E-Learning

A study of students' attitudes and learning outcome when using blended learning with integration of multimedia instructions

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Scientific environment

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Abstract

The advent of new technologies has provided opportunities and challenges for education institutions to seek more effective ways of teaching and learning. E-learning is now an established phenomenon in education and institutions are increasing their effort to offer greater flexibility, more personalized learning, and greater learner satisfaction. Consequently blended learning has emerged as a delivery method that addresses the face-to-face advantages of a traditional classroom and the time efficiency and location convenience of an online teaching and learning environment. The opportunities of flexibility and convenience are not evident in a classroom environment. However the face-to-face interactions provide the foundation for social communication which can be critical to online learning.

Educators who are comfortable with traditional classroom delivery will meet learners' enhanced demands for flexibility through online presence for courses. As educators are generally time-pore, and with little clear direction, research can give them valuable insights into advantaged and disadvantaged of various teaching and learning formats.

This thesis examines students' attitudes when using blended learning with integration of multimedia instructions. It identifies aspects around cognitive learning outcome and provides insight into students' experiences and their overall satisfaction with this instructional design. The main objective with this initiative is to sustain the evolution from traditional teaching to active learning and to better integrate the increasing number of educational resources online. In particular this study includes aspects about students' attitudes towards using a blended learning format, learning theories, the instructional principles of multimedia production, and identification of optimal ways to use e-learning.

This thesis contributes to the field of e-learning by three main contributions (A1-A3):

A1: A contribution utilizing blended learning with integration of multimedia instructions. The quality of the blended learning format is discussed on the basis of the attitudes and experiences from the adult participants. The contribution outlines characteristics about good properties of multimedia instructions to supplement traditional classroom teaching. The content of A1 constitutes a paper that is submitted for journal publication.

A2: A model for testing the cognitive learning outcome using a blended learning format with two different teaching treatments. A2 constituted the main part of a conference proceedings paper. The study further contributes in a book with the title: Cases on managing e-learning: Development and implementation. Will be released in 2012.

A3: This contribution outlines a blended learning course design for postgraduate dental students with emphasis on flexibility and location convenience. The course was redesigned from a former traditional course format. The content of A3 constitutes a paper that is submitted for journal publication.

The research makes a contribution in the exploration of the advantages and disadvantaged of utilizing blended learning. The research methods comprise both quantitative and qualitative investigation approaches. The empirical data for this thesis were collected through 149 participating students and 13 semi-structured interviews.

The thesis supports the view of increased favorable ways of teaching and learning when using new online technologies. However no evidence for increased cognitive learning outcome was identified. Nonetheless the blended learning format with

integration of multimedia instructions holds an experienced potential for improved quality of teaching and learning in terms of enhanced satisfaction among learners.

The main findings.

The thesis contributes to the field of e-learning by the following main contributions. First, an identification of educational key issues favourable to a blended learning format with integration of multimedia instructions; second, identification of factors to produce high quality multimedia instructions; third, the design of a test procedure to conduct measurements on cognitive learning outcome based on a basic retention level and a more advanced transfer level; forth, suggestions how to improve the influence of the internet media for future postgraduate dental educational programs.

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Definitions of main terms

Application software: Known as an application or an "app", is computer software designed to help the user to perform specific tasks.

Blended learning: In this treatise it is defined as a mixture of traditional face-to-face instruction with online learning, in which the online portion is delivered via a courseware through the internet.

Educational format: A plan for the organization and arrangement of a specified teaching and learning approach.

E-learning: E-learning comprises all form of electronically supported teaching and learning. According to Horton (2006) it is "the use of computer and information technologies to create learning experiences".

ICT: Information- and Communication Technology. ICT is an extension off the earlier IT (Information Technology), but the shorter abbreviation is still used.

Instructional design: Instructional design contributes with theories about how human beings learn, strategies for applying these theories, and methodologies to carry out the strategies (Horton, 2006).

Learning: Learning is the process of transforming information and experience into knowledge, skills, behaviors, and attitudes.

Learning activity: "The interaction between a learner and an environment, leading to a planned outcome. It is the planned outcome which makes learning a purposeful activity" (Joint Information Systems Committee, 2007).

Learning Management System: A learning management system (LMS) is a software package that enables the management and delivery of online content to learners. Most LMSs are web-based to facilitate "any time, any place, any pace" access to learning content and administration. Typically, an LMS allows for learning registration, delivery of learning activities, and learner assessment in an online environment (Wikipedia, 2011). An LMS may also be called a Virtual Learning Environment.

Lifelong learning: Ongoing learning in formal, non-formal and informal ways. It stresses that learning is not restricted to the childhood, but takes place throughout life.

Multimedia learning: Multimedia learning takes place when students learn from verbal and pictorial representations such as learning from a series of narrated illustrations or a series of annotated illustrations (Harskamp *et al*., 2008; Mayer, 2009; Schnotz, 2005; Sweller, 2005).

Tool: "An instrument or automated system for accomplishing something in a better way. This 'better way' can mean that the tool makes us more accurate, more efficient, or more productive or that it enhance the quality of the resulting product" (Pfleeger & Atlee, 2010).

Virtual Learning Environment (VLE): A system designed to support teaching and learning in an educational setting for distance education.

Web 1.0 (Learning 1.0): A concept to describe a conventional development and distribution of online content. The applications are fixed, not constructed for interactions between users.

Web 2.0 (Learning 2.0): A concept to describe the way the internet allows people to interact online.

1. Introduction

This chapter outlines the aim of the study, research questions, and the motivation for conducting it. Next the perspectives of students, teachers, and facilitators are described. Further the context to blended learning and the research are presented. Subsequently limitations relevant for the research are described, and finally a thesis outline is presented.

1.1 Aim of the study

The objective of this project can be divided into three phases. In the first phase the teaching and learning qualities of the blended learning format was tested with a group of adult learners. Especially it addresses the link between a blended learning course and participants' attitudes to get an understanding of how they worked and which software applications they preferred to use (Paper 1). Asserted good learning benefits from using multimedia instructions in blended learning through individual interactions gave rice for a new study. In the next phase the goal was to design and carry out a cognitive learning test on retention and transfer to investigate if the blended learning format including multimedia instructions could be more effective for learning than traditional instructions (Paper 2). The results of the first and second phases were leading to the third phase where the procedure was to transfer the overall results into a postgraduate dental blended learning program. The goal was to determine key matters concerning the blended learning format and to identify potential improvements to reinforce future blended educational programs (Paper 3).

1.2 Research questions

The two main research questions for this thesis are:

- How can a blended learning format best serve the interests of adult learners?

- Is the blended learning format more effective for learning than traditional learning?

The specific research questions of the thesis are:

1. Which attitudes do adult learners hold towards a blended learning context including online multimedia instructions?
2. Will there be statistical evidence for better learning outcome by using a blended learning design including multimedia instructions compared with a traditional learning approach (based on subsequent retention and transfer tests)?
3. Which factors are important for postgraduate dental students when using a blended learning approach?
4. Which considerations have to be taken to improve future blended learning courses for postgraduate dental learners?

Research question 1 aims to highlight topics around adult learners' attitudes to a blended learning format including multimedia instructions.

Research question 2 focuses on the cognitive learning potentials of blended learning. The question contributes to examine the cognitive processes underlying multimedia learning. Overall, question 2 is to investigate a blended learning hypothesis pitted against traditional instructions when equivalent learning content is compared on retention and transfer measures. With emphasis on two aspects: *increased retentiveness* and *enhanced learning*, the aim is to achieve knowledge about which format that communicates the highest impact on cognitive learning.

Research question 3 concentrates on usability factors and learning effectiveness. The focus is on perceived advantages and drawbacks of blended learning to target the specific needs of postgraduate dental learners with learning interests tightly connected to their careers.

Research question 4 focuses on considerations to identify improvements that could

enhance the quality of future blended learning courses. Based on empirical data the research suggests that blended learning can be applied into new designs for postgraduate dental students.

Each of the four questions represents a thematic focus and, as a whole, they will contribute to achieve the main aim of the study. By combining learning theories with practical approaches the goal is to contribute to further development and quality assurance of following blended learning designs. The work resulted in three papers that are discussed in chapter 6: Contributions

1.3 Motivation

The motivation for research in the e-learning field is based on the perspective of using blended learning as a teaching and learning format. Blended learning that combines face-to-face instruction and e-learning has been found to be a more effective teaching approach than a pure e-learning approach (Osguthope & Graham, 2003). The concept 'blended learning' sound so simple: mixing e-learning with various types of traditional face-to-face instructions. Nevertheless many challenges lie ahead. Now that the popularity of the internet as an information source has grown extensively (Monathan *et al*., 2008), the difficult task is to find out where and how blended learning can fit into various teaching and learning settings. Further it is to identify how we achieve the best learning outcome among different groups of participants. This thesis makes its contribution to these challenges by trying to categorize and identify participants' attitudes, to investigate the cognitive learning outcome from traditional instructions pitted against blended learning, and to identify the qualities of multimedia instructions as part of a blended learning format.

1.4 The student's perspective

The anticipated advantages of blended learning for students include the opportunities of flexibility according to time and place (anytime and anywhere), and the opening of individual learning activities, communication, and collaboration in virtual environments.

Blended learning from a perspective of students in higher education should cover different stages in a course, e.g. administrative tasks, learning situations, communication and assessment. The e-learning applications should provide learning situations where various theories of learning are taken into consideration to achieve different types of learning objectives (knowledge, skills and attitudes). From a perspective of lifelong learning, learning is now no longer only divided into time and place to acquire knowledge and a place to apply the knowledge acquired. Instead learning is something that takes place on an on-going basis from our daily interactions with others and the world around us (Field, 2006). To be successful with e-learning processes, students should learn how to learn, which requires the learners to be literate with information and to select appropriate learning strategies to keep their motivation high in learning processes.

A key issue for students to be able to learn is according to White & Gear (2010) interactivity. Consequently the technology must be easy to understand and use and the technology should be designed in a way that interactions could take place on various levels and at different depths. It will allow the learners to be selective in what they read and how to get connected with the material.

1.5 The teacher's perspective

Conducting blended learning courses are usually based on a LMS e.g. Moodle, Blackboard, Fronter, and WebCT. One of the weaknesses of these systems is that they give too little attention to instructional concerns and too much to online administration (Britain & Liber, 2004). The aim of any instructional approach is to promote learning. Hence teachers must know the LMS technology according to principles of teaching and learning. Knowledge to and experience with computers is not in itself enough to bring this about. Awareness and understanding of theoretical learning principles and how to implement these theories into specific e-learning activities are important. The blended learning format appears to give an opportunity to change the emphasis from teaching to guiding, with the teacher as a facilitator (Watson, 2003). Furthermore teachers are provided with opportunities to control and facilitate the communication processes related to the diverse e-learning activities.

Online teachers have typically adopted the instructional methods of pioneer online teachers. This means that they are dependent on and limited by the learning system used. 'Many first-time users of VLE seek to adapt the way that they work to the way that the software needs things to be done' (Britain & Lieber, 2004). Many online teachers use a few instructional methods over and over again. This is convenient for inexperienced online teachers. Britain & Lieber (2004) concluded that the majority of VLE's were designed to support an education based on information transmission. However, a model of information transfer alone does not take into consideration the instructional challenges facing teachers and students in online communities. The need among teachers to have enhanced opportunities to initiate and control various instructional designs has been expressed by Griffiths & Blat (2005). They argued the following: 'a number of teachers and learning providers have voiced their opinion that a methodology is required for the first stage of analysis and the creation of the

didactical scenario' (ibid.).

1.6 The facilitator's challenge

A facilitator in this regard is a person who helps to assists with theoretical and technical advices to plan and produce teaching and learning activities. In other words it is someone who knows how to take advantage of learning theories and how to put e-learning activities into action.

It is important that the blended learning design includes a reasonable balance between traditional face-to-face activities and online activities. Osguthorpe & Graham (2003) stated that a vital element in blended learning is to find an advantageous balance.

The design of activities for blended learning is to mix and match what is best for each mode of instruction. This, to a large extent, depends on the blended learning course itself. The blended design must take advantage of the best instructional methods of both face-to-face learning and online learning to create a balance that is taking full advantage of both learning approaches.

When it comes to software based on learning theories, there have been many e-learning solutions conducted to blended learning programs the last decade. A drawback with these many initiatives is according to Roda & Nabeth (2005) often an information overload. They argue by saying: 'This richness of information and tools, whilst having the advantage of creating much more challenging and stimulating environments, often results in the well-known problem of information overload'.

Blinco *et al*. (2004) claims that 'rarely are technologies used in e-learning developed specifically for the learning community'. In the software development process of e-learning applications there is a demand for awareness and understanding of

theoretical learning principles. Because an e-learning teacher does not have any face-to-face interaction with the learners, they are solely connected via the internet. Thus development of effective online material should be based on proven and sound learning theories.

1.7 The blended learning context

In this thesis blended learning will be viewed as the combination of face-to-face and online learning, enabling learning to be extended beyond the classroom and providing opportunities for reflection, interaction, and further engagement with the learning material. We used the mix of traditional face-to-face instructions led by a teacher and online learning in which the online portion was delivered via a courseware. The aim was to choose a mixture that would motivate the students and assist them in successfully mastering the course.

1.8 The research of the study

The research presented in this thesis is conducted within the framework of three research projects. Project number one was a learning course for editors of online information arranged by the Faculty of Medicine and Dentistry, University of Bergen from February to June 2008. Participants were interviewed at the end of the course to identify their attitudes towards the blended learning format and usability factors of utilizing multimedia instructions to compliment classroom instructions. The second project was a cognitive learning test program conducted at seven high schools in natural science. The project presented a test design which compared the learning

outcomes of students who were exposed to two different approaches: a blended learning approach pitted against a traditional approach. The third and final project was a blended learning dental course in clinical pharmacology for postgraduate students arranged by the Faculty of Medicine and Dentistry, University of Bergen in November 2010. Students were interviewed at the end of the course to identify their attitudes, satisfaction, and recommendations to specify improvements for subsequent courses.

The target groups of the qualitative case studies in the research projects 1 and 3 were adult learners. The cognitive learning test of project 2 was conducted with K12 students at various high schools in the city of Bergen, Norway.

1.9 Limitations

Theoretical limitations

The aim of the study is to cast light on the qualities of utilizing the blended learning format by implementation of theoretical principles into the instructional design process. It is of cause not possible to cover all theoretical principles in one study. It was necessary to limit the instructional theories to the behaviorist-, cognitive- and constructivist learning theories. The main reason why these different theories were chosen is because they have various approaches to learning and the learning system. The learning theories can be used to motivate learners, build the whole person, cater for individual differences, promote meaningful learning, encourage interaction, provide feedback, facilitate contextual learning, and provide support during the learning process (Ally *et al*., 2004). Further they are well documented in the literature as contemporary theories for e-learning activities.

Empirical limitations

The number of participants in the case studies using qualitative approaches were small (n=9 and n=6). Nonetheless the blended learning settings, as presented, were ideal to the small numbers of students because they could interact with the content and remain in close face-to-face contact with the instructors and the project group members.

Population limitation

The study uses data samples gathered from educational institutions in Norway. The fact that the participants come from a rich country with a corresponding homogeneous and well-organized school system limits the generalizability of the results. Other studies from different nations, cultures, and contexts should be gathered to confirm and refine the results of this study.

1.10 Outline of the thesis

The thesis is structured as follows:

Chapter 2: Philosophy of teaching and learning

In this chapter the most important contemporary teaching and learning theories are presented. Further the chapter tries to give a framework that covers the central philosophical fields related to the topics of this thesis.

Chapter 3: The e-learning field

The chapter gives a description of the e-learning field and presents issues around the blended learning format. Further it discusses perspectives on instructional design related to learning theories in order to provide a context to the aspects of the thesis.

Chapter 4: Theoretical framework

The chapter gives a representative sampling of the most essential theoretical topics that are fundamental for this doctoral thesis.

Chapter 5: Methods and research design

This chapter gives the methodological foundations for this study. Further it gives reasons for the chosen research methods, and the implications of the choices made during the research processes.

Chapter 6: Contributions

This chapter presents the main contributions of the thesis. A summary of each paper is presented and each paper is connected to the specific research questions it answers.

Chapter 7: Evaluation of the research questions

The chapter first evaluates the research questions before moving on to the evaluation of the main contributions. The contributions are discussed and linked to theories. Finally the validity of the study is evaluated and some reflections on interdisciplinary research are provided.

Chapter 8: Conclusions

This chapter concludes the thesis and provides proposals of further research.

Chapter 9: References

Appendices:

Appendix A contains the papers, which the thesis is based upon.

Appendix B is questionnaires to the multimedia learning test of paper number 2.

Appendix C is examples of the multimedia instructional files.

2. Philosophy of teaching and learning

The chapter tries to give a framework that covers central contemporary philosophical aspects of this thesis on teaching and learning and their impact on science education.

Philosophy (Greek word, from *phileîn*, 'to love,' and *sophía*, 'wisdom,') is the study of the most general and abstract features of the world and categories with which we think: mind, reason, proof, and truth. In philosophy, the concepts with which we approach the world themselves become the topic of enquiry.

2.1 Introduction

The idea of this chapter is to present contemporary teaching and learning theories with relevance to the study. Because the understanding of the topics teaching and learning is characterized by complexity, the present chapter tries to give directions to explain central philosophical orientations of the field. The interest of the chapter will focus at epistemological topics from the mid-twentieth century, when the disciplines of child development and origin of knowledge expanded (Berk, 2009). The central concern is the nature and scope of knowledge. The various theories which emerged in that period still continue to be central in understanding how knowledge is generated. These theories have now been integrated in more complex perspectives of epistemological considerations, which are described in the paragraph of 'new directions'. Finally theories of learning and their impact on science education will be discussed. The aim has been to depict patterns of some of the most important theories.

2.2 Philosophy of teaching and learning

Philosophy of teaching and learning refers to the academic field of applied philosophy. Its central subject matter is education, and its methods are those of philosophy.

2.2.1 Trendsetters on thought and language

Jean Piaget (1896-1980), the founder of a theory called 'genetic epistemology'. The idea of different stages of a child's maturation had been further developed by the psychoanalysts Freud and Erikson. For Piaget, the focus on stages was not so much an issue of emotional maturation as of cognitive development. As structures of the body are adapted to fit the environment, so do the structures of the mind develop in the course of infancy and childhood to adapt to external reality. He believed that as the child grows older, it traverses a series of broad stages of development, each characterized by a qualitatively different organization of cognitive structures. Piaget argued as follow:

> *Fifty years of experience have taught us that knowledge does not result from a mere recording of observation without a structuring activity on the part of the subject. […]. Knowledge proceeds from action, and all action that is repeated or generalized through application to new objects engenders by this very fact a 'scheme', that is a kind of practical concept (Piaget, 1980, p. 23).*

According to Piaget, the speech of the small child is often egocentric, not used for social dialogue, as the child is yet unable to take on another person's point of view.

Later, the child's internalized mental structures become the more organized thinking of the elementary school child, who can handle concrete problems in a logical fashion. In the formal operational stage, which starts around 11 years of age, the structures become the abstract, logically organized system of adult intelligence. Within each stage, equilibrium has to be reached before the child could go on to the next (Berk, 2009).

Piaget thought that little could be done by means of strategically teaching and training, or to accelerate the child's movement through the stages. Instead, the child had to act directly on experience and initiate his or her own cognitive transformation. However, a rich and stimulating environment was still considered important for the developmental change to take place at the optimal pace (Berk, 2009).

To arrive at these conclusions, Piaget used careful observation of children at different ages. In addition, he used his method of clinical interview, which was not standardized questionnaires with 'right' or 'wrong' answers, but the interviews were flexible and with open-ended questions, so that the notion of the child might be clarified (Berk, 2009).

In Russia, Lev Vygotskij (1896-1934) founded a school of thought that was later further developed by Alexander Lurija (1902-1977) and others. In the preface to his main work, 'Myshlenie I rech' (= Thought and Speech), published in 1934, Vygotskij states that the object of study is one of the most complex in psychology, and that this problem has not yet been investigated in a systematic fashion. The book attempts at least a first approach to this task by conducting experimental studies of a number of separate aspects of the total problem: experimentally formed concepts, written language in its relation to thought and inner speech. (Vygotskij & Kozulin, 1986).

Vygotskij concerned himself with the evolution of thought and language in the social context. He reasoned that language evolved both historically and for the child, as a means to communicate with the surrounding world. 'Inner speech' is the term used by

Vygotskij and followers to refer to internal psychological processes, because these processes were viewed as deriving from and reflecting the process of social speech. Humans differ from animals because, with the transition to sociohistorical existence to labor, language was needed and appeared (Lurija & Wertsch, 1982).

Vygotskij's 'inner speech' works with semantics, not phonemics. The syntax of meanings of inner speech is seen as equal original as its grammatical syntax. He found three main semantic characteristics of inner speech, of which the first and basic one is the predominance of the 'sense' of a word over its 'meaning'. (The other two are concerned with word combination).

The 'sense' of a word is the sum total of all the psychological events aroused in our consciousness by the word. It is a dynamic, fluid, complex whole, with several zones of unequal stability. 'Meaning' is only one of the zones of sense, the most stable and precise zone. A word acquires its sense from the context; in a different context the sense will be changed. Meaning, on the other hand, remains stable throughout the changes of sense. 'This enrichment of words by the sense they gain from the context is the fundamental law of the dynamics of word meanings. A word in a context means both more and less than the same word in isolation: more, because it acquires new context; less, because it meaning is limited and narrowed by the context' (Vygotskij & Kozulin, 1986).

Noam Chromsky (born 1928) is the founder of a theory called 'generative linguistics'. He pointed out the fact that children can produce sentences they have never heard. This, along with the additional fact that a normal six year old child has a vocabulary of around 10,000 words (Berk, 2009), made Chomsky suggest that human children are endowed with a 'universal grammar' in their cognitive system (Piattelli-Palmarini, 1980). He argues 'Language acquisition is something that happens to a child placed in a certain environment, not something the child does' (Chomsky, 1993).

2.2.2 Theoreticians' orientations compared

The works of Piaget, Vygotskij, and Chomsky are not easily reconciled. To Piaget, the child is by itself constructing meaning and structure from its own action on the surroundings. To Vygotskij, the language and all other knowledge and skills are developed in the dialogue between the child and the surroundings, while to Chomsky the child is born with a certain ability to acquire language and meaning.

The main difference between Piaget and Vygotskij is that Piaget sees the child as developing according to an inherited program. In his 'cognitive-developmental theory', children on their own hand actively construct knowledge as they manipulate and explore their surrounding world, while Vygotskij sees the development as almost totally depending on social factors. His perspective, known as the 'sociocultural theory' how social interaction, in particular dialogues between children and more knowledgeable members of society, is necessary for children to acquire the way of thinking and behaving that make up a community's culture (Rowe & Wertsch, 2002; Berk, 2009)

The three depicted theoreticians, Piaget, Vygotskij and Chomsky, with different attitudes regarding preconditions for requirement of knowledge, all seem to agree on the following issues:

- that concepts are more fundamental than language
- that thinking is a cognitive process that encompasses more than language
- that language is only important for this process for two reasons: A) to make the process or results conscious. B) to make it possible to transfer the results to other people or to paper. (Piattelli-Palmarini, 1980; Vygotskij & Kozulin, 1986).

2.2.3 New directions

In recent years new theories have been developed regarding acquisition of knowledge. They integrate variable systems. One of the new views is called ‘dynamic systems perspective’ (Fisher & Bidell, 2006; Spencer & Schöner, 2003; Thelen & Smith, 2006). According to these views cognitive processes that guides to mastery of new skills are located in an integrated system, which is formed of the human mind, body, and physical and social worlds. The system is dynamic or constantly in motion. A change in any part will disrupt the relation between organism and environment. When this happens a behavior actively has to be reorganized so that the components of the system can work together again, but in more complex and effective ways.

2.3 Learning

In this thesis learning is defined as the process of transforming information and experience into knowledge, skills, behaviors, and attitudes.

2.3.1 Modern theories of learning

The act of learning involves essentially two types of activity (Quale, 2008):

- Perception (the reception, by the learner of sensory and/or emotive input)
- Reflection (the processing of perceived input, in the mind of the learner)

In the young academic discipline of psychology educational theory has played an important role. Two of the main theoretical and methodological grounds in the previous century were behaviorism and the opposing Gestalt[1] psychology, which can be related to the cognitive theory of learning (Vygotsky & Kozulin,1986; Blackburn, 2008). To behaviorism, all that is possible to study is the behavior of the animal or person who has learned something, but neither the content of the learning, nor the actual process by which it was learned, is accessible to study. This theory is connected to the experiments of Pavlov, who conditioned his dog to salivate at the sound of a bell. To the defenders of this theory, knowledge resides in muscular reactions, not in cerebral exercise. Certain kinds of knowledge are certainly learned by training the muscles, such as how to ride a bicycle. This can be connected to what may be called 'procedural learning'. The memory also learns by 'declarative learning' to store information about names, places, and events. Both of these types of learning can be explained by the behaviorist theory (Sprinthall, Sprinthall & Oja, 1998).

Behaviorism may be associated with the association learning theory, while the opposing 'Gestalt' may be connected with the cognitive theory of learning:

Association theorists see learning as the result of connections (associations) between stimuli (sense impressions) and responses. Dogs salivating or fifth-graders saying 'seventy-two' to the stimulus of 'nine times eight' are all examples of association learning. A bond has been formed between the two elements, a stimulus and a response (ibid).

Cognitive theorists, on the other hand, view learning as a reorganization of a number of perceptions. This reorganization allows the learner to perceive new relationships, solve new problems, and gain a basic understanding of a subject area. A fifth-grader

[1] The key terms of Gestalt are germane, configuration, pattern, and organized whole. The theory developed in opposition to the classical model of the empiricists (Blackburn, 2008).

suddenly realizing that multiplication is successive addition; an ape suddenly understand that by putting two short sticks together, a banana that was out of reach is now obtainable. These are examples of cognitive learning (ibid).

The study of learning has been of great importance both in early psychology and in more recent advances. The debate between the behaviorists, with B. F. Skinner (1904-1990) as their main proponent, and the cognitive-gestaltists led by Jerome Bruner (born 1915) has waged back and forth.

From Skinner's work came the educational tool of 'programmed instruction' in the 1950's and 1960's, whereby the child was led, step by step, through a subject with each little bit of success reinforced. Good teaching according to this view is to arrange the proper sequence of reinforcements and to make sure that these reinforcements will be given when and only when the student is giving the wanted response. Skinner used his system to explain all animal and human learning. For example, Skinner believed that learning to talk follows the principles of operant conditioning, whereby some chance utterance by the baby is reinforced by the mother, and thus becoming more likely to be uttered again. In contrast we have Bruner as the main proponent of the gestalt-cognitive school (Sprinthall, Sprinthall & Oja, 1998).

Bruner insists that the final goal of teaching is to promote the 'general understanding of the matter' […] 'grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully' […]. He stresses the importance in learning of forming global concepts, of building coherent generalizations, of creating cognitive Gestalts (ibid).

Bruner sees it as more important that the students learn the structure of a subject than its many details or facts. He sees the motivation of the learner as the driving principle and holds the intrinsic motivation of the individual to be the main force in learning, although he agrees with Skinner that reinforcement may be important in some instances, especially as feedback informing the student whether a problem is correctly

solved or not. He deems it important for the teacher to arrange for the student to learn by discovery, if not from scratch, then from questioning and prompting from the teacher.

David P. Ausubel (1918-2008) belongs to the cognitive school. He criticizes most fellow psychologist for not distinguishing between different kinds of learning. He acknowledges the behaviorist approach to the rote learning, but sees the need to clearly distinguish this from meaningful learning, which includes concept formation and verbal and non-verbal problem solving. He also sees a distinction between reception learning and discovery learning. According to his understanding it is essential that verbal reception learning is not necessarily rote in character. He also sees an important distinction between a 'theory of learning' and a 'theory of teaching' (Ausubel, 1968; Ausubal & Robinson, 1969).

2.3.2 Science learning

In principle, science learning might be learning from nature (Dewey, 1944). However practice and theories have varied from rigid transmission, to the concentrations on formulas and correct quantitative problem-solving, to extensive use of experiments and science projects, whereby the students are supported to re-discover the now-established laws of nature. These are extremes. The first practice, build on transmission of knowledge and technique, is partly building on the theory that the learner is a 'tabula rasa'[2], and partly based on the attitude that knowledge is based on facts found in the textbook and in the curriculum. As a contrast to this, constructivist

[2] *Tabula rasa* (Latin, blank tablet or slate). The term is used to indicate the state of mind on which no sensation has been impressed.

theory has become the dominant theory of science learning (Grandy, 2007). One of the theorists who had a growing influence on the theories of learning and conception is Vygotskij. Already in the 1920s he expressed: ‘Education is realized through the student’s own experiences, which is wholly determined by the environment, and the role of the teacher then reduces to direction and guiding the environment’ (Vygotskij, 1997). Central to his theory was the concept of ‘mediation’, the use of mental tools such as language. These are used by the teacher in the interaction with students, and the students learn them, and can use these tools in their own cognitive activity. Systematic cognitive mediation involves teaching, so that they can acquire what Vygotskij calls ‘scientific concepts’ as opposed to ‘spontaneous concepts’ that result from generalization and internalization of everyday personal experience in the absence of interactions and corrections from more knowledgeably adults and peers. The scientific concepts, in contrast, represent the generalization of the common human experience and thoughts, and may become internalized in the learner through active mediation form those who already have them (Karpov & Haywood, 1998).

According to Vygotskij, learning can only take place in what he called zo-ped ‘the zone of proximal development’, that is on the borders of what the learner already can and knows (Vygotsky, 1934). In a group of peers, these zones will only partly overlap and collaboration between learners should move the zones along more effectively than if one learner was taught or studying alone.

According to Philips (2007) the educational literature on constructivism is enormous and growing rapidly. He himself offers an introduction of viewing the various forms of constructivism. He defines different dimensions to this broad field of educational theory and research, which clarifies relationships and differences between constructivist orientations. But to delve deeper into these theories would be to go outside the scope of this study.

As a consequence to the discussed theories, we should be able to conclude that the most efficient teaching would be when a teacher teaches a group of students that is allowed to interact constructively. The students could help each other to construct new knowledge that would be necessary for the situation and the teacher could intervene, but should preferable allow the students to struggle with challenging tasks by themselves. Thus the theory of meaningful learning held in the present study is a combination of the personal constructivism of Piaget and followers, and the socially transmitted knowledge of Vygotskij. A student's learning, then, is basically constructivist, shaped in his or her own mind, but is also a result of the common work of learner, teacher, and peers.

2.4 Summary

The objective in this chapter has been to address or bridge the principles of philosophy into general identities of learning theories and education. The purpose of depicting philosophical characteristics has been to understand and guide the realization into both theoretical and practical dimensions of education.

In the context of this study the question of development of learning and educational strategies has been of interest. These philosophical theories discusses above are all related to considerations behind the blended learning format and accordingly to the research of this thesis.

3. The e-learning field

The e-learning field in this thesis is defined as all applications which represent online teaching and learning elements of a blended learning context. Firstly the chapter gives an introduction to the term e-learning and how the term generally is considered. Then the chapter presents the blended learning format and discusses various perspectives on instructional design related to learning theories. Further, in order to provide a context to the case studies of the thesis, it describes some criteria to students' perceived learning and the definition of adult learning. Subsequently a state of the art introduction to e-learning and blended learning is described. Two large-scale quantitative studies from higher education are presented to indicate how students have adopted digital devices into their learning activities and finally trends in e-learning are presented.

3.1 Introduction

Thanks to information and communication technologies a remarkable change in education has followed. Many different methods, techniques and approaches have been developed and implemented to realize requirements for educational purposes (Köse, 2010). Distance education is one of the important branches that are related to the use of information and communication technology in education. Distance education employs different methods and technologies that enable people to get an education from anytime, anywhere. It is defined as a planned education experience with various technologies to reach students in remote places and encourage them to interact with various education activities via special techniques (Greenberg, 1998; Kaya, 2002; Keegan, 2004; Passerini & Granger, 2000). Distance education activities

have so far been done by using television, radio, video cassettes, letter and CD-ROMs. With the rapid improvements in technology, more powerful and effective tools like internet, computers and mobile devises have become apparent in distance education systems. Using these electronic devises to perform learning activities has created a new type of distance education called e-learning.

3.2 E-learning

In the past, the term e-learning referred to any method of learning that used electronic delivery systems. With the development of the internet however, e-learning has evolved and the term is now commonly used to refer to online technologies to create learning experiences. The popularity of the internet as an information source for e-learning has grown extensively (Monathan *et al*., 2008). My attention towards e-learning has been in regard to the educational benefits of combining e-learning with traditional instructions, also called *blended learning*. More specifically, I have been interested in investigating the learning benefits from integrating online course material presented in interactive applications for learners as a supplement to a traditional teaching approach.

3.3 Technology-based learning

E-learning is a part of the comprehensive term Technology-Based Learning (TBL), which constitutes learning via electronic technology, including the internet, intranets, and satellite broadcasts. TBL promotes a great accessibility to learning by offering anytime and anywhere delivery. Especially the internet has become a convenient and

ideal medium for dispersal of learning content. The most common delivery methods and tools used in TBL environments are electronic mailing lists, wikis, virtual collaborative workspaces, blogs (weblogs), multimedia instructions, online forums, web conferences, and LMSs (Cavus, 2010). Koller *et al*. (2008) stated five primary benefits using TBL compared with face-to-face instructions:

1. Accessibility, offering anytime and anywhere delivery.
2. Training that is self-paced and matched to the learners' needs.
3. Full scalability (referring to the number of learners).
4. Timely dissemination of up-to-date information.
5. Streamlined and effective delivery.

Because of the convenience of the internet for dispersal of learning content delivery many learning institutions now provide websites, where tutors upload course material including text, images, and links to external knowledge sources. Initially these websites were a mere repository of knowledge and information, simply providing course material in HyperText Markup Language (HTML) format for students to access, read and learn from, also called Web 1.0 (Brown & Adler, 2008). Since 2004 the development of Web 2.0 has made the delivery applications far more sophisticated. In the following two paragraphs I will explain the ideas behind Web 1.0 and Web 2.0.

3.3.1 Web 1.0 (Learning 1.0)

The idea of learning through digital connections was the link between web and e-learning. The typical challenge with using the Web 1.0 technology are so called *Learning 1.0* activities including basically conventional models of learning. There is a publisher and distributer of content and there is a consumer, who has no say (Padmanabhuni, 2008). The websites are not interactive. Under this philosophy

applications are developed and distributed so that users can download them, but he/she cannot see how the application works or change them. The Web 1.0 and Learning 1.0 strategies have emerged since the mid-1990s and have had a huge impact on education. If we interpret Web 1.0 from a pedagogical perspective there is no difference in the role of the instructions compared to teacher controlled lessons. The instructor is the content creator and the expert who delivers information to the learner. The vast majority of learners are simply acting as consumers of content (Cormode & Krishnamurthy, 2008).

3.3.2 Web 2.0 (Learning 2.0)

Web 2.0 refers to a social use of the Web and allows people to collaborate. Web 2.0 is rather a concept than physical technology, to describe the way the internet allows groups to interact online. Consequently it is the idea of learning through digital connections and peer collaboration. These tools present a user centric information infrastructure that emphasizes participation and provides instructors and learners with complex management systems to present course notes, lecture slides, and additional material online. Generally Web 2.0 systems gives potential to learning platforms that enables delivery, tracking of learning, testing, communication, scheduling, submit and return of assignments, and share of materials. Furthermore, access rights and course registration are provided by these applications (Lonn & Teasley, 2009). Embedding Web 2.0 tools in education is changing the role of the teacher. Redecker *et al*. (2009), states the following of the teachers role:

> *Under the Learning 2.0 paradigm, teachers can be conceived of as 'scaffolding', i.e. as guides, coaches, moderators, who provide a supportive environment in which learners can learn – with one another*

> *and from one another – in the way that best fits their individual learning needs, preferences and strategies (p. 95).*

As a result the learner moves to the centre of the learning process as an active creator of content. This user-centered approach enables students to increase and develop their capacities.

In addition one of the key aspects of using Web 2.0 software is that it involves a wider participation in the creation of information which is shared (Franklin & van Harmelen, 2007). Web 2.0 technology allows participants to gather resources, share the resources with others and facilitate active participation of each user (Minocha, 2009). Referring to Parameswaran & Whinston (2007) we can categorize Web 2.0 software as 'applications and services that facilitate collective action and social interaction online with rich exchange of multimedia information and evolution of aggregate knowledge'.

3.4 Definition of blended learning

Blended learning has gained considerable attention in the research literature but there appears to be little consensus on its meaning and approaches to its practice. Discroll (2002) refers to four different meanings of the term:

1. To combine or mix modes of web-based technology (e.g., live virtual classroom, self-paced instructions, collaborative learning, streaming video, audio, and text) to accomplish an educational goal.
2. To combine various pedagogical approaches (e.g., behaviorism, cognitivism, constructivism) to produce an optimal learning outcome with or without instructional technology.
3. To combine any form of instructional technology (e.g., videotape, CD-ROM, web-based training, film) with face-to-face instructor-led training.

4. To mix or combine instructional technology with actual job tasks in order to create a harmonious effect of learning and working.

From an in-depth study, Oliver and Trigwell (2005) identified a number of varied definitions of blended learning. They categorized them into the following seven areas:

1. Mixing e-learning with traditional learning.
2. Mixing e-learning with face-to-face instructions.
3. Mixing media.
4. Mixing contexts.
5. Mixing theories of learning.
6. Mixed learning objectives.
7. Mixed pedagogies.

Blended learning has increased the possible ways learners can acquire knowledge, with learning occurring across different mediums and various times (White & Geer, 2010).

In this study blended learning will be viewed as the combination of face-to-face and online learning, enabling learning to be extended beyond the classroom and providing opportunities for reflection, interaction, and further engagement with the learning material. I used the mix of traditional face-to-face instructions led by a teacher and online learning in which the online portion was delivered via a courseware through the internet. The aim is to choose a mixture that will motivate the students and assist them in successfully mastering of a course (Alonso *et al*., 2005; Bersin, 2004; Thorne, 2003). Accordingly blended learning courses provide a particularly interesting subject for research into the subject of e-learning. Such courses involve a mixture of traditional instructions and e-learning activities and are typically run on campus (Stubbs *et al*., 2006). According to the Centre for Educational Research and Innovation (CERI) (2005) blended learning is gaining in prominence globally as information and communication technology (ICT) is deployed to complement rather than replace traditional forms of learning (Mitchell & Forer, 2010). It has increasingly been adopted by higher education institutions (Koohang, 2009). Elearnspace (2005)

states that: *Blended learning takes the best of both worlds and creates an improved learning experience for the students*.

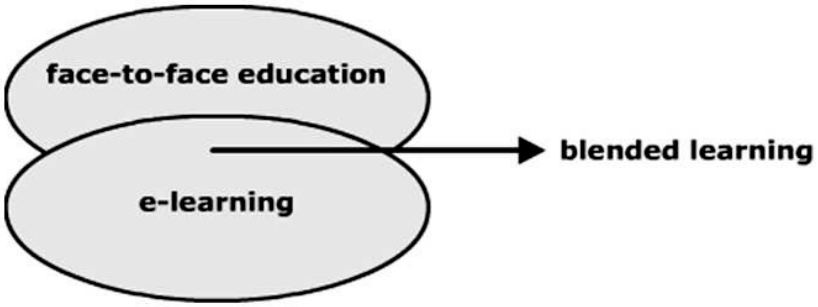

Figure 1: A diagram of the blended learning formed to combine face-to-face instructor-led training and e-learning (adopted from Köse, 2010, p. 2797)

3.4.1 The balance of activities

It is important that the blended learning design includes a reasonable balance between traditional face-to-face activities and online activities. Osguthorpe & Graham (2003) stated that a vital element in blended learning is to find an appropriate balance between face-to-face and online activities. They argue:

> *The balance for online and face-to-face components will vary for every course. Some blended courses, because the nature of the instructional goals, student characteristics, instructor background, and online resources, will include more face-to-face than online strategies. Other courses will tip the balance in favor of online strategies, using face-to-face infrequently. Still others will mix the two forms of instruction somehow equally (ibid. p. 223).*

The design of activities for blended learning is to mix and match what is best for each mode of instruction. This, to a large extent, depends on the blended learning course itself. The blended design must take advantage of the best teaching and learning methods of both face-to-face learning and online learning to create a balance that is taking full advantage of both learning approaches.

Figure 2 depicts the balance activities between face-to-face and online learning. There are activities that are more suitable for face-to-face portions of blended learning. The same is valid for online portions of the blended learning.

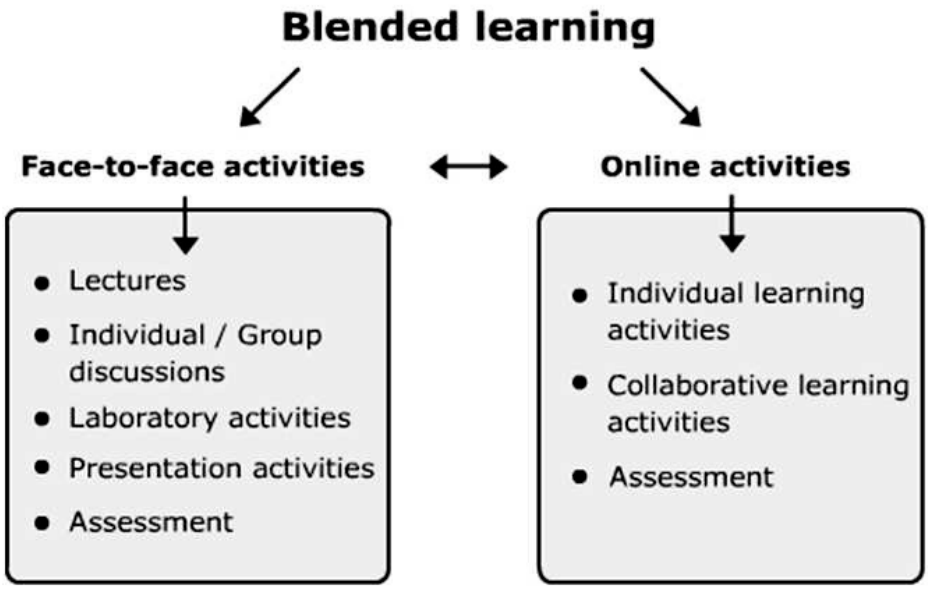

Figure 2: The balance between face-to-face activities and online activities in blended learning (adopted from Koohang, 2009, p. 79)

3.5 Instructional perspectives of e-learning

Principally there are two fields that deal with the implementation of e-learning: the instructional perspective and the theories of learning. The latter has a dominant position. It is difficult to compare and classify in fields like this, because learning theory is a part of teachers' and facilitators' instructional considerations. The distinction tries to express something about the focus in research on implementation of e-learning in teaching.

Accepted theories of learning, e.g., activity theory (Engström, 1987) and situated learning (Lave & Wenger, 1991), are generally inspired by socio-cultural approaches, which claims that human action is mediated by tools or artifact. Following this approach, research on e-learning in education may be considered as defining e-learning as an artifact.

The instructional perspective is apparently less developed in the discussion about e-learning and its impact on teaching and learning. That is why it is emphasized in this thesis. Laursen (1994) defines instructions as the field of educational theory that provides guidelines and tools that are used to develop the practice of teaching. Instruction is consequently a way of concretizing and providing the term of teachers' work. The two fields, instruction and theories of learning, complement each other because of their shared focus on understanding and casting light on the complexity of the social interactions and environment of the learning process (Hokstad, 2002).

The term of instructional design is according to Newby *et al*. (2006) looking at instructions in a general way. 'Instructional design is the process of translating principles of learning and instruction into plans for instructional materials and activities. The emphasis is on creating a plan for developing instructional materials

and activities that increase an individual's learning' (ibid). Some consider technology to be included in instructional design. Reiser and Dempsey (2002) acknowledge this and introduces the concept of 'instructional design and technology' in order to clarify the use of the concept. Gustafson and Branch (2002) are reflecting on uncertainties in the literature about instructional design: 'It is important to note that there is some confusion in the literature on instructional design because the term *instructional development* also has been used to describe the entire process'. When instructional development is used to describe the overall process, the term instructional design is often understood as the design element of Analysis – Design – Development – Implementation – Evaluation (ADDIE), where design includes writing objectives in measurable terms, classify learning as to type, specifying learning activities, and specifying media (ibid). Reigeluth (1999) defines instructional design theory as following: 'A theory that offers explicitly guidance on how to better help people learn and develop'. Further he argues 'In contrast to learning theories, instructional design theories are more directly and easily applied to educational problems, for they describe specific events outside of the learner that facilitate learning, rather than describing what goes on inside a learner's head when learning occurs' (ibid).

The history of instructional design goes back to the 1960s. At this time Silvern (1965) published what might be the first instructional design model of how general systems theory could be used to create effective and efficient aerospace and military training. During the 1970s the use of instructional design systems had become common in all branches of the military and accepted as standard training methodologies in many large organizations throughout the world. 'A factor that did have a major effect on instructional design practices in the 1980s was the increasing interest in the use of microcomputers for instructional purposes' (Reiser, 2002). Following many instructional designers turned their attention towards producing computer-based instruction. During the 1990s the growing interest in constructivism and the rapidly increasing interest in using the internet for distance learning had significant impact on

instructional design principles and practices (ibid).

3.6 Learning through interactions

Reflecting on instructional designs with emphasis on interactions, a key issue should be what makes interactivity successful and what can be learned from interactivity (White & Geer, 2010). 'Interactivity […], is critical in determining the structure and depth of the interaction, and in promoting active learning through frequent exchange and reflectivity' (ibid). Gilbert & Moore (1998) asserted the amount and quality of interaction as crucial for the learning process while also having a significant impact on the learning outcome. In the present study the online learning environment was designed in a way that interactions could take place on various levels and at different depths. It allowed further the learners to be selective in what they read and to get connected with various kinds of supplementary material.

A further advantage of online environments is the new understanding that can emerge from interactions with peers and the teacher. An online environment provides the sources for discussion, while the technology mediates how the interactions can occur. Thus the use of technology can provide opportunities for learners to revise and reconstruct their views and make substantial changes to the way they interpret their world through collaborative activities (Farouck, 2010). Consequently communicative technologies have the ability to facilitate the construction of new and meaningful knowledge. To provide a beneficial learning environment the instructional design of a course should be govern with good educational practice. Kuo *et al*. (2009) found that 'the combination of interactions significantly predicted learner course satisfaction'. Blended learning has increased the possible ways of collaborative interactions. This mode of teaching and learning brings people together physically as well as cater for

social collaborative interactions over the internet. Thus the opportunities have grown via the blended learning structure to allow learners to interact both face-to-face and technology mediated while providing them with flexibility and convenience (Koohang, 2009).

3.7 Designing online learning materials

The aim of any instructional approach is to promote learning. Hence educators and developers must know the principles of learning and how students learn. Because an e-learning instructor do not have any face-to-face interaction with the learners, they are solely connected via the internet, awareness and understanding of theoretical learning principles is important in the development of learning activities. Development of effective online material should be based on proven and sound learning theories.

Different theories have various approaches to learning. The developer of online learning materials must know these different strategies of learning in order to select the most appropriate instructional approach. According to Hoic-Bozic (2010) three learning strategies should make up the learning system: behaviorism, cognitivism, and constructivism. These strategies should be used to motivate learners, facilitate deep processing, build the whole person, cater for individual differences, promote meaningful learning, encourage interaction, provide feedback, facilitate contextual learning, and provide support during the learning process (Ally *et al*., 2004).

The three different schools of learning, the behaviorist, the cognitivist, and the constructivist, provide different approaches to instructional strategies. The behaviorist school postulates that the observably behavior indicates whether or not a learner has learned something (Pavlov, 1927; Skinner, 1974). What is not seen or noticed does

not indicate learning. This external realization of learning is contradicted by the theories of cognitive psychology. Cognitive psychology claims that learning is an internal process, which involves the use of memory, motivation, and thinking and that reflection plays an important part in learning (Craik & Lockhart, 1972; Craik & Tulving, 1975). They emphasize that the processing capacity of the learner and the effort engaged in the learning process reflects the depth of processing. Further the learners existing knowledge structure contributes to the learning process (Ausubel, 1974). The third learning theory, constructivism, claims that learning is an interpretation of information associated to a person's reality. People learn by observation, processing, and interpretation, and then by personalizing the information into personal knowledge (Wilson, 1997). People learn best when they can contextualize the new information to acquire personal meaning.

Different instructional designs have been analyzed by Janicki & Liegle (2001) to identify the components that support quality design of online-based instruction. Components were identified from each of the behaviorist, cognitivist, and constructivist schools of learning. In the following sections these various theories will be described with their implications to online learning.

3.7.1 Behaviourist School of Learning

The behaviourist school considers the mind as a 'black box'. A response to a stimulus can be observed quantitatively, ignoring the effect of thought processes occurring in the mind (Good & Brophy, 1990). The school looks at behaviours as indicators of learning, behaviours that can be observed and measured.

Implication for online learning:
1. Learners should be told the explicit outcome of the learning activities so that they can evaluate their own achieved learning outcome of the online lessons.
2. Learners have to be tested to determine whether or not they have achieved the learning goals.
3. Learning materials have to be sequenced appropriately to promote learning.
4. Learners must be provided with feedback so that they can monitor their achievements and take corrective actions if required.

3.7.2 Cognitivist School of Learning

Cognitivists perceive learning as a mental process that involves thinking, reflection, abstraction, motivation, and meta-cognition (Ally *et al*., 2004). Cognitive psychology looks at learning as an active process of transforming experience into organized concepts, with individual differences between learners regarding abilities and motivation (Hoic-Bozic, 2010). The learner uses different types of memory during learning (Figure 1). The mind obtains information through the senses into the sensory store before processing occurs. When the learner attends the learning material the

instructional strategy has to allow the learner to transfer the information from the sensory store to the working memory (Short-term memory). If the learner enables to process the information efficiently to the working memory it is stored in the long-term memory. The amount of transferred information to the long-term memory is determined by the quality and depth of deep processing in the working memory.

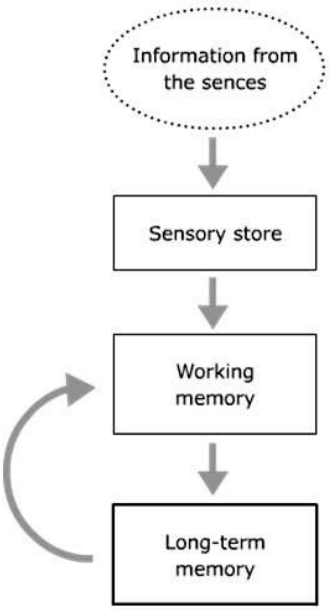

Figure 3: Levels and interactions of mental processes in cognitive learning (adopted from Ally *et al*., 2004, p. 21)

In order to produce instructional online material that promotes the learners with understanding certain theoretical criteria for memory and cognition have to be integrated. The *Cognitive theory of multimedia learning* (Mayer, 2001, 2005; Mayer & Moreno, 2002) and the *Cognitive load theory* provides models for how the mind processes multimedia and online information (Paas *et al.,* 2003, Sweller, 2005). The *Cognitive theory of multimedia learning* is based on three ideas: (1) the dual-channel

assumption - the idea advocates that learners have separate channels for processing auditory/verbal material and visual/pictorial material. The dual channel assumption is a central feature of Paivio's (1986) dual-coding theory and Baddeley's (1998) theory of working memory; (2) the limited capacity assumption - the idea that learners can only acquire a limited amount of information in each channel at any one time (Baddeley, 1998; Sweller, 1999); (3) the active processing assumption - the idea that meaningful learning occurs when learners engage in a substantial amount of cognitive processing in paying attention to essential verbal and visual material, organizes the selected material into coherent representations, and integrates the incoming material with existing knowledge (Mayer, 2001, 2005; Harskamp *et al*., 2008).

The *Cognitive load theory* provides a model for how the mind obtains multimedia information. The central aspect is that the learner's cognitive capacity is limited. The theory distinguishes between tree types of cognitive loads that compete for the limited resources of working memory when complex/intricate verbal and visual information is acquired (Sweller, 1999, 2005): (1) extraneous processing - the assumption that the cognitive processing is unrelated to the instructional goal. It is associated with the mental effort forced by the instructional material, its design and presentation. Extraneous processing does not contribute to the understanding of the material being taught; (2) essential processing - the assumption which involves basic cognitive processing that aims at selecting the relevant words and pictures so that they can be represented in working memory. The more complex/intrinsic the material, the more substantial the essential load; (3) generative processing - the assumption that involves deeper cognitive processing in which the learner organizes and integrates the material. Generative processing is the mental effort that is used to acquire new information and to incorporate it into, or merge it with, existing knowledge structures.

The cognitive school recognizes that students have different strengths and preferences in the way they take in and process knowledge (Felder & Spurlin, 2005). Every person has its own learning style. This brings the importance of including a variety of learning strategies in online instruction to accommodate those differences. Learning styles is a measure of individual differences and refers to how a learner perceive, interacts with, and responds to the learning environment (Ally *et al*., 2004). According to the Kolb Learning Style Inventory (Kolb, 1984), learners can be divided into four categories: concrete-experience learners, reflective-observation learners, abstract-conceptualization, and active-experimentation learners. Kolb's model assumes in order to be effective, that all four approaches to learning might be engaged in an ideal teaching process.

Implication for online learning using cognitive learning strategies:

1. Online instructions should use strategies that allow learners to perceive and pay attention to the information so that it can be transferred to their working memory.
2. The instructions should use strategies to allow learners to retrieve existing information from their long-term memory to help make sense of the new information.
3. Information should be organized to prevent overload during processing in working memory.
4. The instructions should use strategies that promote deep processing to help transfer information to long-term storage. Learners should be required to apply, analyze, synthesize, and evaluate the information because it makes the transfer to the long-term memory more effective (Ally *et al*., 2004).
5. The instructions should allow learners to apply the information to real life situations. This will help to contextualize the learning and to facilitate deep processing.
6. The online instructions should cater for differences in learning styles. The materials

should include learning activities for the different learning styles, so that learners can select appropriate activities based on their preferred style.

3.7.3 Constructivist School of Learning

Constructivism is a philosophical view on how we can understand or know (Savery & Duffy, 1996). The constructivist school recognizes learning as an active process for construction of meaning. The learners do not receive knowledge from an instructor or anybody else. They learn by creating their own versions of the learning matter. What is learned is closely connected to how it is learned. Learning takes place through interpretation and processing what is received through the senses. This means that students should be allowed to construct knowledge rather than being given knowledge through instructions (Duffy & Cunningham, 1998). Situated learning is given high priority by constructivists, as they consider learning to be contextual. What we understand is always a function of the content, the context, the activity, and the goals of the learner (Savery & Duffy, 1996). This means that online learning should allow learners to contextualize the information they study. According to Tapscott (1998) constructivist learning is moving away from one-way learning to construction and discovery of knowledge.

Constructivism is not only about learners constructing their own knowledge as individuals but also about meaningful interactions where social interactions can offer different perspectives providing understanding on their own level. Social constructivism is a theory that argues that knowledge is socially produced by communities of people, and each person can gain knowledge if they join knowledge communities (Vygotsky, 1978). People share their ideas, experiences, feelings and

information, and within this process of exchange they come to an understanding of what is valuable and acceptable. From a social constructivist point of view, learning is considered as an active process in which people construct their knowledge by relating it to their previous experiences in complex and real situations in life and through interaction with the social environment. According to Vygotsky, language and culture play essential roles both in human intellectual development and in how humans perceive the world. These are the frameworks through which humans experience, communicate, and understand reality. As a result, human cognitive structure is essentially socially constructed. Knowledge is not simply constructed but it is co-constructed. The social construction of knowledge through learning is therefore a collaborative process.

Implication for online learning using learning strategies from constructivism:
1. Learning should be an active process facilitating the creation of personalized meaning.
2. Learners should construct their own knowledge through personal interpretation and relevance rather than accepting knowledge from the instructor.
3. Collaborative and cooperative learning activities should be encouraged to facilitate constructivist learning (Johnson & Johnson, 1996; Palloff & Pratt, 1999). Working with others gives learners real-life experience of collaboration in a group, and allow them to use their metacognitive skills (Mayer, 1998; Sternberg, 1998). Metacognition is the learner's ability to be aware of his or her cognitive capabilities and use these capabilities to learn.
4. Learners should be given control over own learning.
5. Learners should be given time to reflect.
6. Learning should be made meaningful for learners.
7. Learning should be interactive to promote higher-level learning, social presence, and develop personal meaning. Heinrich *et al*. (2002), states that learning is the development of new knowledge, skills, and attitudes through interactions with

information and the environment.

3.7.4 The implications of the three learning theories for online learning

Behaviorist, cognitivist, and constructivist theories are contributing in different ways for designing materials for online learning. Even if many of the thoughts overlap in the ideas and principles some differences are apparent. Behaviorist strategies can be used to teach the facts (what to learn). In this process students are given approval and support. Learning is recognized as an incremental, step by step process and is strengthened by repeated success (Hoic-Bozic, 2009). Cognitivist strategies are about the principles of learning (how to learn). The cognitivist school perceives learning as a mental process. Learning is an active process of transforming experience into organized concepts. The focus is on how individuals perceive, interpret, store and memorize information (ibid). The constructivist strategies are stressing circumstances by learning (why we learn). This learning theory perceives learning as an active process of constructing personal meaning by using real-live situation with contextual connections. Students are helped to construct their own understanding and the opportunity to discuss and exchange ideas with peers and instructors.

Since the different schools of learning provide different approaches to instructional strategies, online learning materials should include various activities to accommodate those differences. The reason for this is that contrasting strategies can promote learning at different levels (Berge, 1999; Gilbert & Moore, 1998; Schwier & Misanchuk, 1993). Figure 4 shows interactive strategies to promote various levels of learning based on behaviorist, cognitivist, and constructivist schools of learning. The framework proposes an interaction in online learning strategies of four levels that

goes from lower-level to higher-level interactions. An online instructional design should include principles from all three schools of learning.

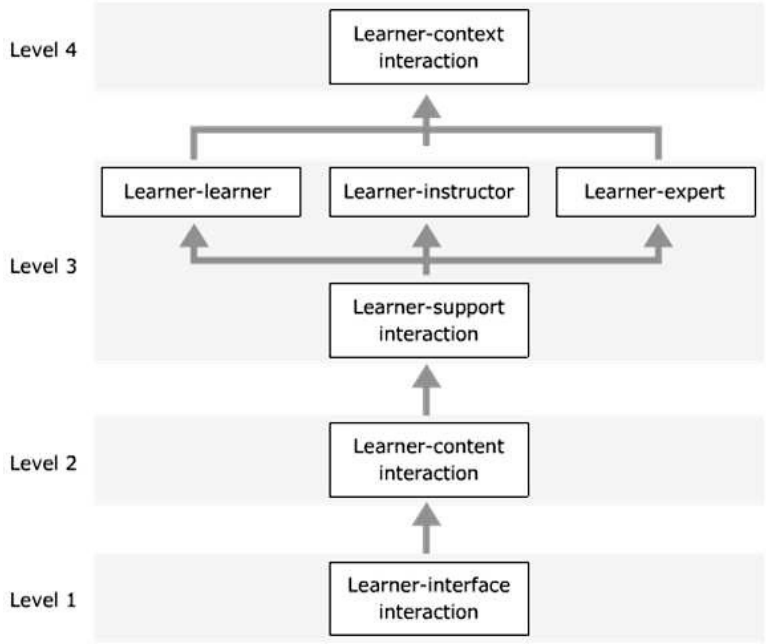

Figure 4: Levels of interactions in online learning (adopted from Ally *et al*., 2004, p. 32)

Level 1. This is the lowest level where the learner has interface-learner interaction to allow the learner to access and sense the learning material. In online learning the interface is with the computer and the learner uses his or her senses to register the information in the sensory storage. The interface should not overload the learners'

sensory storages. It should make it as easy as possible to sense the information for transfer to the sensory store and then into the short-term memory for processing.

Level 2. At this level the learner navigates through the online material to get access to the components of the lessons. These activities could use content that has been created by the instructor or reusable learning objects from a repository (McGreal, 2002; Wiley, 2002). Students should be given ability to choose their own sequence of online material, or should be given one or more different sequences. As the learners interacts with the content, they should be encouraged to apply, assess, analyze, synthesize, evaluate, and reflect on what they learn (Berge, 2002). During this level the learners process the information to transfer it from the short-term memory to the long-term memory. The more associations that are made to the learning content, the higher the level of processing, which results in higher level learning.

Level 3. As the learners work through the content, they will find the need for learner support. Learners should be able to interact with other learners, with the instructor and experts to collaborate, to participate in shared cognition, to form social networks, and to establish social presence (Rourke *et al*., 2001; Thiessen, 2001). Various support options can be useful for learners in the process of creating own versions of the learning matter.

Level 4. This level is a learner-context interaction that should give learners the opportunity to develop personal knowledge and construct personal meaning from the information. The online instructional design should be provided in a way that learners can transfer what they have learned to real-life situations, so that they can go beyond what is presented in the online learning material. In other words the learners should be provided with instructional material so that they can contextualize the information (Ally *et al*., 2004).

3.7.5 Problem-Based Learning (PBL)

PBL is widely accepted as an important learning method within e-learning strategies. PBL is a process that uses concrete problems to motivate students and has a focus on student centered learning activities. Learning occurs in a context and builds on what students already know. Instead of the focus being on teaching, greater significance is given to the learning process (Boud & Feletti, 2001).

With regard to philosophical views of learning PBL is consistent with the theories of constructivism. According to Savery & Duffy (1996) a consistency is prominent within three main aspects:

1. The understanding comes from humans' interaction with their environment.
2. Cognitive conflicts stimulate learning.
3. Knowledge evolves through social interactions.

In contrast to the view of behaviorism, where the understanding is transferred through the instructor, constructivism and the theories of PLB assumes that knowledge not is absolute, but constructed by the learner based on previous knowledge and overall views of the world (Gwendie, 1996). The instructors act more as facilitators than as a primary source of knowledge.

Further the learning structure of PBL has recognizable correlations to lifelong learning with the same high emphasis on self-directed learning and independent studying. To be successful within a context of lifelong learning PBL promotes a valuable contribution to successful learning environments (Linge & Parsons, 2006; Costa *et al*., 2007).

3.8 Usability testing

A practical framework provided by Rubin (1994) defines usability testing. It is a process that evaluates the degree to which a product meets specific usability criteria of a target population. The author considers usability testing as a developing process and defines three fundamental principles to guide research in this area: firstly a structured approach to the collection of information, secondly an empirical measurement of product usage very early in the design process, and thirdly an iterative test design, whereby a product can be modified and tested repeatedly. The usability testing from paper 1 and 3 of this thesis are valued because they might represent responses beneficial to other blended learning settings. The research of paper 1 focused on the usability factors of multimedia instructions in the blended learning context. The research of paper 3 had more focus on the blended learning format and its learning benefits for the participants. Both research approaches combined Rubin's framework with the participatory action research strategy. Rubin (ibid) argues the following to ascertain when an approach is appropriate in iterative processes: 'Surveys can be used any time in the life cycle, but are most often used in the early stages to better understand the potential user.' The research conducted in paper 1 made up an essential starting point to the step-by-step actions research process throughout the thesis. It further had a crucial impact on describing the directions and designs of the two next case studies: firstly a large-scale survey on the quantitative cognitive learning effect of blended learning including multimedia instructions; secondly an in-depth qualitative study of another group of adult learners use of the blended learning format.

3.9 Satisfaction

The most part of research in distance education has examined the effectiveness of distance courses in the light of course grates and test scores. Differently some researchers argue that simply looking over grades is not sufficient to estimate the effectiveness of a course. Other factors like satisfaction might influence students' achievements (Smith & Dillon, 1999). Although students' satisfaction is not necessarily correlated with achievement (Moore & Kearsley, 2005), learner satisfaction has been identified as an important element in assessing the effectiveness of a blended learning course (Giannousi *et al*., 2009). Satisfaction indicates engagement in a course and it seems more likely that satisfied learners achieve their desired outcome (ibid) and that satisfaction is a component for the successful completion of a course (Chang & Fisher, 2003). Furthermore, satisfaction contributes to motivation and engagement, which are essential to students' success (Bollinger & Martindale, 2004). Regarding learners final grades Carini *et al*. (2006) found that although the relationship between engagement and performance was complex, engagement through interactions did have a positive correlation. Others such as Davies & Graff (2005) have refuted the significance between satisfaction and performance. According to Arbaugh (2000) engagement is an aspect that depend on the learner's attitude to the perceived usefulness and the ease of use of the delivery medium. Consequently a blended learning approach has a potential to increase a learners satisfaction by facilitating teaching and learning environments that lead to engagement and interaction.

3.10 Lifelong learning / adult learning

The term lifelong learning stresses that learning is not restricted to the childhood, but takes place throughout life. A resolution from the Commission of the European Communities (CEC) (2006) states the importance of lifelong learning for 'competitiveness and employability, but also for social inclusion, active citizenship and personal development' (ibid). With the development of e-learning environments the needs and formats of teaching and learning has changed dramatically. Learning is now no longer only divided into place and time to acquire knowledge and a place to apply the knowledge acquired. Instead learning is something that takes place on an on-going basis from our daily interactions with others and the world around us (Field, 2006). E-learning environments provide lifelong learning with beneficial education opportunities as stand alone, self-directed, and independent learning processes. E-learning has promoted a development towards more student centered learning activities with distance learning systems. To be successful with e-learning processes, students should learn how to learn, which requires persons to be information literate and to select appropriate learning strategies to keep their motivation high in learning processes. Information literacy forms the basis of lifelong learning. Doyle (1992) defines information literacy as 'to access, evaluate, and use information from a variety of sources'. The American Library Association (ALA, 2000) stated that information literacy is common for all disciplines, learning environments, and all levels of education. It enables learners to master content and extend their investigations, become more self-directed, and assumes greater control over their own learning. These features are the fundamental features that e-learners are required to have.

3.11 State of the art

The e-learning field includes the combination of instructional design and software devises. This section refers from e-learning studies in higher education and tendencies towards different e-learning directions.

3.11.1 E-learning in higher education

Higher educational institutions are increasingly moving toward the use of the internet for delivery of their courses, both on campus and at a distance (Ally *et al*., 2004). With the increasing integration of e-learning into educational programs, there is need for practical guidelines and recommendations to facilitate the development and delivery of effective e-learning environments.

The use of e-learning and blended learning (here understood as the mix of e-learning with traditional learning) in today's higher education is not possible to generalize. Only a few studies cover information from e-learning and blended learning in higher education through large-scale quantitative investigations. In the USA The EDUCAUSE Center for Applied Research (ECAR) study (Smith *et al*., 2009) provides information on technology behaviors, preferences and attitudes of college and university students related to academic experiences. In Norway a survey from Wilhelmsen *et al*. (2009) 'Norgesuniversitetets IKT-monitor' documents the use of ICT in higher education.

The ECAR study (Smith *et al*., 2009) provides information on students' behaviors, preferences, and overall satisfaction with technology. The study analyzed responses

from 30,616 respondents, 91.7% came from four-year institutions. Responses were somewhat biased towards doctoral institutions (55.6%), larger institutions (67.3% enroll more than 8,000 students), and public institutions (74.3%). Respondents reported a weekly use of the university library website of 94.6% and about 9 of 10 (93.8%) used presentation software. Also used by most students were spreadsheets (86.8%). About participation in content creation like Web 2.0 user-driven sites, 44.8% reported that they had contributed with content to video websites, 41.9% to wikis, and a little over a third said they had contributed to blogs (37.3%). Responses about technology adaption were strongly associated with their use and experiences with ICT both generally and in the academic context. Many respondents indicated that they used course or learning management systems (CMSs/LMSs). From 2006 to 2009 the use increased from 79.9% to 91.0%. 88.9% reported that they in 2009 had taken a course that used a course or learning management system. The respondents generally liked to use these systems. 52.0% was positive and 11.2% very positive.

About instructors use of ICT the respondents reported that only 45.0% used ICT effectively in their courses and barely a third of the students said that their instructors provided them with adequate training for the ICT applications in their courses. Further students emphasized convenience as the most positive aspect from ICT. Convenience was the most valuable benefit (70.4% agreed) to ICT in courses. To the question about the quality of being present in classroom settings 59.9% of the respondents indicated that they appreciated the face-to-face learning experiences and only 3.5% would prefer an exclusive ICT dominance in their courses (ibid).

The study ‘Norgesuniversitetets IKT-monitor’ (Wilhelmsen *et al*., 2009) is a survey answered by 188 leaders, 701 teachers, and 5686 students at Norwegian colleges and universities. According to results from the study Norwegian students used the computer on the average 10.4 hours per week working on personal tasks, 9.4 hours per week for study related activities and only 1.7 hours per week in the classroom. In regard to learning management systems the teacher used the LMS to publish messages

and lecture notes, while the students used the LMS to read messages and lecture notes, and the majority of the students also submitted exercises via the LMS. Just below 10% of the students participated in the social Web 2.0 features of the LMS. Teachers and students did not make much use of digital learning resources. ICT was primarily used for word processing and internet searches; not much for participation in wikis, blogs and discussion forums. SMS was the most common communication channel, followed by social networks and chat. E-mail was used weekly or more often by only half of the students.

3.11.2 Trends in e-learning

The trends of e-learning described below are not to be understood as different directions of development. As directions of e-learning they are not mutual exclusive and co-operatively they believable will have the impact of creating new learning environments.

3.11.2.1 Activity-based e-learning

The focus on activity-based learning derived as a reaction to the overemphasis of research and development of reusable content. Activity-based learning concentrates on the pedagogical challenges in e-learning. Karampiperis and Sampson (2005) are some of the researches who have brought considerations into this field of learning

transforming from content-based to activity-based learning.

3.11.2.2 Personalization

The e-learning field has spent much effort on standardization (of learning content, learning activities). As a divergence to this system personalization is a move towards individualization. Johnson *et al*. (2006) defines it as a move to 'empowering users of informal learning resources away from institutions'. Weller (2007) describes two branches of personalization: 'The first is the personalization of content and information, and the second is personalization of tools and services. The second of these has led to the concept of a personal learning environment (PLE)'. Johnson *et al*. (2006) argues that PLE is an initiative towards an open source concept[3] and free personal use of technologies. It will 'include the desire for greater personal ownership of technology, the desire for more effective ways of managing technological services, the desire for the integration of technological activities across all aspects of life, nor just institution-based learning, the removal of barriers to the use of tools and services and the desire to facilitate peer-based working'.

3.11.2.3 Mobile learning

Mobile learning means learning outside a restricted physical location. Portable devices, such as mobile phones, smart phones, PDA (personal digital assistance), and

[3] The concept of open source is the free sharing of technological information that promotes access to the end product's source materials.

laptop computers, have opened the possibilities within mobile learning. The new technologies can be used for teaching and learning, communication and collaboration and are now to some extent being adopted within educational institutions. Dye *et al*. (2005) assert that mobile learning is the next generation of learning.

3.11.2.4 Ambient learning

Ambient intelligence is defined as human beings surrounded by intelligent artifacts, supported by computing and network technologies embedded in everyday objects. The environment should be aware of the presence of a person, perceive the needs of this person and respond intelligently to them in a relaxed and unobtrusive manner (Ducatel *et al*., 2001). Flexibility of e-learning gets another dimension with the introduction of ambient learning, as learning is moved from the computer to the everyday life.

3.11.2.5 Immersive learning

The idea of immersive digital games is proposed by Kickmeier-Rust *et al*. (2007) as the interface for next-generation learning. Immersive learning provides, in contrast to traditional 2D user interfaces (e.g. website interfaces, flash animations, video instructions), a 3D VLE and advanced computer applications that enable realistic simulated environments. ‘Immersive learning technologies in the form of realistic simulations are widely used in ’high stakes’ learning settings such as space training, medical education, and piloting. However, because these types of simulations are very

expensive and resource intensive to produce, their use in education generally has been limited' (Herrington *et al*., 2007).

4. Theoretical framework

The aim with this chapter is to provide a representative sampling of the most essential theoretical topics that are fundamental for my doctoral thesis. To obtain a more extensive understanding the theoretical and methodological premises are outlined. The study has adopted two different research approaches: the quantitative, and the qualitative. It has therefore been of interest to focus on the contradicting structures between these two paradigms. Subsequently the theoretical concepts of phenomenography and epistemology are explained to provide a reasonably balanced and comprehensive introduction to the most basic and important topics of these various philosophical strategies. Next action research is outlined and explained as a theory of practice used in the thesis. Finally the key issues of reliability, validity, and ethics are discussed. These aspects are outlined due to the concern of being able to produce valid and reliable knowledge in an ethical manner.

In the next chapter, chapter 5: *Method and research design*, the different theoretical considerations will be interwoven into the practical topics of the study. This structure will capture the specific essence of the various theories and provide a design to supplement the specific research surveys. With the issue of clarifying the fundamental theoretical structures, it presumable will make the integration process between theory and research outcome less complex.

4.1 Introduction

The methodological considerations in this chapter are a theoretical description of the different methods and paradigms that lies behind this particular study. With

methodology I mean those methods and their practical issues that have been used to bring this study its philosophical and ethical premises. In other words it is a structure of the theoretical conditions of this particular dissertation.

The topics I am focusing on are considered to be theories that could bridge the two types of surveys this study comprises. Initially a detailed in-depth study of a group of adult learners' attitudes to their experience with a blended learning design including multimedia instructions was carried out. Subsequently a large-scale survey in the upper secondary school on the perceptional effect and memory capabilities related to multimedia-learning took place. Finally an in-depth study on a first integration of information technology into an inaugural curriculum in clinical pharmacology was accomplished. The three studies enabled to combine the strength of both research approaches (the quantitative and the qualitative approach) in the same program. The intention was to generate predictions which may be subjects to further quantitative and qualitative research initiatives.

Any study that presuppose to present new knowledge to any audience must begin with some conception of nature, boundaries, and methodical principles of the field. Without this, it could be difficult to communicate the object and purpose, its central research questions and its means of addressing its inferences. With this chapter called 'Theoretical framework' the purpose is to define various philosophical assumptions for this particular study. My intention is to convey a deeper understanding of the philosophical positions behind the study before the descriptive parts are being presented. In the later chapters both theoretical and practical questions will be presented and analyzed synchronously. Their traits will be interwoven in each other and applied to tentative understanding, sometimes descriptive, sometimes normative, and sometimes both.

This research is aiming at achieving insight in adult learners' perceptions on the best use of the blended learning format and to examine the learning outcomes of students who learn with two different treatments in K12 science teaching.

The question to be investigated is not whether these new forms of media are effective tools for learning – there is enough evidence that new media can be effective tools for education, depending on the context and method by which they are used. Instead, the challenge for this study is to identify key issues of blended learning including multimedia instructions.

The theoretical framework is presented through three parts. First I will define the objective and significance of a methodological framework. The influence of the methodological framework on the research problems and research paradigms will be described. Thereafter the concept of epistemology and two paradigms of the epistemological philosophy are presented. Finally concerns about reliability, validity, and ethics in research are described and discussed.

4.2 Methodological framework

The task of methodology is to investigate the methods that can be implemented at various stages of research into different areas, with the aim of systematizing the conditions of a particular study at a particular time (Blackburn, 2008). In other words, methodology in planning an investigation can be defined as the study of methods that can be applied within a discipline.

The study of methods used by a researcher will be affected by the researcher's views on teaching and learning. For example, a researcher coming from a pure science background may view research as producing objective, empirical and verifiable

knowledge, hence the positivist epistemology. He/she will assume reality to be an objective construction outside our perception. In this paradigm the claims for an objectively truth are possible. Such researchers may apply quantitative methods to do his/her research. On the other hand, a researcher coming from a constructivist background may apply a qualitative method to do his/her research, because he/she believes that the research is giving useful and meaningful constructions of the nature. Case (2000) supports Guba & Lincolns' (1994) views that the belief of the researcher influences the research process, whether those beliefs are made explicit or not. Methodology refers to how we will go about studying a phenomenon, whereas method relates to how the research is carried out. The definition of methodology affirms the belief that the perspective and theoretical framework of the researcher have a direct impact on the research method, hence the belief that research is never completely value free. Ingerman (2002) defines methodology as follow:

> *[…] pedagogical research puts much emphasis on articulating and discussing perspective and theoretical framework of the researcher, which may include a discussion of basic assumptions of how the world is constituted, what constitutes knowledge, which method to employ, and why that method should be employed. […]. Emphasis is much more put on the results, even though important details of methods are presented, e.g. presentation of mathematical formalism and sketches of experimental techniques. […]. The point of that is to acknowledge that the validity and generalizability of the research is not ensured by the usage of a certain scientific method, but it depends rather on the researcher's methodology, i.e. his/her underlying beliefs and attitudes including the reason for using a particular method (p. 53).*

A research method is a technique for gathering behavior. All gathering techniques are presumed to be divided into one of the following three categories: listening to (or interrogating) informants; observing behavior; or examine historical traces and records. A methodology is thus a theory and analyses of how research does or should

proceed. It than includes accounts of how the general structure of theory is and its applications in particular scientific disciplines (ibid).

The methodology for this research was guided by elements of four paradigms, all informing the research issues. These research paradigms include the quantitative and the qualitative research approaches, phenomenography, and action research.

4.3 Research paradigms

As described above, decisions about methodology are always theoretically loaded. The concept of research paradigms are reflections regarding the design of a research study. They can also be defined as a variety of strategies. The four paradigms I have chosen for this study represents different approaches. Together they can be assumed to be fractions for shaping the theoretical outline of the thesis.

4.3.1 Introduction to the quantitative and qualitative research approaches

The question of whether the quantitative or the qualitative research approach would be the most appropriate depends on what the study is trying to achieve. In terms of epistemology, quantitative research or experimental research falls into the objectivistic category, and is influences by positivistic theoretical perspectives. In contrast the qualitative research, which falls into a subjectivist category, is influences by a naturalistic approach (Gray, 2009). Punch (2005) asserts that a good researcher knows that the choice of the appropriate method should not be predetermined. To

specify which kind of study qualifies to the two different methods Creswell (2009) argues:

> *In quantitative research, researchers often test theories as an explanation for answers to their questions. […] In qualitative research, […] the inquirer may generate a theory as the final outcome of a study and place it at the end of a project (p. 49)*

Hence quantitative research methods assume that the researcher's task is to find a kind of objective knowledge which not depends on values, attitudes or belief. The qualitative research methods in contrast stress the importance of conducting a dynamic interaction between the researcher and the researched. The goal here is to generate a theory rather than testing a hypothesis.

In the next two paragraphs I will specify the various issues which separate the quantitative and qualitative paradigms from each other.

4.3.2 The quantitative research approach

Typically a quantitative research approach utilizes a deductive way of reasoning. This is most often used at the beginning of a study proposal. The objective is to test a theory rather than developing one. The researcher defines a theory, collects data to test it, and reflects on its confirmation or disconfirmation by the result. The theory becomes thereby a framework for the entire study. Crabtree & Miller (1999) are depicting this research approach with a metaphorical ladder where the research process is presented as a series of steps. See Figure 1.

The form of inquiry seeks the 'Truth', and the arrows point only in one direction to reach this truth. It should be noted that while there is no interaction between the 'rungs' of the ladder, it is an important tool in that the researcher 'climbs a linear ladder to an ultimate objective truth' (ibid. p. 8).

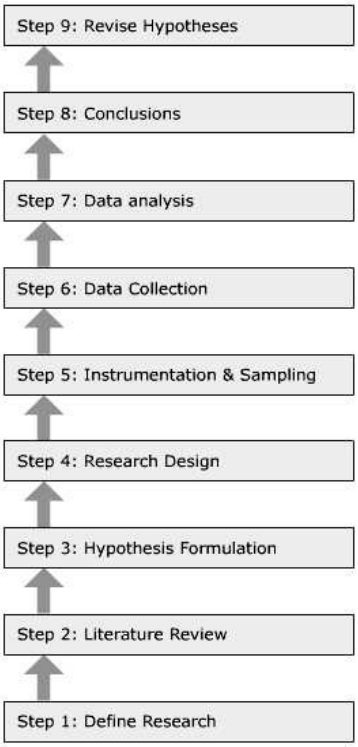

Figure 5: Diagram of the quantitative (positivistic) research process: Testing of theory (adopted from Crabtree & Miller, 1999, p. 8)

As showed in Figure 5, the 'Hypothesis Formulation' in step 3 to the endpoint of step 9 is testing the theory. The process is examining if the hypothesis or the research questions derived from it can be verified. These hypothesis or questions, according to

Creswell (2009), contains variables (or constructs) that the researcher needs to define. For that reason one of the most central issues to the quantitative research method is related to the use of variables. A variable refers to a characteristic or attribute of an individual or an organization that can be measured or observed and that varies among the people or organization being studied (Creswell, 2007).

With a setting on variables the quantitative research tries to generate scientific predictions or explanations for viewing a theory. Creswell (2009) gives a definition of a theory:

> *[…], a theory is an interrelated set of constructs (or variables) formed into propositions, or hypothesis, that specify the relationship among variables (typically in terms of magnitude or direction) (p. 51).*

He goes further by asserting that a theory might appear in a research study as an argument, a discussion, or a rationale. The overall purpose is 'to explain (or predict) phenomena that occur in the world'.

In this study the quantitative research approach has been utilized for certain parts of the study. The research questions and hypotheses have been assembled into a transparent and measurable formulation. The research process made it furthermore necessary to readjust the design, because of discovered intervening variable. Accordingly it has been my intention writing research questions and testing the hypotheses not just as a linear process. Wield (2002) underpins flexibility by arguing:

> *Even after they [questions and hypotheses] have been formulated, either further reading of the literature, or surprises at the piloting or data gathering stages, can force the researcher to amend or even rewrite them (p. 40).*

4.3.3 The qualitative research approach

The best description of qualitative research is that the traditional sense of a qualitative design is not pre-selected, but emerges during the process. The researcher increasingly uses a 'theoretical lens or perspective' (Creswell, 2009) which provides an overall orientation for the study. This 'lens' becomes an advocacy perspective that shapes the types of questions asked, informs how data are collected and analyzed, and provides a call for action or change. From a conventional perspective, the research design will have the following specifications: statement of a problem, statement of a theoretical perspective, statement of a method, a time schedule, samples, and statements of expected end product(s). In viewing these specifications the idea might be created that qualitative research is an ad hoc and unstructured research process, but that is not necessarily true. During a qualitative inquiry the researcher will start with a specific problem; theory emerges from the inquiry; sampling is contingent and serial to maximize the scope and range of information obtained; instrumentation is internal (i.e. subjective), so the instruments becomes refined and knowable as they sort out appearing elements and target in on them; data analysis is open-ended and inductive; timing and results remains unspecified. This implies that the research design of a qualitative research approach emerges, develops and unfolds during the research process.

Very characteristic for the qualitative study, is that the theory becomes a sort of endpoint. It is an inductive process of building from the data to broad themes to a generalized model or theory (Punch, 2005). The logic of this inductive approach is shown in Figure 6.

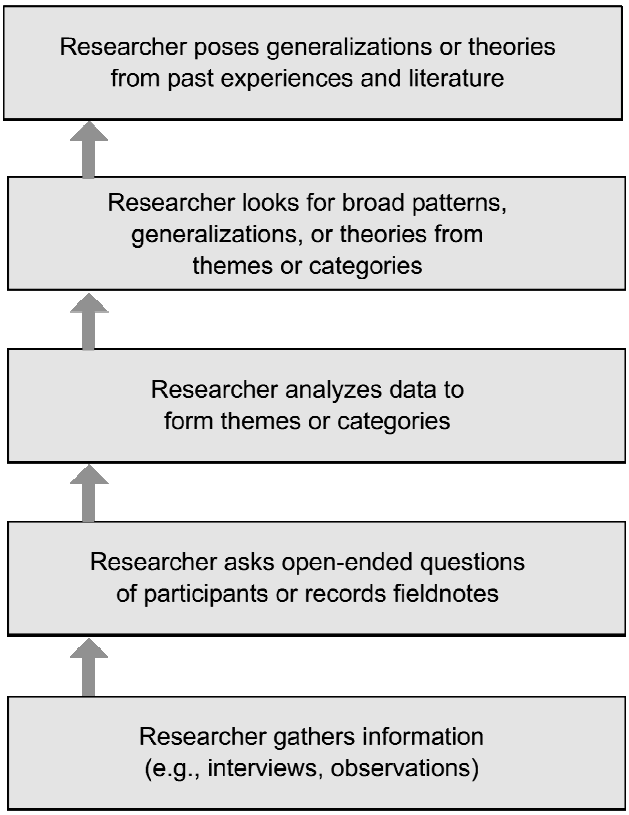

Figure 6: Diagram of the inductive logic of research in a qualitative study (adopted from Creswell, 2009, p. 62)

The paradigm of qualitative research cannot provide a mirror reflection of the social world that positivists strive for, but it may provide access to an understanding of people attributes, to their experiences, and social worlds. The use of participatory action research and semi-structured interviews as research methods in this study investigates different ways in which people experience something or think about something. The latter method, the semi-structured interview research approach, should not be reduced only to be a symbolic interaction. It has an inherent strength of

obtaining knowledge of the social world beyond the interaction. Miller & Glassner (1998) accounts the philosophical strategy as follow:

> *In fact, it is only the context of non-positivistic interviews, which recognize and build on their interactive components (rather than trying to control and reduce them), that 'intersubjective depth' and 'deep mutual understanding' can be achieved (and with these, the achievement of knowledge of social worlds) (p.14).*

Hence it's obvious that this paradigm is working towards subjective interpretations of data samples. Typically clarifying small data collections from close interviews with the researcher 'working toward an articulation of the interviewee's reflections on experience that is as complete as possible' (Marton & Booth, 1997).

4.3.4 Phenomenography

Scholars such as Marton and Booth (1997), Hasselgren and Beach (1996), amongst other contribute to the development and establishment of the concept of phenomenography. Phenomenography is a paradigm that investigates qualitatively the different ways in which people experience something or think about something. The ontological assumptions of phenomenography are subjectivist: The world exists and different people interpret it in different ways. There is only one world, one that is ours, and one that people experience in many different ways (Bowden, 2005).

Phenomenography aims at description, analysis and understanding of experiences as they manifest themselves in different discourses; although most generally in a conversation between the phenomenographer and an interviewee. The same stand, but from the perspective of the paradigm: when the interviews are open, and are analyzed

so that the results that can be described as a few categories of participants' meanings. This method is called phenomenography (Neuman, 1986; Ramsden, 1998; Renström, 1988).

Misher (1986) argues that the meaning, even in structured interviews, is constructed in the co-operating and common understanding between the interviewer and the interviewed.

In this study the use of semi-structured interviews were used in paper 1 and 3. The papers look at attitudes of adult learners on the blended learning format in two various case studies. The methods chosen here were qualitative, as the conceptions presented by the participants did not fit into pre-set categories.

Phenomenography has played an important role in suggesting to educational developers an agenda for researching and improving educational practice. Phenomenographers do not claim to study what is present in the world (reality), but they claim to study what is present in people's conceptions of the world (Webb, 1997). In regard to the latter, conceptions and ways of understanding were not seen as individual qualities, but rather conceptions of reality were considered as 'categories of description' used in facilitating the understanding of specific cases of human functioning. Since these categories of description may appear in different situations, the set of categories are stable and universal between the situations even if individuals move from one category to another on different occasions. The totality of such categories of description denotes a kind of collective intellect, an evolutionary tool in continual development (Marton and Booth, 1997).

Phenomenographers are interested in 'what is present in peoples' conceptions of the world'. Hence certain challenges can be declared in this study. One could be the question of how phenomenography takes the historical and social construction of thought into account. It can be difficult to defend the idea that observations can 'simply' be reported or that categories are 'simply there' in some way outside of the

historical and social experience of the researcher. Bernstein (1983) addresses this issue very clearly stating that: ‘We are always understanding and interpreting in light of our anticipatory prejudgments and prejudices, which themselves are changing in the course of history.’ From the definition of qualitative research and phenomenography they appear to be contradictory. How can an open research approach be combined with a method that operates with a prejudged conception of the researcher? To bring balance into the study, the elements of phenomenography are needed. Even if a phenomenographical approach can not eliminate the researcher to have a presumed perception, make neutral observations, build objective categories and give neutral interpretations, it still reports thoughts and attitudes of the interviewed people. The task of the researcher will be to give validity to his/her particular knowledge conception. So the asserted prejudices of the researcher, as he/she constructs and interprets categories of understanding, never will be free of his/her own historically and socially informed understanding. Consequently, although the researcher uses qualitative research as a data collection and data analysis tool, he/she can never claim to be completely free of his/her own socio-cultural understanding and experiences of the context in which the study is based.

4.3.5 Action research

The term action research has become increasingly used by organizational researchers to describe and justify their activities. Action research is an orientation to knowledge creation that arises in a context of practice and requires researchers to work with practitioners. The approach is used not solely to understand social arrangements, but also effect desired change as a part to generate knowledge and empower stakeholders. Huang (2010) gives the following definition:

> *A transformative orientation to knowledge creation in that action researchers seek to take knowledge production beyond the gate-keeping of professional knowledge makers (p. 93).*

Action researchers do not separate understanding and action; rather they argue that only through action a legitimate understanding is possible. A theory without practice is more a speculation than a theory.

In recent years action research has achieved a level of respect and legitimacy in the education profession as a way for educators to provide their own practice. Also known as 'participatory research' and 'practitioner research' (Volk, 2009). The benefits of instructors applying action research is well documented (Hendricks, 2006; Koshy, 2005; Mills, 2003). In general it is assumed that the quality of teaching can be improved if instructors are empowered and use their own experience to examine a personal and practical issue to ameliorate or change. O'Connor *et al*. (2006) recognized this personal and practical feature when they stated that action research 'is authentic and meaningful to the teacher-researcher because it is conducted by the teacher in his/her own classroom space'. This deviation from the experimental tradition results in different forms of inquiry which entail iterative processes of problem diagnosis, intervention and reflective learning by the researcher and participants.

4.4 Epistemology

Epistemology (from Greek *ἐπιστήμη* - *episteme*-, 'knowledge, science' + *λόγος*, 'logos') or 'theory of knowledge' is a central discipline of philosophy, which is concerned with the nature and scope of knowledge and belief. It is a philosophical inquiry concerning the nature, conditions, and extent of human knowledge. Much of

the debate in this field has focused on analyzing the nature of knowledge and how it relates to similar notions such as truth, belief, and justification. It also deals with the means of production of knowledge, as well as skepticism about different knowledge claims. The overall issue covers some of the most puzzling and persistent issues in all of philosophy (Sosa, 2008; Kvanvig, 2008). A broader definition is that epistemology can be considered as the study of knowledge and justified belief.

I have chosen to outline two of the most discussed branches in the philosophy of epistemology. Firstly the changing forms of knowledge that rise between the empiricism/rationalism controversies will be depicted. Reflections of these two matters have engaged philosophers from ancient times. Accordingly they have had an extraordinary influence on modern philosophy and therefore still are playing a prominent role in contemporary debates. Secondly I will define the constructivist epistemology. Constructivism is the conception of learning as a process of construction by the human mind, and knowledge as the result of this construction (Quale, 2008). It does not focus on an ontological reality, but instead on the reality as constructed.

In the next paragraphs I will describe the most central issues connected to these three directions. They can seem difficult to adapt to common sense at first sight because all three are questioning human's straightforward reflections about the world around and knowledge obtained through perception, interpretation, and memory.

4.4.1 The empiricism – rationalism controversy

The topic of the empiricism-rationalism controversy focuses on scientific methods and the best procedures to ensure scientific progress. Historically the controversy

began between two groups of philosophers. The term 'classical empiricism' identified the one group philosophers (Bacon, Hume, Locke and Mill) who believed that science should start from observations of the real world and inductively develop generalizations, laws and theories. These philosophers shared the following tenet: Experience and observation are the fundamental sources or foundations of our knowledge of the external world (Hunt, 2003). Their counterparts were the classical rationalists (most notably Descartes, Spinoza, and Leibniz). The tenet of the rationalists was that *a priori* [4]reasons alone were the fundamental source to knowledge of the world.

To understand the conflict requires awareness of the objectives of the participants. Both groups accepted fundamentalism; i.e. the view that knowledge must be regarded as a structure raised upon secure, certain foundation (Blackburn). Their approach to reach objective certainties of the external world was basically different. They disagreed vigorously over the best procedures for ensuring scientific progress. But unlike today where most academic philosophers of science are not practitioners of science (Laudan, 1981), all the classical empiricists and rationalists were both philosophers and practitioners. Although sharing the same view towards science and its progress, they were representative of two fundamental conflicting pathways to understanding.

A dramatically change in the philosophical landscape of the contradictions between empiricism and rationalism occurred with the theories evolved by Immanuel Kant (1724-1804). He grounded a hub for all further understanding and development of critical philosophy. The theories of Kant, especially the theories from his *Critique of*

[4] *A priori* knowledge is the central concern of Kant's Critique of Pure Reason. The *a priory* concept is supposed to be a concept that cannot be derived from experience, but which is presupposed in any mode of thought about the world: time, substance, causation, number and the self.

Pure Reason[5] carefully established a middle ground to the empiricism-rationalism controversy. The key task for Kant's middle ground was to explain how universal truth without particular sensory observations was possible. Tlumak (2007) formulates Kant's explanation as follow: The explanation contains two main components. First Kant argues that there are necessary, structural features (forms) of all experience or contented thinking. Second, he argues that the world must conform to these *a priori* forms of experience. One refutes empiricism. Two refutes rationalism. One and two constitutes the core of Kant's theoretical philosophy.

The considerations of Kant were a watershed in history of epistemology and have been the pivotal link between modern philosophies an all major, subsequent movements. The cutting edge in his theory was that cognition not only was guided or determined by objectivism (empiricism), but the objects were products of cognition (rationalism). The humans were not only passive recipients of impressions from sensation, *tabula rasa*[6], but takes cognizance of the external world through senses and good judgment (Alsnes, 2004). Kant refers to a two-sided perception of the external world. The world comprises objective phenomenon's which are certain for us [Ding für uns], as well as hided phenomenon's [Ding für sich], which always will be unknown for us (Sørensen, 1972). Our cognition of the external world is a result of empiricism and rationalism.

This leads us into the assumption that our knowledge not necessarily reflects any external reality, but is a contingent of human perception. Through Kant modern philosophy turned up with a new view of all knowledge: science as a product of culture. Miller (2008) formulates a belief where he relates the conception of

[5] Imanuel Kant, Critique of Pure Reason (Kritik der reinen Vernunft), 1781, known as his first Critique.

[6] *Tabula rasa* (Latin, blank tablet or slate). The term is used to indicate the state of mind on which no sensation has been impressed.

empiricism and rationalism to realism[7] via two dimensions:

> *There are […] two dimensions to realism about the external world: the existence dimension and the independence dimension. […] but in every case… [the reality] is constituted by our knowledge, by our epistemic values, by our capacity to refer to it, by the synthesizing power of the mind, by our imposition of concepts, theories, or language (p. 987).*

Miller argues that the interactive process between reality and construction of knowledge conducts the link to a new paradigm, the paradigm of constructivist epistemology. The link Miller gives indicates a belief of a combined epistemological related dimension. The paradigm of constructivist epistemology will be discussed it the following paragraph.

4.4.2 The constructivist epistemology

Constructivist epistemology argues that the conception of learning is a process of construction by the human mind, and knowledge as the result of this construction. From a constructivist perspective view learning is a process of knowledge construction. (Erduran & Jiménez-Aleixandre, 2008; Quale, 2008). The theory does not focus on the external world as an ontological reality, but as a constructed reality.

The benchmark of constructivism is that human beings do not realize, recognize, and percept their own reality directly, i.e. the ontological reality. Human beings recognize and perceive their own reality in different ways based upon beliefs and the context they are a part of. This involves the topics of when, how and from which cultural and

[7] Realism affirms the real existence of some kind of things.

social position the perception is acquired (Schilling, 2003). Constructivism is all about human reflection on what we define as reality, truth, and facts. These items are, according to the theory, a contingent on conviction, human perception, and social experience.

In a perspective of meaningful learning constructivist epistemology is one of the most useful tools in utilizing digital artifacts. It allows for a branched design, rather than a linear format of instruction. Alonso (2005) argues that:

> *Constructivism builds upon behaviorism and cognitivism in the sense that it accepts multiple perspectives and maintains that learning is a personal interpretation of the world (p. 219).*

Meanwhile the core interest of constructivism is not focused on the interpreted reality, but on the conception of learning as a process of construction, and the acquired knowledge of the learning process.

The constructivist theory has been applied to several different theoretical approaches. Thus many different forms can be found in the literature. For instance Geeland (1997) lists some twenty different constructivist theories with a wide divergence of the research approaches. However, even if there is a great diversity in the field, any theories labeled as ‘constructivist’ must be based on the following proposition:

> *Learning is an active process: the learner actively constructs her own knowledge in the learning process (Quale, 2008, p. 49).*

Although the stated proposition about how people learn, i.e. how they can gain knowledge, is a joint theoretical position, it is not regarded as the complete constructivist theory of learning. According to various theoretical positions, as mentioned above, there are also different approaches to specify the learning process. What need to be examined according to the many theoretical hypotheses are two main directions in which the proposition may be extended: 1. The educational dimension

(the process leading to learning) - in what way do physiological, psychological and sociological factors contribute to learning? 2. The epistemological dimension (the product of learning) – can we accept than any individual construct her/his own knowledge. How can we be sure that different people can communicate and share their knowledge with other individuals?

Quale (2008) describes the different constructivist views in the two dimensions as follow:

> *Clearly, these two dimensions are closely interwoven, in the sense that any constructivist theory address issues related to both. However, the various theories tend to do so with somewhat different emphases: i.e. focusing in the main either on aspects of learning (the process leading to knowledge) or on aspects of knowledge (the product of learning) (p. 51).*

Research and development of knowledge into the constructivist epistemology is used in this study because it allows for the generalization of results within a specific context. Furthermore the theory gives influence to hypothesis about learning and on epistemology (for instance the nature of the knowledge that is gained by learning).

4.5 Reliability, validity and ethics

Kirk and Miller (1986) and Silverman (1993) points out that the issues of reliability and validity are important, because in them the objectivity (of social scientific) is expressed. The aim is to produce descriptions of a social world – not just descriptions (Peräkylä, 1997). The descriptions may in some controllable ways correspond to the social world that is being described. Even though all descriptions are referring to a particular perspective and therefore represent the reality rather than reproduce it

(Hammersley, 1992), the objectives are to conduct descriptions that can be subjected to empirical testing.

Ethical considerations means to ensure that research findings cannot be detrimental to those who are involved. This concern lies, according to Merriam (2009) in the hands of the individual researcher. She argues:

> *No regulation can tell a researcher when the questioning of a respondent becomes coercive, when to intervene in abusive or illegal situations (p. 235).*

In qualitative research the use of ethical concern is most appropriate. Silverman (2005) points out that from an ethical point of view social science research is much more in the fore than in empirical research. He argues as follow:

> *[…] when you are studying people's behavior or asking them questions, not only the values of the researcher but the researcher's responsibility to those studies have to be faced (p. 257).*

This treatise deals with research data based on tapes and transcripts (qualitative data) as well as test scores from a multimedia experiment (quantitative data). According to Kirk & Miller (1986) the primary emphasis by qualitative research has usually been laid on validity rather than on reliability, whereas in quantitative research the emphasis has been laid on reliability rather than on validity. This may imply that qualitative research is well developed in terms of validity and underdeveloped in terms of reliability, and the opposite tendency towards quantitative research.

In the next three parts I will present and discuss reliability and validity with an overall relevance of the theoretical position of this thesis. It involves an effort to assure the accuracy and inclusiveness of the data (reliability) as well as efforts to test the truthfulness of the analytic claims that are being made about those data (validity). Finally ethics are discussed as important implications to the field of belief and trustworthiness.

4.5.1 Reliability

By definition reliability is closely related to the credibility of justified belief. Hammersley (1992) argues:

> *[…] [Reliability] refers to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions (p. 67).*

Among researchers in the social sciences the discussion on reliability is divided into two main structures: firstly the paradigm of research; criticism against either the quantitative or the qualitative research methodology, secondly the conditions of reliability related to the sources of data treatment. Even if the divergence between the two orientations is obvious, it's just as obvious that the motivation of both groups is equal: reliable belief. As Vogel (2008) points it out:

> *[…] [Reliability] is the idea that truth is the ultimate epistemic norm, there is no other. We want what we believe to be true. Moreover because truth is so important, we want our beliefs to be not just adventitiously true, but surely true. Knowledge, than, is securely true belief, […] (p. 348).*

According to Vogel the universal wish for all humans is that their knowledge is judged as true. The issue that matters and produces the academically tension is not truth as legitimate knowledge, but the underlying methodology of producing 'truth'. In the discourse between the two methodological paradigms, the quantitative and qualitative methodologies, the classical conflict is expressed from the viewpoints between empiricism and rationalism stands.

Marchall and Rossman (1989) criticize the justification of positivistic methodologies in social sciences. They argue that concepts of social reality are continually changing and therefore cannot be generalized:

> *Positivist notions of reliability assume an underlying universe where inquiry could, quite logically, be replicated. This assumption of an unchanging social world is in direct contrast to the qualitative/interpretative assumption that the social world is always changing and the concept of replication is itself problematic (p. 147).*

In the paradigm of positivist society research, according to Kvale (2001), the goal is to find generalizations and universal properties to human life. This is not corresponding to the sciences of humanity. The scope of a constructivist approach is to regard every situation as unique and every phenomenon with its own structure and logic.

It is obvious that the disagreement between the positivist and constructivist orientation is methodology-sensitive. There is a contradiction between the hypotheses on the nature of knowledge. Is knowledge based on a universal belief (the objective of quantitative research) or a belief relying on individual and unique considerations of reality (the objective of qualitative research)?

Casullo (2008) explains how reliability and belief can be considered from theoretical different positions. He uses the term reliabilism[8]:

> *Reliabilism requires of a warranted belief that it is produced by a process that is in fact reliable. Although processes such as perception, which involves a causal relation between the believer and the objects of belief, are our present*

[8] Reliabilism. The view in epistemology that follows the suggestion that a subject may know a proposition *p* if (i) *p* is true; (ii) the subject believes *p*; and (iii) the belief that *p* is the result of some reliable process of belief formation (Blackburn, 2008)

> *paradigms of reliable belief forming processes, it remains a contingent matter whether other sorts of belief forming processes are reliable (p. 608).*

When it comes to reliability of different sources of data treatment the orientation is on the quality of data. Here the attention focuses on different methods to gather data and to which extend they produce reliably measures of social life. Again the different theoretical orientations of quantitative or qualitative methodologies cause fundamental discrepancies. However, I shall not discuss here all criteria of asserting reliability. To outline these theoretical issues would be too comprehensive for this thesis. Therefore I have chosen to list the most common methods for data collection:

a. Text interpretations

b. Observational studies

c. Scheduled interviews

d. Audio and video recordings

4.5.2 Validity

> *By validity, I mean truth: interpreted as the extent to which an account accurately represents the social phenomena to which it refers (Hammersley, 1990, p. 57).*

So, according to Hammersley the primary meaning of validity is if one's understanding of a phenomenon is true or not. To argue with trustfulness as condition it is mandatory always to look at the premises of the research methodology. Fundamentally they also have to be true. As asserted above, under the paragraph of reliability, underlying methodology of producing 'truth' is closely related to one's theoretical orientation or use of quantitative or qualitative data sources.

Regardless of the type of research the keystone is that all justified true belief goes through a study's conceptualizing and the way in which data are collected, analyzed, and interpreted (Merriam, 2009). Firestone (1987) argues the following about how the quantitative and qualitative paradigms employ different rhetoric to persuade consumers of their trustworthiness:

> *The quantitative study must convince the reader that procedures have been followed faithfully because very little concrete description of what anyone does is provided. The qualitative study provides the reader with a depiction in enough detail to show that the author's conclusion 'makes sense. […] the quantitative study portrays a world of variables and static states. By contrast the qualitative study describes people acting in events (p. 19).*

Both paradigms have their problems to solve when it comes to generalizability of social findings. Silverman (2000) argues that either paradigm do not have simple

solutions to the question of validity. Both methods of data collection have to be analyzed ‘qualitatively’ because the act of analysis is an interpretation. He recommends quantitative researchers not to be too defensive and qualitative researchers to overcome the temptation of depending on only a few well-chosen examples. They shall not forget that all their data should be genuinely based on critical investigation.

The concept of validity can be further divided into internal and external validity. As a brief definition the internal validity brings up the question of whether the research findings match reality. How congruent are the findings to reality? The object of external validity is to question whether the findings from one study can be generalized, i.e. can be applied to other situations (Merriam, 2009).

As a summary of reliability and validity, it can be stated that they cannot be separated from each other. Especially in qualitative studies reliability and validity are thoroughly interwoven in each other. In practice this indicates that one always must be able to question to what degree one is able to generalize from studies. A procedure can be to first discuss validity, because as Guba & Lincoln (1981) argues:

> *[…] there is no point in asking whether meaningless information has any general applicability (p. 115).*

The validity and possibilities for generalization are therefore closely linked to the reliability, and to what degree the findings in a study can be used in other situations and other studies. Plummer (1983) expresses the underneath cited attitude:

> *The problem, however, is really being tackled from the wrong end; validity should come first, reliability second. There is no point of being very precise about nothing! (p. 101).*

Consequently it has been of particular interest in this study to focus on validity in order to increase the reliability.

4.5.3 Ethics

> *To a large extend, the validity and reliability of a study depends upon the ethics of the investigator (Patton, 2002, p. 552).*

The credibility of a researcher, he continues, depends on training and experience. Further it involves 'intellectual rigor, professional integrity, and methodological competence'. These qualities are essential because as in all research, we have to trust that the study has been carried out with integrity and that it involves the ethical stance of the researcher. More precise ethical issues in the conduct of research include the terms of privacy, consent, confidentiality, deceit, deception and harm (Olesen, 2007).

The nature of ethic concern in this study first of all implies the procedure to inform participants. This issue is based on 'informed consent'. All types of collected data are gained on agreements of informed consent issues. To clarify the concept of informed consent Kent (1996) defines four main topics:

1. Giving information about the research which is relevant to subjects' decisions about whether to participate.
2. Making sure that subjects understand that information (e.g. by providing information sheets written in subjects' language).
3. Ensuring that participating is voluntary (e.g. by requiring written consent).
4. Where subjects are not competent to agree (e.g. small children) obtaining consent by proxy (e.g. from their parents).

Pre-established guidelines like these are good to have in mind when it comes to planning and preparing a research approach. But often unexpected issues in the field have to be resolved as they arise. Such situations which can cause ethical dilemmas generally will depend upon the investigator's own sensibility and values.

One of the techniques used in this present study was data collection through interviewing. This qualitative research approach presents its own dilemmas. As Stake (2005) observes:

> Qualitative researchers are guests in the private spaces of the world. Their manners should be good and their codes of ethics strict (p. 459).

Therefore interviewing carries with it both risks and benefits to the informants. Fortunately as Merriam (2009) argues the 'most people who agree to be interviewed enjoy sharing their knowledge, options and experiences'.

4.6 Summary

Epistemological considerations have been brought into account as a philosophical inquiry to the nature of knowledge. I have tried to define the concepts and problems of two different paradigms: the empiricism/rationalism controversy and the constructivist epistemology. Both paradigms derive reflections on the most ordinary knowledge around us. With first sight they can seem strange to common sense, but indeed they are elementary reflections on matters that can puzzle and engage to new considerations about the justification of knowledge. I have selected these particular two, because they discuss some of the most central issues that are relevant for this study.

The controversy between empiricism and rationalism is one of the epistemological paradoxes that maybe have engaged most philosophers over the past centuries. This classical controversy implies the attitudes between those who affirm, and those who deny the real existence of some kind of things, or some kind of facts. In this study the

classical controversy puts an issue of discourse into the theoretical considerations. It enables an interactive process between comprehension of reality and the construction of knowledge. Hereby it conducts a sort of link to the third epistemological paradigm of this chapter: the constructivist epistemology. In the light of learning and education the constructivist epistemology is of major concern. It has evolved to be the most accepted philosophical belief of knowledge acquisition in our time. In short terms it describes that a learner actively constructs her/his own knowledge in the learning process. Consequently the external world does not represent an ontological reality, but a constructed reality.

Finally the issues of reliability, validity, and ethics are being discussed. These three terms are of major concern when a researcher wants to deepen knowledge to a field that is believed to be believable and trustworthy. Generally the processes of collecting and analyzing data always present problems of these concerns. Deciding what is important. Deciding what should or should not be attended to collecting and analyzing data, is almost up to the researcher and therefore a fundamental question to any kind of research. Conclusively the extent to which a study can be generalized and transferred to other situations is an object of reliability, validity, and ethics.

5. Method and research design

The chapter gives reasons for and describes the chosen research methods, and the implications of the choices made during the research processes. Firstly a clarification of the research strategy is depicted, then I describe the selection of participants, data collection, data analysis, and theory development. Furthermore I describe my role as researcher and some ethical issues of the project. Finally reflections upon weaknesses and strengths of the research method are provided.

5.1 Research strategy

Several research techniques were combined in this thesis to investigate the presented model of blended learning design. The empirical data were collected through two methods: interviews and calculation of quantitative scores from a learning test. Qualitative semi-structured interviews formed the starting point and an orientation towards the second case study that included measurable quantitative challenges. The first study had a decisive function for the following two studies. While the aim of the thesis has been to investigate various key matters related to a blended learning format, the study focuses on forming a reliable understanding to characterize issues around it as a state-of-the-art educational format.

The thesis uses the action research methodology as an inductive procedure, not a deductive. Deductive reasoning is usually based on work from the more general to the more specific, and conclusions follows logically from available facts. An inductive approach is open-ended and exploratory as it moves from specific observations to broader generalizations and theories (Patton, 2002). The problem statement of the

thesis required an exploratory study, and the choice of an inductive approach was appropriate to answer the research questions.

Action research is described as a circle process of planning, acting, observing, and reflecting. The main interest is its relevance to theory and to action (Kemmis & McTaggert, 1988). Action research was used to build the framework to understanding. The method has its focus on the dialectic between theory and practice. During the first case study I had a close participation with the students throughout the course period. During the course I continuously tried to produce software applications according to students' attitudes and preferred learning activities. Hence the approach can be seen as a theory-building method. Systematically I developed my own belief as a central person of the process. Gradually the emphasis of preferred learning activities turned towards multimedia files as supplemental learning material to classroom instructions. Consequently the knowing and understanding of multimedia instructions for blended learning environments became the main subject of concern of this particular case study. This introduced a theory building towards multimedia learning. The gained understanding gave interest to carry out a quantitative study on cognitive learning outcome from multimedia instructions. Theory and practice were used to put the gained understanding to the test. A hypothesis of enhanced cognitive learning outcome was designed by using blended learning pitted against traditional instructions in a test procedure. The later conclusion of the study supported a traditional instruction approach. The H*0* hypothesis[9] of the statistical test prevailed.

A third case study was planned and carried out with a new group of learners. This time with a target group that was expected highly to appreciate time flexibility and location convenience of blended learning: postgraduate dental students. Furthermore an incentive was that Hughes *et al*. (2009) had made a call for research on

[9] The null hypothesis in this study corresponds with the general or default position

postgraduate dental distance learning scenarios. They argued that the future will lead to an increased necessity towards web-based education for this particular target group. With participatory action research leading to problem diagnosis, interventions and reflective learning, the study resulted in new understanding. From my point of view action research provided me with an inspiring research tool promoting different sets of relationships between me and the participants. Thus the quality criteria of the study are derived from an experimental and participatory research method.

5.1.1 Selection of participants

Three different categories of students were chosen for the three case studies of this study: 1) a group of adult employees at the University of Bergen with professions as editors of online information, 2) high school science students for the cognitive learning tests, and 3) a group of adult postgraduate dental students.

The students representing adult employees with professions as editors of online information were selected from a list of people who applied for participation and met the criterion of being responsible for web-based external information tasks. The course program was offered to staff members of the University of Bergen, Norway and announced via the intranet of the university. 12 persons were selected.

The high school classes were picked out by their teachers. A seminar on integration of multimedia instructions in chemistry teaching was developed and arranged at the University of Bergen, Norway, aiming at interested high school chemistry teachers in the district of Bergen. The purpose was to introduce a learning concept on multimedia-lessons for K-12 students. 32 high school teachers were enrolled at the seminar. In addition to hands-on learning activities, the research procedure and

strategy of the current research project were introduced to the participants. The purpose was to receive feed-back on the research idea and for the procurement of voluntary associate chemistry teachers. Eight teachers employed at five different high schools showed their interest for further collaboration. As a result agreements were reached to carry out the experiments on their students in authentic science classroom settings.

The third group of students applied for participation of a learning course named 'Clinical pharmacology for postgraduate dental students'. The course program was offered by the Faculty of Medicine and Dentistry at the University of Bergen. It was announced as reflections on pharmacological reactions and interactions of anaesthetic drugs commonly used in dental treatment. It was emphasized that participants became critical towards available drug information, and consequently able to demonstrate good understanding and reflection on issues regarding this specific field of dentistry. Six postgraduate dental students were accepted as participants.

5.1.2 Data collection

The data collections of the first and third case studies come from qualitative interviewing. I used the semi-structured interview technique. The interviews lasted between 45 and 60 minutes. They were audio taped utilizing a video camcorder and transcripted verbatim. Qualitative interviewing is a tool for understanding the perspectives and experiences of persons being interviewed (Patton, 1987). Maxwell (2005) states that the research questions are identifying the things that need to be understood and the interview questions generate the data that you need to understand about these things.

The study in total consists of 15 face-to-face interviews. The interviewees were 15 adult participants of two groups of students. All interviews were carried out in Norwegian language.

The interviews took place in the following time periods:
The nine employees at the University of Bergen: May 2008.
The six postgraduate dental students: December 2010.

The learning tests:
The data collection of the second case study was accomplished via a LMS. Students' answers of the 12 multiple-choice assessment questions (Appendix B) were registered and saved for further calculations.

5.1.2.1 Semi-structured interviews

The semi-structured interview approach (Kvale, 2001) constitutes the data collection in the two case studies. Kvale & Brinkmann (2008) underlines that interview research is a craft mainly learned through practice:

> *The skills, the knowledge, and the personal judgement necessary for conducting a qualitative interview of high quality require extensive training. The flexible, content- and context-related skills of interviewing are acquired by doing interviews. Whereas the phrasing of questions can be communicated verbally, other aspects of interview skills, such as intonation of questions, the stretching of pauses, sensitive listening, and*

> *the establishing of good rapport in the interview situation, rest largely on tacit knowing acquired through practice and by working with experienced interviewers (p. 89).*

The semi-structured interview means a flexible interview approach, based on a framework of themes explored. I prepared preplanned question ahead, in order to find themes and open-ended questions and to prepare for flexibility doing the interviews, allowing new questions to be brought up based on the answers. The choice of semi-structured interviews was made because of the exploratory focus the technique take into account. Semi-structured interviews are also valuable as a theoretical sampling process, which means that pre-planned questions of late interviews are based on earlier collected data and analysis of these data.

After each interview I discussed the issues raised by the participants with my colleges and thus obtained new perspectives on the content.

The interviews formed the main part of the data collection of the two qualitative research studies. The procedures proceeded through seven stages for interviewing (Kvale, 2001): thematizing, designing, interviewing, transcribing, analyzing, verifying, and reporting. Because of the action research practice an explicit theory building started at very early stages. It started during the first face-to-face classroom meetings where expectations and preferences were discussed with the participants of the two learning courses. Field notes were written about my own reflections, which helped me to generate production strategies of software applications parallel with the course programs. Thus the online learning environments successively were constructed with supportive and supplementary course materials matching the proceedings of the course programs.

5.1.2.2 Participatory research

Participatory forms of research are different practices inspired by action research philosophical assumptions. Participatory forms may imply that researchers under investigation participate actively throughout the whole research process, from the initial design or problem diagnosis, to the adoption of action strategies (Whyte, 1991; Harrison & Leitch, 2000). Therefore the researcher's role moves away from one of an expert to that of an enabler.

In the two qualitative case studies which constitute the main descriptive part of this thesis I administrated the online content of learning materials and monitored where tasks were accomplished. It was useful to be able to track all undertakings because it contributed to the further scaffolding process of theory and practice. Informal interviewing during the course periods and interpretations contributed as well to the developmental processes.

5.1.2.3 Observations

Observations take place in the natural field setting, and the data represent a first-hand encounter with the phenomenon of interest (Merriam, 1998). Skilled observers know 'how to write descriptively; practicing the disciplined recording of field notes; knowing how to separate detail from trivia, […], and using rigorous methods to validate observations' (Patton, 1987). My intention was to supplement my participatory experiences and my interview data with observations, to allow new perspectives to emerge.

Observation was conducted in the first case study of this thesis. During the classroom sessions one of the two teachers mostly had periods where they could follow the preferred learning strategies of the students. Furthermore the online LMS gave an excellent opportunity to monitor all learning activities that took place via the courseware. One of the tools was the multimedia instructions. It was via the LMS a growing popularity of the multimedia instructions initially was observed. Within every classroom session new beliefs from observations were addressed to be discussed with the students. Together with participatory actions, the observations gave me a broader picture of the adult learners' preferences. This kind of unsystematic observation was useful in addition to the interviews, and some of the considerations from the observations assisted me in the following interview situations.

5.1.2.4 The quantitative test method

The quantitative test method of this case study was designed by me, Professor Øyvind Mikalsen and Professor Otto Grahl-Nielsen after having discussed the test structure with the involved high school teachers. The aim of the study was to compare the learning outcome from two groups of students: an experimental group, that repeated a chemistry subject matter with a multimedia instructions and a control group that repeated the same subject matter with traditional paper-based materials.

With specific learning goals as a basis, 12 multiple-choice questions for two topics were created. Both series of multiple-choice questions consisted of 6 multiple-choice questions with 5 answer alternatives for retention measurements and 6 multiple-choice questions with 6 answer alternatives for transfer measurements. The questions were constructed on guidelines of Braddom (1997), Kehoe (1995), and Sprinthall *et*

al. (1988). A pre-test with one science class was conducted to examine possible flaws in the procedure.

In each session the students were randomly assigned to either a test group (the multimedia group) or a control group (the text and diagram based group). The theoretical content of the learning material was exactly the same. All students had a laptop to complete the subsequent multiple-choice test; those in the test group had headphones in addition. The two groups were seated in two divided areas of their own classroom.

The survey comprised three steps. First, the chemistry teacher gave a traditional, plenary lecture of 10 minutes duration on the selected topic, either about *the range of electrode potentials* in electrochemistry or about *the alkans and alkyl groups* in organic chemistry. The only constraint on the lecture was that it should not contain any multimedia material.

In the second step the two groups of students were separated for additional study of the same topic. The test group studied a multimedia lesson on their laptop. The lesson lasted 5 minutes and they were encouraged to study it twice with possible playbacks. The control group studied text and diagrams in a handout distributed by the teacher. The allowed time for step 2 was 12 minutes.
In the third step all students logged on to a website through unique user names and passwords. Here they individually accessed the multiple-choice questionnaire, guided by the researcher. The time limit for answering the questions was 12 minutes.

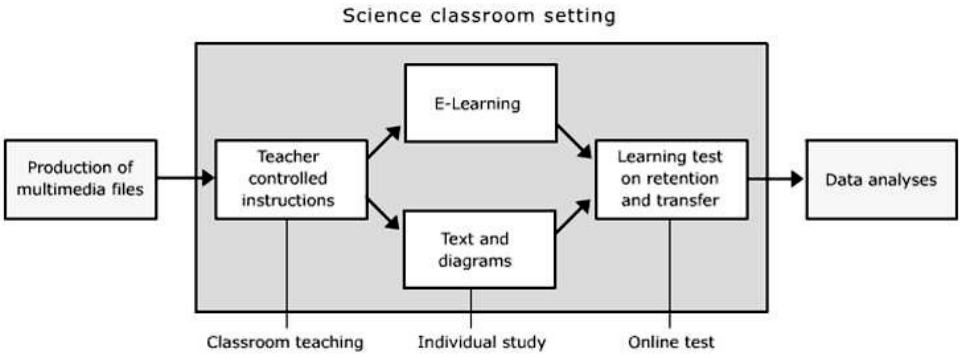

Figure 7: Test procedure of the case study 'The learning effect of using a blended learning design in K12 science teaching'

The learning outcome was measured at two levels: (1) a more basic *retention* level, with 6 questions that tested for comprehension of key concepts. The retention test was intended to measure the participants' memory for the presented material - corresponding to remember fractional and conceptual knowledge in Bloom's taxonomy (Anderson *et al.*, 2001); (2) a more advanced *transfer* level, which assessed participants' ability to apply information presented to novel situations. The transfer test was intended to measure the participants' understanding of the presented material - corresponding to understanding and applying conceptual knowledge in Bloom's taxonomy.

For the retention test participants received 1 point for each correct answer out of a total of 6 points. In the transfer test with 6 questions participants received 1/3 (one-third) point for each correct answer alternative. Each question had 3 correct answer alternatives. Hence the maximum score for each transfer question was one point. The final score for each participant was determined by adding together their scores in each test separately. Total scores were calculated for learning outcome (retention and transfer).

5.1.3 Data analysis

The data analyses were divided into two approaches with regard to the methodological different studies. Qualitative techniques are used in paper 1 and 3. Paper 2 took advantage of a quantitative methodology for its evaluation.

5.1.3.1 The qualitative studies

From the interviews of all participants in the two studies I did the transcribing and the coding. The codes were than clustered and combined into branches. Relationships between branches were sought and tested both within and across transcripts. New emerging themes were formulated in relation to the research questions. Gradually I identified what appeared to be some constant factors that had to be discussed in the empirical data. The process was inspired by Patton (1987) and the concept of *content analysis* (ibid). The technique tries to identify coherence in the data samples via categories, concepts, and examples. Several readings of the interviews were necessary to do the classifying, organization, and simplifying. There were two groups of adult learners involved in the inquiries. I constructed simple matrix in a text editor to provide an overview of the original themes in my interview guide. See table 1. Patton (ibid.) argues that the organization and simplifying of the complexity of data into meaningful and manageable categories is the basic purpose of content analysis.

The categorization of the data was important for my research in order to reduce the number of data units to work with. According to Alvesson & Schiöldberg (2008) there are two types of categories: categories named by the respondent (in vivo

categories) and categories named by the researcher (in vitro categories). An example of an *in vivo category* is ‘the videos’ that in my *in vitro category* is ‘multimedia instructions’.

Categories	Concepts	Empirical data
Structure and format of the course	Flexibility	‘On one occasion I made my assignment at home and delivered via the internet. I could work in my practise a day more.’
	Convenience	‘This course gave me the ability to get the content repeated more often.’
		‘It’s like taking the teacher home with you. Even on a Sunday afternoon, or when it suits you.’
Participants’ satisfaction	Ease of use	‘It [the course structure] enhances the effectiveness and quality of communicating information.’
	ICT artefacts	‘It was important to learn how to use drug databases; how to search for information.’
		‘The multimedia-files were good. This was an example of a picture that has the value of a thousand words. You can easily understand it, faster than reading a text.’
	Learning	‘The first assignment was responsibility for

	methods	own learning on a high level. I learned a lot.'
Identification of improvements	Multimedia instructions	'The lessons should have been video recorded. Since then you could play them ones again and use them as repetition.'
	Learning methods	'Assignment # 2 (students had comment peer students posts) could have been changed into a more relevant task.'
	A new blended learning design	'The blended combination was good, but I think I could have accomplished more of the course via the internet, even to a greater extend.'
	Web 2.0	'The communication in the chat room did not function.'

Table 1: Examples of concepts and major categories, and some quotations from the empirical data pointing to these categories

5.1.3.2 Saturation

How much data is enough in order to answer the research questions when dealing with qualitative research? The researcher is expected to continue theoretical sampling to test and validate the developing codes, concepts, and categories until reaching the point of saturation. According to Strauss & Corbin (1998) 'The theoretical saturation is the point in category development where no new properties, dimensions, or relationships emerge during analyses'. After the two iterative processes of analyzing the data from the two research sides, the improvements of the theory was small and the decision to conclude the research was decided.

5.1.3.3 The quantitative learning test

Firstly the measurements of homogeneity of variance due to topic and normality were assessed. Secondly an ANOVA significance test was conducted for each class to determine if lesson conditions affected the H*0* hypothesis. Means, standard derivations, *F*-scores, and probability for both groups are listed in table 2. To ensure that topic not affected the group results, topic as one between-subject variable was calculated. Finally an analysis of covariance, ANCOVA, was calculated between retention and transfer results.

There was no significant difference due to topic, $F(1,133) = 0.865$, $p > .05$ on retention and $F(1,133) = 0.533$, $p > .05$ on transfer, which renders the results neutral with respect to topic.

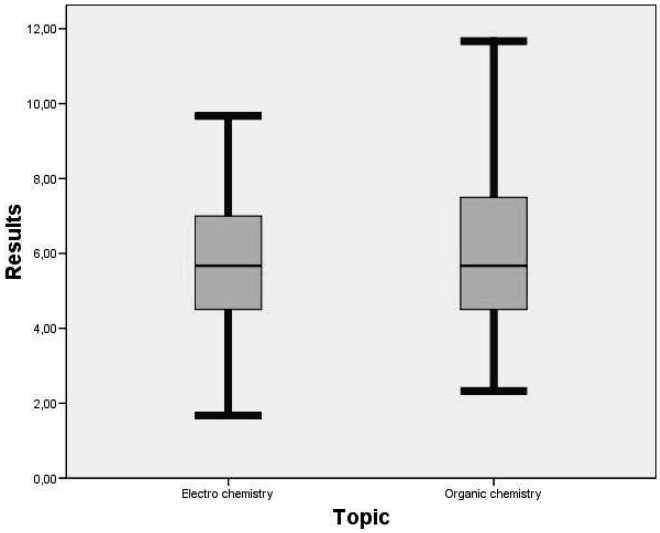

Figure 8: An error bar chart showing the mean values and the upper and lower bounds of error due to topic

With regard to normality a Shapiro-Wilk test showed a normal distribution ($p > .05$).

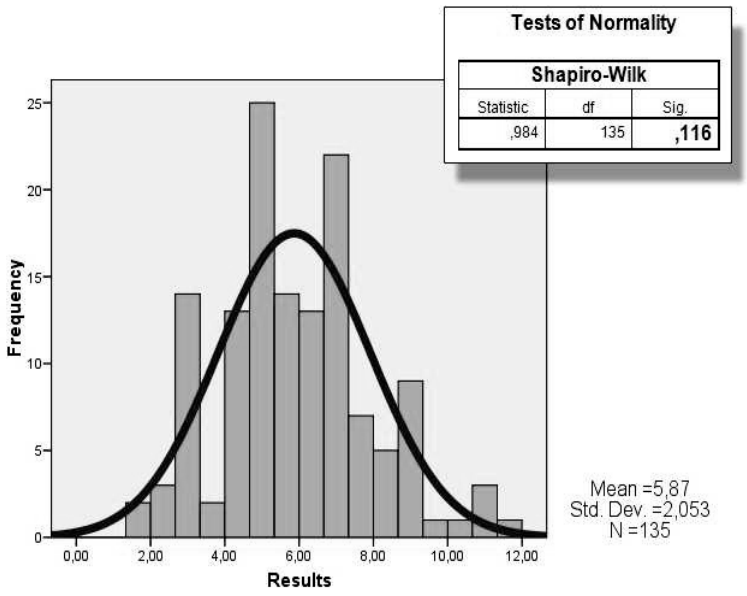

Figure 9: The distribution of the results in the quantitative learning test

The result of ANCOVA, $F(6,128) = 3.228$, $p < .05$, where the transfer scores were analysed with retention scores as covariant, showed significant relation between retention and transfer scores. This means that the test design showed consistency between topics and to the degree to which retention and transfer scores varied together.

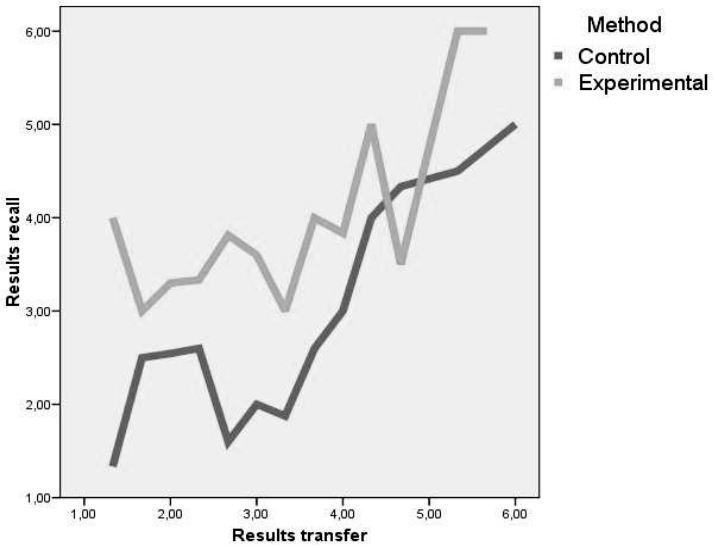

Figure 10: Curves generated from the relationship between the results of the two treatments

Table 2:

Mean Scores, Standard Deviations, F-scores, and Probability for the Differences Between Topic Groups on Retention and Transfer Tests: Total number of students

	Retention				Transfer			
Groups and topic	*M*	*SD*	*F*	*p*	*M*	*SD*	*F*	*p*
All students (n = 135)								
Electrochemistry (n =83)	2.976	1.585			2.731	0.853		
Organic chemistry (n =52)	3.231	1.490			2.859	1.177		
			0.865	0.354			0.533	0.467

Table 3:

Mean Scores, Standard Deviations, F-scores, and Probability for the Differences Between Blended Learning and Traditional Instructions

Groups on Retention and Transfer Tests: Classes 1-7 and total number of students

	Retention				Transfer			
Groups and experiment-control	*M*	*SD*	*F*	*p*	*M*	*SD*	*F*	*p*
Class 1 (n = 14)								
Blended learning	5.143	0.690			3.809	1.426		
Traditional instructions	3.571	1.813			3.714	1.207		
			4.595	0.053			0.018	0.896
Class 2 (n = 20)								
Blended learning	4.100	0.876			2.301	0.598		
Traditional instructions	2.600	1.713			2.566	0.772		
			6.081	0.024*			0.736	0.402
Class 3 (n = 27)								
Blended learning	3.429	1.396			2.857	0.995		
Traditional instructions	2.385	1.387			3.436	1.075		
			3.786	0.063			2.114	0.158

Class 4 (n = 24)	3.769	1.166			2.719	0.506		
Blended learning	3.272	1.489			2.636	0.850		
Traditional instructions			0.840	0.369			0.087	0.770
Class 5 (n = 22)								
Blended learning	3.667	0.888			2.778	0.998		
Traditional instructions	2.700	0.949			2.599	1.085		
			6.080	0.023*			0.163	0.691
Class 6 (n = 16)								
Blended learning	2.700	1.337			2.601	0.886		
Traditional instructions	1.500	1.049			1.778	0.504		
			3.500	0.082			4.261	0.058
Class 7 (n = 12)								
Blended learning	2.000	0.817			2.500	0.692		
Traditional instructions	1.000	1.604			2.375	0.601		
			1.333	1.604			0.105	0.752

*$p < 0.05$

The data support the traditional instruction approach. The H*0* hypothesis in all experiments other than two on retention prevailed. However, on average the blended learning groups showed better performances on retention scores. On seven

comparisons, the traditional instruction approach never scored higher than the blended learning group on retention.

5.2 Theory development

The aim of action research is to try to retrieve the idea of 'good theory' that provides accessible and useful tools for practitioners and other participants in action research.

Throughout the research process it made sense that the theory was part of an action and therefore an action research. When the participants of the case studies acted they obviously intended that their action had an outcome. They chose the actions they thought would produce the outcome they wished. In other words, before they acted they had a theory, perhaps unconsciously, connecting actions and outcome. They might have thought of it as achieving knowledge or understanding, which can be defined as other words for theory (Dick *et al*., 2009). If an outcome is either expected or unexpected, most people are motivated to explain why or why not. They make sense of the event. Accordingly 'theory' becomes a synonym for everyday activities of knowing, understanding and making sense.

A crucial part of the action research is the importance of explicit theory building and testing as an integral part of the action research practice (Friedman, 2009). I followed an action research procedure with association of a quantitative research methodology that resulted in rejection of theory. This may for many action researchers be of interest in interpretation and change because it integrates an antagonistic positivist theorizing. For me this integration meant to go beyond the meaning of participants and exploring unseen causal dimension. The second paper of this study is based on my practice to illustrate this point. This variety of action research is related to Stringer's (2007)

assumption of ‘look, think, act’ where he pays attention to components variously labeled as reflection and thinking. For this doctoral thesis the quantitative study was of relevance to theory building and its relationship to action.

The action research process in this doctoral thesis seems somehow similar to grounded theory, because it was emergent and gradually emerged as the study progressed. Dick *et al*. (2009) points out that similar to grounded theory, action research is an emergent methodological approach where theory building evolves gradually as a study progresses. However, the accepted practical approaches of action research are less rigidly defined than those of grounded theory. In addition the experiences that occurred naturally in the practical situations became a source of the theory. Consequently the theory was emerging and grounded in experience and action. The traditional research approach of the grounded theory methodology is emphasized by of Strauss & Corbin (1998) who claims that the grounded theory is ‘a set of well-developed concepts related through statements and relationship, which together constitute and integrated framework that can used to explain or predict phenomena’. Further active participation is not recommended for grounded theory (Glaser, 2003). With a related assumption, Morse (1998) discourages participation for qualitative studies in general.

The action research in this study provided a lens through which it became possible to explore the qualities of theories in this doctoral process. Theory building and testing became an important component of action. At the end the theories identified dimensions that can be used to illustrate useful details how the dimensions can be applied in practice. For instance the dimensions can be used as taxonomies within which further action research can be applied to practice even after this study is completed.

The choice of writing papers during the doctoral project has been useful and a beneficial part of the analyzing process. Charmaz (2005) argues that writing can lead

to further discoveries and deeper insight and as a result promote for inquiry. This is also my experience from the research process. The writing of the papers during the process provided me with deeper insights and further discoveries as well as moving the action research forward. This entails that the three papers present a gradual development of the doctoral project.

5.3 Researchers role and ethics

The thesis is written in the first person. From my point of view scientific research is a socially constructed reality (Sohlberg & Sohlberg, 2004). Writing the thesis in the third person or passive would not reflect me as an active researcher, but more indicate a role of an impartial and neutral researcher.

To choose the role of closeness instead of distance in a research situation involves the issue of getting near to the research situation. During face-to-face classroom settings naturally situations with intervention in practical situations occurred. The result of such a process can involve that the researcher looses the ability of an analytical attitude to his or her own research. This issue was especially important to be aware of when I collected data through the two interview phases. In the classroom settings I was closely involved as instructor and developer of software applications. This gave me an opportunity to conduct an iterative developing process during the course periods, which gave me an authentic understanding of participants' thoughts, attitudes and experiences. From my viewpoint this particular practice was useful to generate knowledge about participants' preferred learning environments.

The interviewees of the study voluntarily agreed upon joining the study based on full and open information about the study. The study protects people's identities and research locations and all personal data is ensured anonymity.

The study uses standard techniques to make references to authors of books, articles, papers, websites, reports, and projects.

Accuracy is ensured as far as possible through the thorough description of the research process. The trustworthiness of the study is discussed in chapter 7.

5.4 Reflections on method

In the Handbook of Action Research of Reason & Bradbury (2008) action research is defined as:

> *A participatory process concerned with developing practical knowing in the pursuit of worthwhile human processes […]. It seeks to bring together action and reflection, theory and practice (p. 4).*

Dick (2004, 2006) however noted that little has appeared on the building of theory from the experience in action research. This is considered to reflect skepticism towards theory and theorizing, a critique of positivism and its attempt to develop general, unified theory and laws of human behavior. Gergen & Gergen (2008) writes from a social constructivist perspective and argues that action research should not make attempts to 'map the world of human behavior' believing that such maps have no utility 'outside the network of shared understanding that make them intelligible', because they are reflecting aspects of reality that are indeterminate, and because they can be used as tools for control.

This study does not intend to deny a theory or theorizing. It even integrates a case study on a quantitative research method with the aim to unify a theory based on multimedia learning. Nevertheless the study as a whole would not be possible to

conduct with a deductive, positivistic perspective. In the papers 1 and 3 I have as researcher not been unbiased, but played an active role. This can be interpreted as a constructivist approach, because it emphasizes the studies of phenomenon rather than a positivistic method of studying it. According to Lund (2004) it can be argued that the researcher takes a reflective stance because he/she is the primary research tool. He/she is instrumental in placing the research issues on the agenda, in taking a theoretical position for the study, in applying research methods to the inquiry, and in interpreting results.

Apparently this thesis is holding a contradictory position. The first position is to align the study with a hermeneutic point of view; a role of understanding meaning through practical actions within the research procedures. The second position is the wish to establish causal laws in a positivistic model of multimedia learning theory. For me the research process of this thesis has been an action towards understanding aspects of using the blended learning format in education. Through communicative processes such as verbal dialogues and interviews I have attempted to create their understanding of this new student reality. In this process even the second case study with its causal approach played a beneficial role. Park (2001) has reflected on the typologies in action research and has defined the role of causal theories in action research as 'propositional knowledge', but he attributes the usage with no special importance and may even regard it with disfavor.

My argument for this particular action research approach is to achieve a co-created knowledge between causal conditions and social interpretations. Hence building and testing of causal theory could also be an explicit goal of action research. Causal theories and actions could exist in a reciprocal relationship. Meaningful changes require good theory and development of good theory requires attempts to changes conditions in human societies. The argument emphasizes that causal knowledge has consequences for abstract theory and that abstract theory does have practical consequences.

Various research methods of data collection are employed in this study. They are interconnected with a step-by-step consideration of cases and the building and testing of proposals for more powerful educational practices. The quality criteria used in this study are derived from an experimental action research tradition (Cassell & Johnson, 2006).

6. Contributions

This chapter first introduces an overview of the three papers of the thesis and their contributions to the research questions. My contribution is briefly described and each paper is summarized. Finally the chapter gives an overview over the main contributions from the thesis to the blended learning research field.

6.1 The three papers

Paper 1

Rosenbaum, P. L. and Mikalsen, Ø. (2012).

Educational design: Adult learners' attitudes towards a blended learning context including online multimedia instructions. *International Journal of Learning and Teaching (In Progress)*

Paper 2

Rosenbaum, P. L., Mikalsen, Ø. and Grahl-Nielsen, O. (2010).

The learning effect of using a blended learning design in K12 science teaching.

Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (2010). Association for the Advancement of Computing in Education, 2117-2126.

Accepted as a book chapter in *Cases on managing e-learning: Development and implementation.* H. Yang, S. Wang (Ed), 2012.

Paper 3

Rosenbaum, P. L., Mikalsen, Ø., Lygre, H., Solheim, E., and Schjøtt, J. (2012).

A blended learning course design in clinical pharmacology for postgraduate dental students. *The Open Dentistry Journal (In Progress)*

	Paper 1	Paper 2	Paper 3
RQ1: Which attitudes do adult learners hold towards a blended learning context including online multimedia instructions?	X		X
RQ2: Will there be statistical evidence for better learning outcome by using a blended learning design including multimedia instructions compared with a traditional learning approach?		X	
RQ3: Which factors are important for postgraduate dental students when using a blended learning educational approach?			X
RQ4: Which considerations have to be taken in future blended learning programs for postgraduate dental learners?			X

Table 4: Overview of the papers' contribution to the research questions

6.1.1 Me and my colleagues' contributions to the three papers

The three papers appended to this thesis are written by me with decisive contributions by my supervisors Associate Professor Jan Schjøtt, Professor Øyvind Mikalsen, Professor Otto Grahl-Nielsen, Associate Professor Einar Solheim and Professor Henning Lygre. All three papers are closely tied to my PhD project description.

Paper 1: I was responsible for and carried out, the full case study program which included the face-to-face classroom instructions, the online teaching tasks, the development and adjustments of software applications, and the fully qualitative research program. Associate Professor Einar Solheim contributed with helpful in-class tuition. Subsequently I wrote the paper on the basis of advices and valuable discussions with Professor Øyvind Mikalsen. In the end phase of the writing process Associate Professor Jan Schjøtt gave supportive advises to enhance the academic qualities of the paper.

Paper 2: The theoretical framework and instructional learning materials of paper 2 was closely planned and produced together with Professor Otto Grahl-Nielsen. I was responsible for the test concept including the learning experiments, data collection, data analysis, and theory development. Professor Øyvind Mikalsen provided valuable feedback and suggestions regarding the framing of the data collection and the theory development.

Paper 3: This paper presents the first integration of blended learning into an inaugural curriculum in clinical pharmacology at the University of Bergen, conducted by Professor Henning Lygre. Multimedia instructions which were integrated in the online course content showed drug interactions with the human body. These were produced

by Associate Professor Einar Solheim. My technical contribution to the case study was to develop and maintain the online learning environment. During the teaching program I took part in adjusting various software applications according to attitudes and experiences of the students. Further I contributed with learning strategies to the blended learning format of the course. Finally I carried out a qualitative research program and wrote the paper. Associate Professor Jan Schjøtt, Professor Henning Lygre and Professor Øyvind Mikalsen contributed with valuable theoretical details to the writing process.

6.1.2 Paper 1: Educational design: Adult learners' attitudes towards a blended learning context including online multimedia instructions

This paper highlights a group of adult learners' attitudes to their experience with a blended learning format including multimedia instructions. The study was designed as a case study with semi-structured interviews as research strategy. The paper is dealing with the challenges on how blended learning and web-based multimedia instructions can be successfully integrated in teaching and learning activities in higher education. Specifically it addresses the link between a blended learning course and participants' specific experiences to get an understanding of how they worked and perceived their own learning activities. The participants for the research were nine university employees aged 30-46 years representing various positions as publishers of online information where the subject matter of the course was of specific importance.

Figure 11: Elements of the portal of a blended learning course for adult learners at the University of Bergen, Norway. A screen-shot of the original version

The framework of the study paid a special consideration to the nature of the multimedia instructions. The cognitive learning theories of multimedia learning and several principles for the design of multimedia instructions were studied before a development and integration of the multimedia artefacts took place.

Findings indicate that participants responded favorable to the blended learning format with emphasis on improved *flexibility* and *enhanced repetition possibility*. Further the usability factors of *ease of navigation*, *coherence between verbal and pictorial information*, and *social presence* were identified as beneficial for learning activities when using multimedia instructions. Finally *information clearness* and *minimalistic graphical displays* were identified as key matters for multimedia instructions with high quality of teaching.

The conclusion of the study is that multimedia modules successfully can be integrated into teaching and learning activities, and provides a favorable transition to a blended learning format that combines a face-to-face classroom environment with e-learning activities.

6.1.3 Paper 2: The learning effect of using a blended learning design in K12 science teaching

The paper describes a test design which compares the learning outcomes of students who learn with two different teaching treatments. We transferred the test design to seven science classes involving lectures on electrochemistry and organic chemistry in which we compared the cognitive learning outcomes of students who received a blended learning treatment with the cognitive learning outcomes of students who received traditional instructions. I chose two topics which are compulsive in Norwegian K12 science education because I wanted to examine the generalization of the test design by using different topics in the same teaching and learning experiment.

My theoretical goal was to examine the cognitive processes underlying learning from blended learning with the use of multimedia instructions. I focused on two measures of learning: retention tests are intended to measure the level of information perception and implemented as recall tasks, and transfer tests are intended to measure how well the learner can apply what is learned to solve new problems.

In order to produce multimedia instructions that promote learners with understanding certain theoretical criteria for memory and cognition had to be integrated. I based my analysis of multimedia learning on elements of the *Cognitive theory of multimedia learning* and the *Cognitive load theory* that provides a model for how the mind

processes multimedia information.

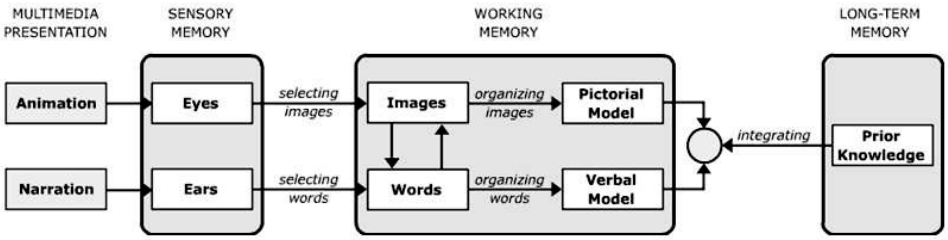

Figure 12: Cognitive theory of multimedia learning (derived from Mayer, 2009, p. 61)

This study was designed to provide a clear test within a school lesson of 45 minutes duration in which teachers lecture plus a multimedia lesson was pitted against teachers lecture plus text and diagram. The research was conducted in authentic and typical science classroom settings.

With specific learning goals as a basis, 12 multiple-choice questions for each topic were created (Appendix B). Both series of multiple-choice questions consisted of six multiple-choice questions with five answer alternatives (retention) and six multiple-choice questions with six answer alternatives (transfer). A pre-test with one science class was conducted to reveal possible flaws in the procedure.

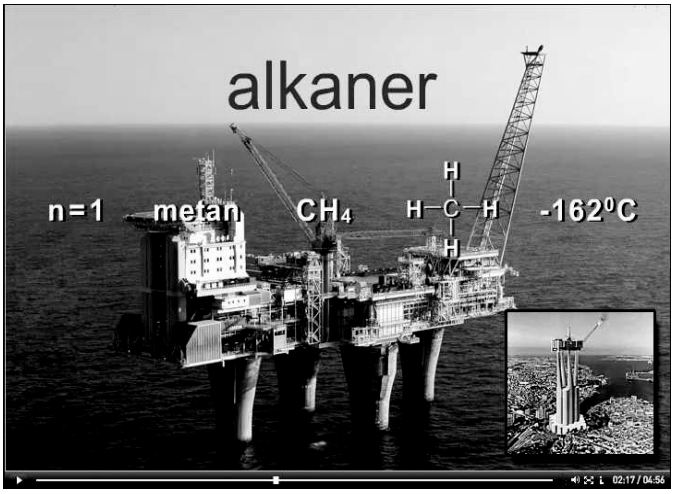

Figure 13: A screen-shot of one of the scenes in the multimedia instruction of '*Alkanes and alkyl groups'*

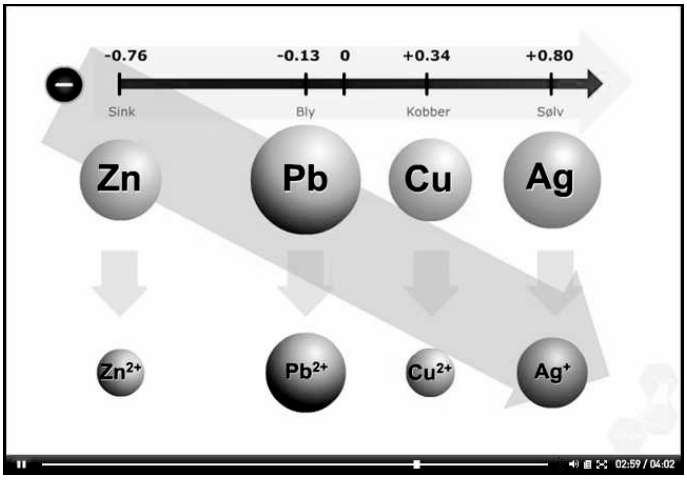

Figure 14: A screen-shot of one of the scenes in the multimedia instruction of '*The range of electrode potentials'*

The results of the case study support the traditional instruction approach. The H*0* hypothesis in all experiments other than two on retention prevailed. However, on average the blended learning groups showed better performances on retention scores. On seven comparisons, the traditional instruction approach never scored higher than the blended learning group on retention. The cognitive theory accounts for good performance on retention when learners engage in essential processing (Harskamp *et al*., 2008). All classes performed poorly on transfer questions, which indicate that neither the experimental group nor the control group engaged on generative load or deep learning. None of the groups were able to construct knowledge stored in the long-term memory, a process called *encoding* (Mayer and Johnson, 2008).

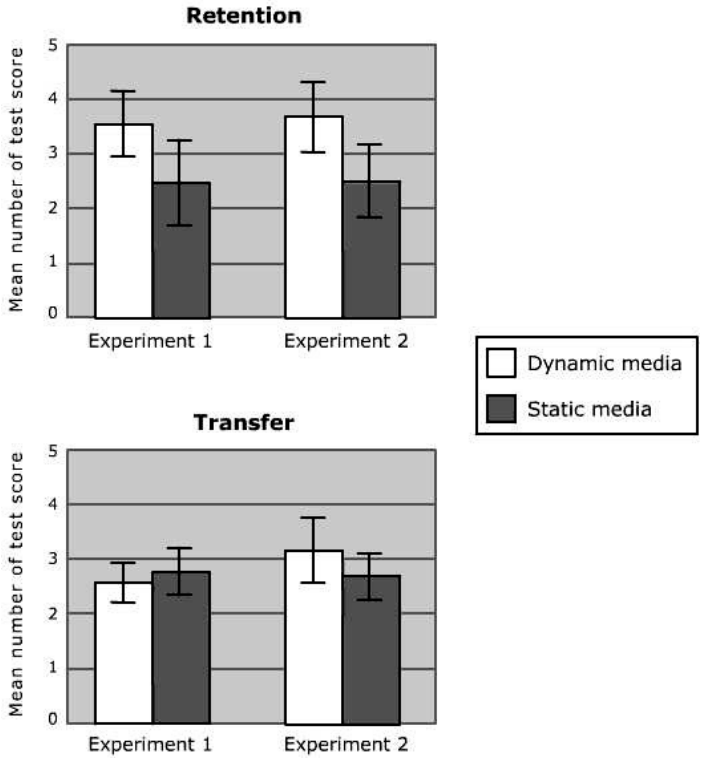

Figure 15: A graphical presentation of the learning test results

Overall, the main contribution of the current study is that there is support to a traditional instruction hypothesis when informational equivalent blended learning content and traditional instructions are compared on retention and transfer measures. It is important to note that the results are consistent across two different topics. From my results, students who learned from blended learning, with the exception of two results on retention, did not score significantly better on post-tests than did students who learned from traditional instructions. The research demonstrated that a blended learning format can be constructed in ways that utilize the features of multimedia presentations.

6.1.4 Paper 3: A blended learning course design in clinical pharmacology for postgraduate dental students

In this study we redesigned a former traditional course format into a combined structure of face-to-face classroom instructions and asynchronous e-learning activities. The aim of the study was to assure that the blended learning format was a novel approach that could meet postgraduate students' needs. In the postgraduate dental education, practical online activities in searching, analysing, and reflecting on information are as important as theoretical ones. Moreover it is important that dentists are familiarized with different aspects of e-learning, since dentistry is a science field where lifelong learning is inevitable. The learning activities of the course were linked to educational strategies of *The Norwegian Dental Association's* (NDA) towards continued professional development called Dental Association's systematic further education (TSE).

This educational model illustrates how transitioning from traditional teaching to a model of online learning can be conducted. A timetable of 4 three-hour face-to-face blocks combined with 3 online blocks was decided to replace the traditional course structure of 15 hours classroom teaching and a final exam. Each online block of the new structure addressed the topics from the initial face-to-face block and included a mandatory assignment dependent on individual and collaborative activities. Each weekly online assignment was commented and assessed by the course instructor. Three approved assignments were required to pass the course.

Figure 16: The interface of the online learning environment

My main finding was that a blended learning course design in clinical pharmacology for postgraduate dental students could represent a flexible, convenient and attractive

alternative for this particular group of students. The feedback from the study was positive. Introducing online material in face-to-face classes can result in a lack of confidence with the technologies and speak for a low student satisfaction. However all students welcomed the blended learning format with positive attitudes and expressed interesting recommendations for future course programs.

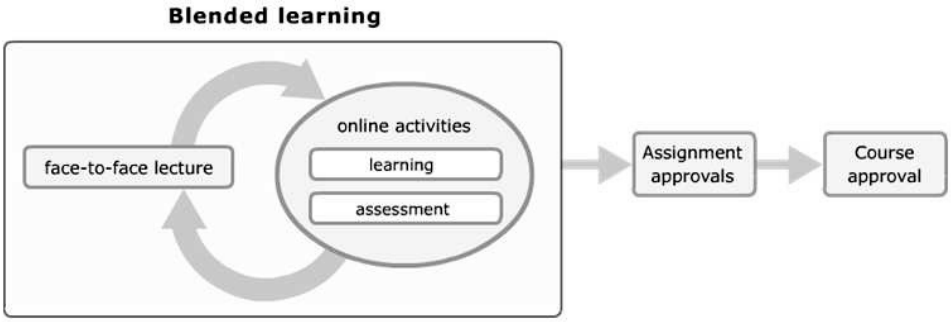

Figure 17: Elements and progression in the blended learning course for postgraduate dental students

I concluded that the blended learning course represented an attractive alternative for this group of students. The findings suggest that blended learning formats can be successfully integrated into postgraduate dentist education and provide a favorable transition to an educational design that combines face-to-face human interaction sessions with online learning activities.

Primarily enhanced flexibility, convenience, and time efficiency were reflected as benefits in the participants' comments. Further it was mentioned that online learning activities helped to change the role of the teacher from being a regular classroom instructor to a supportive facilitator.

One of the objectives of this study was to identify improvements that could enhance the quality of subsequent courses. Comments revealed a consensus of shared viewpoints in order to improve the function of the internet. Proposals were to use the internet as an absolute repository for all teaching and learning activities, to minimize the number of classroom settings in advantage of online video-based features by replacing them with online video conferencing, to improve the quality of mandatory assignments towards PBL-based assignments to meet specific professional needs, and not to force student use of social online communication (Web 2.0).

6.1.5 Contributions to the blended learning research field

Contribution 1: Defining appreciated usability factors of adult learners from using multimedia instructions as part of a blended learning format.

Contribution 2: A test design for measuring the cognitive learning outcome on retention and transfer in real classroom settings between two different teaching and learning treatments.

Contribution 3: Defining key matters for postgraduate dental students when using a blended learning format.

Contribution 4: Defining issues of blended learning courses in the future to meet the interests of postgraduate dental students.

7. Evaluation and discussion of results

The chapter first assesses the blended learning format used in the study. Next the research questions are evaluated before moving on to the evaluation of three of the main contributions. Each contribution is discussed and linked to theories. Finally the validity of the study is described and some reflections on interdisciplinary research are provided.

7.1 Evaluation of the blended learning format

Generally participants expressed positive views about their experiences with the blended learning format. The most appreciated aspect was *flexibility*. Learners were able to deal with the learning content anytime and anywhere, and thus in a position to organize themselves around the tasks. Negative views tended to be related to technical and navigational problems in accessing and using the learning systems.

Using LMS tools within online activities requires some technical skills and a certain degree of confidence. None of the participants expressed a strong negative view regarding the novelty of the educational format even if this kind of approach was new to almost all of them. Using tools within online activities requires some technical skills and a degree of confidence. It might have been their high ICT-literacy from daily online practice related to their job functions that played an important role. It could be assumed that mature students with a lack of experience in technology assisted learning would have expressed some dissatisfaction to such new challenges. In that regard it was rather surprising that the participants felt confident when using the format.

It is obvious that the participants had special characteristics because they all were adult learners and professional engaged in positions where the content of the courses had essential importance for them. Accordingly the informants represented learners who's' learning interest lay on coherence to their professions. In that sense it is difficult to compare these groups of participants with ordinary students in higher education.

In the use of both e-learning and traditional instructions, the students easily adopted the connection between the two segments. Their attitudes were positive. It had been untroubled to handle and understand the material. This may have been related to my participatory action research approach during the entire course periods, in which I regularly talked with the participants resulting in an ongoing reconstruction and adjustment of the software applications as well as of the blended learning structure.

The practice of the various learning theories (see section 3.7) with emphasis on PBL gave valuable experiences to the study. The online segment put forward unconventional learning activities compared with traditional instructions alone. Group work as well as individual learning activities were introduced and accomplished.

The assignments of the courses were evaluated differently. Positive feedback was given to PBL-tasks for solving cases including both individual and collaborative approaches. In fact a number of studies in education support learning advantaged of the PBL method (Dolmans & Smidt, 1996; Sackett *et al*., 1997; Boud & Feletti, 1998). In this study assignments with close relation to needed requirements were valued. Negative views were expressed to assignments for promotion of learning among students and interpersonal understanding. The students preferred learning activities with a clear focus on theoretical and practical issues related to their carriers. Obviously the participants addressed learning priorities close to their current professional needs. One participant argued that peer assessment had no sense. Ramsden (1992) emphasized that learners' priorities play a crucial role for learning

approaches and outcome. In this study it became unmistakably that the adult learners were well defined about their current educational needs.

The teacher-student relationship was commented in regard to an anticipated change in the teacher's role. Student responded positively to the enhanced possibilities for the teacher to act more as a support for their learning activities instead of a person with expert knowledge. The considerations correspond with the change in the role of the teacher towards online environments with PBL activities expressed by Goodyear (1997). Rather than just a provider of answers and content the teacher becomes a guide, resource provider, and expert controller. Bauersfeld (1995) evaluates the teacher's role from a constructivist approach. He argues that constructivism modifies the role, so that teachers can help students to construct knowledge and to get to an understanding of the content rather than to reproduce series of facts. The learning theory involves a change in the teacher's role to be a provider of guidelines and creator of learning environments where students are helped to arrive at their own conclusions.

Social online learning (Web 2.0) is a promising possibility within blended learning formats. The approach plays an important role due to the constructivist theory. The LMS of the courses offered chat rooms and discussion forums. Nonetheless the participants did not use them. Only a very low activity was registered. The participants commented the features with inconvenience. Awkwardness was also mentioned to describe the communication via the internet when participants meet face-to-face on a daily basis. Moore & Aspden (2004) discovered correspondingly that student on blended learning courses used on-campus face-to-face time to discuss subjects with other students instead of using online applications. It is possible that on-campus students do not value the usefulness of online communication when attending blended learning courses. Reasons for low Web 2.0 activities of the studies could be the limited number of participants, which implied reduced possibilities to meet peers online, and/or students' limited previous experiences with social online applications.

Students in medical and dental courses have indicated that discussion boards were not well utilized (de Leng *et al*., 2004). Gupta *et al*. (2004) realized that students were reluctant to communicate their views onto the internet. They argued that students may consider on-line communication just as a supplement to traditional teaching and therefore have a preference to face-to-face interactions. According to Shah & Cunningham (2009) the majority of students believes that e-learning has many advantages; however they consider face-to-face lectures as a 'real contact' (ibid) and accordingly gives them the main priority. Nevertheless it is worth noting that the use of Web 2.0 technologies in higher education is seen by educators as very promising both for the educational process and for self development (Grosseck, 2009).

One of the substantial potentials of blended learning is the ability to integrate multimedia learning activities. The multimedia instructions offered in the studies of the thesis included user controlled animations which explained the basic theories and conceptions of relevant topics. Maha & Tantawi (2009) commended the issue of dynamic online artefacts as variation in teaching and learning by dedicating more time to match different learning preferences when designing courses for adult learners. The authors concluded that facilitators should put more emphasis to match different learning preferences when designing courses. Research indicates that dentists have a highly visual learning preference and shows a priority for sensing and sequential learning strategies (Hughes *et al.,* 2009). Thus multimedia instructions might be a favorable learning method for postgraduate dental students. The experiences from integrating multimedia applications in this study are discussed in section 7.3.1.

The overall attitudes to blended learning suggest that students had positive attitudes towards the format. The participants explicitly stated beliefs that the format had positive impacts for their learning. They expressed the view that they had learned new skills and had gained new insight via the combined teaching and learning segments. These beliefs are not unique to groups of learners. Dantas & Kemm (2008) reported the following from a similar blended learning approach in physiology: 'This mode

[…] can be adopted for other disciplines and may assist students in developing a greater appreciation and a deeper approach for learning' (ibid).

Although the number of participants in the case studies was limited, there was a consistency in their overall attitudes. Hence the blended learning format may be ideal where a small number of students can interact with content and peers, and remain in regularly contact with their instructor.

A test procedure on cognitive learning outcome was designed (see section 5.1.3.3). The experimental group treatment used a blended learning format with integrations of multimedia instructions. The design (Fig. 17) contributed to carry out the learning test and to collect the results from a subsequent multiple choice questionnaires. A detailed description is delineated in section 7.3.2. The students (n = 156) immediately felt confident with the online segment after briefly being introduced to it. Furthermore the empirical test results indicated that a normal performance distribution was achieved with regard to statistical presuppositions. This demonstrates that students quickly got confident and capable of using the technical aspects of the format. Although the case study only provided insight into quantitative performance results, the study gave an indication of the potentials the approach has room for. Hence it is suggested that teachers and facilitators will take advantage of the valuable properties this educational format entails.

7.2 Evaluation of the research questions

Four research questions were formulated to be the conceptual frame of this project:

1. Which attitudes do adult learners hold towards a blended learning context including online multimedia instructions?
2. Will there be statistical evidence for better learning outcome by using a blended learning design including multimedia instructions compared with a traditional learning approach (based on subsequent retention and transfer tests)?
3. Which usability factors are important for postgraduate dental learners when using a blended learning format?
4. Which considerations have to be taken to improve future blended learning courses for postgraduate dental learners?

The research questions require an exploratory approach to the blended learning field, and this has to be taken into account when searching for a proper research methodology. Instead of a research approach describing or evaluating the existing traditional teaching field and the e-learning field, the exploratory focus is on the future. By the use of action research, the exploratory research emphasizes how research on blended learning concepts can be based on empirical work. The aim of the research questions is to discover new ideas, gain a deeper understanding and provide insight into the studied field.

The research questions are interdisciplinary. It is necessary to combine the fields of learning theories and ICT abilities and insight in order to address the research questions. Further reflections of the interdisciplinary research design are provided in chapter 7.4.

7.2.1 Research question 1: Which attitudes do adult learners hold towards a blended learning context

including online multimedia instructions?

This thesis is based on work from three case studies and the research questions are related to elements included in the studies. The first and third case studies focused on the learners' attitudes towards the blended learning format including multimedia instructions. Both groups of adult learners generally expressed positive opinions about the blended learning format. Negative views tended to be related to technical software problems in accessing and using the LMS. None of the participants expressed a strong negative opinion regarding their experience although considering that a majority of the students were enrolled in a blended program of this kind for the very first time.

The students revealed that the blended learning format had been beneficial for their learning. Findings indicate that participants responded favorable to the blended learning format mainly because of improved flexibility, location convenience and enhanced repetition choice.

During the first case study students' feedback made it clear that learning activities via multimedia instructions had a beneficial impact on their perceived learning outcome. Consequently I gradually enhanced my focus to the teaching and learning aspects of multimedia instructions. In order to produce multimedia instructions that promoted the learners with understanding certain theoretical criteria for memory and cognition had to be integrated. I based my analysis of multimedia learning on elements of the *Cognitive theory of multimedia learning* (Mayer, 2005, 2009; Mayer & Moreno, 2002) and the *Cognitive load theory* that provides a model for how the mind processes multimedia information (Paas *et al.,* 2003, Sweller, 2005). The *Cognitive theory of multimedia learning* is based on three ideas: (1) the dual-channel assumption - the idea advocates that learners have separate channels for processing auditory/verbal material and visual/pictorial material. The dual channel assumption is

a central feature of Paivio's (1986) dual-coding theory and Baddeley's (1998) theory of working memory; (2) the limited capacity assumption - the idea that learners can only acquire a limited amount of information in each channel at any one time (Baddeley, 1998; Sweller, 1999); (3) the active processing assumption - the idea that meaningful learning occurs when learners engage in a substantial amount of cognitive processing in paying attention to essential verbal and visual material, organizes the selected material into coherent representations, and integrates the incoming material with existing knowledge (Mayer, 2005, 2009; Harskamp *et al*., 2008). My main contribution during the project period was to improve the quality of the multimedia instructions via 'participatory research' (Henricks, 2006). I used my own teaching experience to change the design of the applications throughout the research period. This practical approach was conducted in the classroom space and gave me a meaningful strategy to improve the quality of the successive production of software applications.

With regard to aspects of learning activities from multimedia instructions students reflected positively on the topics of *ease of navigation*, *coherence between verbal and pictorial information*, and *social presence*. Participants commended the principles to have had a positive impact on their learning experiences. Further *information clearness* and *minimalistic graphical displays* were identified as key matters for multimedia instructions with high quality of teaching.

One of the important foci in instructional design was to understand what students actually preferred to do and what implications it made on their opinions. With dramatic changes in higher education towards enhanced use and implementation of ICT (Hoic-Bozic *et al*., 2009), these findings contribute to serve as guidance how to produce multimedia instructions for individual learning activities. Hence to understand and know about students' requirements when using multimedia instructions in blended learning course programs.

7.2.2 Research question 2: Will there be statistical evidence for better learning outcome by using a blended learning design including multimedia instructions compared with a traditional learning approach (based on subsequent retention and transfer tests)?

During the first case study with focus on best practice of multimedia instructions it became evident that learners appreciated this particular teaching and learning tool. Consequently an interest arose to develop a test design to measure the cognitive learning outcome from using multimedia learning. My aim was to examine the cognitive learning benefits from multimedia instructions as a part of a blended learning format. I focused on two measures of learning: retention and transfer. The study presented a test design which compared the learning outcomes of students who learn with two treatments. I transferred this issue to seven science classes involving lectures on electrochemistry and organic chemistry in which I compared the learning outcomes of students who received a blended learning design and with the learning outcomes of students who received traditional instructions. I chose two compulsive topics in Norwegian K12 science courses to examine if different topics would affect the results in the same learning experiment.

The results support the traditional instruction approach. The H*0* hypothesis in all experiments other than two on retention prevailed. However, on average the blended learning groups showed better performances on retention scores. On seven

comparisons, the traditional instruction approach never scored higher than the blended learning group on retention. The cognitive theory accounts for good performance on retention when learners engage in essential processing (Harskamp *et al*., 2008). All classes performed poorly on transfer questions, which indicate that neither the experimental group nor the control group engaged on generative load or deep learning. None of the groups were able to construct knowledge stored in the long-term memory, a process called *encoding* (Mayer and Johnson, 2008). A possible explanation for the mean score differences in performance between the groups could be the variation on the same theories made available in the experiment settings. Another possible explanation could be that some learners felt more excited about being part of the dynamic lesson group, which made it easier for them to pay attention to the topic than their counterparts and consequently perform better. Being a member of an experimental group could be more mentally stimulating than being a member of a control group. Membership of an experimental group could consequently affect the level of engagement of students and thereby increase engagement with learning materials. Being part of experimental group can motivate people to a higher level of participation: the motivation-performance nexus (Merwe, 2007). This issue was mentioned orally by some of the participants during the tests.

7.2.3 Research question 3: Which factors are important for postgraduate dental learners when

using a blended learning format?

The course of ‘Clinical pharmacology for postgraduate dental students’ was prepared from experiences of the two studies presented above and according to the sequential model of blended learning and online activities proposed by Koohang (2009). The model of Koohang illustrates how transitioning from traditional teaching to a model of online learning can be conducted.

In general the participants liked the blended learning structure. My main finding was that a blended learning course design could represent a convenient, flexible and attractive alternative for this group. Flexibility was commented as a key matter towards educational preference. The blended learning teaching format allowed participants to combine work, studies, and private life with enhanced contentment. Improved possibilities for *anytime and anywhere* freedom was considered as very essential. Further it was mentioned that online learning activities could help change the role of the teacher from being a regular classroom instructor to a supportive facilitator.

The three mandatory assignments of the course were evaluated differently. Participants appreciated the PBL-based assignments, but not the task of commenting each other answers. In fact a number of studies in medical education support learning advantaged of PBL (Sackett *et al.,* 1997; Boud & Feletti, 1998). Participants commented the PBL assignments to have a close relation to their professional requirements. Furthermore they expressed dissatisfaction with the assignment where they had to comment peer student posts. They felt they had to spend time on a non-essential assignment. Obviously participants addressed learning priorities close to their current professional needs.

The multimedia content offered in this study included user controlled animations and explained the basic theories and conceptions of general pharmacology. One interviewee expressed his attitude by saying that the animations were '[…] easy to understand, faster than a text'. This comment is interesting because it might account for the assertion that user controlled animations can promote active learning through learner-content interaction (Holzinger & Ebner, 2003). Maha & Tantawi (2009) commended this issue by dedicating more time to match different learning preferences when designing postgraduate dental courses in biostatistics. The authors concluded that dental educators should put more emphasis on time to match different learning preferences when designing courses. Among orthodontic residents research indicate that dentists have a highly visual learning preference and shows a priority for sensing and sequential learning strategies (Hughes *et al.,* 2009). Thus multimedia learning might be a favorable method to be academic successful for postgraduate learners by representing different modes of teaching delivery styles as a method of acknowledging the diversity of learners. A further explanation is communicated through the self-directed learning theory. Retrouvey & Finkenstein (2008) evaluated dental student responses to a multimedia program tested in a blended learning approach. A main finding was that computer-assisted instructions provided unique opportunities for self-directed learning. Among the students in the current study there were positive attitudes towards integration of user controlled multimedia content. Consequently I ascertain that these features might benefit to dental students' possibilities of being successful in postgraduate courses.

The role of the teacher from being a regular classroom instructor to a supportive facilitator was commented in regard to an appreciated change. The enhanced possibilities for a teacher to act as a support for learning activities were reflections that correspond with Baurenfeld's (1995) constructivist considerations. He emphasizes the modified role of the teacher to assist students to construct their own knowledge and to let him/her get to own understandings rather than only reproducing

series of facts. The online environments and PBL-based tasks contributed to the expected change towards more students centered learning activities (see section 3.7.5).

7.2.4 Research question 4: Which considerations have to be taken in future blended learning courses for postgraduate dental learners?

One of the objectives of this study was to identify improvements that could enhance the quality of subsequent courses. Feedbacks from the participants revealed a consensus of shared viewpoints in order to improve the function of the internet. The various proposals revolved around using the internet as an absolute repository for all teaching and learning activities. Furthermore ideas were raised to convert all teachers led Power Point presentations into video files available on the internet to present the possibility to watch the videos either before or after the face-to-face classroom settings. In addition the participants suggested to reduce the number of classroom settings or even replacing them with video technology. More specifically it was suggested to convert the teacher led classroom instructions into video recorded on-demand controlled video files and by substituting the face-to-face classroom instructions with synchronous online video features. The participants deemed the potential of video software tools as being promising in this educational approach.

7.3 Evaluation of main contributions to the thesis

Three of the main contributions of the thesis are discussed and evaluated in the following. First considerations behind the productions and use of multimedia instructions are discussed. Secondly the development of a quantitative learning test design is evaluated. Finally the instructional design developed to meet the needs of postgraduate dental students in regard to time efficiency and location convenience is discussed.

7.3.1 Evaluation of multimedia instructions

Mayer (2009) defines the term *multimedia learning* as 'learning from words and pictures' and *multimedia instruction* as a 'presentation of material using both words and pictures, with intention of promoting learning'. He is interested in the synchronization of words and images in computer mediated environments and asserts that 'students are more likely to engage in productive cognitive processing when corresponding words and pictures are presented at the same time' (Mayer, 2002). Mayer contributes to this thesis by merging technology based approaches with cognitive learning theories, e.g. by describing specific strategies for a multimedia production.

The nature of multimedia instructions was mainly derived from R. E. Mayer's research based experiments on multimedia instructions and learning. From laboratory settings with adult participants, Mayer (2009) has described several principles for the design of multimedia instructions. For example, the modality principle expresses that

students learn better from graphics and narration than from graphics and on-screen text. Thus, it is recommended that graphics (static and animated visualization) are accompanied by concurrent narration rather than concurrent on-screen text. In productions used for this thesis the verbal forms constituted the groundwork for organization and construction of graphics and animation. Subsequently words and images were synchronized in a video editing software program due to the instructional principles of Mayer and Mayer and Moreno on how to produce *multimedia instruction* (Mayer, 2001; Mayer and Moreno, 2002). To briefly summarize their role, which present the *Cognitive theory of multimedia learning*: multimedia instructions have to include seven principles; (1) the multimedia principle - present animation and narration rather than narration alone; (2) the spatial contiguity principle - present on-screen text near rather than far from corresponding animation; (3) the temporal contiguity principle - present corresponding animation and narration simultaneously rather than successively; (4) the coherence principle - exclude extraneous words, sounds and video; (5) the modality principle - present animation and narration rather than animation and on-screen text; (6) the redundancy principle - present animation and narration rather than animation, narration, and on-screen text; (7) the personalization principle - present words in conversational rather than formal style (ibid).

Using the theories of Mayer and Moreno in the present thesis represents a teaching and learning orientation towards interactivity in online environments, overcoming the disadvantages of early versions of e-learning which used ICT mainly to distribute learning content (Padmanabhuni, 2008). One of the important foci in implementing multimedia instructions was to understand what students actually preferred to do and to hear their opinions about the media. With dramatic changes in higher education towards enhanced use and implementation of ICT there is an unmet demand for guidance how to integrate these new educational challenges. In other words, we need more understanding and knowledge about the opportunities and challenges ICT

applications are providing education and training (Hoic-Bozic *et al*., 2009).

Since the focus of using online multimedia instructions, I evaluated the media from an internet usability perspective. The term internet usability is grounded in research focused on human-computer interaction (HCI) and user-centered design (UCD). According to Brink *et al*. (2002) 'usability is defined as a degree to which people can perform a set of required tasks'. Further they argue that highly usable Web sites are intuitive and transparent to the user. This type of user-centered design makes it easy and efficient for people to achieve their goals without having to deal with an excessively complicated site (ibid).

This thesis has been analyzing usability factors from the perspective of the users in paper 1 and 3. From the two case studies participants reflected over and gave meaningful feedbacks about the usability factors and the design of the multimedia instructions. The tendency was that participants appreciated the multimedia instructions during the courses. Overall they reflected with priority to *ease of navigation* and *coherence between verbal and pictorial content*. The latter topic is a central belief due to the instructional principles of Mayer and Mayer and Moreno on how to produce useful multimedia instructions (Mayer, 2009; Mayer and Moreno, 2002). The statements from the informants were all regarded to multimedia instructions when studying facts to solve concrete problems, rather than for content that would explore a comprehensive theoretical content. It is important to note that participants expressed that when the multimedia instructions contained navigation control it had a positive impact on their learning activities. They obviously felt the interactive tools were effective. Further the aspect of *clarity and simplicity* were the two most mentioned guidelines of the participants for high quality mult

imedia instructions. Both are implicitly integrated as core factors in the *Cognitive load theory*. The theory addresses a general principle of learning material. Instructions should be designed to reduce extraneous load in order to allow the students to devote

their mental resources in organizing and integrating the new knowledge into existing structures (Paas *et al*., 2003, Sweller, 2005).

This thesis recommends that the findings of using multimedia instructions are followed by new studies for other groups of students. Furthermore it should be examined how multimedia instructions could affect individual learners' differences in preferred learning strategies. Such studies would serve to further illuminate the potentials of when and how multimedia instructions could serve learners in the best way.

7.3.2 Evaluation of the quantitative learning test design

All of the components of the test design exist as individual parts, but the strength of the concept is that the components are elevated to another level by combining them into the same model.

The concept has a design to examine the cognitive processes underlying learning from blended learning with the use of multimedia. I focused on two measures of learning: retention tests are intended to measure how much was learned and are implemented as recall tasks, and transfer tests are intended to measure how well the learner can apply what was learned to solve new problems.

The concept is independent of software architecture. The presented case study used common open source LMS software and thus the test procedure is not restricted to a certain commercial application.

Cognitive learning is a complex process and the concept is an attempt to provide a structure of measurable learning outcomes divided between retentive and transfer learning capabilities. A concept was intended to be simple enough in order to be useful and to be considered as a convenient assessment approach. Cognitive learning theories based on multimedia learning (Mayer, 2009) encompassed useful elements for the developed test design of learning outcome.

The test design used a research method that combined cognitive learning outcome with a quantitative research paradigm. The goal was twofold. Firstly I wanted to test retentiveness, secondly to reconstruct the results in terms of a wider view reliable for knowledge building. Hence the focus was on a broader target than mere replication of the results. The results of the quantitative case study were used as objective knowledge for the further research process of the thesis. Silverman (1997) states that 'In research practice, enhancing objectivity is a very concrete activity'. It entails efforts to assure the accuracy of recordings and 'to test the truthfulness of the analytic claims that are being made' (ibid).

Overall there was support to a traditional instruction hypothesis when informational equivalent blended learning content and traditional instructions are compared on retention and transfer measures. It is important to note that the results are consistent across two different topics. From our results, students who learned from blended learning, with the exception of two results on retention, did not score significantly better on post-tests than did students who learned from traditional instructions. This should not be interpreted to mean that blended learning including multimedia lessons is ineffective in all situations. Although a blended learning design did not improve test performance in this study, there may be situations where blended learning designs improve understanding. Nevertheless e-learning could be considered as a supplement to traditional instructions in class settings because it has a positive effect on retention scores in general.

To elaborate and verify the test design more empirical work is necessary, but the empirical work of this thesis provides a useful starting point. The test design is so far used only in one project. Empirical validation and elaboration of the test design in a larger development project would be useful. More empirical grounding and comparisons will bolster the content and usefulness of the concept.

7.3.3 Evaluation of the blended learning design to postgraduate dental students

In paper 3 blended learning is viewed as the combination of face to face and online learning, enabling learning to be extended beyond the classroom and providing opportunities for reflection through interaction and further engagement with the learning material.

The blended learning design is presented as a holistic approach of learning. The term ‘holistic’ indicates that the different parts of the approach should not be considered alone, but should be seen together as a whole, and that the whole is more important than the parts alone.

The blended learning design increased the opportunities for the student group, with learning occurring across different mediums and at various times. The design provided a blended environment that offered the benefits of e-learning such as time efficiency and location convenience and the face to face advantages of one to one personal understanding and motivation.

For the instructor of the course, who had many years of experience from traditional teaching, the blended learning approach provided him with the opportunity to begin to

expand his expertise in the online environment. For him it resulted in a process of getting slowly but surely familiar with the system tools and learning activities of the blended learning design.

A key matter was the saving of travel time. This topic for professionals correspond well with the intentions of the European Working Directive (1993) which promotes the use of distance learning methodologies to reduce the number of travelling hours to host institutions where teaching and learning in medicine and dentistry is undertaken (Ireland *et al*., 2005). According to Shah & Cunningham (2009) research within orthodontic courses for postgraduates in Britain showed an increased tendency towards e-learning activities in remote areas because of timesaving issues. One of the reasons for being forced to travel long distances to host academic institutions the authors deemed to be a shortage of academics in the districts. Hughes *et al*. (2009) evaluated the challenges for orthodontic residency programs in the US. Their finding similarly supports the importance of refining curricula towards more online formats since the physical presence of a teacher in rural districts may not always be possible. Thus it seems relevant to develop and incorporate distance learning methodologies particularly for postgraduate residents located over various geographical distances.

It was clear from the interviews, that the informants, although aware of features such as on-line discussion modules, did not use them. The issue is discussed in sections 7.1.

The findings indicate that the blended learning model provide postgraduate dental students with beneficial time flexibility and location convenience, but also raised issues around replacement of teacher led lecturing in advance of online applications.

Rapid advances in online technology have given educators new ways of delivering teaching and learning content. For adult learners this study suggests that entire internet-based learning activities are one way of assisting students to reach their full academic potential. The main question for further research is to investigate to which

extend students are ready to abandon traditional modes of learning including face-to-face lectures. 'The key factor, however, will be the educational merit of the package produced rather than the technology used' (Lewis *et al*., 2005).

7.4 Validity of the study

The validity of research can be thought of as the degree to which it is accepted as sound, legitimate, and authoritative by people with an interest in research findings (Yardley, 2008). The people who would be interested include other researchers, policymakers and practitioners such as teachers and teacher educators.

To argue for validity of qualitative research is not a clear cut matter compared with quantitative research. In the views of validity it is argued that the term 'validity' should not be applied to qualitative research (Thagaard, 1998). Shenton (2004) discusses the term 'trustworthiness' as a substitute of validity. He argues that trustworthiness of qualitative research generally is often questioned by positivist, perhaps because their concept of validity and reliability cannot be addressed in the same way in naturalistic work. 'Many naturalistic investigators have, however, preferred to use different terminologies to distance themselves from the positivist paradigm'.

Denzin & Lincoln (2003) identifies that the terms of credibility, transferability, dependability, and conformability are replacing the traditional positivist criteria of internal and external validity, reliability, and objectivity.

There are several sets of criteria for evaluating the validity of qualitative studies (Klein & Myers, 1999; Shenton, 2004; Strauss & Corbin, 1998). Strauss & Corbin are listing criteria to ensure the research quality by the need of providing enough

information about the study and the necessity of ensuring the empirical grounding of the study. Examples are if concepts are generated and the major categories that emerged. In the following paragraphs the validity of this study is evaluated by focusing on credibility, originality, resonance, and usefulness.

7.4.1 Credibility

To ensure the credibility, the study has used the well established research method of action research. The research method is interlinking theory and practice in a dialectic process (Dick *et al*., 2009). Raelin & Coghlan (2006) state that action research intentionally merges theory with practice. As a methodological approach there are different views of action research. Coghlan & Brannick (2001) and McKernan (1996) views action research as a systematic self-reflective scientific inquiry to improve practice. In contrast, Aguinis (1993) argues that action research is a deductive causal analysis, a process of hypothesis building, testing and modifying to solve problems with reference to clearly defined goals. Despite the theoretical differences a common criteria is thorough descriptions of the research process (data collection and data analysis to ensure a high level of credibility of any project.

Another specification mentioned by Shenton (2004) is peer scrutiny of the research project. Parts of the project have been presented at an international conference and at various seminars. Further the procedures of the case studies were thoroughly evaluated, both by instructors and teachers who were involved in the programs during the processes of research. Finally constructive feedback was given via supervision from my supervisors during the writing processes and journal referees after completion of the project papers.

Shenton (2004) also mentions frequent debriefing sessions as means to ensure credibility. This study has not been performed as a 'one man show'. All the different parts of the three case studies represented in this thesis have been careful discussed with people involved in my projects. Through discussions in various project meetings development of visions and ideas took place. By exchange of views and clarity of conceptions practical research approaches were designed and engaged.

7.4.2 Originality

This thesis contributes to highlight main issues around the use of the blended learning format, but also points out that further development and research are of importance. The work contributes to the understanding of the criteria for high quality multimedia instructions and to explore the learning effect of using the media. The study uses both qualitative and quantitative research methods portraying the subject matters.

This study also developed a cognitive learning test design within a blended learning mode. The paper with the test design and results was accepted as a proceeding paper at the World E-Learn Conference 2010 and included as a book chapter in *Cases on managing e-learning: Development and implementation.* H. Yang, S. Wang (Ed), 2012.

Other original contributions are the combination of theory and practice interlinked towards a participatory action research approach. This kind of research method combined with semi-structured interviews provided the study with unexpected and interesting data.

7.4.3 Resonance

Resonance is dealing with the fullness of the study experience and by links drawn to other environments by the researcher. Resonance is increased by a strong combination of credibility and originality (Charmaz, 2005). A large number of categories found through the data collection and analysis phases are reflected in the two qualitative case studies of this thesis.

Volk (2009) focuses on the researcher's empowered experience with the topic. Via action research this thesis has achieved a level of own experience to examine personal and practical issues utilizing a blended learning format including multimedia instructions. With regard to the issue that learning is a complex circumstance, the study never will be able to cover a complete learning situation. The definition of a focus on blended learning including multimedia instructions narrows the research area to a manageable research topic. Trying to portray the fullness of an interdisciplinary research study would be an impossible challenge.

7.4.4 Usefulness

Usefulness has been an important factor of the work. To emerge guidelines and tools for peer developers of blended learning programs has been a main incentive for me. It is my suggestion that the experiences from this study can be used in different types of instructional designs especially when integrating multimedia instructions as e-learning artifacts. This may be regarded as strength of usefulness, because the results can be useful to various projects in combining instructional design with internet technology.

The choice of using action research also emphasizes the study's focus on usefulness, as action research has its roots in an 'orientation to knowledge creation that arises in a context of practice and requires researchers to work with practitioners' (Huang, 2010).

The research knowledge that has risen of this study is planned to be further developed in blended learning projects.

7.5 Reflections on interdisciplinary research

The problem statement of this thesis requires interdisciplinary research, which entails both challenges and opportunities. The main contributions of the thesis, key matters of the blended learning format, multimedia instructions, the cognitive learning test design, and enhanced quality of future blended learning approaches, necessitated development of applications to solve the aims of the study. The combination between designing ICT artifacts and research including instructional design meets due to Hevner *et al*. (2004) the paradigm of *Design science*. Design science has its roots in engineering, and is fundamentally problem solving in regard to identify organizational problems. This thesis has used action research, which may be considered as design science when applied to projects with exploratory perspectives. Hevner *et al*. (2004) defines seven design research guidelines which all are covered by this research project.

- Guideline 1, 'Design as an artifact'. This guideline requires the creation of an innovative, purposeful artifact. An artifact is defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and

practices), and instantiations (implemented and prototype systems). The results of this thesis can in the terms of design science be characterized as models (the blended learning concepts), methods (the cognitive learning test concept) and instantiations (the multimedia instruction modules).

- Guideline 2, 'Problem relevance'. In order to keep abreast and meet learner demands for flexibility, many universities and higher education institutions are requiring an online presence for all courses.
- Guideline 3, 'Design evaluation'. This guideline is one of the key issues of any action research approach. The theory of action research project highlights the importance of evaluation to justify its particular philosophical stance (Cassell & Johnson, 2006).
- Guideline 4, 'Research contributions' is fulfilled by the presented models to improve the quality of teaching and learning processes. Often the contribution of design science is the artifact itself, but it may also include foundations (the creative development of novel constructs, models, methods, and instantiations) or methodologies (Hevner *et al*., 2004).
- Guideline 5, 'Research rigor'.
- Guideline 6, 'Design as a search process'. Guideline 5 and 6 are fulfilled by the nature of action research. As a deviation from the experimental tradition it results into the development of certain forms of inquiry action research entail that iterative processes of problem diagnosis, interventions and reflective learning by the researcher and participants (Cassell & Fitter, 1992).
- Guideline 7, 'Communication of research'. This topic is fulfilled by the publication of three papers, the present thesis, and by presentations at various seminars and a conference.

8. Conclusions

The title of this thesis has a broad scope. It is a study of students' attitudes, cognitive achievements, and experiences with the use of blended learning including multimedia instructions. This chapter sums up the study. The chapter also outlines possible future research.

8.1 The research procedure

The first case study tried via participatory action research to develop a blended learning program. This was a participatory action research practice that included successive adjustments of the course design according to expectations, experiences, and opinions from the participants. The responses were accordingly considerations in that particular context. From the responses a conception of multimedia instructions as supplementary learning activities emerged. This led to theories of multimedia learning and development of multimedia files that became integrated in the course design. The adoption of multimedia into the course created one of the key factors for the development and research of this study.

From subsequent interviews of the adult learners it was obvious that the blended learning format with emphasis on the multimedia instructions had been beneficial to students' individual learning activities. As such, it became important to explore more details in regard to this particular ICT artifact. Further the positive feedback gave the incentive to design a cognitive learning test to specify the learning benefits of the method.

After the first case study was evaluated a test design to measure the cognitive learning effect from multimedia learning was developed. The procedure of the second case study used the test design for a series of hypothesis-testing experiments designed into positivist philosophical assumptions. The contribution of the study was that there was no support to a traditional instruction hypothesis when informational equivalent blended learning content and traditional instructions are compared on retention and transfer measures. Consequently the key challenge of the thesis was not to conduct further research on the learning outcomes but instead to investigate how the blended learning format suited a new and different group of adult learners: dental postgraduate learners. Despite the focus was on time flexibility and location convenience the participants' interpretations of the organizational situation for their further needs and demands became a central aspect of the case study.

The research evaluates the factors required for a successful use of blended learning including multimedia instructions. The thesis has involved a step-by-step consideration of cases that functioned as an analytic inductive process and used two different research methodologies for its data collections: the quantitative and the qualitative research methodologies.

8.2 Addressing the research questions

The research questions are evaluated in chapter 7, and this section concludes on how the research questions are addressed throughout the thesis.

Research question 1 (Which attitudes do adult learners hold towards a blended learning context including online multimedia instructions?) was answered by the contribution of the first and the third paper. The findings indicate that the blended

learning format was favorable to *improved flexibility*, *location convenience*, and *enhanced repetition possibilities*. Regarding the multimedia instructions *ease of navigation*, *coherence between verbal and pictorial information,* and *social presence* were identified as beneficial usability factors.

Research question 2 (Will there be statistical evidence for better learning outcome by using a blended learning design including multimedia instructions compared with a traditional learning approach - based on subsequent retention and transfer tests?) is replied in the second paper. There was support to a traditional instruction hypothesis when the learning outcome results from blended learning and traditional instructions were compared on retention and transfer.

Research question 3 (Which factors are important for postgraduate dental students when using a blended learning approach?) is reflected in the third paper. *Flexibility* and the issue of *saving travel time for professionals* were key matters. Further the study showed enhanced possibilities for the teacher to act more as facilitator for the students' learning activities than a primary source of knowledge.

Research question 4 (Which considerations have to be taken to improve future blended learning programs for postgraduate dental learners?) is answered in the third paper through student considerations towards enhanced time flexibility and location convenience. Suggestions were broad up to convert more content into online features, with the purpose to reduce the number of classroom settings or even entirely to replace them via online video conferences.

8.3 Further research

Although my study provides insight into what contributed to characterize teaching and learning aspects with the blended learning format, there is much to be done to enhance and improve learning opportunities for students. It is recommended that the findings of this thesis are followed by new studies for different groups of students. Furthermore to examine how integrated multimedia instructions could affect individual learners' differences in preferred learning strategies. Such studies would serve to further illuminate the potentials of when and how blended learning could serve learners in the best way.

More research is also needed to pinpoint the characteristics of blended learning formats. On the basis of this research we recommend further studies on integration of multimedia in blended learning settings as supplementary learning material. One possibility could be to investigate how blended learning formats are able to improve students' cognitive development. Furthermore statistically robust research is required on the *Cognitive load theory* to explore the links between working- and long-term memories when integrating e-learning into classroom settings.

Additionally research has to be conducted towards blended learning formats with enhanced time flexibility and location convenience. A possibility is to convert entire curriculums into online features, with the purpose to reduce the number of classroom settings or even entirely to replace them. Finally learning strategies towards specific professional needs has to be investigated more deeply.

8.4 Closing comments and future research

With dramatic changes in higher education towards enhanced use and implementation of ICT (Hoic-Bozic *et al*., 2009), there is an unmet demand for guidance how to meet these new educational challenges. In other words, we need understanding and knowledge to combine educational values with those ICT resources we offer our students.

I think that the ICT development in the resent years represents a technical improvement in all regions of digital application and infrastructure. For learners laptops are common devises and fast broadband internet connections are no longer a problem. A new landscape for exiting research questions is emerging. Students are beyond the stage of fascination, teachers are more digitally competent and experienced, and application developers working with creation of tools are operating more with interface structures than hard core coding languages. It has become easier to investigate instructors' teaching and students' learning activities in various designs of teaching and learning formats.

I have tried to present both realities and visions of adult learners. They have made me realize that adult learners are pragmatic and focused towards teaching formats that allow them to combine work, studies, and private life with enhanced contentment. They are careful with accepting large changes in their daily life. Looking ahead more research is necessary for being prepared for next generation of adult learners, who will be highly familiar with digital devices and well accustomed with the digitalized world of information.

References

Aguinis, H. 1993. Action research and scientific method: Presumed discrepancies and actual similarities. *Journal of Applied Behavioral Science*, 29(4): 416-431.

Akkoyunlu, B., Soylu, M.Y. 2008. A study of students' perceptions in a blended learning environment based on different learning styles. *Technology & Society*, 11(1): 183-193.

ALA. 2000. Information Literacy Competency Standards for Higher Education: American Library Association.

Albrecht, B. 2006. Enriching Student Experience Through Blended Learning, Vol. 12: Educause Center for Applied Research, Research Bulletin.

Ally, M., Anderson, T., Elloumi, F. 2004. Foundations of Educational Theory for Online Learning, *Theory and Practice of Online learning*. Athabasca, AB, Canada: Athabasca University.

Alonso, F. 2005. An instructional model for web-based e-learning education wirh a blended learning process approach. *British Journal of Educational Technology*, 36(2): 217-235.

Alsnes, K. 2004. *Besettelse. Historien om Europa, 1600-1800*: Gyldendal Norsk Forlag AS.

Alvesson, M., Schiöldberg, K. 2008. *Tolking og reflection* (2 ed.): Narenaya Press.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., et. al. 2001. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy for educational objectives*. New York: Longman.

Arbaugh, J. B. 2000. How Classroom Environment and Student Engagement Affect Learning in Internet-based MBA Courses. *Business Communication Quarterly*, 63(4): 9-26.

Ardito, C., Constabile, M. F., De Marsico, M., Lanzilotti, R., Levialdi, S., Plantamura, P., Roselli, T., Rossano, V. and Tersigni, M. 2004. Towards Guidelines for Usability of e-Learning Applications. In C. Stary, Stephanidis, C. (Ed.), *LNCS 3196*: 185-202. Berlin: Springer-Verlag.

Arksey, H., Knight, P. 1999. *Interviewing for Social Scientists*. London, U.K.: SAGE.

Association), A. A. L. 2000. Information Literacy Competency Standards for Higher Education.

Ausubel, D. P. 1968. *Educational psychology: a cognitive view*. New York: Holt Rinehart and Winston.

Ausubel, D. P., Robinson, F. G. 1969. School learning: an introduction to educational psychology. London: Holt Rinehart and Winston.

Ausubel, D. P. 1974. *Educational psychology: A cognitive view*. New York: Holt, Rinehart and Winston.

Babb, K. A., Ross, C. 2009. The Timing of Online Lecture Slide Availability and Its Effect on Attendance, Participation, and Exam Performance. *Computer & Education*, 52(4): 868-881.

Baddeley, A. 1998. *Human memory*. Boston: Allyn & Bacon.

Baruque, L. B., Melo, R. N. 2004. Learning theory and instructional design using learning objects. *Journal of Educational Multimedia and Hypermedia*, 13(4): 343-370.

Bauersfeld, H. 1995. The Structuring of the Structures: Development and Function of Mathematizing as a Social Practice. *L. P. Steffe & J. Gale (Eds.), Constructivism in Education. Hillsdale, New Jersey: Lawrence Erlbaum Associates Publishers*.

Bennett, P. N., Glover, P. 2008. Video streaming: Implementation and evaluation in an undergraduate nursing program. *Nurse Education Today*, 28(2): 253-258.

Benton, W. 1972. *Encyclopedia Britannica*: Publisher.

Berge, Z. L. 1999. Interaction in post-secondary Web-based learning. *Educational Technology*, 39(1): 5-11.

Berge, Z. L. 2002. Active, interactive, and reflective learning. *The Quarterly Review of Distance Education*, 3(2): 181-190.

Berk, L. E. 2009. *Childs Development* (8 ed.). Boston: Pearsons.

Bersin, J. 2004. *The Blended Learning Handbook*. New York: Wiley.

Blackburn, S. 2008. *The Oxford Dictionary of Philosophy* (2 ed.): Oxford University Press

Blinco, K., Mason, J., McLean, N., Wilson, S. 2004. Trends and Issues in E-learning Infrastructure Development: A white paper on E-Learning Infrastructure Development.

Bollinger, D. U., Martindale, T. 2004. Key factors for determining student satisfaction in online courses. *International Journal of E-Learning*, 3(1): 61-67.

Boud, D., Feletti, G. 2001. *The Challenge of Problem Based Learning* (2 ed.). London, U.K.: Kogan Page.

Bowden, J. 2005. Reflections on the phenomenographic research process. In P. G. J. Bowden (Ed.), *Doing Developmental Phenomenography*. Melbourne: Victoria: RMIT University Press.

Brandom, C. L. 1997. A brief guide to writing better test questions. *American Journal of Psysical Medicine* 76: 514-516.

Brinck, T., Gergle, D., Wood, S. D. 2002. *Designing Web sites that work: Usability for the web*. San Francisco: Morgan Kaufmann Publishing.

Britain, S., Lieber, O. 2004. A Framework for the Pedagogical Evaluation of eLearning Environments.

Brown, J. S., Adler, R. P. 2008. Minds on fire: Open Education, the Long Tail, and Learning 2.0. *Educause Review*, 43(1).

Bryant, A., Charmaz, K. 2007. *The SAGE handbook of grounded theory*. London, U.K.: SAGE.

Budenz, A. W. 2008. Selection factors for local anesthetic agents. *J Calif Dent Assoc*, 36(10): 735-738.

Bullen, M., Pasian, B. L., Woodill, G. A. 2006. When worlds collide: Project management and the collegial culture. In B. L. Pasian, Woodill, G. A. (Ed.), *The Impact of E-learning on the Use of Campus Instructional Space*. Toronto, Canada: CeLEA.

Carini, R. M., Kuh, J. D., Klein, S. P. 2006. Student Engagement and Student Learning: Testing the Lincages. *Research in Higher Education*, 47: 1-32.

Carroll, J. M. 1998. *The Nurnberg funnel: designing minimalist instruction for practical computer skill*. Cambridge: MIT Press.

Case, J. 2000. *Students' perceptions of context, approaches to learning and metacognitive development in a second-year chemical engineering course*. Monash University.

Cassell, C., Fitter, M. 1992. Responding to a changing environment: An action research case study. In D. Hosking, Anderson, N. R. (Ed.), *Organizational change and innovation*: 288-304. London: Routledge.

Cassell, C., Symon, G. 2004. *Essential guide to qualitative methods in organizational research*. London: SAGE.

Cassell, C., Johnson, P. 2006. Action research: Explaining the diversity. *Human Relations*, 59: 783-814.

Casullo, A. 2008. Revisability, Reliability and A Priori Knowledge. In E. Sosa, Kim, J., Faint, J., McGrath, M (Ed.), *Epistemology: An Anthology*: 595-611: Blackwell Publishing Ltd.

Cavus, N., Kanbul, S. 2010. Designation of Web 2.0 tools expected by the students on technology-based learning environment. *Procedia Social and Behavioral Science*, 2: 5824-5829.

CERI. 2005. *E-Learning in Tertiary Education: Where do we stand?* Paris: OECD Publishing.

Chamaz, K. 2006. *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. London: SAGE.

Chamaz, K., Henwood, K. 2007. Grounded theory in psychology. In C. Willig, Stainton-Rogers, W. (Ed.), *Handbook of Qualitative Research in Psychology*. London: SAGE.

Chang, V., Fisher, D. 2003. The validation and application of a new learning environment for online learning in higher education. In D. F. M. S. Khine (Ed.), *Technology-rich learning environments: A future perspective*: 1-18. Singapore: World Scientific.

Charmaz, K. 2005. Grounded Theory in the 21st Century, *The Sage Handbook of Qualitative Research*: SAGE Publications.

Chomsky, N. 1993. *Language and thought*: Moyer Bell.

Coghlan, D., Brannick, T. 2001. *Doing action research in your own organization*. London: SAGE.

Cohen, S. 1998. Contextualist Solutions to Epistemological Problems: Skepticism, Gettier, and the Lottery. *Australian Journal of Philosophy*, 76(2): 289-306.

Commission, E. 2007. Communication from the commission to the council and the European parliament: The e-learning action plan. In EU (Ed.).

Communities, C. o. t. E. 2006. Adult learning: It is never too late to learn, *COM, 614 final*. Brussels.

Cormode, G., Krishnamurthy, B. 2008. Differences between Web1.0 and Web2.0.

Corovic, S., Bester, J., Miklavcic, D. 2009. An e-learning application on electrochemotherapy. *Biomedical Engineering Online*, 8: 1-15.

Costa, R. J., Honkala, M., Lehtovuori, A. 2007. Applying the problem-based learning approach to teach elementary circuit analysis. *IEEE Transactions on Education*, 50(1): 41-48.

Craik, F. I. M., Lockhart, R. S. 1972. Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11: 671-684.

Craik, F. I. M., Tulving, E. 1975. Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, 104(268-294).

Craptree, B. E., Miller, W. L. 1999. *Doing Qualitative Research*: Thousand Oaks, CA: SAGE Publications.

Creswell, J. W. 2007. *Qualitative inquiry and research design: Choosing among five approaches* (3 ed.): Thousand Oaks, CA: SAGE.

Creswell, J. W. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches* (3 ed.): SAGE Publications.

Dantas, A. M., Kemm, R. E. 2008. A blended approach to active learning in a psychology laboratory-based subject facilitated by an e-learning component. *Advances in Physiology Education*, 32: 65-75.

Dar-Odeh, N. S., Abu-Hammad, O. A., Al-Omiri, M. K., Khraisat, A. S., Shehabi, A. A. 2010. Antibiotic prescribing practices by dentists: a review. *Ther Clin Risk Manag*, 21(6): 301-306.

Davies, D., Graff, M. 2005. Performance in e-learning: online participation and student grades. *British Journal of Education Technology*, 36: 657-663.

de Leng, B. A., Dolmans, D. H., Muijtjens, A. M., van der Vleuten, C. P. 2006. Student perceptions of a virtual learning environment for a problem-based learning undergraduate medical curriculum. *Medical Education*, 40: 568-575.

Del Corso, D., Ovcin, E., Morrone, G. 2005. An instructor friendly environment to foster learner-centered customization in the development of interactive educational package. *IEEE Transactions on Education*, 48(4): 574-579.

Denscombe, M. 2003. *The good research guide for small-scale social research projects* (2 ed.): Open University Press.

Deubel, P. 2003. An investigation of behaviourist and cognitive approaches to instructional design. *Journal of Educational Multimedia and Hypermedia*, 12(1): 63-90.

Dewey, J. 1944/2007. Democracy and Education. In R. Curren (Ed.), *Philosophy of Education: An Anthology*: 47-54: Simon & Schuster Adult Publishing Group.

Dick, B. 2004. Action research literature: Themes and trends. *Action Research*, 2(4): 425-444.

Dick, B. 2006. Action research literature 2004-2006: Themes and trends. *Action Research*, 4(4): 439-458.

Dick, B. 2007. What can grounded theorists and action researchers learn from each other). In K. C. A. Bryant (Ed.), *The Sage handbook of grounded theory*: 370-388: Thousand Oaks, CA: SAGE.

Dick, B., Stringer, E., Huxham, C. 2009. Theory in action research. *Action Research*, 7(1): 5-12.

Dolmans, D., Schmidt, H. G. 1996. The advantages of problem-based curricula. *Postgraduate Medical Journal*, 72: 535-538.

Donaldson, M., Goodchild, J. H. 2010. Appropriate analgesic prescribing for the general dentist. *Gen Dent*, 58(4): 291-297.

Doyle, C. 1992. Outcome measures for information literacy within the national education goals of 1990, Final Report to the National Forum on Information Literacy ed., Vol. Summary of Findings. ED 351033.

Driscroll, M. 2002. Blended learning: Let's get beyond the hype.

Ducatel, K., Bogdanowicz, M., Scapolo, F., Leijten, J., Burgelman, J. C. 2001. ISTAG Scenarios for Ambient Intelligence in 2010. In I. A. Group (Ed.), *Tecnical Report*.

Duffy, T. M., Cunningham, D. J. 1996. Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* 170-198. New York: Simon & Schuster Macmillan.

Edginton, A., Holbrook, J. 2010. A Blended Leaning Approach to Teaching Basic Pharmacokinetics and the Significance of Face-to-Face Interaction. *American Journal of Pharmaceutical Education*, 74(5): Article 88.

Elearnspace. 2005. Blended.

Engström, Y. 1987. *Learning by expanding*. Helsinki: Orienta-Konsultit.

Erduran, S., Jiménez-Aleixandre, M. P. 2008. Argumentation in Science Education: Perspectives from Classroom-Based Research. *Science & Technology Education Library*, 35.

Ertmer, P. A., Newby, T. J. 1993. Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, 6(4): 50-70.

Farouck, I. 2010. *A Case Study of the Effect of Online Content Difficulty in Collaborative Learning Communities in College Education*. Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education Orlando.

Felder, R. M., Spurlin, J. 2005. Applications, Reliability and Validity of the Index of Learning Styles. *International Journal of Engineering Education*, 21(1): 103-112.

Field, J. 2006. *Lifelong Learning and the New Educational Order*: Trentham Books.

Firestone, W. A. 1987. Meaning on method: The rhetoric of quantitative and qualitative research. *Educational Researcher*, 6(2): 187-205.

Fisher, K. W., Bidell, T. R. 2006. Dynamic development of action and thought. In T. M. Learner (Ed.), *Handbook of child psychology*, Vol. 1: 313-399. Hoboken: Wiley.

Foley, R. 2008. Skepticism and Rationalism, *Epistemology: An Anthology*: 322-332: Blackwell Publishing Ltd.

Franklin, T., van Harmelen, M. 2007. Web 2.0 for Learning and Teaching in Higher Education. London: The Observatory of Borderless Higher Education.

Friedman, V. J. 2009. There is nothing so theoretical as good action research. *Action Research*, 7(1): 31-47.

Garland, K. V. 2010. E-learning vs. classroom instruction in infection control in a dental hygiene program. *Journal of Dental Education* 74(6): 637-643.

Garnham, C., Kaleta, R. 2002. Introduction to hybrid courses. *Teaching with Technology Today*, 8(6).

Geelan, D. 1997. Epistemological anarchy and the many forms of constructivism. *Science & Education*, 6: 15-28.

Gergen, K., Gergen, M. 2008. Social construction and research as action. In P. Reason, Bradbury, H. (Ed.), *The handbook of action research: Participative inquiry and practice*, 2 ed.: 159-171. London, U.K.: SAGE.

Giannousi, M., Vernadakis, N., Derri, V., Michalopoulos, M., Kioumourtzoglou, E. 2009. *Students' satisfaction from blended learning instruction*. Paper presented at the Sixth Theory of Cryptography Conference San Francisco.

Gilbert, L., Moore, D. L. 1998. Building interactivity into Web courses: Tools for social and instructional interaction. *Educational Technology*, 38(3): 29-35.

Ginns, P. 2006. Integrating information: A meta-analysis of spatial contiguity and temporal contiguity effects. *Learning and Instruction*, 16: 511-525.

Glaser, B. G., Strauss, A L. 1967. *The Discovery of Grounded Theory: strategies for qualitative research*. New York: Aldine de Gruyter.

Glaser, B. G. 1978. *Theoretical Sensitivity: Advances in the Methodology of Grounded Theory*. California: The Sociology Press.

Glaser, B. G. 2003. *The grounded theory perspective, II: Description's remodeling of grounded theory*. Mill Valley, CA: Sociology Press.

Good, T. L., Brophy, J. E. 1990. *Educational psychology: A realistic approach* (4 ed.). New York: Longman.

Goodyear, P. 1997. The ergonomics of learning environments: learner-managed learning and new technologies, *3rd Congress on New Information Technologies for Education*: 7-17. Malaga, Spain.

Goodyear, P. 2002. Psychological foundations for networked learning. In C. J. C. Steeples (Ed.), *Networked learning: perspectives and issues*: 49-75. London: Springer Verlag.

Goodyear, P. 2005. Educational design and networked learning: Patterns, pattern language and design practice. *Australian Journal of Educational Technology*, 21(1): 82-101.

Grandy, R. E. 2007. Constructivisms and Objectivity: Disentangling Metaphysics from Pedagogy. In R. Curren (Ed.), *Philosophy of Education: An Anthology*: 410-416: Blackwell Publishing Ltd.

Gray, D. E. 2009. *Doing Research in the Real World*. London: SAGE Publications.

Greenberg, G. 1998. Distance education technologies: Best practice for K-12 settings. *IEEE Technology and Society Magazine*, 17(4): 36-40.

Griffiths, D., Blat, J. 2005. The role of teachers in editing and authoring units of learning using IMS Learning Design. *Advanced Technology for Learning*, 2(4): 243-251.

Grosseck, G. 2009. To use or not use web 2.0 in higher education? . *Procedia Social and Behavioral Sciences*, 1: 478-482.

Guba E. G., L. Y. 1981. *Effective evaluation*. San Francisco: Jossey-Bass.

Guba E. G., L. Y. 1994. *Handbook of Qualitative Research. Competing Paradigms in Qualitative Research*: Thousand Oaks, Ca: Sage.

Gunawardena, C. 1995. Social presence theory and implications for interaction and collaborative learning in computer conferences. *International Journal of Educational Telecommunications*, 1: 147-166.

Gupta, B., White, D., Walmsley, A. D. 2004. The attitudes of undergraduate strdents and staff to the use of electronic learning. *British Dental Journal*, 196: 487-492.

Gustafson, K. L., Branch, R. M. 2002. What is instructional design. In R. A. Raiser, Dempsey, J. V. (Ed.), *Trends and issues in instructional design and technology.* : Merrill Prentice Hall.

Gwendie, C. 1996. Problem-Based Learning: A Paradigm Shift or a Passing Fad? In M. E. Online (Ed.).

Gyabak, K., Schmoelz, A. 2010. *Adventure Web 2.0: Exploring the Possibilities of New Media Tools in Creating Dynamic & Engaging Online Learning Experiences*. Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2010 Orlando.

Haga, S., Tangerud, H., Befing, E. 1997. Vilkår for eit verdig liv: Edvard Befring 60 år. Lillestrøm. *SVS Undervisningspublikasjoner*.

Hammersley, M. 1990. *Reading Ethnographic Research: A Critical Guide*. London: Longmans.

Hammersley, M. 1992. *What's Wrong with Ethnography: Methodological Explorations*. London: Tavistock.

Hargadon, S. 2008. Web 2.0 is the future of education, Vol. 2011.

Harrison, R. T., Leitch, C. M. 2000. Learning and organization in the knowledge-based information economy: Initial findings from a participatory action research case study. *British Journal of Management*, 11: 103-119.

Harskamp, G. E., Mayer, R. E., Suhre, C. 2008. Does the modality principle for multimedia learning apply to science classrooms? *Learning and Instruction*, 17: 465-477.

Hasselgren, B., Beach, D. 1996. Phenomenography is what Phenomenographers do when doing Phenomenography, *Reports from the Department of Education and Educational Research*, Vol. 5. Göteborg: Göteborg University, Sweden.

Heinich, R., Molenda, M., Russell, J. D., Smaldino, S. E. 2002. *Instructional media and technologies for learning*. Upper Saddle River: Pearson Education.

Hellevik, O. 1991. *Forskningsmetode i sosiologi og statsvitenskap*. Oslo: Universitetsforlaget.

Hendricks, C. 2006. *Improving schools through action research: A comprehensive guide for education*. New York: Pearson.

Herrington, J., Reeves, T. C., Oliver, R. 2007. Immersive Learning Technologies: Realism and Online Authentic Learning. *Journal of Computing in Higher Education*, 19(1): 80-99.

Hesse-Biber, S. N., Leavy, P. 2006. *The Practice of Qualitative Research*: Thousand Oaks, CA: SAGE.

Hesse-Biber, S. N. 2007. Teaching Grounded Theory. In A. Bryant, Charmaz, K. (Ed.), *The SAGE Handbook of Grounded Theory*. London: SAGE Publications.

Hevner, A. R., March, S. T., Ram, S. 2004. Design science in information System Research. *MIS Quarterly*, 28(1): 75-105.

Hoic-Bozin, N., Mornar, V., Boticki, I. 2009. A blended learning approach to course design and implementation. *IEEE Transactions on Education*, 52(1): 19-30.

Hokstad, L. M. 2002. IKT og læring – et didaktisk perspektiv. In T. L. H. S. Ludvigsen (Ed.), *Et utdanningssystem i endring: IKT og læring* 208-225. Oslo: Gyldendal Akademisk.

Holzinger, A., Ebner, M. 2003. Interaction and Usability of Simulations and Animations: A case study of the Flash Technology. In M. Rautenberg, Wesson, J. (Ed.), *Human-Computer Interaction*: 777-780.

Horton, W. 2006. *E-Learning by Design*. San Francisco: Pfeiffer.

Hove, M. C., Corcoran, K. J. 2008. If You Post It, Will They Come? Lecture Availability in Instructory Psychology. *Teaching of Psychology*, 35: 91-95.

Huang, H. B. 2010. What is good research? . *Action Research*, 8(1): 93-109.

Hughes, J. M., Fallis, D. W., Peel, J. L., Murchison, D. F. 2009. Learning Styles of Orthodontic Residents. *Journal of Dental Education*, 73(3): 319-327.

Hunt, S. 2003. Controversy in Marketing Theory: For Reason, Realism, Truth, and Objectivity, *Morris B. Holbrook*. Columbia University.

Ingermann, Å. 2002. *Exploring Two Facets of Physics. Coherent Current Transport in Superconducting Structures. Phenomenographic studies in Sense-making in Physics*. Chalmers University of Technology and Göteborg University, Göteborg. Sweden.

Ireland, A. J., Smith, A. S., Alder, D. M., Sandy, J. R., Chadwick, S. M. 2005. Building a learning community on-line: the first step towards a national virtual learning environment in orthodontics. *Journal of Orthodontics*, 32: 214-219.

Izzo, A. A., Ernst, E. 2009. Interactions between herbal medicines and prescribed drugs: an updated systematic review. *Drug*, 69(13): 1777-1798.

Joint Information Systems Committee (JISC). 2007. Learning resources and activities.

Johnson, D. W., Johnson, R. T. 1996. Cooperation and the use of technology. In H. Jonassen (Ed.), *Handbook of research for educational communications and technology* 170-198. New York: Simon & Schuster Macmillan.

Johnson, M., Liber, O., Wilson, S., Sharples, P., Milligan, C., Beauvoir, P. 2006. *Mapping the future: The PLE reference model and emerging technology*. Paper presented at the 13th Association for Learning Technology Conference.

Jones, C., Asensio, M., Goodyear, P. 2000. Networked learning in higher education: Practitioners' perspectives. *Journal of the Association for Learning Technology*, 8(2): 18-28.

Jones, R. B., Maramba, I., Boulos, M. N. K., Alexander, T. 2009. Use of Live Interactive Webcasting for an International Postgraduate Module in eHealth: Case Study Evaluation, Vol. 2011.

Kant, I. 1959. *Critique of Pure Knowledge*. London: Dent/Everyman.

Karampiperis, P., Sampson, D. 2005. *Designing Learning Services: From Content-based to Activity-based Learning Systems*. Paper presented at the The 14th International Conference on World Wide Web.

Karpov, Y. V., Haywood, H. C. 1998 Two ways to elaborate Vygotskij's concept of mediation. *American Psychologist*, 53(1): 27-36.

Kay, J. 2001. Learner Control. *User Modeling and User-Adopted Interaction*, 11: 111-127.

Kaya, Z. 2002. *Distance Education*. Ankara: PegemA.

Keegan, D. 2004. *Foundations of Distance Education*. New York: Routledge.

Kehoe, J. 1995. Writing multiple-choice test items. *Practical Assessment, Research & Evaluation*, 4(9).

Kemmis, S., McTaggert, R. 1988. The action research planner. In 3 (Ed.). Victoria: Reakin University.

Kent, G. 1996. Informed consent, *The principled researcher*: 18-24. Sheffield: Social Sciences Division, The Graduate School, University of Sheffield.

Kickmeier-Rust, M., Pierce, N., Conlan, O., Schwarz, D., Verpoorten, D., Albert, D. 2007. Immersive Digital Games: The Interface for Next-Generation E-learning? In C. Stephanidis (Ed.), *Universal Access in HCL*, Vol. Part 3. Berlin: Springer Verlag.

Kilic-Cakmak, E. 2010. Learning strategies and motivational factors predicting information literacy self-efficacy of e-learners. *Australasian Journal of Educational Technology*, 26(2): 192-208.

Kirk, J., Miller, M. L. 1986. *Reliability and Validity in Qualitative Research*. London: SAGE.

Klein, H., Myers, M. D. 1999. A set of principles for conducting and evaluating interpretive field studies in information science. *MIS Quarterly*, 23(1): 67-94.

Klein, P. 2003. How a Pyrrhonian Skeptic might Respond to Academic Skepticism. In S. Lope (Ed.), *The Skeptics: Contemporary Essays*: 75-94. Aldershot: Ashgate.

Kolb, D. A. 1984. *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs: Prentice-Hall.

Koller, V., Harvey, S., Magnotta, M. 2008. Technology-Based Learning Strategies, Social Policy Research Associates Inc.

Koohang, A. 2009. A learner-centered model for blended learning design. *International Journal of innovation and learning*, 6(1): 77-91.

Koshy, V. 2005. *Action research for improving practice: A practical guide*. London: Paul Chapman.

Kumta, S. M., Tsang, P. L., Hung, L. K., Cheng, J. C. Y. 2003. Fostering Critical Thinking Skills through a Web-Based Tutorial Programme for Final Year Medical Students-A Randomized Controlled Study. *Journal of Educational Multimedia and Hypermedia*, 12(3): 267-273.

Kuo, Y., Eastmond, N., Bennett, L., Schroder, K. 2009. *Student perceptions of interactions and course satisfaction in a blended learning environment*. Paper presented at the World Conference on Educational Multimedia, Hypermedia & Telecommunications

Kvale, S. 1997. *Det kvalitative forskningsintervju*. Oslo: Gyldendal.

Kvale, S. 2001. *Det kvalitative forskningsintervju*. Oslo: Ad Notam Gyldendal.

Kvale, S., Brinkmann, S. 2008. *Interviews. Learning the craft of qualitative research interviewing*. London, U.K.: Sage Publications.

Kvanvig, J. K. 2008. Why Should Inquiring Minds Want to Know?: Meno Problems and Epistemological Axiology. In E. Sosa, Kim, J., Faint, J., McGrath, M. (Ed.), *Epistemology: An Anthology*: 492-506: Blackwell Publishing Ltd.

Köse, U. 2010. A blended learning model supported with Web 2.0 technologies. *Procedia Social and Behavioural Sciences*, 2: 2794-2802.

Laudan, L. 1981. *Science and hypothesis: historical essays on scientific methodology*: Dordrecht.

Laursen, P. F. 1994. Teacher thinking and didactics: a prescriptive, rationalistic and reflective approach. In G. H. I. Carlgren, S. Vaage (Ed.), *Teachers' mind and actions: research on teachers' thinking and practice* 125-136. London: Falmer Press.

Lave, J., Wenger, E. 1991. *Situated learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lazar, J. 2006. *Web usability: A user-centered design approach*. Boston: Pearson Education, Inc.

Lewis, M. J., Davies, R., Jenkins, D., Tait, M. I. 2005. A review of evaluative studies of computer-based learning in nursing education. *Nurse Education Today*, 25(8): 586-597.

Linge, N., Parsons, D. 2006. Problem-based learning as an effective tool for teaching computer network design. *IEEE Transactions on Education*, 49(1): 5-10.

Liotsios, K., Demetriadis, S., Pombortsis, A. 2006. Blended Learning Technologies in Lifelong Education: Lessons Learned from a Case Study. In K. T. W. Nejdl (Ed.), *EC-TEL*: 634-639.

Lonn, S., Tearsley, S. D. 2009. Saving Time or Innovating Practice: Investigating Perceptions and Uses of Learning Management Systems. *Computer & Education*, 53(3): 686-694.

Luna, R., Hall, R., Hilgers, M., Ge, L. 2010. GIS Learning Tool for Civil Engineers. *International Journal of Engineering Education*, 26(1): 52-58.

Lund, A. 2004. *The teacher as interface. Teachers as EFL in ICT-rich environments: beliefs, practices, appropriation*. University of Oslo, Oslo.

Lurija, A. R., Wertsch, J. V. 1982. *Language and cognition*. New York: Wiley.

Mackey, T. P., Ho, J. 2008. Exploring the relationships between Web usability and students' perceived learning in Web-based multimedia (WBMM) tutorials. *Computers & Education*, 50(386-409).

Maha, M. A., Tantawi, E. L. 2009. Factors Affecting Postgraduate Dental Students' Persormance i Biostatistics and Research Design Course. *Journal of Dental Education*, 73(5): 614-623.

Marchall, C. a. R., G. 1989. *Designing Qualitative Research*. London: SAGE Plublications.

Marton, F. B., S. 1997. *Learning and Awareness*. New Jersey: Lawerence Erlbaum Associates.

Mary, C. 2010. *Moodle 2.0 First Look*. Birmingham: Packt Publishing.

Mayer, R. E. 2001. *Multimedia learning*. Cambridge: Cambridge University Press.

Mayer, R. E., Moreno, R. 2002. Animation as an Aid to Multimedia Learning. *Educational Psychology Review*, 14: 87-99.

Mayer, R. E. 2002. Cognitive theory and the design of multimedia instruction: An example of the two-way street between cognition and instruction. *New Directions for Teaching and Learning*, 89: 55-71.

Mayer, R. E., Massa, L. J. 2003. Three Facets of Visual Learners: Cognitive Ability, Cognitive Style, and Learning Preference. *Journal of Educational Psychology*, 95(4): 833-846.

Mayer, R. E. 2005. Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning*: 31-48. New York: Cambridge University Press.

Mayer, R. E. 2005. Principles for managing essential processing in multimedia learning: segmenting, pretraining, and modality. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning*: 169-182. New York: Cambridge University Press.

Mayer, R. E. 2005. Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning*: 183-200. New York: Cambridge University Press.

Mayer, R. E. 2009. *Multimedia learning* (2 ed.). Cambridge: Cambridge University Press.

McGreal, R. 2002. A primer on metadata standards. In A. University (Ed.).

McKernan, J. 1996. *Curriculum action research*. London: Kogan Page.

McMullin, E. 1986. *The shaping of scientific rationality: Construction and constraint*: University of Notre Dame.

Merriam, S. B. 1998. *Qualitative Research and Case Study Applications in Education: Revised and Expanded from Case Study Research in Education*. San Francisco: Jossey-Bass Inc. Publishers.

Merriam, S. B. 2009. *Research. A Guide to Design and Implementation*. San Francisco: Jossey-Bass.

Merwe, A. 2007. Using Blended Learning to Boost Motivation and Performance in Introductory Economics Modules. *South African Journal of Economics*, 75: 125-135.

Meyer, R. E. 1998. Cognitive, metacognitive, and motivational aspects of problem solving. *Instructional Science*, 26: 49-63.

Miller, A. 2008. Realism and Antirealism. In E. Lepore (Ed.), *The Oxford Handbook Philosophy of Language*: Clarendon Press

Miller, J. G., B. 1998. The 'Inside' and the 'Outside': Finding Realities in Interviews, *Qualitative Research, Theory, Method and Practice*. London, U.K.: SAGE Publications

Mills, G. 2003. *Action research: A guide for the teacher researcher*. Upper Saddle River: Merrill Prentice Hall.

Minocha, S. 2009. A case study-based investigation of students' experiences with social software tools. *New Review of Hypermedia and Multimedia*, 15(3): 245-265.

Mishler, E. G. 1986. *Research interviewing: Context and narrative*. Cambridge: Harward University Press.

Mitchell, P., Forer, P. 2010. Blended Learning: The Perception of First-year Geography Students. *Journal of Geographic in Higher Education*, 34(1): 77-89.

Mitov, G., Dillschneider. T., Abed, M. R., Hohenberg, G., Pospiech, P. 2010. Introducing and evaluating MorphoDent, a Web-based learning program in dental morphology. *Journal of Dental Education*, 74(10): 1133-1139.

Monahan, T., McArdle, G., Bertolotto, M. 2008. Virtual reality for collaborative e-learning. *Computer & Education*, 50: 1339-1353.

Moore, G. E. 1962. Proof of an External World, *Philosophical Papers*: 144-148. New York: Collier Books.

Moore, K., Aspen, L. 2004. Coping, adapting, evolving: the student experience of e-learning. *Library and Information Update*, 3(4): 22-24.

Moore, M. G., Kearsley, G. 2005. *Distance education: A systems view* (2 ed.). Belmont, CA: Wadsworth.

Moreno, R. a. M., R. E. 2000. Engaging students in active learning: The case for personalized multimedia messages. *Journal of Educational Psychology*, 93: 724-733.

Morse, J. M. 1998. Validity by committee. *Quantitative Health Research*, 8(4): 443-445.

Mortera-Gutiérrez, F. 2006. Faculty best practice using blended learning in e-learning and face-to-face instruction. *International Journal of Distance Education*, 5(3): 13-37.

Murphy, R. J., Gray, S. A., Straja, S. R., Bogert, M. C. 2004. Student learning preferences and teaching implications. *Journal of Dental Education*, 68(8): 859-866.

Narayanan, N. H., Hegarty, M. 2002. Multimedia design for communication of dynamic information. *International Journal of Human Computer Studies*, 57: 279-315.

Neuman, D. 1986. *The origin of arithmetic skills*. Göteborg, Sweden: Acta Universitatis Gothoburgensis.

Newby, T. J., Stepich, D. A., Lehman, J. D., Russell, J. D. 2006. *Educational technology for teaching and learning* (3 ed.): Pearson Merrill Prentice Hall.

Nielsen, J. 2002. Flash: 99% bad.

Nurko, C., Proffit, W. R. 2005. Acceptability and perceived effectiveness of web-based self-instruction in clinical orthodontics. *Angle Orthodontist*, 74(4): 521-525.

O'Connor, K., Greene, C. Anderson, P. 2006. Action research: A tool for improving teacher quality and classroom practice, *American Educational Research Association Annual Meeting*. San Francisco.

Olesen, V. L. 2007. Feminist Qualitative Research and Grounded Theory: Complexities, Critisicm, and Opportunities, *The SAGE Handbook of Grounded Theory*. London, U.K.: SAGE Publications.

Oliver, M., Trigwell, K. 2005. Can blended learning be redeemed? *E-Learning*, 2(1): 17-26.

O'Reilly, M. 2000. *Reinvigorating Educational Design for an Online World*. Paper presented at the Conference of the Australasian Society for Computers in Learning in Tertiary Education, Southern Cross University.

Osguthorpe, R. T., Graham, C. R. 2005. Blended learning environments: definitions and directions. *The Quarterly Review of Distance Education*, 4(3): 227-233.

Padmanabhuni, S. 2008. Learning Services.

Pahinis, K., Stokes, C. W., Walsh, T. F., Cannavina, G. 2006. Evaluating a Blended-Learning Course Taught to different Groups of Learners in a Dental School. *Journal of Dental Education*, 71(2): 269-278.

Pahinis, K., Stokes, C. W., Walch, T. F., Tsitrou, E., Cannavina, G. 2008. A Blended Learning Course Taught to Different Groups of Learners in a Dental School: Follow-Up Evaluation. *Journal of Dental Education*, 72(9): 1048-1057.

Paivio, A. 1986. *Mental representations: A dual coding approach*. Oxford: Oxford University Press.

Palloff, R. M., Pratt, K. 1999. *Building learning communities in cyberspace*. San Francisco: Jossey-Bass.

Parameswaran, M., Whinston, A. 2007. Social computing: An overview. *Communications of the Association for Information Systems*, 19: 762-780.

Park, P. 2001. Knowledge and participatory research. In P. Reason, Bradbury, H. (Ed.), *Handbook of action research*, 1 ed.: 81-90. London, U.K.: SAGE.

Passarini, K., Granger, M. J. 2000. A developmental model for distance learning using the internet. *Computers and Education*, 34(1): 1-15.

Patton, M. Q. 1987. *How to use qualitative methods in evaluation*. London, U.K.: Sage Publications.

Patton, M. Q. 2002. *Qualitative Research & Evaluation methods* (3 ed.). London, U.K.: Sage Publications.

Pavlov, I. P. 1927. *Conditioned reflexes*. London: Clarendon Press.

Pereria, J. R., Pleguezuelos, E., Men, A., Molina-Ros, A., Molina-Tomas, M. C., Masdeu, C. 2007. Effectiveness of using blended learning strategies for teaching and learning human anatomy. *Medical Education*, 41(2): 189-195.

Persson, K., Axtelius, B., Söderfeldt, B., Ostman, M. 2009. Monitoring oral health and dental attendance in an outpatient psychiatric population. *J Psychiatr Ment Health Nurs*, 16(3): 263-271.

Peräkylä, A. 1997. Reliability and Validity in Research Based on Tapes and Transcripts. In D. Silverman (Ed.), *Qualitative Research: Theory, Method and Practice*. London, U.K.: SAGE Publications.

Pfleeger, S. H., Atlee, J. M. 2010. *Software engineering: Theory and Practice* (4 ed.): Pearson Education.

Philips, D. C. 2007. The Good, the Bad, and the Ugly: The many Faces of Constructivism. In R. Curren (Ed.), *Philosophy of Education: An Anthology*: 398-409: Blackwell Publishing Ltd.

Piaget, J. 1980. The psychogenesis of knowledge and its epistemological significance. In M. Piattelli-Palmarini (Ed.), *Language and Learning*. Cambridge: Harvard University Press.

Pind, J. 1998. Advances in dyslexia research. *Trends in Cognitive Science*, 2(1): 1-2.

Plass, J. L., Chung, D. M., Mayer, R. E., Leutner, D. 1998. Supporting visual and verbal learning preferences in a second-language multimedia environment. *Journal of Educational Psychology*, 90: 25-36.

Plummer, K. 1983. *Documents of Life: an introduction to the problems and literature of a humanistic method*. London: U.K.: Unwin Hyman.

Punch, K. 2005. *Introduction to Social Research: Quantitative and Qualitative Approaches* (2 ed.). London, U.K.: SAGE Publications.

Paas, F. G. W. C., Touvinen, J. E., Tabbers, H., Van Gerven, P. 2003. Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist*, 38: 63-71.

Paas, F. G. W. C., Touvinen, J. E., Tabbers, H., Van Gerven, P. 2003. Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist*, 38: 63-71.

Quale, A. 2008. *Radical Constructivism. A Relativist Epistemic Approach to Science Education*: Sense Publishers.

Raelin, J. A., Coghlan, D. 2006. Developing manages as learners and researchers: Using action learning and action research. *Journal of Management Education*, 30(5): 670-689.

Ramsden, P. 1988. *Improving learning: New perspectives* London, U.K.: Kogan Page.

Ramsden, P. 1992. *Learning to Teach in Higher Education*. London: Routledge publishers.

Reason, P., Bradbury, H. 2008. *The handbook of action research: Participative inquiry and practice*. London, U.K.: SAGE Publications.

Redecker, C., Ala-Mutka, K., Bacigalupo, M., Ferrari, A., Punie, Y. 2009. Learning 2.0: The Impact of Web 2.0 Innovations on Education and Training in Europe. In J. S. a. T. Reports (Ed.): European Comission.

Reigeluth, C. M. 1999. *Instructional-design theories and models*: Lawrence Erlbaum Associates, Inc., Publishers.

Reiser, R. A. 2002. A history of instructional design and technology. In R. A. Raiser, Dempsey, J. V. (Ed.), *Trends and issues in instructional design and technology*: Merrill Prentice Hall.

Reiser, R. A., Demsey, J. V. 2007. *Trends and issues in instructional design and technology* (2 ed.). Saddle River: Pearson Education, Inc.

Renström, L. 1988. *Conceptions of matter: A phenomenographic approach*. Göteborg, Sweden: Acta Universitatis Gothoburgensis.

Retrouvey, J., Finkenstein, A. 2008. Blended Learning in Orthodontic Diagnosis: An Interactive Approach. *Journal of the Canadian Dental Association*, 74(7): 645-649.

Rochester, C. D., Pradel, F. 2008. Students' perceptions and satisfaction with a web-based human nutrition course. *American Journal of Pharmaceutical Education*, 72(4).

Roda, C., Nabeth, T. 2005. Paper presented at the IADIS International Conference CELDA, Lisbon: Portugal.

Rogers, T. 2008. Student engagement in the e-Learning process and the impact on their grades. *International Journal of Cyper Society & Education*, 1(2): 143-156.

Rourke, L., Anderson, T., Garrison, D. R., Archer, W. 2001. Assessing social presence in asynchronous text-based computer conferencing. *Journal of Distance Education*, 14(2).

Rowe, S., Wersch, J. V. 2002. Vygotsky's model of cognitive development. In A. F. G. Bremner (Ed.), *Blackwell handbook of infant development* 538-554. Oxford: Blackwell.

Rubin, J. 1994. *Handbook of usability testing: How to plan, design, and conduct effective tests*. New York: John Wiley & Sons, Inc.

Ruiz, J. G., Mintzer, M. J., Leipzig, R. M. 2006. The impact of e-learning in medical education. *Academic Medicine*, 81: 207-212.

Rush, A. 2008. The Design of Online Tertiary Courseware for a Blended Learning, Project-Based, E-Business Management Program in the Middle East. *International Journal on ELearning*, 7(4): 667-701.

Sacchanand, C. 2002. Information literacy instruction to distance students in higher education: Librarians' key role, *68th IFLA Council and General Conference*.

Sackett, D. L., Richardson, W. S., Rosenberg, W., Haynes, R. B. 1997. *Evidence-based medicine: how to practice and teach*. New York: Springer Publishing Company.

Sandars, J. L., N. 2010. Twelve Tips on usability testing to develop effective e-learning in medical education. *Medical Teacher*, 32(12): 956-960.

Savery, J. R., Duffy, T. M. 1996. Problem based learning: An instructional model and its constructivist framework. In B. G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design*: 135-148.

Schilling, V. 2003. Konstrutivisme: Læring og erkendelse, *Filosofi og fysiklæring*: The Ministry of Education, Denmark.

Schneidermann, B. 2002. *Leonardo's laptop: Human needs and the new computing technologies*. Cambridge: The MIT Press.

Schnotz, W. 2005. An integrated model of text and picture comprehension. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning*: 49-70. New York: Cambridge University Press.

Schwier, R. A., Misanchuk, E. 1993. *Interactive multimedia instruction*. Englewood Cliffs: Educational Technology Publications.

Shah, R., Cunningham, S. J. 2009. Implementation of the virtual learning environment into a UK orthodontic training programme: the postgraduate and lecturer perspective. *European Journal of Dental Education*, 13: 223-232.

Shenton, A. K. 2004. Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22(2): 63-75.

Silverman, D. 1993. *Interpreting Qualitative Data: Methods for Analyzing Talk, Text and Interpretation*. London, U.K.: SAGE Publications.

Silverman, D. 1997. *Qualitative Research. Theory, Method and Practice*. London: SAGE Publications.

Silverman, D. 2005. *Doing Qualitative Research. A Practical Handbook* (2 ed.). London, U.K.: SAGE Publications.

Silvern, L. C. 1965. *Basic analysis*. Los Angeles: Education and Training Consultants Company.

Skadberg, Y. X., Kimmel, J. R. 2004. Visitors' flow experience while browsing a web site: its measurement, contributing factors and consequences. *Computers in Human Behaviour*, 20: 403-422.

Skinner, B. F. 1968. *The technology of teaching*. New York: The Free Press.

Skinner, B. F. 1974. *About behaviorism*. New York: Knopf.

Smith, P. L., Dillon, C. L. 1999. Comparing distance learning and classroom learning: Conceptual considerations. *The American Journal of Distance Education*, 13(2): 6-23.

Smith, S. D., Salaway, G., Caruso, J. B. 2009. The ECAR Study of Undergraduate Students and Information Technology.

Smith, S. M., Woody, P. C. 2000. Interactive effect of multimedia instruction and learning styles. *Teaching of Psychology*, 27(3): 220-223.

Smits, P. B. A., Verbeek, J. H. A. M., Nauta, M. C. E., Cate, T. J. T., Metz, J. C. M., van Dijk, F. J. H. 2004. Factors predictive of successful learning in postgraduate medical education. *Medical Education*, 38: 758-766.

Sohlberg, P., Sohlberg, B. M. 2004. *Erkendelsens former - Vitenskapsteori og forskningsmetoder*. Århus: Forlaget Klim.

Solheim, E. 2011. eFarmakologi, Vol. 2011.

Sosa, E. 2008. *Epistemology: An Anthology*: Blackwell Publishing Ltd.

Spencer, J. P., Schöner, G. 2003. Bridging the representational gap in the dynamic systems approach to development. *Developmental Science*, 6: 392-412.

Sprinthall, N. A., Sprinthall, R. C., Oja, S. N. 1998. *Educational Psychology: A Developmental Approach* (7 ed.). New York: McGraw-Hill.

Stake, R. E. 2005. Qualitative case studies. In N. K. Denzin, Lincoln, Y. S. (Ed.), *The Sage Handbook of qualitative research* 3ed.: Thousand Oaks, CA: SAGE.

Stensmo, C. 2007. *Pedagogisk filosofi: en introduksjon*: Lund Studentlitteratur.

Sternberg, R. J. 1998. Metacognition, abilities, and developing expertise: What makes an expert student? *Instructional Science*, 26: 127-140.

Strauss, A., Corbin, J. 1990. *Basics of qualitative research*. London, U.K.: SAGE Publications.

Strauss, A., Corbin, J. 1998. *Basics of Qualitative Research. Techniques and procedures for developing grounded theory*: Thousand Oaks, CA: SAGE Publications.

Stringer, E. T. 2007. *Action Research* (3 ed.). London, U.K.: SAGE Publications.

Stroud, B. 1984. *The Significance of Philosophical Skepticism*. Oxford: Clarendon Press.

Stubbs, M., Martin, I., Endlar, L. 2006. The structuration of blended learning: Putting holistic design principles into practice. *British Journal of Educational Technology*, 37(2): 163-175.

Sweller, J. 1999. *Instructional design in technical areas*. Camberwell: Australia Council for Educational Research.

Sweller, J. 2005. Implications of cognitive load theory for multimedia learning. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning*: 19-30. New York: Cambridge University Press.

Sørensen, H. 1972. *Verdens litteraturhistorie: Følsomhedens tid 1750-1800*, Vol. 6: 398-403. Copenhagen: Politikens Forlag.

Tabbers, H. K., Martens, R. L., van Merrienboer, J. J. G. 2004. Multimedia instructions and cognitive load theory: Effect of modality and cueing. *British Journal of Education Psychology*, 74: 71-81.

Taber, K. S. 2000. Case studies and generalizability: grounded theory and research in science education. *International Journal of Science Education*, 22(5): 469-487.

Tapscott, D. 1998. *Growing up digital: The rise of the Net generation*. New York: McGraw-Hill.

Tennyson, R. D., Sisk, M. F. 2011. A problem-solving approach to management of instructional systems design. *Behaviour & Information Technology*, 30(1): 3-20.

Thagaard, T. 1998. *Systematikk og innlevelse - en innføring i kvalitativ metode* (3 ed.): Fakbokforlaget.

Thelen, E., Smith, L. B. 2006. Dynamic systems theories. In T. M. Learner (Ed.), *Handbook of child psychology*, 6 ed., Vol. 1: 258-312. Hoboken: Wiley.

Thiessen, J. 2001. *Faculty attitudes in delivering undergraduate distance education*. Athabasca University, Athabasca.

Thomas, G. M. 1995. Education – past, present, future. In D. R. Walling (Ed.), *At the threshold of the millennium*. Bloomington, Indiana: Phi Delta Kappa.

Thorne, K. 2003. *Blended Learning*. London, U.K: Kogan Page.

Tlumak, J. 2007. Classical Modern Philosophy. A contemporary introduction, *Routledge contemporary introductions to philosophy*. Loyola University of Chicago: Tayler & Francis Books.

Tu, C. H. 2002. The measurement of social presence in an online learning environment. *International Journal on E-Learning*, 1: 34-45.

Tulving, E., Kroll, N. 1995. Novelty assessment in the brain and long-term memory encoding. *Psychonomic Bulletin & Review*, 2: 387-390.

Vaughan, N. 2007. Perspectives on Blended Learning in Higher Education. *International Journal on E-Learning*, 6(1): 81-94.

Volk, K. S. 2009. Action research as a sustainable endeavor for teachers. *Action Research*, 8(3): 315-332.

Vygotskij, L. S., Kozulin, A. 1986. *Thought and language*. Massachusetts: MIT Press.

Vygotsky, L. 1934/1986. *Thought and language*. London: The MIT Press.

Vygotsky, L. S. 1978. *Mind in Society*. London: Harvard University Press.

Watson, D. M. 2003. The teacher – the forgotten stakeholder? In K. W. L. C. Dowling (Ed.), *ICT and the teacher of the future*: 29-38. New York: Kluwer.

Watson, J. B. 1924. *Behaviorism*. New York: Norton.

Webb, G. 1997. Deep and Surface: Towards a critique of phenomenography. *Higher Education*, 33(2): 195-212.

Weller, M. 2007. *Virtual learning environments - Using, choosing and developing your VLE*: Routledge Taylor & Francis Group.

White, B., Geer, R. 2010. *Learner practice and satisfaction in a blended learning environment*. Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education Orlando.

Whyte, W. F. 1991. Comparing participative action research and action science. In W. F. Whyte (Ed.), *Participative action research*. Beverly Hills: Sage.

Wield, D. 2002. Planning and organizing a research project. In S. Potter (Ed.), *Doing Postgraduate Research*: Newbury Park, CA: SAGE Publications.

Wikipedia. 2011. Wikipedia, The Free Encyclopedia.

Wiley, D. 2002. Learning objects need instructional design theory. In A. Rossett (Ed.), *The ASTD e-Learning handbook* 115-126. New York: McGraw-Hill.

Wilhelmsen, J., Ørnes, H., Kristiansen, T., Breivik, J. 2009. Digitale utfordringer i høyere utdanning. Norgesuniversitetets IKT-monitor, *Norgesuniversitetets skriftserie nr. 1*.

Williams, B. R., Kim, J. 2005. Medication use and prescribing considerations for elderly patients. *Dent Clin North Am*, 49(2): 411-427.

Williams, M. 1991. *Unnatural Doubts*. Oxford: Blackwell Publishers.

Wilson, B. G. 1997. Reflections on constructivism and instructional design. In A. J. R. C. R. Dills (Ed.), *Instructional development paradigms* Englewood Cliffs: Educational Technology Publications.

Wu, J.-H., Tennyson, R. D., Hsia, T.-L. 2010. A study of student satisfaction in a blended e-learning system environment. *Computers & Education*, 55: 155-164.

Yardley, L. 2008. Demonstrating validity in qualitative psychology. In J. A. Smith (Ed.), *Qualitative psychology. A practical guide to research methods*: 235-252. London: Sage publications.

Young, G. 2002. Hybrid teaching seeks to end the divide between traditional and online instructions. *Chronicle of Higher Education*(A33-A34).

Zemsky, R., Maeroff, G. 2007. E-Learning: Successes and Failures. *The Chronicle of Higher Education*, 53(18): 1-7.

Zerger, A., Bishop, I. D., Escobar, F., Hunter, G. J. 2002. A self-learning multimedia approach for enriching GIS education. *Journal of Geography in Higher Education*, 26(1): 67-80.

Zhang, D., Zhou, L., Briggs, R. O., Nunamaker, J. F. 2006. Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. *Information & Management*, 43: 15–27.