasks can include research or fieldwork, and be scripted to a variable amount. An example of such research could be observing customer behavior and movement patterns in a shop inside a virtual world.

Learning by collaborating

Collaborative learning takes places in teams. It usually includes problem-solving or other form of structured inquiry. The focus is around increasing the team members' metacognitive habits, their understanding of distributed cognition, and social dynamics of group work. This approach is based on statement that it is more beneficial to learn collaboratively as competitively.

This point of view is explained for example by Johnson D. and Johnson R. (1994).

Learning by being

Brown and Duguid (2000) have described what means "learning to be." Learning by being means learning by exploring self and identity. It can mean assuming identities and dispositions through enculturation. This has been achieved for example by role-playing, or performing Shakespeare in original setting or costumes inside the virtual world.

Learning by building

One way to teach understanding of concepts to students is to make them build objects inside the virtual world. This can be done individually or in a group. After building the object, the students can be required to implement scripts to them to provide some functionality. By building, the students can demonstrate their understanding of mathematical or physical concepts, their aesthetics, or logical flow of algorithms they use inside scripts. For example, the students could be asked to build a motherboard of a computer and attach six explanation notes to different parts of it. This could demonstrate their understanding on the different parts and the composition of the motherboard.

Learning by championing

Learning by championing means to take a cause for example from the real life and fight for it inside the virtual world. Some organizations do this for example for health education. The students could be asked to design and implement an installation or exhibit in order to raise the knowledge of others about a cause meaningful for them.

Learning by expressing

Learning by expressing means that the students choose some of the material from the in-world experience and present it to outside-world audience. This can be achieved for example using blogs, podcasts, or machinimas. This can teach skills such as storyboarding, editing audio and video, literary critique, and creative writing. Hung and Chen (2008) call this type of dialectical interaction "selves to reifications." They propose that learners are able to articulate their understanding by externalizing with the help of technology. This lens suits for example for media or language courses.

2.12 Results of literature review

Reports of virtual worlds usage in education were available in literature. Advantages and problems of using virtual worlds in education were analyzed and presented, and based on literature material it was possible to answer the research question 1. In addition, literature provided background to virtual world history and usage, shed some light on different pedagogical approaches, and offered some tools that can be used in the course production process in chapter 4.

Table 4: Impact table based on the literature. The table describes the lessons, and shows the source sections and the affected phases of the production process presented in chapter 4 for each lesson.

Effect to phase	**Source section**	**Lesson**
Planning/ implementation	2.2	Choose a didactic approach rather than end up with one, choose based on the teaching

		situation and subject, and students. How to plan, how to implement?
Planning/ implementation	2.2	Subject-, problem-, or student centered? Make a decision based on what the environment supports.
Planning/ implementation	2.2	There are different learning styles, try to activate each.
Planning/ implementation	2.4	Synchronous implementation allows better knowing and interacting with classmates, leads to increased engagement with the class-related material. Asynchronous better for study at your own pace –solution.
Environment	2.6.2	Use the framework to justify virtual world usage, if they are mixed to non-educational games.
Preparation	2.6.2	Offer possibility to customize the avatar.
Preparation	2.6.2	Create trust by using unique names on avatars, or by sharing features with real life persons.
Preparation	2.6.2	Instructor avatar should be made identifiable for students. This could be achieved with shared features to real life person, or by a distinctive feature like carrying a large signpost.
Planning	2.6.5	Consider whether to use face-to-face, pure virtual, or mixed activities based on the needs.
Planning	2.6.5	Implementing multiple media allows the students to engage their full learning styles, creates more opportunities for engagement, and

		means for interaction.
Environment/ planning	2.7	Use the facets framework to compare different virtual worlds, if your university has not already chosen a virtual world for you.
The environment	2.8	Justifying virtual world usage can be made through the advantages they offer. Choose appropriate advantages for the specific situation.
Planning/ implementation/ follow-up	2.8	Use the reported advantages to identify the ones present in current case. This allows you to maximize their effect.
Planning/ implementation/ follow-up	2.9	The usage of virtual worlds creates some problems. If the risks for them can be identified, they can be prepared for, and their impact minimized. Use the provided list and analyze their effect to your situation to minimize their effect.
Planning	2.9	If effective dialogue needs to be present, considered use of the in-world presence layers and possibly external services, such as wikis, blogs or a virtual learning environment (VLE).
Planning/ implementation	2.10	Use the reported applications as a tool when thinking possible activities to reach the learning goals of the course.
Planning	2.11	Use the six lenses –tool to innovate educational approaches for your course.

3 Identifying focus themes from messages of a virtual-world educator community

This chapter responds to the research question 2 by analyzing messages of a virtual-world educator community and identifying focus themes. Those themes highlight special areas that need attention when producing a course that utilizes 3D virtual worlds.

The community analyzed is an active electronic mailing list for educators in Second Life called SL Educators ("The Educators Archives, SL Educators (The SLED List)," 2009). This list is hosted by Linden Labs. Warburton (2009a) states that the SLED-mailing list activity is high, but at the same time notes that clear guidelines for practice remain difficult to find. The message categories and types are analyzed, and the topics of questions posed to list are explored.

3.1 Data collection

There has been a varying amount of messages to the list each month of 2009. The amount of monthly messages has varied from 336 to 1167 messages. Two months were chosen from 2009 to be analyzed, so they would be recent and portray current state of the list. February was chosen to show messages during a semester and July to show messages off-semester during the planning phase of the coming courses. In February, there were 1145 messages to the list from 318 different senders, and in July 771 messages from 245 different senders. The messages from these months were available from the list archive.

3.2 Data analysis

The two months under analysis were assessed separately. Each message was categorized into one or more of the categories, and the type of each message was determined. This was done by going through the messages manually one by one, and analyzing the message subject and content. The categories were created while analyzing the messages. Every time a message did not fit to a previous category, a new one was created. In the end, some categories too narrow to be interesting or categories including only a few messages were combined to a more general category. This type of category creation allows the identification of the focus themes. The messages were divided into four types: "question," "comment," "link," and "other." This way, all the questions could be analyzed separately, and the amount of links sent to the list is found out. Table 5 and Table 6 describe the categories and types used.

Table 5: Descriptions of categories used in SL Educators electronic mailing list message categorization. A message can belong to multiple of these categories.

Category	**Description**
Processes/best practices	Messages about working teaching or learning processes. Looking or reporting of best practices.
Technical	Messages about technical solutions. Could relate for example to computers, software, and client or server software of the virtual world.
Spam/list announcement	Spam messages, automatic vacation replies, or list announcements.

Event	Messages about events taking place inside the virtual world.
Psychology/education	Discussions about psychology and pedagogical views.
Avatar	Messages about avatars and avatar customization.
Resource	Messages about in-world and out-world resources available for use.
Tool	Messages about in-world tools, for example a voting-box tool.
News	Messages presenting or discussing news articles.
Not interesting	Messages not relevant for this research, for example vacation responses.
Research	Messages about research. Some researches look for help, or some might post the results of certain research.
Conference	Conference advertisement and discussion.
Community	Communal messages.
Art	Messages about art.
Scripting	Messages dealing with scripting (programming inside a virtual world).
Building	Messages about in-world building.
Jobs	Educational and virtual world job offers and discussion.
Course advertisement	In-world and out-world course advertisements.
Cross Media	Messages about bringing other medias, like www-pages or video, inside the virtual world.

SL World/grid	Discussions about the arrangements of Second Life world or grid.
School administrative/ strategy level	Messages considering the strategic level view of virtual worlds in education.

Table 6: The message types used for the messages of SL Educators electronic mailing list. A message can have multiple types.

Type	**Description**
Question	Questions
Comment	Comments or discussion
Link	Link to in-world place or web-resource
Other	Other types, messages not relevant, for example vacation responses.

3.3 Findings

This section presents the findings from the analysis done on the electronic mailing list. These findings answer the research question 2 and provide input to the production model created to answer the research question 3. First, the general topic distribution of the messages is discussed. Then, the type distribution of the messages is presented. Finally, the category distribution of question messages is explained.

3.3.1 Messages categories

A message can include multiple categories. The percentages of messages belonging to each category can be seen in Figure 2. The detailed results are presented in Table 10 in Appendix A (p. 111). The percentage values after each category show the percentage of the messages belonging to that category. As each message can belong to multiple categories, the percentages do not add together to 100 %. The categories "spam/list announcement" and "not interesting" were dropped from the results, as they are not relevant when searching for the focus themes.

The five most common categories were determined by counting the ranks of the categories together from both months. Three most common categories by combined rank were "processes/best practices," "technology," "event." Almost as common were "resource," "research," "community," and "tool."

The results show the most common category to be "processes/best practices." The expertise and experience from other list members seem to be an important resource for educators in a variety of situations. Advice is sought for all part of the process of using 3D virtual worlds for education.

The second most popular category was "technology." It became obvious that inadequate technology is creating problems for educational uses of 3D virtual worlds, at least for Second Life users. For example, educators were looking for working computer configurations, software for creating machinima, and looking for solutions to technical problems. Some problematic issues were voice chat, the user interface of the client software, and the client software installation and management in centrally managed IT environments.

The third most common topic was "event." The messages in this category deal with events, which take place inside the virtual world. Less than every

tenth message belonged to this category. It seems that many events take place in Second Life. In addition, the organizers use the SLED-list for one advertisement channel. For educators, it is useful to belong to these communities, as it allows event organizers to reach them. Most of these events or resources advertised on this list are openly available for educational uses without cost.

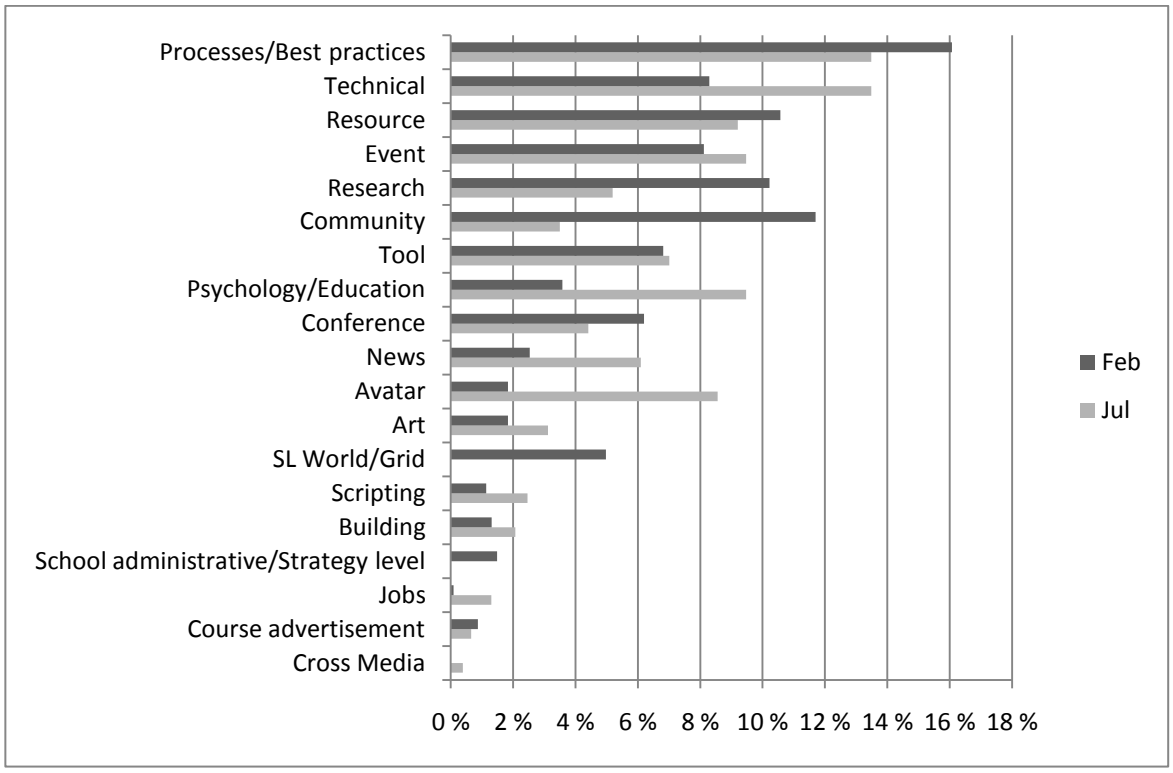

Figure 2: The percentages of messages belonging to each category in February and July 2009. (Feb: 1145 messages from 318 different senders, Jul: 771 messages from 245 different senders)

3.3.2 Message types

The percentages of each message type can be seen in Figure 3. The detailed results are presented in Table 11 in Appendix A (p. 112). The message type "other" is removed from the rankings, as the messages in it were mainly spam or otherwise not interesting for this study. Most of the messages were

"comment," that is, discussion. However, it is interesting that in both analyzed periods showed more "link" messages than "question" messages. There seems to be more information sharing in the form of resource links, news links, event links, than there are questions posted to the list. It does not mean that the amount of questions is low, but the fact, that so many resources are shared is noteworthy, as it can be a considerable advantage for educators.

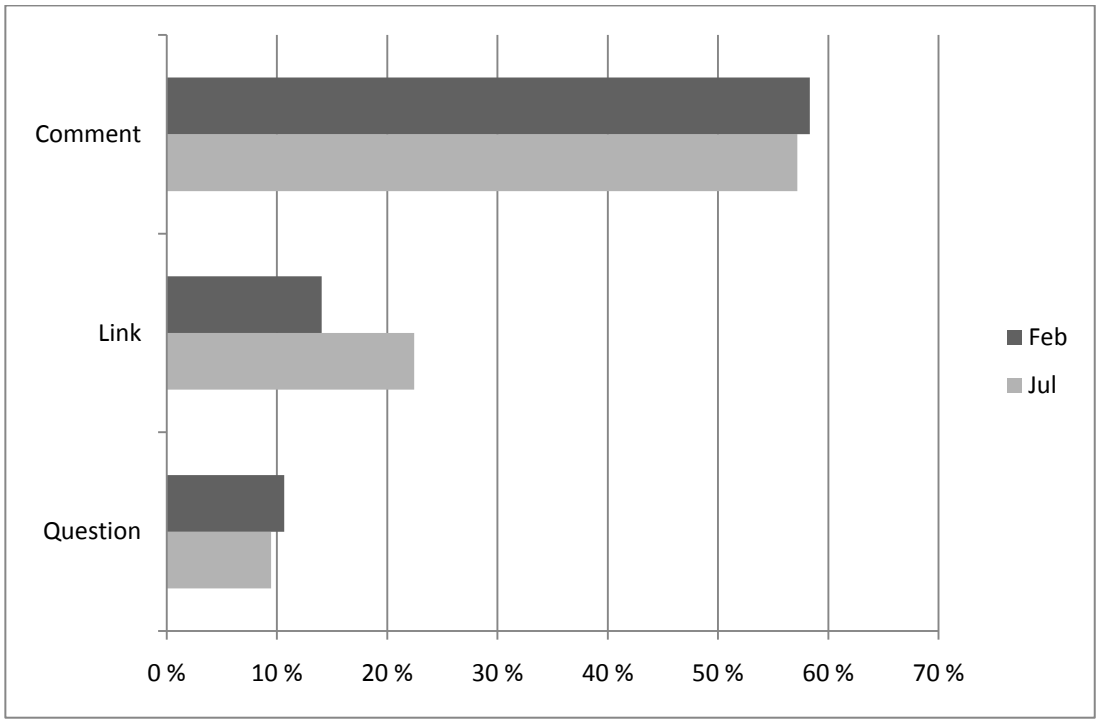

Figure 3: The percentages of messages types in February and July 2009. (Feb: 1145 messages from 318 different senders, Jul: 771 messages from 245 different senders)

3.3.3 Categories of questions

Each message thread that included "question" as a type in one of the messages was examined. The amount of message threads in each category was counted to find out the common topics of the questions. The categories

"spam/list announcement" and "not interesting" were dropped from the results, as they are not relevant when searching for the most interesting topics. Figure 4 shows the calculated amounts of each category and their respective percentages.

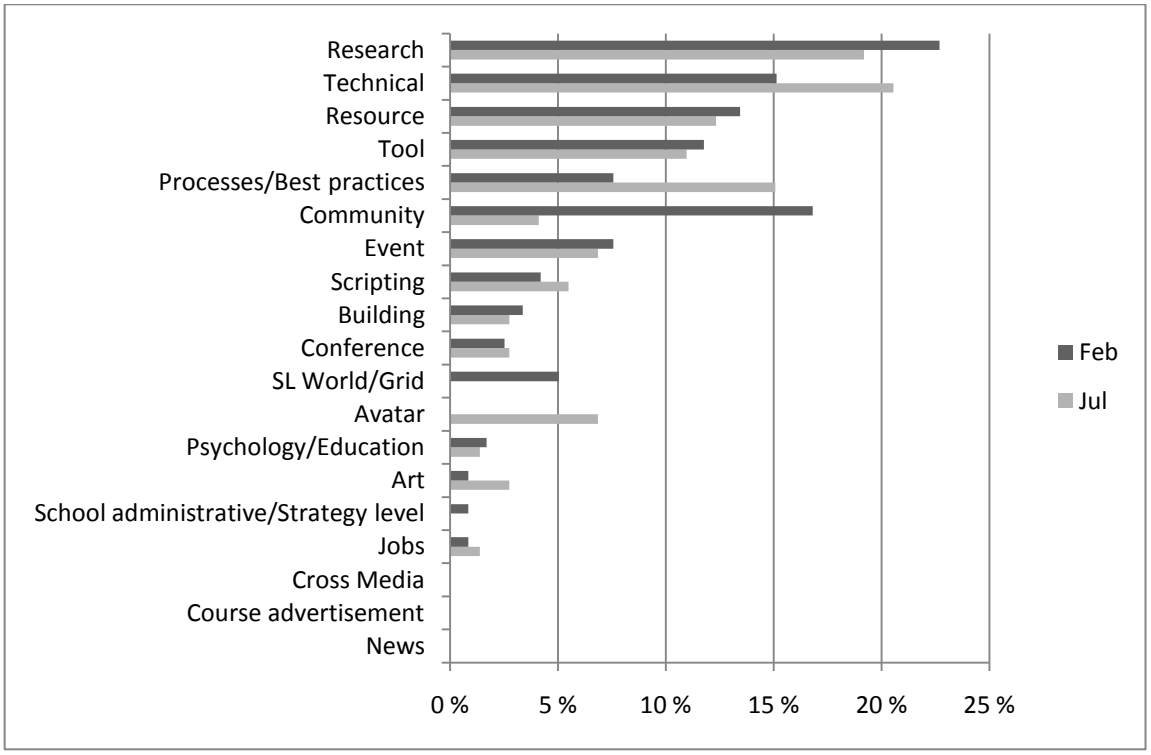

Figure 4: Categories of questions in February and July 2009. (Feb: 119 questions from 88 different senders; Jul: 73 questions from 54 different senders)

The ranks of the question categories each month were added together in order to get the five most important ones. The most common categories for questions were "research," "technical," "resource," "tool," and "processes/best practices."

The questions in the category "research" included mainly researchers looking for participants for questionnaires or interviews. Some were looking for the basic articles about education in virtual worlds.

Technical questions were the second common ones. It shows that technical issues and problems should be taken seriously. Educators need to plan how to avoid technical problems and how to overcome them if they appear. This amount of questions could also indicate a need for separate technical support if virtual worlds are to be widely used in the department or in the university.

Third most common questions category was "resources." Educators were asking the list for resources that they could use in their own course, or when doing a demonstration about the use of virtual worlds. It seems that communities, such as the SLED-list, are used to share and find resources that could be used in education.

Fourth common category was "tool." As in real world, there are tools available inside virtual worlds to use in lectures or other educational activities. Some examples are voting, video, and presentation tools. New educators asked where to find these tools. More experienced educators responded by sending links to basic collections of tools or to the specific tool that was sought.

Fifth most common question category was "processes/best practices." It seems that educators are eager to find and share the best practices found by experience. The support of the community seems to have an important role, and attention should be paid to it. If more widespread use of virtual worlds is planned in a university, one person could be given the role of community manager or virtual world support. This person could take part in different communities and take part in planning the educational activities of the university, so that she could gain as much experience, tools and good practices to share to the people in her university. Of course each instructor using virtual worlds in her courses, could also take part in communities, but it can easily be quite time consuming, and to support people with less time to

put in community activities, this support person could be invaluable resource.

3.4 Results of the community mailing list analysis

The lessons from the community analysis were collected and presented as an impact table. The lessons and the phases they have an impact on are shown in Table 7.

Table 7: Impact table based on the community analysis. The table describes the lesson and shows the phase of the production process presented in chapter 4, that the lesson affects.

Effect to phase	**Lesson**
All	Community support available, use it!
Environment/ planning/ implementation	There are many technical problems. Support resources are needed, investments for hardware suggested, and training necessary.
Planning	Many virtual events suitable for education and support exist. Use for educational ideas, peer support, or integrate them straight to teaching.
Environment	The education community showed plenty of research interest towards education in virtual worlds. Research could be used as a reason to justify virtual world experiments. Published literature can also be used to gain ideas and learn from the experiments of other educators.

Implementation	Resources and places are shared and offered for use if asked. It is possible to arrange demos without owned land areas. Community is helpful towards other educators.
Implementation	As resources and tools are shared, a lot of effort can be saved if ready-made tools and resources are used. Only if customization is necessary, building own tools should be considered.
All	Best practices are shared in communities in addition to literature. Belonging to and following a community seems very useful. It might be too much demanded for every teacher to do that, but maybe a role of central community manager for a university could be established. The manager could belong to relevant communities, and share the lessons and resources to other teachers for example through training sessions.

4 A model for producing a university course that uses 3D virtual worlds

This chapter answers the research question 3 by presenting a model for the production process of a course that uses 3D virtual worlds as a tool. This chapter begins by describing aspects related to the model followed by the description of the process phases in section 4.3. The model is developed for specifically higher education, but it could be modified to suit to other

education levels as well. The model is constructed based on the literature (for example Pesonen, Pilli-Sihvola, & Tiihonen, 2000) and the collected focus themes. Table 4 (p. 53) and Table 7 (p. 65) show how each lesson maps to a section of the model. Figure 5 shows an overview of the process phases.

The goals of the production process are to produce the course cost-efficiently, with high quality, and trying to ensure wide and long usage. However, the presented model should be used only as a basic framework. In reality, the process is unique each time, and it needs to be customized to the specific situation. It is possible for some of the phases to take place simultaneously, due to practical reasons.

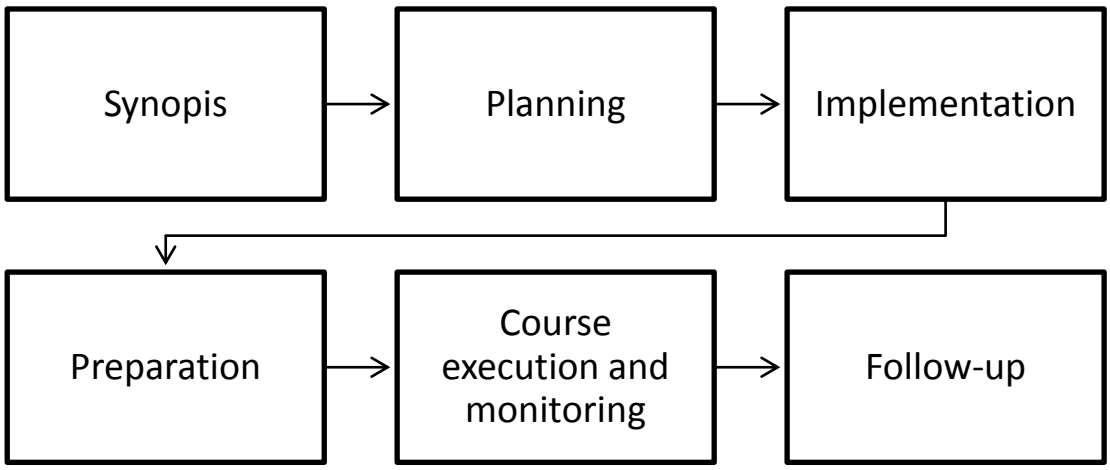

Figure 5: Overview of the course production process.

4.1 Roles and responsibilities

Depending on to what degree planning and construction of the virtual world is done inside the university; many kinds of expertise are needed. A variety of roles is present in the production. It is possible that one person has several of these roles. Table 8 describes the roles involved in the process. Table 13 in Appendix B (p. 114) shows how different roles participate in the

different phases of the production process. It might be useful to consider using more finished virtual world solutions or buying services outside the university, if not all of the expert resources required are available inside the university.

Table 8: Roles in the production process (adapted for virtual worlds from Pesonen et al., 2000, p. 136).

Role	Description
Project coordinator	Project coordinator manages the general view. Project coordinator represents the client/publisher and has the main responsibility of the production process. Tasks include contract negotiations, copyright issues, guiding meetings, team communication, schedules, budgeting, and project monitoring. Project coordinator can raise issues for the content expert, if needed.
Content expert	Content expert provides the team with her opinion, experience, and expertise about the topic of the course. She works as a content scriptwriter, i.e., produces the learning material, exercises, and the syllabus. The content writing includes making teaching solutions and planning the studying processes of the students. She needs to know how students work with the material provided, and how the instructor is acting inside the virtual world. The content expert does not need to focus on how the implementation is done, but instead must describe the learning goals, activities, and interactions.

Instructor	Based on experiences the person in the role of the content expert is the best choice for the course instructor, i.e., the teacher. This is because the course is planned according to her educational views. The instructor needs earlier teaching or instruction experience and desire to guide the students inside a virtual world. Earlier experience about virtual worlds is not needed, but then more time and energy for planning and instruction tasks are required.
Web didactic expert	Web didactic expert works in the role of production scriptwriter. She has expertise in guiding educational activities in Internet and virtual world. She needs to be familiar with the tools and learning processes.
Www-producer	The www-producer builds the www and virtual world solutions with the developer according to the production script. She plans the visual layout and chooses the final implementation solution for the tools and environment. The www-producer orders the technical solutions needed from the developer. She takes part in the meetings discussing the structure and functional requirements of the course. She also is responsible for the needed updates and changes to the learning environment during the course.
IT support	IT support gives technical support during the course.
Graphical designer	Graphical designer implements the visual layout and creates the graphics used.
Developer	Developer plans and implements the needed solutions

	for used tools and user management issues. The functional parts of the course should be clearly planned, so that developer can just easily implement them. She usually cooperates with the www-producer and the graphical designer.
Course secretary	The course secretary gives information about the course, processes the course participation applications, manages user access rights, announces course news and issues, and exports the course credit records to databases.
Marketing responsible	Has responsibility of the course marketing. She creates the advertisement and brochures.

4.2 The environment

The environment of the course has a major impact to the planning and implementing of the course. Virtual worlds may already be implemented in the university, and knowledge acquired through experiences. If the course is the first one using virtual worlds, a lot more resources are needed. The following paragraphs describe the different environment aspects to be analyzed.

The knowledge and skills people have using virtual worlds are increasing all the time. Gartner Research (2007) predicts, "80 % of active Internet users will have a 'Second Life' in the virtual world by 2011." At that time, the knowledge of users about basic usage of virtual worlds will be better than currently. The university might already, or in the near future, offer basic intro courses to virtual world usage. Currently, many universities offer basic

introduction courses to the IT environment of the university, in basic computer usage, and software usage. If the university does not currently offer courses utilizing virtual worlds, it might be necessary to influence some strategy level planners. The framework from section 2.6.2 can be used to make the difference clear between virtual worlds and non-educational games. It is also possible to use relevant advantages of virtual world usage in education (reported advantages are presented in section 2.8) to justify virtual world usage to the source of funding or the strategy level planners.

There are various interest groups involved when introducing new technology to education. Some of them have a greater impact than others do; nevertheless, all should be considered. The involved interest groups and descriptions are shown in Table 9.

Table 9: Interest groups involved when introducing new technology to education.

Interest group	**Description**
Students	Take part in the course. Have varying background and skill-sets.
Strategy level planners	A higher-level board planning teaching tools and technologies used in the university.
IT support	Support for the computer environment of the university. IT support might also have the responsibility of maintaining and supporting locally hosted virtual world or other technology tools, and their user access rights.
Course staff	Staff has various duties for the course. They plan, organize, share material, guide, instruct, and

	evaluate.
Teachers outside the course	They are not involved in the course, but might show interest towards the use of virtual worlds. They might be over skeptic toward the use of new technology and give unnecessary critic.
Environment provider	Environment provider offers the virtual world environment, and the tools used inside it.
Simulation developer	The developer plans and/or builds the education area or simulation inside the virtual world.
Course cooperation partners	The course can include group work done for companies. The company's ability to use the new technology must be considered, and user access rights resolved.

One important feature of the environment of the course is the support available. Does the university already provide some resources for educators who want to use virtual worlds in education? Possible ways to support include training courses, IT support, dedicated or otherwise competent hardware, software updates/customization, technical equipment to enable hybrid teaching, authentication methods for students and their avatars, land areas and facilities inside virtual world, virtual world expert services etc.

This support could have a huge effect not only on the quality of the teaching, but also to the amount and type of resources required from the course staff. On the other hand, growing amount of virtual world teaching also has effect on the support, as more users and educators mean more support resources are used.

Educator's background and skill-level

Educator background and skill level affect the course implementation. If the educator already has experience on using virtual worlds, she can use this experience as a starting point. In addition, the level of involvement the educator has had in virtual world usage and communities is important. The more experienced user she is, the more ideas and skills she has in planning and implementing the course. If she does not have such experience, communities, training or peer support can be ways to overcome. Holmberg and Huvila (2007) suggest a list of five things what an educator needs when planning teaching in virtual worlds: an idea, content, a trusted guide, a safe area, interest towards using virtual worlds in education, and excitement. There are also tests available for educators that evaluate their skills for using virtual worlds in education (Fleep, n.d.).

Student's background and skill-level

If no introduction or virtual world basic usage courses are mandatory in the university, the technical skill base of the students can be variable. Introductions and guides for the tool usage might be needed, and some time from the course dedicated to teaching basic usage skills. In all cases, the course plan should include the necessary virtual-world skill level.

The students can also have varying attitudes towards using virtual-world technology in education. The technology can be new, and its advantages unclear. The students can think this is only another burden for them. If they do not already have avatars inside the virtual world, they have to take the time to create and customize one. They might feel that the educators expect them to use their free time as well to explore the virtual world. Educator must pay attention to give the students good reasons why virtual worlds are used, motivating the students to use them.

The IT environment

Some virtual worlds have their server run by a company; others have server software available for downloadable and installable inside the IT infrastructure of the university. Depending on the university, there might be differing capabilities and processes (technical and organizational) in place for this kind of action. It might be easier to integrate the virtual world to other systems in use in the university if the server is hosted locally. Such systems can include learning environments (i.e., Moodle), blogs, wikis, and systems used in returning assignments.

The IT resources used can dictate the quality of using virtual world. Many virtual worlds have quite intensive system requirements for the computers and network used. The computers must be efficient enough to render graphics smoothly, and the network capacity good enough to allow many simultaneous connections to the virtual worlds. The computers must have the client software installed (if the virtual world cannot be used inside a web browser) and all the necessary firewall ports must be open. All of these things must be tested, and it is suggested to contact local it support with details at latest after the world to be used is chosen.

In addition to computers, other tools and gadgets can be used to improve the experience. For example, voice chat works bests with headsets equipped with microphones. If hybrid-environment is to be used, additional hardware is required: video projectors, video/web cameras, and possibly interactive white boards are needed.

Technical problems are currently a major issue related to virtual world usage. Using adequate computers and equipment are only one side to this problem. Another is the availability of IT support for the educators and students.

Practical details of the course

The learning goals of the course have effect on the planning, but now it is enough to consider the relevant practical issues. Group size can limit the reasonable activities inside the virtual world. If the course is a distance course, no face-to-face sessions can be held. The course details might also affect what background the students have. If there are people attending outside the university, they might not have the needed user accounts. These issues must be considered and resolved.

4.3 Description of the production process phases

4.3.1 The synopsis phase

The process starts with the synopsis phase. Here the existing concept of the course is evaluated in more detail. The definition, depth, and scope of the content are analyzed. The educational and functional goals are described. The schedule and resources are studied. The members of the production team are chosen. Approximation of the costs and the budged are formulated. In addition, the integration of this course and materials to other learning environment tools is shortly described.

The idea for the course and its implementation should be clear by now. In this phase, meetings are held and frames for the project created. One possibility is to arrange public meeting, where people outside the project team can bring their ideas for the course.

4.3.2 The planning phase

Whether to use virtual worlds or not?

First, the learning goals of the course should be listed. Then each of these goals should be evaluated thinking whether it could be achieved better using virtual worlds. Not all of the tasks related to the educational goal need to take place inside the virtual world. Moreover, not all goals need to be achieved using the same methodology inside the virtual world. Depending on the learning goal, face-to-face, purely virtual, or mixed activities can be chosen.

At the same time, the didactic approach used should be chosen, as it affects the way the learning goals are reached. The different didactic approaches were shortly presented in section 2.2. If ideas are needed how virtual worlds could be used in achieving certain goals, it is possible to ask for help from a community or even the students! In addition, the six lenses (section 2.11) or reported activities (section 2.10) are available as an inspiration tool.

Virtual worlds allow easy implementation of a synchronous solution. Based on literature this allows the students to better know and interact with classmates, consequently increasing engagement with the class-related material.

The advantages of virtual worlds are listed in section 2.8, and the possible problems in section 2.9. They should be considered and analyzed when thinking of the decision whether to use virtual worlds. This allows maximizing the relevant advantages. In addition, the risks of relevant problems should be identified, listed, and prioritized. Then, their impact can be minimized by trying to prevent them from realizing or by preparing for their consequences.

After all the learning goals have been analyzed, a decision should be made if it is useful to use 3D virtual worlds in teaching these goals. If they are to be used, the virtual world to be used needs to be chosen. In some universities, the choice might already been made by higher strategic level planners. If not, the faceted classification method applied to virtual worlds can be used to help the choice. This method was presented in section 2.7. The choice should support the course goals in one way or another, for example by fitting well with the learning goals, or allowing the use of established training and knowledge present in the university. There are ready-made lists of virtual worlds available online and in literature, for example by Robbins (2009b) and de Freitas (2008).

Content planning

In content planning, or content scriptwriting, the scope and the content of the course are described. In this phase, the material, exercises, diagrams, and tables are chosen or created. All the necessary material is acquired and the needed licenses for them obtained. The functionalities and interactions are described.

Production planning

The production scriptwriting starts when the content scriptwriting is nearly finished. The production scriptwriting means planning how the course will utilize virtual worlds and Internet technologies. In production scriptwriting, the web didactic expert and content expert work cooperatively. The view of the content scriptwriter forms the basis for the structure of the course, activities, and interactive solutions, and the media adaptation of the course material. It should also be considered whether the environment and educational goals suit best for subject-, problem-, or student-centered approach. Implementing multiple different media allows students to engage

in their full learning styles, and creates more opportunities for engagement and means for interaction. If effective dialogue needs to be present, the use of the in-world presence layers (Warburton, 2009) and possibly external services, such as wikis, blogs, or a virtual learning environment (VLE) should be considered.

Each course needs a structure (the different parts and the connections between them), a plan for interactive activities, necessary working spaces, and tools. All the planned solutions need to be logically coherent from many viewpoints: structure, content, students, instructor, and the producers.

The www-producer will build the Internet-based and virtual world parts of the course according to the production script created in this phase. When the first draft of the production script is ready, the web didactic expert starts to cooperate with the www-producer. A good production script defines the different parts of the course, their interconnections, the technical solutions used, and their working principles.

Design and visual design

Decisions need to be done about the content design. Where will the content be located? How realistic it needs to be? What needs to be created? What we construct self and what will be bought? What objects will be manipulated and need to have functions? These kind of questions need to be answered.

Nummenmaa (2007) studied how students' emotions affect the experience in online environments. The result was that students' emotions affect their level of activity and participation. So to increase the activity and participation levels, students' emotions should be considered when planning the use of virtual worlds in education. The results from Riva et al. (2007) support this result. They found that the feeling of presence was greater in more emotional virtual environments. This brings up the aspects of design and appearance.

In addition to the emotional aspects, the organization standards might have an impact on the visual design. It might have visual design guidelines that should be followed to some degree, at least if the learning venue is going to be public or used to communicate with the interest groups of the organization.

4.3.3 The implementation phase

In the implementation phase, the virtual world environment and other online resources are prepared to act as a learning environment. All the needed building, land acquisition, content upload, setting access restrictions, preparing locations, and other tasks necessary are done.

Depending on the activities planned for use inside the virtual world a variety of tools is needed. Not all virtual worlds provide basic tools needed for example that are present inside a traditional classroom by default. It might be necessary to buy some tools or to seek free resources. Luckily, good selections of educational tools are quite easily available for the most common virtual worlds. Such tools can include presentation tools, external media import tools, voting tools, visualization tools, and even ready-made classrooms.

As in all online education, license issues must be considered carefully. This is a two-step task. First, it must be checked that it is allowed to present all the material produced by others. Second, the license of the material produced must be considered. As some virtual worlds are public, it might be necessary to limit the access to some material by access restrictions or to share the material in some other media.

If the students produce videos, texts, or other material, the copyrights of that material should be checked and needed permissions asked from the students beforehand. The students should also be told what happens to the

material they have produced (videos, buildings etc.) after the course ends. It might be an unpleasant surprise for them, if all what they have build are deleted after the course ends without a possibility for them to copy them. The possibility to copy or archive the material depends for example on the virtual world used. As the issues in question are similar to those with more traditional online education, some existing materials can be used as a starting point (for example Suomen virtuaaliyliopisto, n.d.).

Not all type of course goals and activities require an owned place inside the virtual world. In some cases, it is adequate to use public places for conventions, tour educational locations as a group, or allow the students to explore the virtual world individually or as a group. Depending of the course objectives, it might be necessary to have own land for use during the course. If the students are making a business plan and then executing the idea, they might need an area to build for example. In some virtual worlds, a fee is needed to rent a land. Some universities might offer spaces for courses to use freely or by reservation.

Safety measures might be needed depending on the situation and the educational group. Such measures could mean for example limiting some areas inside virtual worlds for certain groups of users or using completely private areas or environments offered only inside the university campus.

Some general guidelines to building are to vision places where people want to spend time. It is not enough just to build copies of real campus areas; actually, they might be hard to navigate inside a virtual world. The places build should be social allowing and promoting interaction and cooperation. The buildings should be something that is used and wanted. It might be useful to open the course or university area for open building and innovation process, and after some months see, what is used and what is not. Then

based on this data, the area can be rebuilt to support activities needed and wanted.

The user account issues must be considered when building in virtual worlds. Depending on the virtual world, it can be hard to transfer ownerships and user access later if the person responsible changes. There should be shared accounts for building, so that access to those avatars is easily transferable to a new person if the old one leaves the position.

There are few options to find ready-made content. They can be found from shops inside the virtual world, ordered from a company that sells or builds them in ready packages or custom made, or then communities can be used and peer educators asked if they have free and ready solutions that could be adapted. If such communities or resource pools exist inside the university, even better. For example, some tools are available in Second Life from the EduFinland community (EduFinland, 2009).

Other media can be inserted inside the environment. Internet resources such as blogs, videos, RSS-feeds, or Twitter feeds can be presented inside the environment. This is one way to connect the virtual world area to the other tools and resources helpful for the course.

The environment and user accounts might also be needed to integrate to other tools used in the course. In some virtual worlds, this might be easy due to existing projects, for example, Second Life environment can be integrated with Moodle-learning environment using the SLOODLE-project (SLOODLE, 2009).

Functions and advanced building can require programming skills. Programming is needed in implementing interactive content and advanced functionalities. Difficulty of the programming depends on the tools offered by the virtual world used. It is possible to find ready scripts for basic

functionalities, and to customize them to work as needed. Programming work can also easily be bought from a contractor.

4.3.4 The preparation phase

Guides

Guides are an important resource for educators and students. They allow self-studying avatar creation, basic usage, and university specific customizations. Depending on the client software it might be needed to customize settings on each computer the user uses the software on separately. Guides help to standardize this process.

Many guides are available online. Some are general, some created specifically for educational use. Still, creating own guide should be considered as this allow the guide to be customized to the local environment, implemented training, student skill level, and the activities required by the course.

Training

Depending on the environmental issues, training might be necessary for course staff or students. It can be part of the course. Alternatively, if the university offers many courses that utilize virtual worlds, it might offer training as a separate course. The level and time involved depends on the environment, the users, and the activities planned. Basic usage needs less skill than for example building and scripting.

Users need to create account and avatar for the training, or at latest as a part of the training. Time should be given for the users to customize avatar to their liking. Holmberg and Huvila (2008) used the names of students' avatars to create trust and recognition as Dickey (2005a) has suggested. The students used their first name as the first name of their Second Life avatar, and they

could choose any last name offered by Linden Labs to their avatar. The instructor avatar should be easily identified for example by sharing features with the real life instructor, having easily identifiable features, or by using a carried signboard.

Depending on the virtual world, the user account creation might need some actions. For example, in Second Life it is not possible to create more than five user accounts from the same IP address in one day. It is necessary to notify the service provider Linden Labs with the IP address or range used, so that it is possible to create the user accounts for all the students at the same time from one classroom.

Usage guides can be used to support training or to enable self-training. If the environment is a popular one, guides can be found from the Internet. If it is not or the required training is very specific and detailed, it might be necessary to create customized material.

Sarah "Intellagirl" Robbins keeps 2-hour boot camp for local students at the beginning of each course that uses virtual worlds. Her students have a list of tasks they are supposed to do. For example, they have to find a nice place and take a picture of it. They have to make a new friend and take a picture with her. In addition to this boot camp, Sarah offers an optional building workshop during the course. For distance students the same methodology is used, but more time is required. (Robbins, 2009c)

Holmberg and Huvila (2008) arranged two orientation sessions for discussion and practice before the course in Second Life. This way all students were guaranteed some level of familiarity with the Second Life environment.

Testing

Testing should be intensive and complete. Many things can change rapidly inside a virtual world, such as the user interface of the client, the available

simulations, and the availability of educational places. If the virtual world chosen is subject to these kinds of changes, testing should be done as near the time of the course as possible, but still leaving time for implementing possible changes.

It can be difficult to test the real situation, as during the course there probably are greater amounts of concurrent users than it is possibly to have in testing. This can be problem for network connections or if some areas inside virtual world limit the amount of concurrent users.

Alternative plan

For each activity planned to take place inside the virtual world there should be an alternative plan that can be executed in case the original activity does not succeed. There are many reasons why this can happen. The students may have problems, the IT infrastructure of the university may fail, the virtual world can be unreachable, the technical problems or hardware performance may result in an unusable experience etc. Whatever the reason is there should be something that can replace the particular event, activity, or technological solution. For example if there are problems using the voice chat for a four-person meeting in-world, a fallback solution could be to use a Skype-conference in addition to the virtual world software.

4.3.5 The course execution and monitoring phase

Launch of the course

Launch of the course is an important milestone as it ends the preparation stage and starts the execution stage. The teaching starts and virtual world environment is opened. As the students are experimenting with the environment, they might need more support at this stage. Support and

careful planning helps to create a good first impression, important for the motivation of the students.

During the course, the task of the instructor is to execute the instructing according to the contract and the plan. Instructing can include tasks such as guiding learning conversations, giving lectures, directing role-plays, giving tours of educational places, evaluating returned assignments, and guiding students. The instructor decides who will pass the course.

Small changes and updates to the environment might be necessary during the course, keeping the information current. The www-producer is responsible of these changes. In addition, support is needed from the IT support.

On-going evaluation

Mayrath, Sanchez, Traphagan, Heikes, and Trivedi (2007) found a need for on-going evaluation. For example, a weekly review process of the progress, feelings, and problems of the students could be implemented. Only having reception hours might not be enough. Instead, a weekly query or short reporting email or blog post from the students could be an efficient way to implement an on-going evaluation. If the evaluation is done in small enough cycle, the needed changes can be implemented faster.

Helpful practical tricks

Communities and online resources can be used to find helpful tricks and best practices for arranging education in the specific virtual world chosen. The tips can be very specific, but still valuable. For example, in Second Life groups can be created for sending messages to the students, my notes –tab in profiles can be used to make notes about students as they are visible only to the one making the notes etc.

Jones et al. (2005) note that each time students logged in to a virtual world they were scattered around the world and there was some difficulty to get them all to the same virtual place at the same time. These kinds of problems can be avoided by finding and using these best practices.

4.3.6 The follow-up phase

Feedback and evaluation

After the course, there are still tasks to do. One of them is to evaluate the course. This can be done through feedback from the students and their performance. Did the students reach the educational goals? Was there enough support available? Were the instructions, guides used, and evaluation criteria presented clear?

It is also useful to evaluate not only the course content and success, but also the production process undertaken. How did the course production process perform? What was good, were the any problems? What practices proved to be good? What changes are necessary for the next time?

Material re-usage and archiving

Used and produced material should be analyzed for re-usability. Is some or all of the material usable in the next instance of this course or in some other course? Are changes necessary? Should the work of the students be archived for some way, for example if there are some questions later on about their evaluation?

Development based on feedback

Final step in this process is developing the course and the production process based on the feedback got from students and the persons involved in the production process. Changes can be made to content, structure, or syllabus. Virtual world areas the course used can be improved.

One important step is to collect and document experiences and best practices found during the course production. This can help others who are planning to use same kind of tools.

4.4 Summary of the production process

This chapter answered the research question 3 by creating a model for producing a university course that uses 3D virtual worlds. First, the environmental factors of the course were analyzed. Then the roles present in the process were described. The backgrounds and skill-levels of educators and students were considered, as well as the practical details of the course. Then the different phases of the model were presented. The presented model can be used as a starting point or a checklist, when planning to utilize 3D virtual worlds in a university course.

5 Discussion and conclusions

This chapter summarizes and evaluates the results from the research. The chapter begins with discussion of the answers to the three research questions. Then more attention is given to student view, strategic level view, and practical implications. The end of the chapter evaluates the study, and suggests further research topics.

5.1 Applying 3D virtual worlds to higher education

5.1.1 Found advantages and problems

Literature review showed a wide variety of advantages and problems related to the usage of virtual worlds in higher education. Identifying them can help to maximize the advantages and minimizing the problems. They are a helpful tool when choosing which learning goals should be pursued using a virtual world. When the advantages and problems are understood, it is easier to apply virtual worlds as a tool in a proper way and in a suitable situation. Literature reported advantages included conducting activities in a risk-free environment, enchanting collaboration and communication, increasing engagement, enabling an alternative space for instruction and tasks, and the visualization of difficult content. Respectively, reported problems included the difficulty to find appropriate value-added educational applications; the inability to read "natural" physical cues; technological issues; costs; behavioral, health and safety issues; the lack of standards; and user adoption problems.

5.1.2 Focus themes in the production process

Based on literature research and the analysis done on the mailing list of Second Life educator community, focus themes having impact on the production process of the course were found. These themes were based on experiences educators have had in applying 3D virtual worlds to education. Found themes included the importance of virtual community support, technical problems, and using ready-made resources. The results had effect on the production process presented and helped to give attention to important aspects. The effects are shown in Table 7 (p.65).

5.1.3 The course production process

Chapter 4 describes the course production process answering the research question 3 in detail. The process was based on the process of producing an online course. It is modified to maximize the advantages and minimizing and preparing for the problems of using 3D virtual worlds in teaching. In addition, focus themes in the process were searched from a virtual world educator community.

When examining the process it must be remembered that it should always be customized based on the university, learning goals, student background, and people involved in production. The process includes many roles and interest groups whose needs should be considered. The strategic level environment has impact in the production process. Section 5.1.5 discusses this in more detail.

The presented process model provides a base for planning and executing the production process. It makes sure that all necessary aspects are considered. It provides tools and ideas for educators. However, it does not limit the educators to build only one kind of courses, but it allows them to use creativity and leaves them freedom. It works as a supporting structure for the process.

When using this process model, other tools in addition to virtual worlds should be considered. Even when the course uses virtual worlds, this should not limit the view of the educator. Many other useful resources and tools for education use exist. The educator should consider the mix and role of each tool, so that the right tools are chosen for each course.

The process with all the different roles and phases can seem intense. It should be noted that the roles are present even when they are not consciously chosen. However, when they are assigned to specific people, the

responsibilities and tasks of each person are more clear and the process more explicit.

5.1.4 The student view

Students can have prejudiced attitudes towards virtual worlds. It might be hard to see the advantages of using one in education, and it is easy to think that it just means more work for the students when learning to use a new system. This can easily lead to low motivation levels before the course. Especially, if some research is to be conducted during the course, the students might feel like test subjects, that only suffer from the chosen technology. However, it is common that after the course the students report good experiences about the virtual world usage. Among networked students, good experiences about a useful and interesting course spread fast.

The reached learning results can depend on the individual learner. Students have different learning profiles and backgrounds. Depending on the individual, the dominant learning style varies. These factors affect the learning experience inside the virtual world.

5.1.5 Strategic level view

The production process of online courses states new requirements for the organization in question, such as requirements for IT infrastructure, education planning, teaching, flexibility, new customer service view, and organizational learning. These requirements create a broader strategic level view for the process from the viewpoint of the organization. The production process is also a change process in the strategy level. It can be a difficult one, possibly revealing weaknesses inside the organization and illogicalities in the functions of the organization. (Pesonen et al., 2000)

Organizations must make strategic choices about the goals and motives related to the development of virtual world teaching. It is resource intensive to produce virtual world and web based solutions to use as a teaching tool, and develop these production processes. It might look cheaper to implement some ready-made package solutions because of smaller development costs. Even then, resources are needed for teaching, student guidance, and support. Actually, if the learning environment is customized to allow self-studying and independent work, it might not exceed the cost of ready packages in the learn term because of saved guidance fees. (Pesonen et al., 2000)

Developing an online class is more time consuming than developing a face-to-face course. Because of this, the compensation offered from teaching a course using virtual worlds as a tool can be an important motivator for the teacher. Fort Hays State University offers three different monetary rewards for developing an online course. In addition, it rewards the online educators in tenure consideration. (Wang, Gould, & King, 2009) These kinds of motivators can be used to encourage educators to develop courses that use virtual worlds.

There also exists a level higher than the university level. For example, the University of Texas System has started a project to explore the use of virtual worlds for learning, and they are bringing their entire 16-campus system into Second Life (Lester, 2009).

5.1.6 Practical implications

Based on the findings there are advantages in virtual world usage in education. It is also clear that it is not the prime time of this technology yet, but the virtual world technology and culture are improving at a fast pace. Universities must prepare for the change by exploring the technology and acquiring knowledge. Knowledge can be gained from research reports and

communities. It could be useful to have someone in university to join such virtual world education community so that the university is up-to-date in the virtual world development. By sharing experiences and best practices, the knowledge about virtual world in education develops.

It is also becoming necessary to include the virtual world skills to syllabus. This brings everyone on the same line with the students who play virtual games. As the knowledge and basic skills improve, it is also easier to motivate the students to use virtual worlds in courses. Before that, they might fear extra work and technical problems.

Lester (2006) from Linden Lab has suggested the following strategies to utilize Second Life in education successfully. They can be adapted to using other virtual worlds as well.

1. Explore and learn about Second Life as much as possible.
2. Converse with other educators currently utilizing Second Life.
3. Develop concise, measurable goals.
4. Write a paper about your Second Life experiences and utilize other venues to share your knowledge.
5. Be open to the potential of Second Life and the variations in activities possible.
6. Think creatively about new uses for instruction and avoid applying old models of thinking.
7. Capitalize on feedback from students' experiences.

5.2 Evaluation of study, reliability, and validity

This study focuses on current moment, not future. The reported advantages, problems, and educational applications are based on previous research. As technology and the virtual world uses develop all the time at a fast pace, it means that the advantages, problems, and uses are viable to

change possibly in the very near future. Virtual worlds are in the same stage than the Internet was in the middle of 1990s. At that time, users would have difficult time imagining the uses of the Internet today. Thus, it is not adequate to refer to the advantages and problems reported in this study forever, but experimentation should continue.

Some of the sources used in the literature review are not research articles that would have undergone a comprehensive review process. Instead, lighter online journals were used. These publications are for example made more easily after reporting experiences after a course. In fact, for example Linden Labs encourages educators to report experiences about using Second Life in education (Lester, 2006). To justify the use of such lighter literature, it is necessary to think about the type of the research questions. Such publications were used to collect reported uses, best practices and new creative ideas how to apply virtual worlds into educational context. In this type of role, the data sources are valid for this research. Moreover, the literature analysis reached a good answer to the research question 1.

The empirical study was conducted on a mailing list focused on education in Second Life. However, Second Life is only one of the hundreds virtual worlds available. It is questionable how much the results gained can be generalized to apply to all virtual worlds. There were two reasons that support the choice to focus to this specific mailing list in this study: First, the mailing list forms a very active virtual world educational community, if not the most active. The amount of different people taking part in the conversations were adequate (in February 318 different people, in July 245 different people). Second, the empirical part was used to gain insight to reported experiences, look inside a virtual world community, and to find focus areas for the process developed. These two reasons make the mailing

list choice reasonable. Trends did rise from the analysis, so it seems the analysis method and level chosen were satisfactory for this research.

The production process model was constructed based on models of producing online courses from literature. Those models were modified based on literature, found advantages and problems of virtual worlds in education, and educational community message analysis. The existing models of online course production seem to be a good starting point, as they were developed to add a new technological dimension to education. The issues of organizational and cultural change in the early days of online education seem to be quite similar to the situation now, when considering the usage of virtual worlds in education. The model brings up many questions to be answered. However, it is necessary, that the answers to these questions are searched case-by-case. The model should not be considered as a detailed systematic plan for production but instead as a tool bringing front issues and lessons from experience to be considered in the production process.

5.3 Further research topics

The increased popularity of virtual worlds has presented many questions and opened up field for research. Based on this research only, many topics seem to require more research interest. One of the most important topics is planning the strategic level view. How universities should react to this new technology? On some levels, it might be possible to use same strategies that were used when technology enabled online courses as a starting point. Research company Gartner Research (2008) advices companies to limit invests to virtual worlds, and to do some experimentations in small-scale before starting more extensive ones. One reason to limit the investments is the amount of different possible future scenarios of virtual worlds. The links and content transfers possibilities between the different worlds, and the

training needs when changing the virtual world are unknown, it is dangerous to choose one direction if heavy investments are done.

Some virtual worlds allow the customization of the client software by altering the source code. One research topic would be to customize a client strictly for supporting educational uses.

A more psychological topic would be the investigation the effect of immersive 3D spaces to memory. Junglas, Johnson, Steel, Abraham, and Loughlin (2007) argue that social psychological theories that have been previously applied to understand learning styles in the real world need to be readdressed in the virtual world. When the students are immersed inside the environment, exploring, building, cooperating, and receiving information, this probably has effect to the memory and the learning efficiency.

References

ASU partners with Clemson to create virtual world technology. (2008). *Techniques: Connecting Education & Careers*, *83*(2), 60.

Barab, S. A., Hay, K. E., Squire, K., Barnett, M., Schmidt, R., Karrigan, K., …Johnson, C. (2000). Virtual solar system project: Learning through a technology-rich, inquiry-based, participatory learning environment. *Journal of Science Education and Technology*, *9*(1), 7–25.

Bartle, R. A. (1996). Hearts, Clubs, Diamonds, Spades: Players Who Suit MUDs. *Journal of MUD Research*, *1*(1). Retrieved from http://www.mud.co.uk/richard/hcds.htm

Bartle, R. A. (2003). *Designing Virtual Worlds*. Indianapolis: New Riders Publishing.

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

Bell, M. W. (2008). Toward a Definition of "Virtual Worlds". *Journal of Virtual Worlds Research*, *1*(1), 1-5.

Bisoux, T. (2008). Bringing virtual worlds to business school. *BizEd*, *7*(1), 28-35.

Bonabeau, E., Dorigo, M., & Theraulaz, G. (1999). *Swarm intelligence: from natural to artificial systems*. Oxford University Press, USA.

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 and 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*(3), 219-232.

Brown, J. S., & Duguid, P. (2000). *The social life of information*. Boston, MA: Harvard Business school press.

Bryson, S. (1996). Virtual reality in scientific visualization. *Commun. ACM*, *39*(5), 62-71.

Bugeja, M. J. (2007). Second Thoughts About Second Life. *Chronicle of Higher Education*, *54*(3), C2-C4.

Castronova, E. (2004). *Synthetic worlds*. Chicago: The University of Chicago Press.

Conway, C. (2007). Professor avatar. *Inside Higher Ed*. Retrieved August 14, 2009, from http://www.insidehighered.com/views/2007/10/16/conway/

Dede, C., Brown-L'Bahy, T., & Whitehouse, P. (2002). Designing and studying learning experiences that use multiple interactive media to bridge distance and time. In C. Vrasidas & G. Glass (Eds.), *Distance education and distributed learning* (Vol. 1, pp. 1-29). London: Eurospan. Retrieved from http://www.lesley.edu/faculty/tbrownlb/T502/index.htm

Delwiche, A. (2006). Massively multiplayer online games (MMOs) in the new media classroom. *Journal of Educational Technology and Society*, *9*(3), 160-172.

Dickey, M. D. (2005a). Brave New (Interactive) Worlds: A Review of the Design Affordances and Constraints of Two 3D Virtual Worlds as Interactive Learning Environments. *Interactive Learning Environments*, *13*(1-2), 121-137.

Dickey, M. D. (2005b). Three-Dimensional Virtual Worlds and Distance Learning: Two Case Studies of Active Worlds as a Medium for Distance Education. *British Journal of Educational Technology*, *36*(3), 439-451.

Duffy, T., & Cunningham, D. (1996). Constructivism: Implications for the design and delivery of instruction. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology*. New York: Simon & Schuster Macmillan.

EduFinland. (2009, October 13). EduFinland. Retrieved October 13, 2009, from http://edufinland.fi/

Engeström, Y. (1981). *Johdatusta didaktiikkaan [An introduction to didactics]*. Valtion koulutuskeskus. Julkaisusarja V n:o 13. Helsinki: Valtion painatuskeskus.

Erickson, J., & Siau, K. (2003). e-ducation. *Commun. ACM*, *46*(9), 134-140.

Ermi, L., & Mäyrä, F. (2005). Fundamental Components of the Gameplay Experience: Analysing Immersion. In *Changing views: Worlds in play* (p. 14). Vancouver: University of Vancouver. Retrieved from http://www.digra.org/dl/display_html?chid=06276.41516.pdf

Eschenbrenner, B., Nah, F., & Siau, K. (2008). 3-D virtual worlds in education: Applications, benefits, issues, and opportunities. *Journal of Database Management*, *19*(4), 91-110.

Finnish National Board of Education. (2005). *Finnish National Core Curriculum for Basic Education 2004*. Helsinki: National Board of Education.

Fleep. (n.d.). Personality Quiz: Are you ready to teach in Second Life? Retrieved October 21, 2009, from http://www.quibblo.com/quiz/7 --PShe/Are-you-ready-to-teach-in-Second-Life

Foster, A. (2007a). 'Immersive education' submerges students in online worlds made for learning. *Chronicle of Higher Education*, *54*(17), A22.

Foster, A. (2007b). Professor avatar. *Chronicle of Higher Education*, *54*(4), A24-A26.

de Freitas, S. (2008). *Serious virtual worlds: a scoping study*. Bristol: Joint Information Systems Committee. Retrieved from http://www.jisc.ac .uk/media/documents/publications/seriousvirtualworldsv1.pdf

Gartner Research. (2008, April 23). Gartner identifies six best practices companies should consider before they virtualize their servers.

Retrieved October 23, 2009, from http://www.gartner.com/it/page.jsp?id=654011

Gartner Research. (2007, April 24). Gartner says 80 percent of active Internet users will have a "second life" in the virtual world by the end of 2011. Retrieved September 21, 2009, from http://www.gartner.com/it/page.jsp?id=503861

Gibson, W. (1995). *Neuromancer*. London: Voyager.

Gilman, R., Tashner, J., Bronack, S., Riedl, R., & Cheney, A. (2007). A 3D world builds community across countries and continents. *TechLearning*. Retrieved from http://techlearning.com/story/showArticle.php?articleID=196604336

Goral, T. (2008). Sizing up Second Life. *University Business*, *11*(3), 60-64.

Gorsky, P., & Caspi, A. (2005). A critical analysis of transactional distance theory. *The Quarterly Review of Distance Education*, *6*(1), 1–11.

Graham, C. (2006). Blended learning systems: Definition, current trends, and future directions. In C. Bonk & C. Graham (Eds.), *Handbook of blended learning: Global perspectives, local designs.* San Francisco, CA: Pfeiffer.

Graham, C., Allen, S., & Ure, D. (2003). Blended learning environments: A review of the research literature. Unpublished Manuscript, Provo, UT.

Graves, L. (2008). A Second Life for higher ed. *US News & World Report*, *144*(2), 49–50.

Herring, S. C. (2007). A faceted classification scheme for computer-mediated discourse. *Language@ Internet*, *4*(1), 1-37.

Holmberg, B. (1995). *Theory and practice of distance education* (Second edition.). London: Routledge.

Holmberg, K., & Huvila, I. (2008). Learning together apart: Distance education in a virtual world. *First Monday, 13*(10). Retrieved from http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2178/2033

Holmberg, K., & Huvila, I. (2007). *Oppimisen kolmas ulottuvuus – Second Lifen mahdollisuudet virtuaaliopetuksessa [The third dimension of learning - The possibilities of Second Life in virtual education]*. Presented at the Pedagogisia verkkoja kokemassa, Turku. Retrieved from http://www.slideshare.net/kholmber/oppimisen-kolmas-ulottuvuus-second-lifen-mahdollisuudet-virtuaaliopetuksessa-130230

Hung, D. W., & Chen, D. T. (2008). Learning within the worlds of reifications, selves, and phenomena: expanding on the thinking of Vygotsky and Popper. *Learning Inquiry*, *2*(2), 73–94.

Jennings, N., & Collins, C. (2007). Virtual or virtually U: Educational institutions in Second Life. *International Journal of Social Sciences*, *2*(3), 180–186.

Johnson, D. W., & Johnson, R. T. (1994). *Learning together and alone.*

Cooperative, competitive, and individualistic learning. Boston: Allyn and Bacon.

Joly, K. (2007). A Second Life for higher education? Virtual worlds may wind up breathing new life into teaching, learning, and creative expression. *University Business*, (June). Retrieved from http://www.universitybusiness.com/viewarticlepf.aspx?articleid=797

Jones, J. G. (2008). Issues and concerns of directors of postsecondary distance learning programs regarding online methods and technologies. *American Journal of Distance Education*, *22*(1), 46 - 56.

Jones, J. G., Morales, C., & Knezek, G. A. (2005). 3-Dimensional online learning environments: examining attitudes toward information technology between students in Internet-based 3-dimensional and face-to-face classroom instruction. *Educational Media International*, *42*(3), 219-236.

Junglas, I. A., Johnson, N. A., Steel, D. J., Abraham, D. C., & Loughlin, P. M. (2007). Identity formation, learning styles and trust in virtual worlds. *ACM SIGMIS Database*, *38*(4), 96.

Juul, J. (2005). *Half-Real: Video Games between Real Rules and Fictional Worlds*. Cambridge, MA: MIT Press.

Kay, J., & FitzGerald, S. (2008). Educational uses of Second Life. Retrieved August 14, 2009, from

http://sleducation.wikispaces.com/educationaluses

Keegan, D. (1980). On defining distance education. *Distance Education*, *1*(1), 13-36.

van Kokswijk, J. (2003). *Architectuur van een cybercultuur.* (PhD dissertion). Universiteit Twente. Retrieved from http://www.kokswijk.nl/publications/files/Samenvatting.pdf

Lester, J. (2009, September 15). The First Statewide Rollout of a Virtual World Learning Environment: The University of Texas System in Second Life [Web log message]. Retrieved October 23, 2009, from https://blogs.secondlife.com/community/learninginworld/blog/2009/09/15/the-first-statewide-rollout-of-a-virtual-world-learning-environment-the-university-of-texas-system-in-second-life

Lester, J. (2006). Pathfinder Linden's guide to getting started in Second Life. In *Proceedings of the Second Life Education Workshop at the Second Life Community Convention, San Francisco* (pp. v.-vii.). United Kingdom: University of Paisle. Retrieved from http://www.simteach.com/SLCC06/slcc2006-proceedings.pdf

Lim, K. Y. T. (2009). Editor's Corner: The six learnings of Second Life: A Framework for designing curricular interventions in-world. *Journal of Virtual Worlds Research*, *2*(1), 3-11.

Lombardo, T. (2007). The Pursuit of Wisdom and the Future of Education.

Retrieved from http://www.mcli.dist.maricopa.edu/dd/wisdom05 /pursuit_of_wisdom.pdf

Manninen, J., Burman, A., Koivunen, A., Kuittinen, E., Luukannel, S., Passi, S., Särkkä, H. (2007). *Environments that support learning - an introduction to the learning environments approach*. Vammala: Vammalan Kirjapaino Oy.

Mantovani, F., Castelnuovo, G., Gaggioli, A., & Riva, G. (2003). Virtual Reality Training for Health-Care Professionals. *CyberPsychology & Behavior*, *6*(4), 389.

Mason, H. (2007). Experiential education in Second Life. In *Proceedings of the Second Life Education Workshop 2007* (pp. 14-18).

Mayrath, M., Sanchez, J., Traphagan, T., Heikes, J., & Trivedi, A. (2007). Using Second Life in an English course: Designing class activities to address learning objectives. In *MEDIA World Conference on Educational Multimedia, Hypermedia and Telecommunications, Vancouver, Canada*.

Meadows, M. (2008). *I, avatar: the culture and consequences of having a second life.* Berkley: New Riders.

Mennecke, B., Roche, E. M., Bray, D. A., Konsynski, B., Lester, J., Rowe, M., Townsend, A. M. (2008). Second Life and other virtual worlds: A roadmap for research. *Communications of the Association for Information Systems*, *22*, 371-388.

Mikropoulos, T. A. (2001). Brain activity on navigation in virtual environments. *Journal of Educational Computing Research*, *24*(1), 1-12.

Nummenmaa, M. (2007). Emotions in a web–based learning environment. *Annales Universitatis Turkuensis*, *B 304*. Retrieved from https://oa.doria.fi/handle/10024/27232

Ondrejka, C. (2008). Education unleashed: participatory culture, education, and innovation in Second Life. *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning*, 229-251.

Paquette-Frenette, D. (2006). Intergroup dynamics in site-based distance courses: Inclusion, alienation, and the hierarchy of presence. In M. Tullloch, S. Relf, & P. Uys (Eds.), *Breaking down barriers: The international experience in open, distance and flexible education* (pp. 161-169). Bathurst, NSW, Australia: Charles Sturt University.

Passig, D., Klein, P., & Noyman, T. (2001). Awareness of toddlers' initial cognitive experiences with virtual reality. *Journal of Computer Assisted Learning*, *17*(4), 332-344.

Pesonen, S., Pilli-Sihvola, M., & Tiihonen, J. (2000). Verkkokurssin tuotantoprosessi [The production process of a web course]. In J. Matikainen & J. Manninen (Eds.), *Aikuiskoulutus verkossa [Adult education in Web]*. Tampere: Tammer-Paino.

Peterson, M. (2006). Learner interaction management in an avatar and chat-

based virtual world. *Computer Assisted Language Learning*, *19*(1), 79-103.

Ranganathan, S. R. (1933). *Colon classification.* (1st ed.). Madras: Madras Library Association.

Reusser, K. (1995). From cognitive modeling to the design of pedagogical tools. In S. Vosniadou, E. De Corte, R. Glaser, & Mandl (Eds.), *International perspectives on the design of technology-supported learning environments*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Richter, J., Anderson-Inman, L., & Frisbee, M. (2007). Critical engagement of teachers in Second Life: Progress in the SaLamander project. In *Proceedings of the Second Life Education Workshop 2007* (pp. 14-18). Retrieved from http://www.simteach.com/slccedu07proceedings.pdf

Riedl, R., Bronack, S., & Tashner, J. (2005). Innovation in learning: Assumptions about Teaching in a 3-D Virtual World. Presented at the International College Teaching Methods and Styles Conference, Reno. Retrieved from http://bronack.net/pubs/bronackRiedlTashner-CTMS05.pdf

Riva, G., Mantovani, F., Capideville, C. S., Preziosa, A., Morganti, F., Villani, D., … Alcañiz, M. (2007). Affective interactions using virtual reality: The link between presence and emotions. *CyberPsychology & Behavior*, *10*(1), 45-56.

Robbins, S. (2009a, upcoming). *Incommensurate wor(l)ds: A faceted classification of virtual worlds communication mechanics* (PhD Dissertation). Ball State University.

Robbins, S. (2009b, February 1). *Virtual Worlds Facet Study*. Retrieved November 18, 2009, from http://spreadsheets.google.com/pub?key =pgKqGR6eOiPOKjMG9f856Sw

Robbins, S. (2009c, August 6). *Workshop*. Presented at the Oppiminen eri maailmoissa, Savonlinna.

Schultze, U., & Rennecker, J. (Eds.). (2007). Reframing online games: Synthetic worlds as media for organizational communication. In *Virtuality and Virtualization*, IFIP International Federation for Information Processing (Vol. 236, pp. 335-351). Boston: Springer.

Schultze, U., Hiltz, S. R., Nardi, B., Rennecker, J., & Stucky, S. (2008). Using synthetic worlds for work and learning. *Communications of the Association for Information Systems*, *22*. Retrieved from http://aisel.aisnet.org/cais/vol22/iss1/19

Siau, K., & Shen, Z. (2003). Building customer trust in mobile commerce. *Communications of the ACM*, *46*(4), 91-94.

Siau, K., Sheng, H., Nah, F. F., & Davis, S. (2004). A qualitative investigation on consumer trust in mobile commerce. *International Journal of Electronic Business*, *2*(3), 283-300.

Siau, K., Sheng, H., & Nah, F. F. (2006). Use of a classroom response system to enhance classroom interactivity. *IEEE Transactions on Education*, *49*(3), 398–403.

Siau, K. (2003). Evaluating the usability of a group support system using co-discovery. *Journal of Computer Information Systems*, *44*(2), 17-28.

SLOODLE (2009, October 13) *SLOODLE - Simulation Linked Object Oriented Dynamic Learning Environment*. Retrieved from http://www.sloodle.org /moodle/

Stephenson, N. (1993). *Snow crash*. London: Penguin Books.

Suomen virtuaaliyliopisto. (n.d.). Tekijänoikeus verkko-opetuksessa. Retrieved October 23, 2009, from http://www.virtuaaliyliopisto.fi/vy _tietovarantoja_fin/vy_tietovarantoja_tepa_fin.html

Svärd, P. (2009, April 22). *Second Lifen peruskäyttö ja opetusvälineitä [Basic usage and teaching tools for Second Life]*. Presented at the Interactive Technology in Education, Conference Workshop, Hämeenlinna.

Tashner, J., Riedl, R., & Bronack, S. (2005). Virtual worlds: Further development of Web–based teaching. In *Book of Proceedings — Hawaii International Conference on Education* (pp. 4579–4588). Honolulu.

Tella, S. (1996). Tiedosta tie tulevaan [Know the road to the future]. *Ote - opetus & teknologia [Teaching and Technology]*, *4*(1), 38-43.

The Educators Archives, SL Educators (The SLED List). (2009). Retrieved

September 8, 2009, from https://lists.secondlife.com/pipermail /educators/

Wang, H., Gould, L. V., & King, D. (2009). Positioning Faculty Support as a Strategy in Assuring Quality Online Education. *Innovate*, *5*(6). Retrieved from http://www.innovateonline.info/index.php?view =article&id=626&action=article

Warburton, S. (2008a). Loving your avatar: identity, immersion and empathy [Web log message]. Retrieved August 17, 2009, from http://warburton .typepad.com/liquidlearning/2008/01/loving-your-ava.html

Warburton, S. (2008b). Six barriers to innovation in learning and teaching in MUVEs [Web log message]. Retrieved August 17, 2009, from http://warburton.typepad.com/liquidlearning/2008/07/six-barriers-to.html

Warburton, S., & Perez-Garcia, M. (2009). 3D design and collaboration in massively multi-user virtual environments. In *Cases on collaboration in virtual learning environments: processes and interactions*. Hershey, PA: IGI Global.

Warburton, S. (2009). Second Life in higher education: Assessing the potential for and the barriers to deploying virtual worlds in learning and teaching. *British Journal of Educational Technology*, *40*(3), 414-426.

Wilson, B. (Ed.). (1996). *Constructivist Learning Environments:*

Case Studies in Instructional Design. Englewood Cliffs, NJ: Educational Technology Pub.

von Wright, J. (1993a). Oppimisen tutkimuksen opetukselle asettamia haasteita [The challanges that the research of learning creates for teaching]. *Kasvatus*, *27*(1), 9-21.

von Wright, J. (1993b). *Oppimiskäsitysten historiaa ja pedagogisia seurauksia [History of learning concepts and pedagogical consequences]*. Opetushallitus [Finnish National Board of Education]. Helsinki: Painatuskeskus Oy.

Yellowlees, P. M., & Cook, J. N. (2006). Education about hallucinations using an internet virtual reality system: a qualitative survey. *Academic Psychiatry*, *30*(6), 534.

Appendices

Appendix A Detailed results of the email analysis

Table 10: The percentages of messages of belonging to each category in February and July 2009. First two columns show the percentages and the last two the rank of each category in respective month.

Category	Feb	Jul	Feb rank	Jul rank
Processes/best practices	16 %	13 %	1	1
Technical	8 %	13 %	5	2
Resource	11 %	9 %	3	5
Event	8 %	9 %	6	3
Community	12 %	4 %	2	11
Research	10 %	5 %	4	9
Psychology/education	4 %	9 %	10	4
Tool	7 %	7 %	7	7
Conference	6 %	4 %	8	10
Avatar	2 %	9 %	13	6
News	3 %	6 %	11	8
Art	2 %	3 %	12	12
SL World/grid	5 %	0 %	9	18
Building	1 %	2 %	15	14
Scripting	1 %	2 %	16	13
Course advertisement	1 %	1 %	17	16
Jobs	0 %	1 %	18	15
School administrative/strategy	1 %	0 %	14	19

level				
Cross media	0 %	0 %	19	17

Table 11: The percentages of messages of each type in February and July 2009. First two columns show the percentages and the last two the rank of each type in respective month. Rank for type "other" are not available, as that type was dropped from the results.

Type	**Feb**	**Jul**	**Feb rank**	**Jul rank**
Comment	58 %	57 %	1	1
Other	17 %	11 %	NA	NA
Link	14 %	22 %	2	2
Question	11 %	9 %	3	3

Table 12: Categories of questions in February and July 2009.

Category	**Feb**	**Jul**	**Feb rank**	**Jul rank**	**Sum of ranks**
Research	23 %	19 %	1	2	3
Technical	15 %	21 %	3	1	4
Resource	13 %	12 %	4	4	8
Processes/best practices	8 %	15 %	7	3	10
Tool	12 %	11 %	5	5	10
Community	17 %	4 %	2	9	11
Event	8 %	7 %	6	6	12

Scripting	4 %	5 %	9	8	17
Building	3 %	3 %	10	10	20
Conference	3 %	3 %	11	11	22
SL World/grid	5 %	0 %	8	15	23
Avatar	0 %	7 %	17	7	24
Psychology/education	2 %	1 %	12	13	25
Art	1 %	3 %	14	12	26
Jobs	1 %	1 %	15	14	29
School administrative /strategy level	1 %	0 %	13	16	29
Cross media	0 %	0 %	16	17	33
Course advertisement	0 %	0 %	18	18	36
News	0 %	0 %	19	19	38

Appendix B Roles present in the different phases of the production process

Table 13: Participation of roles in the different phases of the production process.

Role	Synopsis	Planning	Internet-implementation	Preparation	Course execution and monitoring	Follow-up
Project coordinator	X	X	X	X	X	X
Content expert	X	X			X	
Instructor	X	X		X	X	X
Web didactic expert		X	X			
Www-producer			X	X		

IT support				X	X	
Graphical designer			X			
Developer			X			
Course secretary				X	X	X
Marketing responsible				X		