Communication in an online learning environment

-A social perspective on developing learner to learner communication

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Abstract

The current learning management systems do not enable the students to communicate both course related and social information in a satisfactory manner. This might put the students at risk of feeling isolated, but there is also a risk it might decrease the students results.

This research aims to examine why students are unsatisfied with the communication in LMSs and to provide knowledge and a suggestion of a system design that enables the students to interact satisfactory.

The participants in the study were found to be unsatisfied with the separation of synchronous and asynchronous communication functions. Both functions has benefits, but they should be incorporated in one function. Neither did the LMS notify the students about other students participation in discussion, nor tasks performed in the system.

Moreover, this research follows a design science process that combines the soft systems methodology and the unified process to develop new knowledge and artefacts that are used as suggestion for action to improve the situation.

A system design is proposed that combines asynchronous and synchronous communication while also include a mechanism for notify the students of each others activities in the system.

Keywords: Online learning, LMS, CMC, asynchronous, synchronous, Learning management systems, Comet, AJAX, design
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1 Introduction

This chapter provides an introduction to the topic, previous research and the research question as well as the scope and limitation of the research. The chapter also provides a disposition overview.

In the academic world, collaboration is of essence. In order to learn, students often discuss with other students and take an active part of both gathering and analysing data. Collaboration has been proved to stimulate students and improve results (Giannoukos et al., 2008) and has been an essential part of education in many years (Franceschi and Lee, 2008).

When studying at a campus, a student has the ability to engage in face to face communication with classmates and teachers. The ability to communicate, interact and acquire a feeling of social presence among classmates is an important factor for the students to achieve success in their studies (Li et al., 2008, Franceschi and Lee, 2008). Since students that engage in face to face communication are able to see and hear other peoples actions, such as what they are looking at or what they are doing, they acquire a social awareness of the communicating group. Furthermore, the presence of other people in the social setting is evident. For online students, the situation is quite different and the social awareness has to be facilitated by technical means (Buder and Bodemer, 2008). Hrastinski (2007) points out that as an online student, one typically uses an LMS to “meet” with the classmates and teachers. A LMS is designed to be a virtual classroom environment (Franceschi and Lee, 2008) where students and teachers can communicate with each others. The current systems are, however, not enough to enable the distance students to collaborate in a way that help them in their learning process (Franceschi and Lee, 2008). In a LMS, such as Blackboard, there are both asynchronous and synchronous functions for communication and collaboration. Communication can be achieved via discussion boards, chats and private massaging (Li et al., 2008). These functions are not efficient enough to enable the students to feel part of a community (Franceschi and Lee, 2008).

The Swedish National Agency for Higher Education (Högskoleverket) states that in the academic year of 2007/2008 over 100 000 of the total 385 000 students were enrolled in distance education courses or programs on Swedish universities. Of these 100 000 students, 40% also attended courses at campus while 60% were only registered to distance courses (Högskoleverket, 2009). This puts at least 60 000 of the students in Swedish universities at risk of feeling isolated and thereby also less
motivated in their studies.

This dissertation will examine the way students use a Learning Management System (LMS) to collaborate with both synchronous and asynchronous communication tools in their learning and also suggest a design solution to provide the students with an enhanced way of communicating online.

Synchronous communication is intended to be processed immediately by the receiver(s) and when needed, a response is given promptly. Asynchronous is on the other hand more disconnected as the sender communicates information and the information is processed at the receiver(s) terms (Hrastinski 2007). Hrastinski (2007) also states that the difference of synchronous and asynchronous communication is only a matter of degree since a tool such as a email, which is commonly seen on as a asynchronous medium, can be used in a synchronous way if the parts of the conversation stays logged in to their mail accounts to receive the other parts email shortly after it was sent.

Asynchronous communication is an important feature in LMSs as it enables the students to set their own study schedule and also enables the students to participate in discussions and take part of the course content at any time from anywhere on the planet (Li et al. 2008). In online learning, the asynchronous discussions is the main form for collaborative learning among the students (Dennen and Paulus 2005). The asynchronous communication tends, however, to prevent the feeling of belonging to a community and to perceive social presence among the students (Shih and Swan 2005). The support for social presence in the medium affects the use of the medium, the users are aware of the degree of social presence of the medium and they tend not to use the medium for interacting on a higher degree of social presence than that of the medium it self (Williams and Cristie, 1976, cited in Shih and Swan 2005). The social participation and the ability to perceive social presence is influenced not only by the students themselves or in groups but also the technologies used and the interface of the learning environment.

Hrastinski (2008) states that online students uses synchronous communication for less complex issues such as planning of work and social activities, while asynchronous communication is used for more complex issues when the students need more time to reflect on the information. If the different ways of communicating are used for different types of communication, the question rises if the shift from one communication activity to another may effect the communication flow. As mentioned, Hrastinski (2008) states that students often use communication tools designed for
asynchronous communication to perform synchronous communication, a statement which can be seen as supported by Li et al. (2008) whom discuss the importance of synchronous communication in online learning and state that instead of implementing the forms of communication separately, such as chat (synchronous) and discussion board (asynchronous), they should be integrated to maximize the benefits of the LMS. The combination of the communication forms can then provide a socially aware collaborative e-learning environment.

Besides the differences in synchronous and asynchronous communication, the structure of the communication is also an important factor in student satisfaction. A study by Vonderwell and Zachariah (2005) showed the importance of a learning environment enabling the students to discuss in a multi threaded way rather than in one long thread. The multi threaded discussions are more structured and the topics are easier to keep track off. Depending on the degree of participation among the students the discussions may lead to information overload or lost focus on the topic as less active students may not read older post and thereby post information that has already been posted (Vonderwell and Zachariah 2005).

Despite the growing use of LMS in Sweden, and possibly in other countries, the systems used do not provide the students with functions that are efficient enough (Franceschi and Lee 2008) to create a feeling of social presence. High bandwidth solutions, like video meetings, have been suggested (Ciocco et al 2005). Video may be very good in creating a face to face simulation, but does instead miss on the importance (Li et al. 2008) of being asynchronous and offers less flexibility and a higher cost (Ciocco et al. 2005). What remains to be discovered, however, is how the students perceive the process of social interactions in the communication and what needs to be changed in the information systems that are used to communicate.

The purpose of this research is to design a information system that enables students to perceive social presence of each other while they interact and learn. This is done by applying a design science approach. Moreover, by using a soft systems approach to examine the human activity systems in online learning with a LMS (in this case Blackboard) at Linnaeus university, the focus is on the participant’s experience of the use of the LMS in learner to learner interaction. By assessing the situation with a soft systems approach, requirements for a hard systems development are engineered and aims lead to the development of a new system for communication in learning environments. Even though a LMS contains many functions, such as the functions used for handing in assignments and teacher guidance, this research will focus on the learner to learner
communication from a social perspective.

The output of this research aims to provide the LMS developer community with a suggestion on how it can improve the architectural designs of the communication in LMS in order to better suit the learners needs.

1.1 Research question

Based on the problems found in learner to learner communication via LMS, and the importance for the distance students to be able to interact with each other in the learning process, two questions have been formulated:

- (Q1) How do students perceive the social interaction in their use of a LMS?
- (Q2) How can a computer communication system be designed to provide the students with social awareness in the communication?

The first question aims to investigate how social interaction is supported in a LMS. If it, as Franceschi and Lee (2008) state, do not support social interaction enough, this question seeks to understand what the communication model is missing.

The second question uses the results from the first question in order to design a system that provides the students with the ability to socially interact in a way that current systems do not.

1.2 Scope and limitations

There are many platforms for online learning and they have a many valuable functions that are vital for the conduction of distance education. This research does, however, only focus on the learner to learner communication within the learning platform.

The scope is limited to only study students at Linnaeus university and their use of Blackboard LMS. It is possible that the result will be applicable at other universities and other LMS’s, but this will not be investigated in this paper.

Internet technology evolve constantly and new possibilities are developed at a rapid pace, this research does not consider future or new developments in hardware or internet connectivity. However, the focus lies in designing a system that is supported by the currently used hardware such as server machines, internet connections as well as client computers.
1.3 Disposition

This dissertation is divided in following sections:

1. Introduction – An introduction to the research and the topic.

2. Research Methodology – In this section the epistemological view and the methodological standpoint through out the research are discussed and explained.

3. Theoretical foundation – This section describes the theoretical foundation of the researched problem. Previous research as well as neighbouring areas are presented.

4. Development process – Provides a overview of how the methodologies are used and realized in the development process.

5. Empirical process – The empirical process and findings of a study among students at Linnaeus university are presented.

6. Analysis and development of artefacts – Analysis of the empirical findings. The analysis is also used as a basis for a development of a new communication model. The results and the relation to the literature and the area of which the research contributes is discussed.

7. Conclusions – The result is discussed in relation to the research problem and conclusions are drawn about the result.

8. References – A list references used in the dissertation.

2 Research methodology

The chapter presents the methodological aspects that guides the research as well as the research methods and the design science process that this research is based upon. Furthermore, the practical structure and data collection is presented.

2.1 Type of research

This paper is a traditional dissertation at masters level as defined by Hart (2005). The result will be applicable as knowledge for both the researcher and information system developers in the online learning area.
The research can be divided in two parts and each part corresponds to one research question. The first part is to gather knowledge on how students use a LMS. The second part is to use the knowledge from the first part to understand how to design a communication model that considers the social perspectives of the users.

2.2 Research method

The research method is the strategy of inquiry that influences the researcher in research design and how to collect data. The method is dependent on the researchers underlying philosophical assumptions (Myers and Avison 2002, Cresswell 2009).

Cresswell (2009) states that there are three different types of research strategies of inquiry; qualitative where rich data is interpreted by the researcher in order to gain understanding of the researched phenomena, quantitative research that is a mean of testing and analysing measurable data and mixed methods research where both qualitative and quantitative methods are used (Cresswell 2009). Based on the research problem, this research analyses qualitative data to guide the design and has a qualitative approach to the strategy of inquiry. The research method used can thereby be classified as qualitative as described by Cresswell (2009).

2.3 Research strategy

The term “research strategy” is defined in different ways by different authors. Blaxter (2006) states that the research strategy is the approach to the entire research but the actual strategy is, however, often defined by the strategy of inquiry. Cresswell (2009) defines the strategy of inquiry in the research as the research strategy seeing that it may been seen as the foundation of a research. Furthermore, Hamilton and Ives (1982) and Dunne (2005) describe research strategy in a similar way.

Besides being qualitative, quantitative or mixed, the research is also influenced by the researchers underlying philosophical assumptions. This underlying epistemology or worldview greatly influence the way the research is conducted as well as the outcome of the research (Järvinen 2004). Cresswell (2009) describes how the researchers worldview affects how he/she sees upon the subject of the research and how the research is to be conducted.

The positivist worldview is common in traditional quantitative research and is also called
positivist/postpositivist (Cresswell 2009). This worldview builds on positivistic assumptions where the researcher sees the reality as something measurable and objectively describable (Myers and Avison 2002) and, as the word *post* implies, includes reflecting after positivism (Cresswell 2009).

Other researchers are more interpretive in how they perceive reality. The *Social constructivist* worldview is described by Cresswell (2009) as a worldview where the researcher relies on the participant’s views on the studied situation and tries to interpret the participant’s meanings of the world. The social constructivist worldview is typically used by qualitative research approaches such as case studies and phenomenology (Cresswell 2009).

In the 1980s and 1990s a new type of worldview arose from researchers who felt that neither postpositivist and constructivist fitted for research aimed to help marginalized people. The *advocacy and participatory* worldview became a choice for researchers who studied marginalized individuals and groups with a political agenda such as feminism and queer theory. The worldview focus on bring about change to help these marginalised peoples (Cresswell 2009).

In design science the researcher knows that a piece of information is factual and what that information means for the process of artefact construction (Vaishnavi and Kuechler 2008). This is a pragmatic view that Cresswell (2009) describes has a concern of actions, situations and consequences with a focus on problems and solutions. The pragmatic researcher uses all approaches available on the researched problem. This research has an design science approach and focuses on the design of artefacts. This is done with a pragmatic worldview, a worldview which according to Vaishnavi and Kuechler (2008) also is the underlying epistemology shared by most researchers conducting design science research.

**2.4 Soft Systems Methodology**

The idea of Soft Systems Methodology (SSM) is to take action in situations that are considered problematic. SSM is often used in action research; to examine a problematic situation and to find feasible and desired changes to the situation. The changes are implemented to improve the situation (Checkland 1993). Since this research aims to design new artefacts to improve a situation rather than to take action as in action research, parts of SSM will be used to analyse the current situation from the users perspective.

SSM can be used to create a soft system “back end” before the proceeding of the system.
engineering process, which is a way of fitting SSM in the information systems development process (Avison and Fitzgerald 2006, Avison et al 1999, Baskerville and Wood-Harper 1998). Since this research includes human activities in online learning by examining the social systems of communication in learner to learner interaction, SSM is a suited methodology to be used in this research in order to examine the human activities in Blackboard.

The result of the analysis will generate valuable knowledge in how the students perceive the social interactions while using a LMS. This knowledge will then serve as the soft “back end” for designing new artefacts with regard to the users activities and worldviews.

SSM is used to monitor the social reality where online students communicate. The research follows parts the first version of SSM which is based on a seven stages iterative process (Figure 1) to gain knowledge about the problematic situation and to find feasible changes that will improve the situation.

![Figure 1, The seven stages of SSM. Adopted from Checkland (1985).](image-url)
As illustrated in figure 1, the first stage is to examine the real world problem situation unstructured followed by the second stage were the problem is expressed. SSM does not provide systematic steps that form a method that result in a solution, but provides a pedagogical tool for assessing the situation and to define the situation. The use of a rich picture (RP) that in a carton style express the situation can be useful in understanding of the situation (Flood 1999). According to Bell (2003) the RP is an illustration of the perceived environment in where the situation occurs. The RP makes it easier to ensure that the participants of the study share the same view on the situation (Checkland 1993). To express the problem, tasks, as well as perceived issues within the tasks will be identified and expressed.

The third stage is to create root definitions, which is to build what Checkland and Poulter (2010) calls “activity systems” which is the activity performed by humans and viewed through a described worldview. The root definitions are descriptions of the activity system (Checkland and Poulter 2010).

According Venable (2006), parts of SSM can be selected and used in the systems developments process and since stage 1 and 2 is used to understand and express the problematic situation, the focus of stage 3 will be to create root definitions of a system that does not inhabit the problems found in the previous stages. This use differs from SSM since the focus changes from examine the real world problem to examine the possibilities of a solution. In this research, the understanding of the real world problem as expressed in stage 2 will be sufficient to gain knowledge in how the students perceive the social interaction in their use of an LMS. The following stages will therefore focus on the suggestion of a solution rather than the problem.

To include the soft system aspect of designing the new system, the focus of the study will still be on the human activities performed by the students, hence the SSM steps are followed even though they are altered to focus on the new system rather than the real world. By using this altered version of SSM, the new system will be designed in close cooperation with its users to ensure that the problematic situation of learning and collaborating in an online environment is captured and analysed from the users perspective.

Models are created in stage 4 of the SSM process and are used as a base for rational discussions about how to improve the problematic situation. The models are created from the root definitions, thus, the models in this research will be of a new system in contrary to SSM where the models are
based on the real world. By comparing the models with the reality (stage 5), it is possible to influence discussions on how to improve the situation.

There are different ways of conducting the comparison. One way is to have informal discussion with the participants where the models are analysed in relation to the reality. Another way, the most commonly used, is to use a matrix and formal questioning to stimulate a discussion of what is appropriate in each activity defined in the models. A third method is conducted by describing scenarios of how an activity is done in the real world and comparing it with a scenario of how it would be done according to a conceptual model (Checkland 1993; Checkland and Sholes 1990). Due to the third method's similarities to use cases (Bustard and Wilkie 2000), this method is used in this research. The changes that arise from the comparison are discussed with the participants of the study in stage 6 to ensure that the changes are desired and feasible (Checkland 1993).

The seventh stage is to take action to improve the situation, which is a stage that is left out of this research since it would require the new system to be implemented. Due to time limitations, this research will only result in a suggestion of a design and no implementation of the design.

Even though this research follows this modified version of SSM, the methodology will be referred to as SSM in this paper.

### 2.5 Unified Process

The Unified Process (UP) is a software engineering process or software development process. The process defines who, what, when and how to develop software (Arlow and Neustadt 2005). UP was first developed by Ivar Jacobsen and the other authors (Rumbaugh, Booch, Kruchten and Royce) of the Unified Modelling Language (UML) (Avison and Fitzgerald 2006, Arlow and Neustadt 2005).

The core of UP lies in the use of use cases which are descriptions of how the system is used. UP is generic and does not itself define the actual software development process - it rather defines a set of steps that define the different actions that needs to be taken throughout the process (Avison and Fitzgerald 2006).

UP build on phases that are iterated throughout the process. Each iteration has five core workflows:

(Arlow and Neustadt 2005)

- Requirements - Capturing what the system should do
• Analysis – Refining and structuring the requirements
• Design – Realising the requirements in system architecture
• Implementation – Building the software
• Test – Verifying that the implementation works as desired

Figure 2, UP process structure (Arlow and Neustadt 2005)

Figure 2 describes the four phases that UP is divided in and emphasises the amount of work put on each workflow in each phase. One or more of the core workflows serve as main focus of each phase and each phase may have different amounts of iterations (Arlow and Neustadt 2005). There is not always a need to realize all phases (Avison and Fitzgerald 2006) and the result of this study will not be implemented in a real environment, hence the final phase (transition) will not be conducted in this research.

The phases and workflows of UP generate models and diagrams that are represented with the Unified Modelling Language (UML) (Arlow and Neustadt 2005).

2.5.1 Unified Modelling Language

The majority of models and diagrams of UP are modelled from an object oriented point of view. Object orientation is a method of analysis and design of systems that are organized as a collection of co-operative objects (Avison and Fitzgerald 2006). Each object is an instance of a class that
defines an abstraction of an entity (Arlow and Neustadt 2005).

The objects and their relation to each other in UP is modelled with UML. UML is, however, a modelling method and not a methodology for object oriented systems development. UML does not enable the developer with a process of how the development is to be conducted. Instead, UML is used in combination with UP, and was developed to enable the developer to use the method in a structured methodology (Avison and Fitzgerald 2006).

2.6 Literature study

The literature study is grounded in the search of relevant articles and books. There are two main sources of literature that are used throughout the work with this dissertation: the university library and article databases. Search words such as eLearning, CSCW, SSM, social, asynchronous, synchronous, presence and combinations of the words in phrases such as social presence in asynchronous eLearning were used to find relevant literature. The articles and books reference lists where also used to find literature on similar topics.

2.7 Design science research process

The research uses design science as a process framework to address the research question stated. Design science tries to solve problems by creating innovations and new ideas based on existing theories that are tested and modified (Hevner et al. 2004). Vaishnavi and Kuechler (2008) also state that design science tries to solve problems and means that it sometimes is called “improvement research” due to it's problem solving and performance improving nature.

The research process that is chosen for the research is design science as defined by Vaishnavi and Kuechler (2008) and is divided in five different steps where every step might have some output to the research and/or return in more knowledge to the researcher (figure 3). As described by Bukova (2009), the “Awareness of problem” is the step that leads to the actual research proposal. The next step is to create a suggestion of a tentative design for the development. The artefact created in the development step is then evaluated in how it meet the requirements. The final step is to draw conclusion of the work. The conclusion outputs the result of the research (Vaishnavi and Kuechler 2008).
March and Smith (1995) suggest four types of artefacts to be developed in design science: *constructs*, *models*, *methods* and *instantiations*. Each of these artefacts can in design science be built and evaluated.

The constructs are the concept that forms the domain. Constructs are, according to March and Smith (1995), important for both designers and researchers to provide them with a way of thinking of the software. The constructs may be represented as entities, attributes, relationships, constrains and identifiers (March and Smith 1995). The SSM study results in a conceptual view of the current situation and will be the base when developing the constructs through the unified process.

The constructs are described with modelling techniques such as the UML (Rosener and Avrilionis 2006) to represent a semantic net or a diagram of the system (Arlow and Neustadt 2005). The diagram forms a model artefact that illustrates the constructs and their relations. March and Smith (1995) state that a model can be viewed on as a description that shows how things are. The models will be created in different abstractions and levels to illustrate both physical and logical models of the system and will be a part of the UP workflows analysis and design (Arlow and Neustadt 2005).
The tasks that are intended to be performed by the system is described as methods which March and Smith (1995) describe as a set of steps, such as an algorithm or guideline. The methods are designed and used to retrieve, add and manipulate data. The methods can be the construction of a user's needs such as problems or implementation factors (March and Smith 1995).

As March and Smith (1995) describes, the instantiation of an artefact is the realization of the artefact in its environment. The instantiation will in this research be a prototype of the system in a test environment to enable the design to be evaluated. According to March and Smith (1995), a prototype of the designed system can be used to evaluate the system by testing its feasibility to address the problem. Since prototyping is a part of UP (Arlow and Neustadt 2005), the designed artefacts will be evaluated by testing the feasibility of the different prototypes developed throughout the development process.

Based on the result of the evaluation, a conclusion will be drawn and an outcome will be presented. The outcome includes not only the conclusion but also the artefacts designed. As showed in figure 3, the result is not the only thing gained from the research as there is also new knowledge as a result of the research. Moreover, the new knowledge gained throughout the research is also used in each iterated cycle of the process where each iteration result in new knowledge and artefacts that are used in the overall research process (Vaishnavi and Kuechler 2008). The knowledge gained from the process is, according to Vaishnavi and Kuechler (2008), objectively constrained within a context where the iterations of the process reveals the meaning of the knowledge.

A design science research project can contribute to academia in various ways. Hevner et al. (2004) state that the contributions from a Information Systems (IS) research effort shall contribute in the areas of design artefacts, design foundations and/or design methodologies. March and Smith (1995) state, on the other hand, that an innovative and creative design artefact is in itself enough to be contributing to the research community – a statement that is shared by Vaishnavi and Kuechler (2008), who state that a design artefact that is innovative and not “state of practice” is a valid contribution to the research community. This research is guided by the suggested process by Vaishnavi and Kuechler (2008) and aims at resulting in a new innovative artefact. Since the designed artefact in this research will not be implemented in a real world situation, the artefact can not be evaluated in its effect on the problematic situation. The evaluation according to the design science process by Vaishnavi and Kuechler (2008) will be built on a review and reflection of the artefact and the process as well as the methodologies used.
2.8 Practical structure

The practical structure of the research follows the design science research process as described below, where the SSM study aims at provide understanding of the problematic situation and through the conceptual model become a basis for the suggestion of development through the UP phases inception and elaboration (figure 4).

![Diagram of Practical Structure]

**Figure 4. Practical structure of the research.**

When the situation has been expressed with SSM, a literature review is to be conducted to gain knowledge in current techniques and theories that can guide the development phase. The theories will include both theories in system design and theories based on existing research in online learning, such as for example the work of Erickson and Kellog (2000) and Giannoukos et al, (2008).

2.8.1 Data collection

Data is collected from the social participation with the student users of Blackboard at Linnaeus
university. It is collected through SSM workshops and discussions. The purpose of the data is to learn about and express the problematic situation as perceived by the participants as well as to gain knowledge about the requirements of a new system.

The workshops were conducted in a way were I functioned as a participating researcher that led the workshops. The participating students, as described in section 4.2, was introduced to the research subject without any details on the problems described in the introduction section of this paper. Furthermore, the structure of the workshop was explained to the participants. None of the participants had previous experience in SSM, thus an introduction to SSM as used in this research were provided.

The first workshop focused on a discussion related to the participants use of Blackboard and together with the participants I designed the first rich pictures (appendix 1). During the workshop I collected notes on the participants thoughts and opinions of the topic.

To gain knowledge not only in the participants view of the system, but also their way of using it, the participants were asked to identify tasks and activities that they performed in their use of the system. This was conducted in group discussions while the participants had access to Blackboard to be able to elaborate and communicate as if it were using it in a real world scenario. Each task was then discussed and the issues found when performing the tasks was noted.

A second workshop were conducted where I presented the root definitions (see section 5.3) and the conceptual models (see section 5.4). In the second workshop the participants were instructed to discuss and compare the real world with the conceptual model based on user scenarios when performing the tasks and activities in Blackboard and the conceptual model. The data was collected by writing summary notes of the themes of discussion.

3 Theoretical foundation

In the following section the theoretical background of online learning will be discussed with a focus on the psychological importance of interaction and collaboration.

Furthermore, the technologies used in web based education will be addressed in relation to their use in online learning.
3.1 Online learning

Online learning is derived from correspondence teaching and learning which has been used since the 1800s (Holmerg 1995; Gunawardena and McIsaac 2004). Correspondence or distance learning have gradually been developed as new communication mediums evolved. Since the early 1980s, computer conferencing systems have been in use by educational institutions as an informal medium for delivering education. At first, a few educational organisations used these systems for information exchange and problem solving activities. In the 1990s, the use of computer networks evolved over time to become a preferred tool for distance education (Björck 2004).

Even though there has been a lot of development on online learning since the 1800s, the current LMSs do not provide sufficient platforms to support the students in their learning. Franceschi and Lee (2008) state that the systems used today do not provide means of collaboration that is sufficient to the learners needs. Furthermore, a study on student’s acceptance of educational technology by Keller (2005) show that only between 13 and 35 percent of the 106 participating students perceived usefulness and added educational value in the use of a web based online learning platform.

According to Hrastinski (2007) computer supported learning has traditionally been based on objectivist theories on learning where it is assumed that the knowledge can be considered an object that can be absorbed by the students. In objectivist learning, a teacher’s goal is to transfer objects of knowledge to the students, who are to obtain as complete knowledge as possible from the objects. The knowledge obtained is ideally identical to the knowledge obtained by other students from the same object (Hrastinski 2007). These traditional ways of learning did not appear to fit online learning (Shih and Swan 2005) and therefore, in the 1990s, the constructivist theories gained in popularity (Hrastinski 2007).

The constructivist view on knowledge is, on contrary to objectivist, a view where there is no correct way to structure the world. Instead, there are many ways to structure the world and many meanings and perspectives on phenomenons (Hrastinski 2007). The learning is, like objectivist, focused on the individual learner.

The social perspective is, however, an important factor in learning. Hrastinski (2007) argues for a third perspective on learning: a social perspective where knowledge is gained through sharing and interacting with others. Hrastinski (2007) also states that it is argued that the constructivist and the social perspective can be combined to provide the best way of learning. This social constructivist
perspective is credited to Lev Vygotsky, one of the late 1900s and the early 2000s most significant and influential educational psychologists (McQueen 2010). Shih and Swan (2005) discuss how the social constructivist perspective, which has a primary focus on learning in group collaboration, is the dominating perspective in online learning.

In social constructivist learning, the student gains knowledge from group activities and social interaction. The students share multiple perspectives on the topic of discussion and can thereby formalize their own knowledge based on their interpretation of multiple perspectives on the same topic (Shih and Swan 2005). Social learning theories advocate that learning is a part of all human activities, not just those activities that take place inside a classroom (Hrastinski 2007). The knowledge can simply not be transferred from one person to another since an individual has prior knowledge that is used to interpret the knowledge transferred. The knowledge must instead be constructed based on prior knowledge with consideration of the community from where the knowledge adhere (Leinonen et al. 1999).

In online learning, a tool such as Blackboard is used to support the social interaction and collaboration that enable the students to learn through constructivist and social constructivist learning theories. The tool is not only used as a source of information but enables the students to share their interpretation of the information as well as construction of new knowledge (Leinonen et al. 1999).

3.1.1 Student interaction

The communication in online learning platforms is conducted through different types of interaction. Moore (1989) suggests that at least three types of interaction is to be distinguished: learner-content interaction, learner-teacher interaction and learner-learner interaction.

3.1.1.1 Learner-content interaction

The first type of interaction is between the learner and the content. The content is crucial and without it there would be no education (Moore 1989). The learner interacts with the content, such as text, by reading it and forms new ideas and knowledge based on the content (Hrastinski 2007).

The learner-content interaction is somewhat similar to Holmberg’s (1998) guided didactic conversations where the learner interacts with texts written to simulate conversations. This type of
conversations can be created in an online learning environment by changing the content depending on the learners' actions (Gunawardena and McIsaac 2004).

3.1.1.2 Learner-teacher interaction

The ability to interact with the teachers is highly appreciated by learners since the teacher often is the expert of the content and area of the course. The learners can also gain motivation and guidance by the teachers (Moore 1989). This type of interaction is highly desired by many learners, especially when introducing new knowledge (Gunawardena and McIsaac 2004).

Hrastinski (2007) states that the quantity and quality of learner-teacher interaction needs to be balanced. Hrastinski is of the opinion that studies show that teachers who frequently add posts to a discussion may inhibit the learners from adding posts themselves. Furthermore, a teacher that interacts little with the learners may be problematic since the learners may need the teachers' motivation (Hrastinski 2007).

3.1.1.3 Learner-learner interaction

The learner-learner interaction is the main focus of this dissertation and is the interaction that occurs between the students. It can be both structured and non-structured (Gunawardena and McIsaac 2004). Earlier distance educations did not support this type of interaction. It is this type of interaction that has made collaborative learning and social support possible for distance students (Hrastinski 2007).

Empirical studies show that learner-learner interaction is both cognitive and social. The cognitive interaction can be, for example, communication of content while the social interaction is the communication of the social aspects such as emotional communication (Hrastinski 2007). This type of interaction is extremely valuable and sometimes even crucial for learner success (Moore 1989) by providing the opportunity for learners to be able to socially negotiate meaning and construct new knowledge (Gunawardena and McIsaac 2004). The learner-learner interaction challenges the thinking and practice of learning environments in the move towards more learner-centred environments (Hrastinski 2007; Gunawardena and McIsaac 2004).
3.1.3 Participation and social presence

A student is helped in the learning process by participating in a group. There are two main reasons for how participation helps the student. First, the participation convey socio-emotional variables that is favourable for the learning climate. Second, the group help reduce the uncertainty and anxiety in conducting new or complex tasks (Björck 2004).

According to Vonderwell and Zachariah (2005) there are three types of participants in online learning: the active participants that take an active role by both read other posts as well as adding their own post to the discussion, the “lurkers” that seldom adds new posts but read others and those that do not take part of the discussions at all or very little.

The participation is an important part of the online education process. Studies have been conducted that show that the outcome of students that are actively involved in collaboration is as good as, or even better, that of students of traditional education (Björck 2004). Björck also claims that both less advanced and more advanced students gain knowledge by collaborating. According to Björck (2004), the less advanced students learn from the explanations of the more advanced students, while the more advanced students learn by explaining to the others.

The feeling of social presence affect what is communicated and it is important to know the listeners of our communication in order to construct the information in the way that the communicator believes is suitable to the listeners. Even though a student is participating in a discussion, he/her may not know who, or if any, other is participating in the same discussion. In the physical reality we know, or at least think we know, who is listening when we communicate. This knowledge about the receivers affects what we communicate (Erickson and Kellog 2000).

Swan and Shih (2003) describe the affective feeling of connection with the other participants as an important factor for the student’s satisfaction. Both Swan and Shih (2003) and Tu and McIsaac (2002) describe social presence as a measure of a feeling of community. Research shows that students that study online score higher on assignments if they perceive high social presence in their learning environment. The perception of the social presence is significantly related to the students overall learning satisfaction (Shih and Swan 2005).
3.2 Computer-Mediated Communication

Computer-Mediated Communication (CMC) is often classified as being either synchronous or asynchronous. The phrase does not only mean the tools of communication but also a medium and a mean of social interactions (Hrastinski 2007).

Online students uses CMC to interact with other students and the teachers (Hrastinski 2007). A LMS, such as Blackboard, is a medium for CMC and is according to Li et al. (2008), a tool for online learning through both synchronous and asynchronous communication. Hrastinski (2008) argues that there are three types of communication through CMC in online learning (table 1).

<table>
<thead>
<tr>
<th>Type of exchange</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content-related</td>
<td>• Ask for answer on content-related question</td>
</tr>
<tr>
<td></td>
<td>• Share information</td>
</tr>
<tr>
<td></td>
<td>• Express idea or thought</td>
</tr>
<tr>
<td>Planning of tasks</td>
<td>• Plan work, allocate tasks, coordinate joint efforts, or review drafts</td>
</tr>
<tr>
<td></td>
<td>• Negotiate and resolve conflicts</td>
</tr>
<tr>
<td>Social support</td>
<td>• Express companionship, emotional support, or advice</td>
</tr>
<tr>
<td></td>
<td>• Use emotions (such as ☺, ;))</td>
</tr>
<tr>
<td></td>
<td>• Provide support when problems arise (such as when having technical difficulties)</td>
</tr>
<tr>
<td></td>
<td>• Talk about things other than class work</td>
</tr>
</tbody>
</table>

*Table 1, Types of communication (adopted from Hrastinski 2008)*

Furthermore, Hrastinski (2008) state that there is an ongoing debate discussing the usefulness of asynchronous versus synchronous communication in online learning. Hrastinski (2008) also state that the debate has moved from trying to find the “best” way of communicating in online studies and become more focused on when, why and how to use the two types of communication to best support the users needs.

3.2.1 Social awareness

The term “social awareness” is commonly used in computer supported collaboration literature even
though the concept of awareness is quite vague (Buder and Bodemer 2008). Schmidt (2002) goes as far as arguing that it is not even a concept any longer, since it has been used in so many contradictory ways. Dourish and Bellotti (1992) did, however, define the term as the “understanding of the activities of others, which provides a context for your own activity”.

In this paper the term is used as what Buder and Bodemer (2008) call group awareness, which they mean is the knowledge and perception about other persons presence and the products of other persons, as well as the activities performed by other person while interacting in a collaboration environment.

In CMC, social awareness is based on the idea that members of a group shares real-time information about their state or situation, such as the users presence and their performing of activities. The information that is shared can be either be transmitted automatically or user initiated, depending on the content of the information as well as the activity that triggers the change of state (Raento and Oulasvirta 2006).

### 3.2.2 Asynchronous communication

Asynchronous communication is often provided through email and discussion boards and provides both teachers and learners with support of work relations even though they are not online at the same time (Hrastinski 2008). Asynchronous communication is a key component in online learning as a user can log in and take part of the information at any time (Hrastinski 2008), but it has also the advantage of mainly being text based and does not require the users to have high speed internet connections (Cockburn and Thimbley 1991).

A study made by Hrastinski (2008) indicate that the majority of all information shared in asynchronous discussions by online students where related to the content of the course. Even though the results may suggest focused students, it may also show that the students are at risk of feeling isolated and not part of a learning community (Hrastinski 2008). Hrastinski (2008) also points out that there was problems for smaller groups to get the asynchronous discussions started. This problems was, however, not noticed in larger groups.

### 3.2.3 Synchronous communication

Unlike asynchronous communication, synchronous communication occurs in real time with the
participating parts of the communication engaged in the communication at the same time. Teachers and learners that use synchronous communication are often communicating on a more social level. The use of synchronous communication also helps the students feel less isolated and more as participants (Hrastinski 2008). The use of synchronous communication creates a more relaxed approach in relation to strict asynchronous communication (Cockburn and Thimbleby 1991).

3.3 Technology

For online education, the LMSs normally consists of a web application. The LMS is therefore tied to the possibilities of the technologies used in developing web applications (Darbhamulla and Lawhead 2004).

Web applications and web pages build on a client-server architecture where the client (browser) communicates with the server via the HTTP protocol. A running web server listens on an network port for incoming HTTP requests. The clients generate requests that are sent to the server which process them and returns a response (Wang 2008).

The communication between the client and the server can only be instantiated from the client. In early versions of the HTTP protocol there could only be one request per connection. However, later versions include the functionality to keep the connection alive. This ability was introduced in HTTP 1.1 to improve the performance (Wang 2008).

Even though the connection is kept alive, the server can not notify the client. To get information from a web server trough the HTTP protocol a full cycle of sending a request that is processed on the server and return as a response has to be completed (Wang 2008). This requires the entire web page to reload even though there is only need to update some part of the page (Kuuskeri and Mikkonen 2009).

In recent years, Asynchronous JavaScript And XML (AJAX) has been incorporated in rich web applications to provide the web pages with the ability to update parts of the web page without reloading the entire page (Kuuskeri and Mikkonen 2009). AJAX makes it possible for the the web page, with the use of JavaScript, to create a connection to the web server in the background to retrieve and process data in order to manipulate the content of the web page. As the name suggests, AJAX is communicating in a asynchronous manner with the server, a request is instantiated on the client, the server processes the request and returns a response to the client. The client then processes
the response (Kuuskeri and Mikkonen 2009).

3.3.1 Comet

Since AJAX makes it possible to connect asynchronously to a web server in the background, but still requires the client to initiate the connection and to send the request (Wang 2008), a couple of workarounds has been developed that share the name Comet (Kuuskeri and Mikkonen 2009).

The idea behind Comet is to use the technologies capabilities to communicate in the background to simulate a two way communication (Kuuskeri and Mikkonen 2009). One of the first methods of Comet was to use polling where the client polls (send request to ask for changes) to the server, if there where any changes, they where returned in the response (Wang 2008). Polling was found to be band-with consuming since a lot of overhead was sent and many requests were sent between any changes (Kuuskeri and Mikkonen 2009). To minimize the amount of requests sent to the server, long polling can be used. Long polling is achieved by the client by establishing a connection to the server by sending a request and the server does not return a response until there is a change of state so that the response contains any new information. When the response is returned or when the time-out for the connection is reached, the client immediately initiates a new connection (Kuuskeri and Mikkonen 2009).

Long polling consumes less band-with and are less resource intense to the client (Kuuskeri and Mikkonen 2009), but requires the server to manage all connected clients (Wang 2008). The web servers management of all connected clients raises a problem since the connected clients require a separate thread to keep track of the connection which may generate problem in a web server since they often have a limited number of allowed threads (Kuuskeri and Mikkonen 2009). This is a problem that, according to Ren et al (2008), is due to the fact that Comet differs from the original model of the web where the client is requesting one page at the time. The source to this problem is that the user interfaces of web applications has evolved and become more complex than the underlying protocol and technologies (Kuuskeri and Mikkonen 2009).

3.3.2 The Bayeux protocol

The Bayeux protocol is a development of a publisher/subscriber pattern where clients can publish information to channels and all clients subscribing to the channel get the new information. The idea
of using Bayeux in combination with Comet is to let the clients and servers communicate over HTTP where the servers holds information of each client and the channels subscribing clients. Each change in a channel is an event that is communicated to the subscribing clients (Singhera 2008).

The protocol is not tied to any specific server or software, hence it can be implemented with a mixture of techniques, for example in a web client and a web server using Comet techniques. The messages sent between the client and server must be formatted in a way that suits both parts of the communication. Web applications that builds on the comet paradigm uses JavaScript, hence JavaScript Object Notation (JSON) is a suited format for Bayeux messages (Singhera 2008).

### 3.4 Interaction designs in LMSs

In an LMS, such as Blackboard, Moodle or It’s learning, the platform is used to publish study material and to let the students and teachers communicate. The communication is normally conducted in an asynchronous manner via threaded discussion boards (Vrasidas 2004). LMSs, are translations of the real world into a virtual one, the courses become e-courses where the teacher can post material to the students and face-to-face conversations is replaced by the discussion boards (Colazzo et al 2009). As stated above, this kind of communication tools are insufficient to support social constructivist learning.

There are, however, attempts to provide the learners with tools that support them in their quest of socially construct new knowledge. Ericsson and Kellogg (2000) describes Babble as a tool to allow social translucence in a digital world. Babble is their prototype of a graphical activity monitor that shows the users activities in a discussion to allow the users to “see” each others through graphs. The graphs represent users and their activities and thereby allows the users to follow other users activities in a graphical way. Jyothi et al (2007) suggest a model similar to Babble where graphs represent users activities in the discussion boards of an LMS. Their suggestion is a add-on to Moodle to allow the users to follow each others in the asynchronous discussion boards. The visual aid supports and motivates the students to take an active part of the discussions. By allowing the students to graphically follow the communication, the discussions are easier to keep structured which enhances the interaction between the students and thereby increase their possibilities to construct new knowledge (Jyothi et al 2007).

Blackboard Inc. has developed other means of supporting social communication in their LMS. They
have included blogs and Facebook connectivity in the system (Godwin 2009). Besides sharing their thoughts in the discussion boards and chat, the students can share information in different forms by including images and video in their blogs. This development open up the system and let the students connect to their friends and contacts outside of the LMS, which can be very valuable to the students as they can collaborate more and become more influenced by “outside” factors. The openness can, however, become an distraction and remove focus from the studied topic (Colazzo et al 2009). Moodle, an open source LMS, has tackled the social needs of the students in another way. Besides the synchronous chat rooms and course related discussion boards, “virtual cafes” can be created. The virtual cafe is a separate asynchronous discussion board where the focus is on social communication, to build relationships between the students (Moodle 2010).

4 Development process

This chapter outlines how the research is realized and explains how the methodologies are used in the development process. The chapter also describes which artefacts are designed throughout the process.

4.1 SSM and UP combined

Avizon and Fitzgerald (2006) state that a comparison of methodologies generate a better understanding of the nature of the methodologies and improve future information systems development. Since this research study both the soft systems of the human activities of interactions in online learning and the hard systems of software development, a comparison and description of the usage of the two methodologies are provided.

Avizon and Fitzgerald (2006) suggest a seven elements model for methodological comparison. The model is however able to be edited (Avizon and Fitzgerald 2006). In the following description of the methodological realization, the model is edited to illustrate the way the methods are used in this research.

4.1.1 Philosophy

UP deals with hard scientific developments which are characterized by a science paradigm, while SSM has a holistic approach which is characterized by a systems paradigm (Avison and Fitzgerald
2006). The systems paradigm is used in this research to examine the human activity systems in the use of LMSs. By examining the communication from a soft systems point of view, the social aspects of the communication is captured.

Goguen (1993) discuss the importance of the social aspects in requirements engineering and states that the requirements engineering process can never be a entirely formal process since it lies in it’s nature to discover client needs. Therefore, instead of designing a system from a hard systems point of view where the system was created with regard to the technical possibilities, the use of this combination of methodologies aims to expand the soft systems of students in collaboration to include hard systems artefacts. This places the hard system inside the soft system in contrary to enable the soft systems to use an external hard system. After all, as emphasised by Goguen (1993): “Computer-based systems is built for people by people. It is designed to serve human purpose, and exists in some human context.”

4.1.2 Model

SSM is used to capture the human activities that occur when students use a LMS, but also to create models over the problematic situation, such as the rich picture. The models created with SSM is mainly process oriented (Avison and Fitzgerald 2006) and is used to generate knowledge of the processes conducted by the students. The process information is used as a base for the requirements analysis in UP. UP uses both process and data oriented models (Avison and Fitzgerald 2006) and processes models. Such models are the use case diagram that represent the processes found in the SSM study. The data models in UP are developed with a base in the requirements, the literature and creativity.

4.1.3 Scope

The scope of the methodologies are illustrated in figure 5, the phases supported in each methodology is described by Avison and Fitzgerald (2006). The use of both methodologies provides a methodology with the benefits of both hard and soft systems thinking. The hard system analysis in UP is highly influenced by the result of the SSM study.
The strategy indicates the methodologies concern of organization-wide context. This research does not concern the organisation such as the university, which makes that phase unimportant. The feasibility, on the other hand, is a phase that is conducted in both SSM and UP. The SSM part of the phase is to evaluate the social parts of the use of Blackboard, while the UP part is to evaluate the technological requirements to build the system. The analysis phase is seen on as an important part in both SSM and UP. The analysis phase ties together the two methodologies by using the SSM analysis of the current situation as the basis of the requirements analysis in UP. Logical design is used to design the new artefacts on both a conceptual and a more detailed level, while the physical design describes the physical requirements of the design. A key phase that was not covered by any of the two methodologies is programming. The programming of a prototype is performed in a test environment to evaluate the artefact instantiations as well as to test the possibility of technical design ideas developed throughout the research. The programming is conducted in two different techniques, the client side of the system is developed mainly in JavaScript while the server side is developed with the programming language C# in the .NET framework. There are also some supporting mark-up and style techniques, such as HTML, ASP.NET, CSS, and XML. The programming phase will lead to the testing phase where the new artefacts are tested in the test environment to examine the artefacts ability to meet the requirements. The implementation was left
out of the research since they require the artefact to be implemented in a real environment which due to the time limit of this research, is left for future research. In the *evaluation* phase the system is tested in an test environment to find to which level the requirements are meet.

### 4.1.4 Outputs

The outputs of the SSM study are used in an iterative way and some of the outputs are only used within the study itself, such as the rich pictures. The root definitions and the gained knowledge of the problematic situation are used as a bases of the analysis phase in UP to develop requirements and to generate understanding of the new systems requirements. The conceptual models are used as a basis for the use cases in the UP study which in turn outputs the new systems design artefacts.

### 4.1.5 Practice

There is a difference in the methodologies practice since SSM has a academic background and a broad academic user base (Avison and Fitsgerald 2006) whereas UP is more commercial and even if it has a broad user base, it is mostly used in the commercial development industry (Avison and Fitzgerald 2006, Arlow and Neustadt 2005).

SSM is also more focused on the actors/stakeholders while in UP the actors/stakeholders has a proactive role (Avison and Fitsgerald 2006).

In this research SSM is used to create an understanding of the research problem but also to gain academic validity in the need of a new system.

### 4.2 SSM study participants

Since the SSM study focus on the communication between students in Blackboard, the choice of participants was decided to be among students at Linnaeus university that uses or have used Blackboard in their studies. The participants have used Blackboard in different ways: some have used it as complement to on campus studies, some as a platform for distance education with no on campus possibilities and one participant as a mixture of the previous (table 2).

Boeije (2010) suggests that participants can be recruited by billboards, advertisements in magazines or on the Internet. Another way might be to search for participants on physical locations where suitable participant might reside.
The first method used to recruit the participating students in this research was by posting a request on Blackboards virtual billboard for a group of distance students. However, none of the students replied. Second, the more direct method of asking students at campus if they or someone they knew where willing to participate in the study gave a better result. Five students were found and the author of this dissertation was included as a participating researcher in the study. All participants also had experience in campus-only studies.

<table>
<thead>
<tr>
<th>Used Blackboard as a...</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>...complement to on campus studies.</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>...platform for distance education</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>.. both a platform for distance education and as a complement for on campus studies</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 2. Representation of participants use of Blackboard.

### 4.3 Design artefacts

Following the design science research process to create the set of artefacts that is suggested by March and Smith (1995) aims to lead to a proposed design of a new communication model for web based communication. The research process suggests the first step to be “awareness of problem” which was conducted through literature review to examine what the problem is (as stated in the introduction chapter).

The next part of the problem awareness is to find out how the problem is perceived by the students. This is the focus of the SSM workshops which aim to provide the first set of artefacts, a rich picture that serves as a holistic view of the domain of the problematic situation. Furthermore, the SSM study is used to create conceptual models and root definitions; artefacts that generate knowledge that is to be interpreted as how the student would want to be able to communicate and thereby also be used as a base for the suggestion of a new system.
With the base of what was learned though the SSM study, the design science process is iterated to design further artefacts. Each of the following iteration is, however, interrelated to each other and each iteration is a part of the first iteration of the process (figure 6). Each iteration provides new knowledge and new artefacts to be used in the following iteration. The iterations in figure 6 are illustrated as a circle divided in two parts where the part at the top is the input to the specific iteration and the part at the bottom is the output that also is used as input to the next iteration.

After the SSM study in the main process, a new iteration is realized which use the knowledge gained from the SSM study to design the conceptual constructs. This iteration moves the thinking from soft systems thinking to hard systems thinking by designing the use cases of the analysis phase in UP. The awareness of problem in this second iteration is the knowledge gained from the first iteration. The second iteration results in method artefacts in the form of use cases and their specifications as well as the sequence diagrams.

The next iteration of the process focus on the previously designed artefacts and gained knowledge
to design a set of constructs to be used in the analysis phase of UP. These constructs serve as the conceptual building blocks for a logical design of the communication model and as a crucial part of the following iteration of the design science process - the design of the logical model, the analysis class diagram.

The logical model is an artefact that serves as a base for designing the physical artefacts. The models provide an awareness of problem for the next iteration. The logical model serves as problem domain description of what to be design as a physical model. Through literature, knowledge is gained to guide how (technically) to develop the physical design artefacts, the models of the architectural overview, the meta models of the design phase in UP.

A new iteration of the design science process is then started to design the physical constructs and models of the system, the design class diagram. The new knowledge gained from the previous iterations lead to the development of a prototype which serves as a base for the last iteration to design an instantiation of the system.

The accumulated knowledge and the designed artefact through all iterations becomes the result of the main process, and is thereby the suggested change to the problematic situation as defined by the SSM study, and also the conclusions and suggestion for further research.

5 Empirical process

This chapter explain the work and resulting findings of the SSM study including the rich picture, the issues found in the human activity systems, root definitions and conceptual models of a new system as well as comparison between the conceptual models and the real world. Lastly, a set of suggested changes are presented.

The first step was to discuss the situation as described in the introduction with the participants of the study.

The study was conducted through workshops with the participants. During the first workshop the author of this dissertation functioned as a modeller of the rich picture. The workshop started with an introduction to the philosophy of SSM followed by an unstructured interview with the participants about the problematic situation. The interview showed that none of the participants felt that Blackboard gave them the requested support for collaboration and interaction with fellow students.
One participant said that “I do not find Blackboard to help me collaborate, I only use the discussion board if it is mandatory.”.

After the interview, the actual SSM session was conducted. The focus of the SSM study lied on the collaboration and interaction between the students.

5.1 Rich picture

During the SSM study, a rich picture was modelled to give an abstract image of the perceived reality of the collaboration part of the system. At first, there where two different rich pictures: one for synchronous interaction and one for asynchronous interaction (appendix 1). Both rich pictures were later merged into one as it was found that they had much in common.

During the creation of the rich picture, the participants were asked to collaborate and discuss how they perceived the real world problem. The discussion lead to the creation of the rich picture as seen in figure 7.
The creation of the rich picture was a straightforward process where the participants shared the same view on the system. All participants quickly identified the discussion board, chat and private messaging as something they use in a daily basis in non-educational purposes in other systems.

The rich picture (figure 7) describes the participants' view of the real world situation. The yellow smiley illustrates the student itself with a circle around that indicates the relationship with the world outside of the system, such as family and friends and information gained from other sources which are affecting the student's knowledge base and his/her way of constructing knowledge from the information communicated within the system.

The purple arrow indicates the student's awareness of their own as well as other students' communication. Questions felt by the participants in the communication is illustrated by the...
questions in the speech bubble, which indicate that the participants felt that they were not aware of other students activities in the communication. The bullet point describes feelings that the participants wished they felt when using the system.

From the student goes a blue line illustrating the asynchronous information flow to and from the discussion board function and a red line showing the synchronous information flow to and from the chat function. Both the chat and the discussion board are different functions but they both store chunks of information as posts, with the difference that the discussion board organizes the posts in threads. The similarities in the different posts are illustrated by the dotted brown line.

At the top of the picture there is an information cloud that is meant to illustrate the content of the posts as information intended to be interpreted by receiver(s) of the communications (green line).

The communicated information in the posts can be specialized in either contextual or social. The colours blue and red does not only show the type of communication, but also the main type of information communicated through the two types of communication. Meaning that contextual information is mainly communicated through asynchronous communication and social information through synchronous communication.

5.2 Tasks and issues

The created rich picture gives a view of the whole system with both asynchronous and synchronous communication as well as all different flows of information in the system. To structure the different tasks in the system, the participants were asked to identify human activity systems or tasks that could be regarded as subsystems of the whole. If they found problems and issues in conducting the activities, they were asked to describe the issue and how they perceived the issue to effect the conduction of the task. Each task corresponds to an object in the Rich picture and the objects relation or flow of information between itself and other objects. The tasks are the activity systems performed by the students in the whole system.

The participants identified the following task:

- Take part in discussion
- Posting to discussion
- Chat
- Social participation
- Internal communication linking

Each of the tasks is described below together with the issues found while performing the task. The issues where assigned a set of attributes to identify and describe the issue (table 3).

<table>
<thead>
<tr>
<th>ID</th>
<th>An identifier of the issue formatted as: [Task number].[Issue number]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>A short descriptive name of the issue</td>
</tr>
<tr>
<td>Description</td>
<td>How the issue is perceived by the participants</td>
</tr>
<tr>
<td>Perceived result</td>
<td>The result of the issues as perceived by the participants. The result has negative effect on the participants feeling of social presence.</td>
</tr>
</tbody>
</table>

*Table 3. Template for describing an issue.*

By following the template in table 3, the issues in the activities can be identified and related to each task, which in turn, create a better understanding of the issues as perceived by the participants while performing the tasks.

### 5.2.1 Take part in a discussion

The first task the participants agreed upon was that they had to process the information given to them by Blackboard to find the discussion topic the wanted and thereby be able to participate.

<table>
<thead>
<tr>
<th>ID</th>
<th>1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Thread Control</td>
</tr>
<tr>
<td>Description</td>
<td>It can be hard to keep track of what threads are and are not of interest.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• The student has to scan multiple threads before finding the one searched.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>1.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Loss of topic</td>
</tr>
<tr>
<td>Description</td>
<td>A thread may move towards another topic during the discussion.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• The thread becomes hard to follow and topics are hard to find.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Information overflow</td>
</tr>
</tbody>
</table>
Many posts does not have valuable information.

It is hard and time consuming to find relevant posts in the threads.

If a thread with no interest to the student has unread posts, the student is notified on the start page that the class has a new post. There is no information on which thread the new post is, or how many new posts there are.

The notification gets ignored and the student has to browse the thread of interest to find out if there are any new posts.

When a student is participating in a discussion he/she may add information to the thread in the discussion board. The participants identified one issue in this activity.

It is hard to get an overview of the different posts and to determine if a post is an answer to another post or a completely new post.

Answers to posts may be added as new posts instead of answers which may create difficulties to follow the thread.

The chat is used to synchronously interact with other students. The chat has, according to the participants, some issues making it hard to use.

When the chat session is finished, the information in the posts are deleted by the chat program.

The students has to copy the conversation to an external file.

The information disappears.
<table>
<thead>
<tr>
<th>ID</th>
<th>3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Chat in threads</td>
</tr>
<tr>
<td>Description</td>
<td>All posts in a chat room is displayed on the same area. There is no logical connection between answers and questions.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• It is hard to keep the topic, especially if there are many students in the chat.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Late entry</td>
</tr>
<tr>
<td>Description</td>
<td>When entering a chat that has been going on for some time, it can be hard to catch up in the discussion due to many posts of unrelated matters such as post containing emotional matters.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• It takes long time for the student to read trough all posts to find the relevant information.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>3.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Private chat</td>
</tr>
<tr>
<td>Description</td>
<td>The chat rooms are shared for all students in the course. All students can see the other students posts.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• The students does not use chat for individual group work. The participants felt that they wanted to be able to chat in private groups to express themselves socially and emotional.</td>
</tr>
</tbody>
</table>

### 5.2.4 Social participation

The participants felt that one of the main tasks of Blackboard was to be able to socially interact with the other students but that Blackboard has significant issues in providing the tools necessary for that.

<table>
<thead>
<tr>
<th>ID</th>
<th>4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>No emotions in discussions</td>
</tr>
</tbody>
</table>
| Description | The participants felt that the nature of a discussion board did not give them the
ability to express emotions such as smiley's or encouraging phrases. The information was solely contextual.

<table>
<thead>
<tr>
<th>Perceived result</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The discussions stays formal resulting in lack of community feeling and friendship among the students.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>4.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>No private groups</td>
</tr>
<tr>
<td>Description</td>
<td>The discussions and chats are available for every student in the course.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• The students may feel inhibited to communicate privately in groups since they know that others (outside of the group) are able to read what they write.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>4.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Sense of presence</td>
</tr>
<tr>
<td>Description</td>
<td>The students can see whom is online but not who is currently engaged in a specific discussion or activity.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• There is no feedback in whether the intended respondent of the communication has received the information or not.</td>
</tr>
</tbody>
</table>

### 5.2.5 Internal communication linking

The participants stated that they sometimes wanted to move from one form of communication to another. This task has two issues depending on in which direction the mode was going from.

<table>
<thead>
<tr>
<th>ID</th>
<th>5.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Chat to discussion board</td>
</tr>
<tr>
<td>Description</td>
<td>When planning work in the chat, the participants felt that the chat session sometimes moved over to discuss more complex issues. These issues would preferentially be moved over to a persistent state such as the discussion board. However, there are no export functions available in the chat.</td>
</tr>
</tbody>
</table>
| Perceived result | • This issue creates extra activities to be performed in order to manually
export the posts from the chat to a new discussion thread. Participants felt that the extra work needed made them either stay in the chat even though they would prefer the discussion board or made them not use the chat at all, conducting their planning in the discussion board.

<table>
<thead>
<tr>
<th>ID</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Discussion board to chat</td>
</tr>
<tr>
<td>Description</td>
<td>When in discussing a topic in the discussion board the participants sometimes need to discuss planning and more social matters regarding the same topic as discussed. The participants felt that these type of discussions where not easily done in the discussion board and should rather be conducted in a synchronous manner such as a chat.</td>
</tr>
<tr>
<td>Perceived result</td>
<td>• Either the discussion board is used for the communication of unrelated topics or the participants simply do not discuss such matters at all. The participants did not use the chat at all to discuss discussion board related matters even when they felt needed to.</td>
</tr>
</tbody>
</table>

### 5.3 Root definitions

The human activity systems that were believed to exist in the communication tools of Blackboard were defined as root definitions. The first root definitions was created during group discussions with the participants to be as complete as possible. After the group discussions, the author of this dissertation, compiled the root definitions and let the participants take part of them through mail conversations in order to get additional input to the root definitions.

In SSM, the transformation process does not state how the transformation is performed, it should exist of input and output were the output is the input in a transformed form. Since this SSM study is being a part of a design science study and is to be used to design a new system, the use of transformation, CATWOE and root definitions is altered to better fit this purpose. A purpose that is to design a communication system that provides the students with social awareness in their communication.
The issues described in the previous section does define the problems as perceived by the participants in the study. As stated in section 2.4 this stage of the SSM study is altered to focus on the requirements of a new system based on the issues found in the tasks. By altering this stage to focus on the new system from a human activity viewpoint instead of stay focused on the real world problem the root definitions can be used to understand *how* a new system could allow the tasks to be performed without the issues of the real world situation.

The root definitions are represented with the transformation process and the CATWOE used to create them. The input in the transformation processes described below, is always the students need. The need is then transformed to a result (output). How the transformation is performed are suggestions based on the notes taken from the discussion about the issues in performing the tasks.

The CATWOE is based on the following template (Checkland and Poulter 2010):

- **Customers** – The victims or beneficiaries of the transformation
- **Actors** – Those who perform the transformation
- **Transformation** – The purposeful activity of transforming an input to output
- **Worldview** – The worldview which makes the transformation meaningful
- **Owner** – The owner of the transformation
- **Environmental constrains** – Elements outside the system which are taken for given

The CATWOE is according to Checkland and Poulter (2010) a useful format to describe the root definition, writing it down as a statement is however meaningful to create a holistic account of what is being modelled.

The root definitions are phrases that describe the activity, *what* the activity do, the *transformation* that is done and *why* it is done. The worldview states a relation between why to do what. The phrase can be formulated through the PQR formula where P do, by Q to achieve R. By formulating the root definition with the PQR formula the phrase answers the what, how and why (Checkland and Poulter 2010). In this altered use of root definitions, the *how* to perform the transformation also is included in the definition.
5.3.1 Take part of discussion

<table>
<thead>
<tr>
<th>Transformation process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Need</strong></td>
</tr>
<tr>
<td>Need to find the right discussion and the relevant posts in that discussion.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

C - Customer | Student |
---|---|
A - Actors | Students, The LMS |
T - Transformation | The student needs to find the right discussion in order to take part of it. |
W - Worldview | A student needs to easily find relevant information in the discussions to learn. |
O – Owner | The LMS |
E – Environmental constrains | A discussion topic |

A system owned by the LMS to let students find the right discussion to be able to take part of the discussions and thereby learn through collaboration. The process is done by with a clear overview in the LMS and appropriate notifications as well as the the possibility to mark posts as relevant which will help the student to find the right threads.

5.3.2 Posting to a discussion

<table>
<thead>
<tr>
<th>Transformation process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Need</strong></td>
</tr>
<tr>
<td>Need to post information to the collaborators as a new post or</td>
</tr>
</tbody>
</table>
A system owned by a student that is a sender of information lets the sender add new information to the discussion thread. The process is done by having a clear design that lets the sender find the right place to post the information.

### 5.3.3 Chat

<table>
<thead>
<tr>
<th>Transformation process</th>
<th>Need</th>
<th>How</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need</td>
<td>Need to be able to maintain and create new synchronous discussions that support both simple and complex topics. Post needs to be able to indicate as important for the discussion to enable new participants to enter the discussion.</td>
<td>Discussions can be ordered in threads. The posts are stored for later retrieval. Posts can be marked as interesting.</td>
<td>The students can follow long going synchronous conversations. Synchronous mode gives the students room for emotional and social expressions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C - Customer</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Actors</td>
<td>Students</td>
</tr>
<tr>
<td>T - Transformation</td>
<td>Students can create synchronous discussions that support both simple and complex issues. Posts are stored and are able to mark as important.</td>
</tr>
</tbody>
</table>
To collaborate, the students need to be able to share emotional and social information as well as discussing complex educational related issues.

<table>
<thead>
<tr>
<th>W - Worldview</th>
<th>To collaborate, the students need to be able to share emotional and social information as well as discussing complex educational related issues.</th>
</tr>
</thead>
<tbody>
<tr>
<td>O – Owner</td>
<td>The LMS</td>
</tr>
<tr>
<td>E – Environmental constrains</td>
<td>A group of course participants</td>
</tr>
</tbody>
</table>

A system where students create synchronous discussions where they can discuss both simple and complex issues. The system enables the students to mark posts and create threads which will make it easy to follow and new participants can join effortlessly.

### 5.3.4 Social Participation

<table>
<thead>
<tr>
<th>Transformation process</th>
<th>Need</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Need to interact socially and emotionally.</td>
<td>The students can see each others actions and feel a greater sense of community and thereby are more socially active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>How</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graphically indicate the students presence and actions in the communication.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable private interactions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combine chat and discussion board to support emotional expressions even in complex discussions.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C - Customer</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Actors</td>
<td>Students</td>
</tr>
<tr>
<td>T - Transformation</td>
<td>The need to interact socially and emotionally are meet by letting the students presence and actions in public and private threads and discussions be communicated to other students.</td>
</tr>
<tr>
<td>W - Worldview</td>
<td>A combined synchronous and asynchronous communication model enable the students to</td>
</tr>
</tbody>
</table>
A system in the LMS where students are able to interact both socially, emotionally and more complex issues as well as in private and public. The system indicates the students activities in the interactions to let them feel each others presence.

### 5.3.5 Internal communication linking

<table>
<thead>
<tr>
<th>Transformation process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Need</strong></td>
</tr>
<tr>
<td>Need to enable the communication between the different types of communication functions in the LMS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C - Customer</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Actors</td>
<td>The LMS</td>
</tr>
<tr>
<td>T - Transformation</td>
<td>Communication between the chat and discussion board is done by merging the two functions to one synchronous threaded discussion function.</td>
</tr>
<tr>
<td>W - Worldview</td>
<td>Students collaborate more easily in one function than in two. There is no need to separate synchronous and asynchronous communication.</td>
</tr>
<tr>
<td>O – Owner</td>
<td>The LMS</td>
</tr>
<tr>
<td>E – Environmental constrains</td>
<td>Previous limitations in HTTP are bypassed with comet and AJAX.</td>
</tr>
</tbody>
</table>

A system where the LMS lets the students communicate both synchronous and asynchronous. This is done by combining the functions of the chat and the discussion board with the help of new
technologies.

5.3.6 Summary of root definitions

The root definitions are summarized to describe the whole system where all sub systems root definitions are merged into one:

*A system owned by the LMS to let students find the right discussion to be able to take part of the discussions and thereby learn through collaboration. The process is done by using a clear overview in the LMS with appropriate notifications as well as the possibility to mark posts as relevant which will help the student to find the right threads. A student who is a sender of information can add new information to the discussion thread by finding the right place through a clear design. Students can create synchronous discussions where they can discuss both simple and complex issues. The system enables the students to mark posts and create threads which will make it easy to follow and new participants can join effortlessly. The students are able to interact both socially, emotionally and more complex issues as well as in private and public. The system indicates the students activities in the interactions to let them feel each others presence. The LMS lets the students communicate both synchronous and asynchronous. This is done by combining the functions of the chat and the discussion board with the help of new technologies.*

5.4 Conceptual model

From the summary of the root definitions (section 5.3.6) the conceptual model of the system (figure 8) is derived. The model shows how a student is engaged in a community and learn through collaboration and social participation with other students.

Since the root definitions are altered to describe the new system, the conceptual models are describing the activities and subsystems of the suggested new design. The models serve as a first set of artefacts in the design science process as described in figure 6 (section 4.3) from where to analyse the functional requirements of the system. The models are to bee seen on as conceptual models of the new design in the design science process rather than conceptual models in SSM.

Avison and Fitzgerald (2006) suggest the use of levels to ensure that the model is understandable, yet detailed. The models are also presented with a textual representation to further describe the systems, which Avison and Fitzgerald (2006) state as important to ensure that the systems are
understood. In the models below, the activities that are being performed in each sub system is illustrated by squares with rounded corners. Each activity can be related to other activities as well as other sub systems (illustrated by squares). The activities are performed by students (smiley faces) and may affect other students or even entities within the system, such as a discussion. An entity is illustrated by a square with grey background.

Figure 8 is a high level model of the system which include the lower level subsystem “social participation” and the activities “Learning”, “Engage in a community” and “Collaboration”. The model illustrates how students can socially participate through the activities.

![Diagram](image)

*Figure 8, A conceptual model of the system.*

The subsystem “social participation” is described in a separate model (figure 9) and visualises a system where students are notified by each others actions through the activity “monitor actions” that is triggered by an activity performed by a student. The communication is performed in the subsystem “Internal communication linking”. The communication in the social participation of the system can be both private and public.
Figure 9, A conceptual model of the subsystem “Social participation”

In figure 10 a model of the subsystem “internal communication linking” describes how the, according to Hrastinski (2007), normally synchronous communication function, chat, and the normally asynchronous communication function, discussion board, is combined to create a synchronous threaded communication function to allow the students to interact with each others. This subsystem contains three subsystems of it’s own, “Chat”, “Take part of discussion” and “Posting to a discussion”. Each of these three sub system are combined to generate the “Discussion” function that incorporates the functionality of the three subsystems.
Figure 10, A conceptual model of the subsystem “Internal communication linking”

Figure 11 shows the subsystem “Chat”. This subsystem is the main system for the communication since it is a system that allows the students to create and join discussions that are also stored for later usage. The system also allows the students to mark information as relevant, which extends the system “Posting to a discussion” to mark a post as relevant.
The subsystem “Chat” includes the subsystem “Posting to a discussion” which is a subsystem that allows a student to post information to a discussion. Figure 12 is a model of the system and shows how a student uses the subsystem “Take part of discussion” to find the discussion in where to post new information.

Figure 11, A conceptual model of the subsystem “Chat”
Figure 12, A conceptual model of the subsystem “Posting to a discussion”

The subsystem “Take part of discussion” (figure 13) describes how a student can request to view a specific discussion, find relevant posts in a discussion. The system also generates an overview of the discussions as well as notifies the student of changes in discussions of interest to the student.
5.5 Comparison of conceptual model with real world

As described in section (2.4) the real world is compared to the conceptual models by using scenarios of how an activity is performed in the real world versus how the same activity is performed in the new design. A scenario is a set of steps of how the activity is performed. The purpose of the comparison is to find relevant changes in the human activity systems to enable the new design to support social awareness.

Each of the models were discussed with the participants in a workshop where a scenario for each model was created and related to a similar scenario in Blackboard. Some of the models are left out from the comparison since Blackboard or the conceptual models do not support the activities or the comparison did not generate any differences.

Each of the compared activities are described with a main scenario which is the scenario the
participants used most frequently. If the activity can be performed in multiple ways, an alternative scenario is provided. Each of the activities are represented by a scenarios for both Blackboard and the respective conceptual model to perform the same activity.

**Take part of discussion**

<table>
<thead>
<tr>
<th>System</th>
<th>Blackboard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main scenario</strong></td>
<td>1. The students chooses in which course the discussion is taking place and navigates to that course page.</td>
</tr>
<tr>
<td></td>
<td>2. On the course page, the student selects to view the discussion board.</td>
</tr>
<tr>
<td></td>
<td>3. The student searches the discussion board page to find the discussion of interests.</td>
</tr>
<tr>
<td><strong>Alternative scenario</strong></td>
<td>On 1 in main scenario:</td>
</tr>
<tr>
<td></td>
<td>1. The system indicates that a discussion has changes by displaying a link on the course selection list.</td>
</tr>
<tr>
<td></td>
<td>2. The student clicks the link and gets redirected to the discussion board of the course.</td>
</tr>
<tr>
<td></td>
<td>Continue on 3 in main scenario.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>Conceptual model (Figure 13)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main scenario</strong></td>
<td>1. The system presents the available discussions to the student.</td>
</tr>
<tr>
<td></td>
<td>2. The student selects the desired discussion from a list with discussions.</td>
</tr>
<tr>
<td><strong>Alternative scenario</strong></td>
<td>1. The system displays recent changed discussions.</td>
</tr>
<tr>
<td></td>
<td>Continue on 2 in main scenario.</td>
</tr>
</tbody>
</table>

The comparison of “Take part of discussion” shows that the activity performed through the conceptual model requires less actions to be taken by the students to find the requested discussion since it does not require the student to choose which course the discussion is related to. Blackboard may, however, be more structured if there are many discussions, since it organizes the discussions in related to courses.

**Posting to a discussion**
### System

<table>
<thead>
<tr>
<th>Main scenario</th>
<th>Blackboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Do activity “Take part of discussion”.</td>
</tr>
<tr>
<td>2.</td>
<td>Select to add new post or add a reply to previous post</td>
</tr>
<tr>
<td>3.</td>
<td>Add information</td>
</tr>
</tbody>
</table>

Both activities starts after the student has performed the activity “Take part of discussion” which means that the activity can only be started if the student has selected a discussion to take part in. No differences was found in the activity.

### Chat

<table>
<thead>
<tr>
<th>Main scenario</th>
<th>Blackboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The student selects course on start page.</td>
</tr>
<tr>
<td>2.</td>
<td>The student selects the function “chat” in the menu.</td>
</tr>
<tr>
<td>3.</td>
<td>A list of available “rooms” are displayed and the student chooses one room.</td>
</tr>
<tr>
<td>4.</td>
<td>The student can send text and draw images that are displayed for the other users of the room.</td>
</tr>
</tbody>
</table>

Both activities starts after the student has performed the activity “Take part of discussion” which means that the activity can only be started if the student has selected a discussion to take part in. No differences was found in the activity.

### System

<table>
<thead>
<tr>
<th>Main scenario</th>
<th>Blackboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Do activity “Take part of discussion”.</td>
</tr>
<tr>
<td>2.</td>
<td>Select to add new post, reply to a previous post.</td>
</tr>
<tr>
<td>3.</td>
<td>Add information</td>
</tr>
</tbody>
</table>

Both activities starts after the student has performed the activity “Take part of discussion” which means that the activity can only be started if the student has selected a discussion to take part in. No differences was found in the activity.

### System

<table>
<thead>
<tr>
<th>Main scenario</th>
<th>Conceptual model (Figure 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Do activity “Take part of discussion”</td>
</tr>
<tr>
<td>2.</td>
<td>Select to add new post, reply to a previous post.</td>
</tr>
<tr>
<td>3.</td>
<td>Add information</td>
</tr>
</tbody>
</table>

Both activities starts after the student has performed the activity “Take part of discussion” which means that the activity can only be started if the student has selected a discussion to take part in. No differences was found in the activity.

### System

<table>
<thead>
<tr>
<th>Main scenario</th>
<th>Conceptual model (Figure 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The student can perform scenario “Posting to a discussion” or mark post as relevant which extends the functionality of “Posting to a discussion” with the ability to mark posts a relevant.</td>
</tr>
</tbody>
</table>

Both activities starts after the student has performed the activity “Take part of discussion” which means that the activity can only be started if the student has selected a discussion to take part in. No differences was found in the activity.

### System

<table>
<thead>
<tr>
<th>Main scenario</th>
<th>Conceptual model (Figure 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The student can create a new discussion.</td>
</tr>
</tbody>
</table>

Both activities starts after the student has performed the activity “Take part of discussion” which means that the activity can only be started if the student has selected a discussion to take part in. No differences was found in the activity.
Blackboard has a separate function for performing synchronous communication, this activity is in the conceptual model performed in the discussion function. The scenarios in the two system are therefore different since in Blackboard, the chat is a function of its own which requires the student to initiate the specific function for synchronous communication, while in the conceptual model, the synchronous communication is conducted through the discussion function. While communicating, the student can, however, draw images in blackboard which is not supported in the new system.

### Social participation

<table>
<thead>
<tr>
<th>System</th>
<th>Blackboard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main scenario</strong></td>
<td>1. The students can synchronously/asynchronously interact with private messaging, chat or discussion boards.</td>
</tr>
<tr>
<td></td>
<td>2. A student can see online students in each course to find someone to interact synchronous with.</td>
</tr>
<tr>
<td></td>
<td>3. Receiving student(s) that are online may or may not notice the information sent by the sending student</td>
</tr>
<tr>
<td><strong>Alternative scenario</strong></td>
<td>1. The students can asynchronously interact with private messaging or discussion boards.</td>
</tr>
<tr>
<td></td>
<td>2. A student can send messages to any student or post information to the discussion board.</td>
</tr>
<tr>
<td></td>
<td>3. The receiving student(s) take part of the information when online.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>Conceptual model (Figure 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main scenario</strong></td>
<td>1. The student can synchronously/asynchronously interact with private or public discussion threads.</td>
</tr>
<tr>
<td></td>
<td>2. The student can see online students actions, such as latest posts and what threads the students are viewing in real time as well as their current actions (writing information to a thread, browsing threads).</td>
</tr>
<tr>
<td></td>
<td>3. Receiving student(s) that are online are notified of changes in their threads of interests.</td>
</tr>
</tbody>
</table>
The alternative scenario for the main scenario is:

1. The student can follow discussions that take place when the student was offline, since they are stored.
2. Receiving student(s) are notified of changes in their threads of interest when they return online.

The social participation activity differs quite a lot from the real world and the conceptual model. Blackboard does indicate the students online/offline status while the conceptual model indicates the actions of the students which enables other students to track a user's actions and to know if someone is participating in the same discussions as themselves. Furthermore, the conceptual model enables the students to communicate in private discussion while blackboard enables the students to send private messages.

The conceptual model does also support the students to receive information about changes in threads marked as interesting as well as reading posts that are being posted in real time while the post is being written.

5.6 Changes

The workshop with the participants that resulted in the comparison (section 5.5) ended with a discussion about feasible and desired changes. The participants discussed the differences and concluded that the proposed conceptual system and the real world system (Blackboard) was fundamentally different:

“When analysing the communication in this depth, we conclude that there is a lot to change in Blackboard’s communication. The differences in the proposed conceptual system and Blackboard are fundamentally different. It would be ideal to use the learner-content functions of Blackboard combined with the new concept of learner-learner communication” (Participants conclusions)

Through the discussion the following changes were found desirable:

Thread structure

The discussion threads shall be presented without the need for a student to select a specific course. The thread may, however, be organized under different courses but they should all be available from
the same place with a minimum of user actions needed to browse to the requested thread.

**Presence indication**

The system shall not only indicate whether a student is online or not. The actions performed by the students shall be sent to other students that are related to that specific student. The students currently viewing a specific thread should be presented as viewers of the thread. If a student are writing a post to a thread, that action should be presented in the thread so that other students can pay attention to that post.

**Participation**

When participating in a discussion the student should be able to participate in other discussions simultaneously without using different browser windows.

**Notifications**

The notifications of new posts should be presented on the start page so that a student do not have to navigate to a specific course to find new posts. Students should also be notified of newly created threads.

**Communication**

The communication should always be synchronous and new posts and threads should be presented to the readers in real time with no need for the student to reload the page. Even though the communication is synchronous, the information should be stored and organized for the students to take part of as well as to continue the discussion at a later time.

**6 Analysis and development of artefacts**

>This chapter analyses the findings of the SSM study in relation to the literature review. The result of the analysis is used as a basis of the development of new artefacts which are provided and explained in the chapter. Furthermore, a discussion as well as a review and reflection of the process and methodologies used in the research is provided in the end of the chapter.

In this analysis, the result of the SSM study is analysed and put in relation to the literature to serve as a base for the development of a new communication system. The development follows the UP
steps as stated in chapter 4 and uses the SSM result to engineer requirements for the new system.

The analysis starts with the design and development section that is divided in the UP workflows requirements, analysis and design and ends with a discussion that evaluates the research, the resulting artefact as well as an evaluation of the methodology that was used to reach the result.

6.1 Design and development

Artefact design is a creative engineering process with little guidance to gain from the literature. It is, however, important to document the decisions during the process (Offermann et al 2009). This chapter explains the process of designing the artefacts that will serve as a suggestion for a design in order to improve the situation as described in section 5. The design and development of the artefacts are in this chapter documented with UML diagrams and specifications that are the result of the UP phases inception and elaboration. Besides being a creative process, the design and development are based on the empirical findings of the SSM study to set the requirements of the new system.

From the data collected in the SSM study, two crucial points were found that serve as the basis for the design of the artefacts:

1. Presence - The participants where emphasising the need for a tool that better supported their natural ways of communicating. The participants felt that in a real life scenario, they always knew who were involved in the discussion by both watching them and thereby creating an awareness of the involved persons and by being able to react on the involved persons gestures and activities in the discussion.

2. Synchronous interaction - The participants urged for a more organic tool that could enable them to participate in more than one discussion simultaneously with no need for multiple browser windows open or the need for them to refresh the page to seen any new additions to the discussions.

Except from these two points, they also found problems using the chat since it does not enable them to discuss threaded or to save the content, which may lead to information overflow and information that is hard to keep track of. The ability to create private discussions was also suggested as something the participants could use, but they did not see this matter as an important one. The overall feeling among the participants was that a LMS was something they used in online learning to be able to interact with other students, but it was perceived like a set of industry standard tools,
such as online forums and chats, and not a tool designed to enrich their study experience and help them in the learning process. The participants were of the opinion that that the forum and chat in Blackboard were just as any other forum or chat found on the Internet and did not influence them to contribute to the discussion or to use the system for their social needs.

As the literature study suggests, the feeling of isolation created by lack of awareness of classmates presence might decrease the students result in relation to on campus students (Shih and Swan 2005). Even though Blackboard has no function to show which students that at the moment are participating in a certain discussion, it has a function that shows the students that are online at the moment. A participant said during a workshop that: “The ability to know if a certain person is online or not does not really help since I do not know he/she is active in any discussions“.

6.1.1 Requirements

The requirements of the system were defined through the use of SSM in cooperation with the participants of that study. UML provide use cases to model requirement (Arlow and Neustadt 2005) which are created from the models created and the knowledge gained from the soft systems back-end generated by the SSM study.

6.1.1.1 Actors

Actors are who and what that are using the system. The actors may be persons that use the system, persons or machines that install, starts and shut down the system. Some things might even happen in the system at a specific time, hence the time can be an actor (Arlow and Neustadt 2005).

In this case, the actors are always students as it is only the communication between the students that is designed. The students can, however, have different roles as they can be both senders and receivers of the information. The actors are therefore defined as a generalized student that is specialized in a sender and a receiver.

6.1.1.2 Use cases

The actors were used to define what each role of student could do in the system. Every activity was then modelled in a use case diagram (figure 14) with relations to the performing actor as described by Arlow and Neustadt (2005). The use cases were developed by analysing the needs found in the
SSM study.

Each use case of the UML use case diagram (figure 14) describes in short what activity the use case enables for the actor. The use cases are specified in detail in tables (appendix 2). There is no standard in UML for use case specifications, but Arlow and Neustadt (2005) suggest a format template (appendix 3).

6.1.2 Analysis

The analysis phase is about understanding the big picture of the system. The models are not created to be exact blue prints of the system, but rather human understandable models of what the system may be built with. The analysis models visualises the business domain rather than solve the actual problem by describing what the system will do and leave out how it will do it. The two key parts of analysis is to create a class diagram of the domain and to perform use case realizations to prove the use cases valid (Arlow and Neustadt 2005).

By analysing the use cases as described by Arlow and Neustadt (2005), a set of analyse classes were found. In figure 15 the classes of the system and their relation to each other are visualised.
By using the classes found, some of the more complex use cases are realized with the use of sequence diagrams. The realization also overlaps the requirements workflow since use cases may need to be changed in order to be realized, which is the strength of the iterations in UP (Arlow and Neustadt 2005).

The sequence diagrams can be found in appendix 4. In the sequence diagrams, manager classes are used to perform tasks on the classes used in the use case. To make the domain clearer in the analysis class diagram, these managers are left out of the UML class diagram (figure 15).

6.1.3 Design

The main work of the design workflow lies in the end of the elaboration phase and the beginning of the construction phase and is to some extent concurrent with the analysis workflow. It is, however, important to distinguish the models created in analysis and design from each other (Arlow and
Neustadt 2005). Arlow and Neustadt (2005) state that in the design workflow, there is an involvement of technical solutions such as persistent data storage facilities and class libraries.

The analysis models are to be seen on more as conceptual models while the design models are considered physical models. The difference in the models may create a gap between the conceptual and the physical view (Arlow and Neustadt 2005).

In this section, the result of the design workflow is presented. The result is a representation of the findings of experimental prototyping in the construction phase as well as rigorous tests performed during the prototyping.

6.1.3.1 Architectural overview

The base of the system contains of one server and an web application that serves as a client to the server. The web application can be placed on any web server and provides the user with a client software that runs in the browser and communicates with the server software. An overview of the components, machines and artefacts is modelled as a deployment diagram in figure 16 where the required hardware systems are illustrated as blue boxes with either purple components illustrating pre-existing software or light red artefacts illustrating new artefacts.
The architectural overview as modelled in figure 17 describes a meta-model of the design of the artefact. The meta-model describes packages of models that represents parts (sub systems) of the whole system. The packages shown in cyan are parts of the system but not described in detail as they are loosely coupled to the communication model that is being designed. The packages shown in blue are more detailed since they do affect the communication model and consist of the sub systems that serves as the client and the server.

*Figure 17, Architectural artefact overview of the system*
Web client

The Web Client package is the part that runs in the students browser and contains the Graphical Users Interface (GUI) as well as the client side of messaging and notification mechanism. The clients are loaded from any web server, such as the Internet Information Services from Microsoft. When the web client loads in the browser a Comet long polling connection is established to the server, which has a different architecture than a normal web server (see below). The GUI uses two different connections in the background, one regular AJAX connection and one Comet connection (figure 18). The long polling connection is used to let the server notify the web client when information has been added or changed on the server.

The AJAX connection is used in the web client to add information to the server from the client, such as post new information to the server and to request information that does not need to be generated from others.

![Client-Server communication diagram](image)

Figure 18, Client-Server communication

This architecture enables the client to work as a normal rich internet application using AJAX but also adds the simulated two way communication to enable the web client to listen to events on the server.

A prototype of the GUI was built to test the abilities of the server as well as to serve as a evaluation of the concept. To enable the GUI to use as little mouse clicks as possible and at the same time create a rich overview of the discussions, the GUI is built as a framework in where applications can be placed (figure 19). The applications can be a set of discussion threads, a notification application
or any other necessary application.

Figure 19, Prototype of GUI framework

The framework is in figure 19 loaded with three applications. A is a notification application that notifies the student about recent changes. B is a application that shows the a discussion divided in three threads while C is a application that shows a two threaded discussion.

Figure 20, A notification application

Figure 20 displays the users latest notifications. The application shows the headers of all activities.
that is of interest for the user and allows the user to expand any notification to retrieve more information.

![Discussion application (no thread expanded)](image)

**Figure 21, Discussion application (no thread expanded)**

Figure 21 shows a discussion application for a discussion called “Allmänt”. The discussion contains one public and one private thread. In the discussion application the threads are presented with header and content information. The threads have to be expanded in order to display the posts.
In figure 22, a thread is expanded and an answer is being typed. Each thread shows the users that are reading it as well as the user/users that are typing. When typing each character is reported to the server via AJAX and the user that are active in the thread gets the text via Comet, character by character.

**Server**

The server package is an artefact that functions like a regular web server but instead of ending each
request when it is processed, it also have the ability to keep the connection open. To keep track of
the clients and what information they are awaiting, the server is using the publish/subscribe pattern
where the clients are subscribing to channels. When a user publishes information to the channel, all
users that are subscribing to the channel gets a response on their Comet connection informing them
which channel the response concern and what information was added/edited.

The publisher/subscriber pattern is a loosely coupled paradigm, which means that the clients do not
need to know of each others existence. This makes the pattern very useful in distributed systems
such as a web communication system (Pohja 2009).

To enable the channels to have different functionality, each channel uses a dynamically loaded
module which is loaded into the server system process when needed. The modules are disconnected
from each others but can, if needed, communicate with each others via the server. Different
applications can use multiple channels and the channels can use different or same modules. Due to
this architecture, the system can get added functionality just by adding new modules. New channels
can be created by the modules and to ensure the clients are able to subscribe to new channels, a base
channel uses a module that keeps track of the other channels and creates connections between the
students and courses based on their relations to each other.

The server can run modules in a “background” mode where the modules performs tasks without
being called by from any client. This functionality differs greatly from normal web servers where
each task performed is a result of a initiated request/response cycle. By running modules in the
background, the server can create channels that do not need a client to be the publisher. This
functionality is very useful in monitoring students activities, for example when a student is inactive
for a period. Instead of letting the client publish information that the user is inactive, a background
module can keep track of the clients and publish notifications of the inactivity to the subscribers.
This helps keep the amount of connections to the server at a minimum as well as the users activity
monitor more accurate since the server always knows when a client has been inactive.

The combination of Comet and the publisher/subscriber pattern does, however, not solve the scale
problems of regular web servers as described in chapter 3.3.1. To overcome those problems, the
incoming connections are processed on threads, but as soon as a connection has been added to a
connection handler on the server, the thread exits, leaving the new connection idle and waiting on
publishing events on the main thread. If a publisher adds information to a channel, the channel
handler creates a new thread to handle the responses to the subscribing clients. This models does not lock a thread for each connection and uses the server threads only when they are needed, on incoming requests and on responses.

6.2 Discussion

This research is conducted with a multi-methodological research approach following the design science approach by Vaishnavi and Kuechler (2008). The output of a design science research effort may result in a variety in the types of contributions (Hevner et al 2004). The precise objective of the output and contribution lacks consensus in the research community (Vaishnavi and Kuechler 2008). This research aimed at the construction of artefacts; a research aim that only recently gained some legitimacy in the IS research community (Vaishnavi and Kuechler 2008). It is, however, important to acknowledge the value of the research to the community.

Furthermore, it is important to emphasise that the suggested action to be taken in order to improve the situation is a suggestion based on a simulation to evaluate to which degree the prototype met the requirements developed from the SSM study and not how the artefacts perform in a real world situation.

It is also important to acknowledge that the SSM study was conducted on a group of students in a workshop manner. Since the students were discussing with each other during the workshops the result of the study should be interpreted with that in mind. Also peer pressure and other social hierarchies may have been of impact to the result. It should be made clear to the reader that those eventual impacts were not taken in consideration when interpreting the data. Moreover, as the author has previous experience of LMS, it must be taken in consideration when interpreting the result that the author’s structure of the SSM study may have led the students on a certain path in a similar way as a researcher with a more positive stance to the current LMSs may lead the participants on another path.

Lastly, creativity and experience plays a great role in information systems design. Even though a researcher may interpret the SSM workshop in a way similar to my interpretation, he/she may choose a completely different path in designing the artefacts.
6.2.1 Review and reflection on the design artefacts

In order to support the LMS developer community, a set of artefacts were developed. The artefacts were developed from the knowledge gained from the empirical data combined with theoretical knowledge in web based information systems development and online learning.

In order to design a new communication model with support for social awareness and thereby also create an environment where distance students can feel part of a community it is important to design a system that is aware of the users actions. The system shall inform the students of each others actions in a multi way manner; in other words, the system shall be able to initiate communication from both the client and server.

Since the distance learning is conducted in web based environments, the system has to use new techniques that incorporate new functionality in HTTP, which by design does not support other than one way communication (Wang 2008).

The developed artefacts form an architectural suggestion of how to design a communication system that combines the advantages of asynchronous communication, such as persistent storage of the posted information and a threaded structure of the discussions, with direct synchronous communication and thereby allows the users to share both contextual, planning and social information in the same function. Furthermore, the artefacts include a suggestion of how to indicate the students presence in the communication. The indication could, however, be enhanced by combining the the system with the graphical monitor developed by Jyothi et al (2007) to indicate the users actions not only in text but also in graphs.

The system architecture builds on a combination of two parts: the web client and the server. The web client is highly dependent on the techniques that fall under Comet technology, such as AJAX, to ensure a rich user interface with a simulated persistent connection to the server. The server is a form of web server that handles HTTP requests, but does not handle each request in a separate thread which makes the server able to handle multiple simultaneous persistent connections. A crucial part of the client-server communication is the use of channels and the publisher/subscriber pattern, which is used to inform the subscribing client of all activity in the channels of which the the client subscribes - even channels that runs background modules that do not need a client to publish information to subscribers.

The proposed design uses existing techniques mixed with new techniques to simulate multi way
communication. On the side of a regular web server, a new server is implemented that handles the client request in a different manner than the web server and consequently, the system simulates a two way communication between the server and client. This design bypasses the limitations of HTTP by enabling the clients to subscribe to channels on the server which updates the client when needed.

By incorporating the new design in a LMS the student would be able to, in real time, be aware of each others activities in the discussions. The design also erases the differences in chat and discussion board by making the discussion support both synchronous and asynchronous communication without any of the limitations of either of the communication types. The design radically changes the way the students interact with each other. Unlike other LMS developer approaches to enhance the social participation and feeling of community, this suggestion changes the way of interacting in the LMS rather than just use existing techniques in different manners like the virtual café in Moodle or the blog functionality in Blackboard.

This research contributes to the LMS developer community both theoretically and practically. The SSM study contributed to better understanding of the human activities that are performed by the students in learner to learner interactions. This understanding shows how the student perceive the social interactions in current LMSs. The practical contribution consists of the artefacts developed to form a new communication model that support all three types of communication described by Hrastinski (2008) and also enables the students to be socially aware in the interactions. The contribution also includes the knowledge in how to develop such a system.

6.2.2 Review and reflection on process and methodologies

Software development is hard and sometimes even impossible to realize without any guiding methodology. The selection of the methodologies is important for the success of the project and can be done in generally two different ways. The researcher can select one methodology and follow the steps carefully or she/he can select two or more suitable methodologies and adjust them to suit the specific project (Yaghini et al. 2009).

In this research, SSM is used in combination with UP. The two methodologies where selected because they focus on soft systems and hard systems, respectively.

When evaluating the contributions of the research it is important to understand how the
development process is related to the design science process. The methodological construction of the artefacts is an object for theorizing in the development community (Vaishnavi and Kuechler 2008) that can be used in future research, both as guidance but also for evaluation purposes.

![Diagram](image)

*Figure 23, Mapping of the design science steps to the research steps*

The main process of this research is conducted as described in figure 23. This process is based on the modified SSM study to generate knowledge on how to solve the problematic situation and the unified process to use the result of the SSM study to design a new system. Knowledge about the problematic situation as well as how to design the new system was gained through a set of iterations of the design science steps as described in chapter 4. Through the SSM study the problems faced by the students in the current system were captured and analysed, not only from a view point of the problematic situation in the current system, but also with a focus on how to solve the problems with a new system. Due to this shift in focus, valuable knowledge about the problematic situation where found and could be addressed immediately in the design of the new system.

Even though it felt that this approach gave a set of steps for developing the artefacts in a combined soft/hard approach with regard to both the systematic human activities and the scientific technology aspect, it can not be said that this approach is the best approach as the solution is yet to be evaluated in form of usability and performance in a real world setting. The scope of this approach does, however, include every part of the methodological scopes (except programming) as described in the

It appears that the soft systems approach was valuable in the creation of knowledge about the problematic situation faced by the students, but it did also generate knowledge of why LMSs is insufficient in supporting the students' needs of collaboration. By understanding the problem from a soft systems view, with knowledge in the human activities that take place in a LMS, the system requirements were captured with a focus on the users actions rather than the users believed needs or technology which would be the case if using a hard approach to requirements engineering, such as the process suggested in UP/UML.

Furthermore, the knowledge gained throughout the SSM study was used as a base for the hard systems approach incorporated in the unified process of developing the system. This combination proved to be valuable as it widened the horizon to include the soft systems thinking in the design creating a holistic view of the entire system including the actions taken by the users as parts of the whole system.

7 Conclusions

This chapter aims to conclude the findings of the research. Furthermore, this chapter provide a suggestion for further research on the topic as well as a reflection on the research process.

An important factor in the construction of new knowledge is the ability to communicate, interact and to acquire a feeling of social presence among classmates. For a student to feel social presence and as a part of a community is important for the students results in the studies. In on campus studies the students are able to engage in social discussions and communication that allows the students to express themselves in a way that also communicate social information. About 60 000 of the 385 000 students in Swedish universities does, however, conduct their studies through an LMS with little to no physical meetings with their classmates. The LMS is used as a virtual classroom where the students can take part of the course content and communicate with classmates. Unfortunately, the LMS’s used today does not support the students to interact in a way that is enough to enable the students to feel social presence and as a part of a community.

This research examines the LMS currently used at Linnaeus University and aims at finding reasons
for why the system is not enough to enable the students to feel social presence in their communication. By examine the reasons found in relation to technical possibilities, the aim is also to design a new system without the limitations in communication that is found in the current system. To investigate how students interact socially in an LMS and how to design a system that is satisfactory, two research questions where provided:

- (Q1) How does students perceive the social interaction in their use of a LMS?
- (Q2) How can a computer communication system be designed to provide the students with social awareness in the communication?

Literature in online learning, computer-mediated communication and web based technologies were reviewed, resulting in findings on theories of knowledge building, communication and information types used in learning. Furthermore, the literature findings included theories and patterns for web based communication design. Empirical data were collected through a modified version of SSM, used to find the problems in the currently used LMS. The empirical data was used to generate knowledge of the problems faces by the students while communicating and socially interact in the LMS. This new knowledge then served as a base for the requirements construction of a new communication system.

The analysis of the empirical data revealed that the participants felt unable to interact in a way that communicated social presence. The chat function were the only function that provided some real time feedback even though limited to only notify if a student is logged in or not, thus, the communication did not generate a feeling of community since it lacks detailed real time user feedback. Real time user feedback would allow the students to more accurately follow other students activities in the communication. The separate communication functionalities, discussion board and chat, where experienced as an inhibiting factor to the interaction since the information is instantiated as different classes depending on if the used function is asynchronous (discussion board) or synchronous (chat).

Moreover, information posted via one function is only accessible through that function, thus the students has to change communication function to communicate different types of information, which causes interruptions in the flow of interaction. This may have a negative effect on the communication since the students is at risk of not post the information at all since they felt the other alternative (change of communication function) to interrupt the flow of interaction.
With the previously stated findings as a foundation, a communication system that provides the students with social awareness can be designed by creating a system that does not separate the chat function from the discussion board function. By incorporating techniques such as Comet and a new thread efficient web server it is possible to simulate multi-way communication between the LMS web client and server and thereby enabling real time user feedback in the entire system. This design would allow for a merging of the discussion board and chat into a synchronous discussion board with user activities notifications that enables the students to be socially aware of themselves and others activities.

7.1 Reflection

The research provided new knowledge in both how to conduct academic research and system development. The literature has been valuable to gain knowledge in the psychology of learning and helped to create knowledge in current use of LMSs. Moreover, the existing literature did not only provide justification to this research by emphasizing the importance of collaboration and social presence in learning (Giannoukos et al, 2008, Franceschi and Lee 2008, Shih and Swan 2005), but also provided a knowledge base that was very valuable in the understanding of the result of the SSM study and how to incorporate the findings in a new design. The knowledge base gained from the literature in relation to the SSM study helped to create the ideas and opinions that were needed in the creativity process of designing the new artefacts.

It is important to mention the book by Vaishnavi and Kuechler (2008). Besides being a practical guide for design science research, it also provided the reader with information related to research and examples of how to stimulate the creativity, which were found very valuable.

The SSM study was performed on participants with no previous experience in SSM. They were provided with a short introduction SSM and the steps which this research follows. The introduction was given by me on the first workshop and the participants quickly understood the concepts of human activity systems and rich pictures. The root definitions and conceptual models where perceived as more complicated, but understood. Considering the change of focus in the SSM study to the new system, I got the impression that the participants where more enthusiastic in the workshop and discussion regarding the new system rather that examine the problematic situation of the current system.
When examining the LMS and the literature, it appears that designers of LMS have not aimed to develop new types of communication to fit the purpose of the LMS, but they have rather used widely used functions and put them together in a package. In my opinion there is very little difference between a discussion board in Blackboard and any of the many forums on the Internet.

I believe that the outcome of this research can very well be valuable to the future LMS developers, but also a valuable addition to the discussion mentioned by Hrastinski (2008) on “asynchronous vs. synchronous” communication in online learning.

Considering the amount of distance students in Sweden only, over 100 000 according to Högskoleverket (2009), and the large amount of unsatisfied students (Keller 2005), the need for better LMSs is crucial. The SSM study showed that the students did not perceived the social interactions to be enough in Blackboard. Therefore, it can be concluded that there is a need for a new communication model.

7.2 Future research

During this research, some important parts has been found needing further investigation.

First, and maybe most important, is to validate the need for the proposed design. Since the study was conducted on a small scale in a single university, further studies of the distance students on other universities with other LMSs as well as further studies at Linnaeus university could be carried out. Due to the limitations in the SSM study it can not automatically be assumed that the same result is valid for other universities.

Second, the design has to be tested and evaluated not only from its functions but also from its usability and effect. Research needs to be conducted in order to study if the design actually improves the students ability to perceive social interactions in the communication and thereby also improve their results. In other words, if the suggested action actually would improve the situation and make the student more satisfied. As stated in the theoretical foundations chapter, established LMS developers are re-designing their systems to enable better support for social interaction. Blackboards approach to enable blog functionality in their LMS is another way of trying to support the students needs and may very well be sufficient. Is it enough to use these “state of practice” functions and put them together in a package? Or is a change of the practice (for example in how asynchronous/synchronous communication is used) needed to enable the students to communicate
in a satisfactory manner?

Lastly, to evaluate the research design itself to examine if the design does actually provide a viable result, i.e. does the research design generate realistic outputs that can be used in real world situations?

8 References


Hevner Alan, March Salvatore, Park Jinsoo, Ram Sudha (2004), Design Science in information systems research, *MIS Quarterly* Vol. 28 No. 1, pp. 75-105/March 2004


Högskoleverket (2009), *Högskoleverkets årsrapport. Rapport 2009:12 R*, [online] Available at:


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Appendices

Appendix 1 – Rich pictures

Rich picture of synchronous communication
Rich picture of asynchronous communication
### Appendix 2 – Use cases

<table>
<thead>
<tr>
<th>Use case: BrowseDiscussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID:1</td>
</tr>
</tbody>
</table>

**Brief description:**
The system displays the discussion threads to the students

**Primary actors:**
Student (receiver)

**Secondary actor:**
Student (receiver), Student (sender)

**Preconditions:**
1. Student is logged in to the system

**Main flow:**
1. The use case begins when the Student selects “discussions”
2. For each thread in discussion
   2.1 The system add a link to the thread
   2.2 If thread is marked as interesting
      2.2.1 The system marks the thread as interesting
   2.3 If the thread contains new posts
      2.3.1 The system shows the amount of new posts in the thread
      2.3.2 For each new post in discussion
         2.3.2.1 The system displays an expandable panel with information (author, title, and content) about the post.
   2.4 For each notification on the thread object
      2.4.1 If notification is Student (receiver)
         2.4.1.1 Display the Student (receiver) in a list of readers
      2.4.2 If notification is Student (sender)
         2.4.2.1 Display the Student (sender) in a list of senders (Active participants)

**Postconditions:**
1. Student can choose one or more discussions to participate in.

**Alternative flows:**
none
<table>
<thead>
<tr>
<th>Use case: Participate in discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID:2</td>
</tr>
<tr>
<td>Brief description:</td>
</tr>
<tr>
<td>The student can read the selected discussion thread</td>
</tr>
<tr>
<td>Primary actors:</td>
</tr>
<tr>
<td>Student (receiver)</td>
</tr>
<tr>
<td>Secondary actor:</td>
</tr>
<tr>
<td>Student (sender)</td>
</tr>
<tr>
<td>Preconditions:</td>
</tr>
<tr>
<td>1. Student is logged in to the system</td>
</tr>
<tr>
<td>Main flow:</td>
</tr>
<tr>
<td>1. include (BrowseDiscussions)</td>
</tr>
<tr>
<td>2. The student (receiver) selects a discussion thread to participate in.</td>
</tr>
<tr>
<td>3. For each post in the thread</td>
</tr>
<tr>
<td>3.1 The system creates an expandable panel with information about the post (Author, Title, Content and time of creation)</td>
</tr>
<tr>
<td>3.2 Add Buttons to “Like”, “Make thread of post”, “Reply” and “Mark as relevant”</td>
</tr>
<tr>
<td>3.3 If the post parent is the thread</td>
</tr>
<tr>
<td>3.3.1 Add the posts panel in the thread display</td>
</tr>
<tr>
<td>3.4 If the post parent is other post</td>
</tr>
<tr>
<td>3.4.1 Add the posts panel to the parent posts panel</td>
</tr>
<tr>
<td>Postconditions:</td>
</tr>
<tr>
<td>1. The student (receiver) can read and participate in the thread</td>
</tr>
<tr>
<td>Alternative flows:</td>
</tr>
<tr>
<td>none</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use case: CreateThread</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID:3</td>
</tr>
<tr>
<td>Brief description:</td>
</tr>
<tr>
<td>The student creates a new discussion thread</td>
</tr>
<tr>
<td>Primary actors:</td>
</tr>
<tr>
<td>Student</td>
</tr>
</tbody>
</table>
Secondary actor:
none

Preconditions:
1. Student is logged in to the system

Main flow:
1. The use case begins when the student selects to create a thread
2. The student adds information about the thread (Topic, related course)
3. The student adds the contextual information about the thread (e.g. a question)
4. If the student selects “private discussion”
   4.1 For each student in the creating students courses
      4.1.1 The system displays the student
   4.2 The creating student selects students to be part of discussion
   4.3 The system creates the thread and adds the selected students as allowed participants
5. Else
   5.1 The system creates the thread and adds all students on the related course as allowed participants

Postconditions:
1. A new thread has been created

Alternative flows:
none

Use case: CreateThreadFromPost
ID:4
Brief description:
A student creates a new thread from a post in a discussion
Primary actors:
Student
Secondary actor:
none
Preconditions:
1. The student is logged in to the system
2. The student is participating in a discussion

| Main flow: | 1. The use case begins when the student selects “Create thread from post” on a post in a discussion |
|           | 2. include (CreateThread) |
|           | 3. The systems informs the new thread about what information to add to the thread. |

| Postconditions: |
| 1. A new thread has been created from the selected post post |

| Alternative flows: |
| none |

| Use case: MarkPost |
| ID:5 |
| Brief description: |
| A student marks a post as relevant to the discussion |
| Primary actors: |
| Student |
| Secondary actor: |
| none |
| Preconditions: |
| 1. The student is logged in to the system |
| 2. The student is participating in a discussion |

| Main flow: |
| 1. The use case begins when the student selects “Mark post” |
| 2. The student adds a motivation on why the post is relevant |
| 3. The post is marked as relevant by the student |

| Postconditions: |
| 1. A post has been marked as relevant |

| Alternative flows: |
| none |
### Use case: Read

**ID:** 6  

**Brief description:**  
A student reads a post

**Primary actors:**  
Student (receiver)

**Secondary actor:**  
none

**Preconditions:**  
1. The student is logged in to the system  
2. The student is participating in a discussion

**Main flow:**  
1. The use case starts when the user has participated in a discussion a defined time period  
2. If the student select a specific post  
   1. The post is selected as being read  
3. Else  
   1. The thread is selected as being read

**Postconditions:**  
1. The student has read a thread  
2. Other student in the same thread has been notified about the students presence

**Alternative flows:**  
none

---

### Use Case: Perform activity

**ID:** 7  

**Brief description:**  
A students activity is monitored

**Primary actors:**  
Student

**Secondary actor:**  
none

**Preconditions:**
1. The student is logged in to the system

Main flow:

1. The use case begins when the student gets logged in to the system
2. While student is logged in
   2.1. The system monitors the Student’s mouse actions and keyboard actions in the system as well as posts and read of information
   2.2. If activity is recorded
       2.2.1. include (Notify[active])
       2.3. While TimeSinceLastRecordedAction (e.g. mouse movements) is lower than defined time
           2.3.1. include (Notify[unactive])

Postconditions:
1. A Student’s participation status has been changed

Alternative flows:
none

---

**Use Case: Notify**

**ID:** 8

**Brief description:**
The system is notified on a student’s changes and relay the notification to other students

**Primary actors:**
Student

**Secondary actor:**
Students

**Preconditions:**
1. The student is logged in to the system

**Main flow:**

1. The use case starts when activity is recorded from the student
2. For each student in relation to the notifying student
   2.1. An notification is sent by the system to the related student
   2.2. The system shows the notification for the related student

**Postconditions:**
1. Students have been notified on changes made by the Student

Alternative flows:
none

Use Case: NotifyPresence

ID: 9

Parent use case: 8

Brief description:
The system is notified on a student's change in presence and relays the notification to other students.

Primary actors:
Student

Secondary actor:
Students

Preconditions:
1. The student is logged in to the system

Main flow:
1. (o1) The use case starts when a presence activity is recorded from the student.
2. (2) For each student in relation to the notifying student:
   2.1 (o2.1) A notification about the notifying student's change in presence is sent to the student.
   2.2 (2.2) The system shows the notification for the related student.

Postconditions:
1. Students have been notified on changes made by the Student

Alternative flows:
none

Use Case: NotifyParticipation

ID: 10

Parent use case: 8

Brief description:
The system is notified on a student's change in participation and relays the notification to other students.
### Primary actors:
- Student

### Secondary actor:
- Students

### Preconditions:
1. The student is logged in to the system
2. The student adds a new post
3. The student creates a new thread
4. The student is writes a post
5. The student mark a post as relevant

### Main flow:
1. (o1) The use case starts when a participation activity is recorded from the student
2. If the student writes new post, adds new post, mark new post or creates a new thread from a post
   2.1 For each Student that are present in the thread
      2.1.1 (o2.1) A notification about the changes in information is sent to the student
      2.1.2 If the new information is a new post
         2.1.2.1 A new panel for the post is created in the thread
         2.1.3 (o2.2) The system shows the new information to the student
3. If The student Creates a new thread from scratch
   3.1 For each student that has access to the new thread
      3.1.1 (o2.1) A notification about the new thread is sent to the student with access
      3.1.2 (o2.2) The system shows the new thread in the students list of threads

### Postconditions:
1. Students has been notified on changes in information made by the Student

### Alternative flows:
- None

---

**Use Case:** PostInformation  
**ID:** 11  
**Brief description:**
The user adds information to a thread

Primary actors:
Student

Secondary actor:
none

Preconditions:
1. The student is logged in to the system
1. The student is participating in a discussion

Main flow:
1. The use case starts when the student selects “new post” or “reply”
2. The system shows a text box where the student can write information
3. While the student is typing
   3.1 The character is recorded by the system
4. The post is added to the discussion

Postconditions:
1. Students has created a new post and added information to the discussion

Alternative flows:
none
Use Case: ReplyPost
ID: 13

Parent use case: 11

Brief description:
The user adds information to a thread by replying a post

Primary actors:
Student

Secondary actor:
none

Preconditions:
1. The student is logged in to the system
1. The student is participating in a discussion

Main flow:
1. (o1) The use case starts when the student selects “reply”
2. (o2) The system shows a text box in relation to the post that is being replied to, where the student can write information
3. (3) While the student is typing
   3.1 (3.1) The character is recorded by the system
4. (4) The post is added to the discussion

Postconditions:
1. Students has created a new post and added information to the discussion

Alternative flows:
none
Appendix 3 – Use case template

Use case: The name of the use case
ID: The id of the use case
Brief description:
A brief description of the use case
Primary actors:
The performing actor
Secondary actor:
Other actors related to the use case
Preconditions:
The state of the actors and system must be in in order to start the use case.
Main flow:
The flow of actions and information. Presented as pseudo code.
Postconditions:
The state of the system and actors after the use case has executed
Alternative flows:
If there are alternatives to the main flow, they can be stated here.

Appendix 4 – Sequence diagrams

The use cases realized as sequence diagrams.

Browse Discussions
Participate in discussion

1: Browse Discussions()

- loop
  - 1.1: CreateDiscussionLink()
  - alt
    - 2: Mark As Interesting()
    - alt
      - Loop through all threads
    - alt
      - Loop through all new posts in thread
    - Loop through all notifications connected to the thread

2: Mark As Interesting()

3: Add New Posts Information()

4: Add Notifications()

5: Return discussions
CreateThread

```
include BrowseDiscussions

1: SelectThread(d=22)

loop
  1. SelectPost()

alt
  2. AddPostToThread()
  3. AddPostAsReply()

4: return thread

For each post in thread

If posts parent is thread, else is reply.
```
MarkPost

Activity
Notify related students about the activity

Notify inactive