After they turn on the screen: Use of information and communication technology in an upper secondary school in Iceland

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Dissertation submitted in partial fulfilment of a Ph.D.-degree
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I dedicate my thesis to the memory of my father Matthías Andrésson (1931-2005) who believed in education and technology as a way to promote progress for humanity.
Would you tell me, please, which way I ought to go from here?' Alice speaks to Cheshire Cat. 'That depends a good deal on where you want to get to,' said the Cat. 'I don't much care where--' said Alice. 'Then it doesn't matter which way you go,' said the Cat. '--so long as I get somewhere,' Alice added as an explanation. 'Oh, you're sure to do that,' said the Cat, 'if you only walk long enough' (Carroll, 2007, p. 90).
Abstract

The main aim of this study is to seek to further the understanding of the influence of information and communication technology (ICT) in education at the beginning of the 21st century. The focus is on how teachers use ICT in their teaching and how students learn in an ICT environment. For this purpose the influence of ICT on teachers’ and students’ beliefs, actions, values and pedagogy were investigated.

The theoretical underpinnings of the thesis are derived from four different discourses about the influence of ICT on education. Fox and Twining’s (2006) rationales for ICT use in education provide the context of the questions asked in the thesis, with reference to the more general discussion about the use of ICT in education. The framework of ten Brummelhuis and Kuiper (2008) draws attention to the various driving forces of ICT in relation to the learning processes, and Mishra and Koehler (2006) present an important perspective on the intersection and relationship between technological, pedagogical and content knowledge. Finally and foremost, the framework presented by Webb and Cox (2004) provides a fruitful theoretical base and guides the whole work, in particular as it emphasises the affordances that ICT offers and suggests how the teachers and students make use of it, very importantly on the basis of their knowledge and beliefs or attitudes.

The study takes, as a point of departure, the use of ICT in an environment that can be expected to give an exemplary view of what is done at the frontier of ICT use, in a normal school environment. A case study was conducted at one upper secondary school, Menntaskólinn í Kópavogur (MK). At the beginning of the century MK was already a promising ICT school which supported an ICT educational environment. The school was chosen as it had a long history of initiatives in ICT use and the teachers, identified by the school authorities as active ICT users, also had a history of ICT use in their work. Their students were also approached as well as the school authorities. In total eight teachers and six students were interviewed, diaries from five teachers were analysed, activities in 12 class rooms were observed, students activity in the learning management system (LMS) and their grades from 12 classes were analysed and 89 students participated in a survey.

The research questions relate to teachers’ and students’ knowledge, beliefs, values and behaviour; ICT affordances for learning activities and the teachers’ ICT pedagogical reasoning and the government and school ICT policies. In order to obtain as full a picture as possible a mixed-method design was used with
both qualitative and quantitative methods for data gathering and analyses. This included interviews with teachers, students and the headmistress of MK, observations of classroom activities, teachers’ diaries and a questionnaire that was administered online to a group of students. In addition, students’ grades and log files from their LMS use, as well as information from the school website and public records were utilized and the author’s experience from running ICT development programmes in the school.

The results from the different studies presented in this thesis give a picture of teachers, who apparently worked hard to integrate technology in their educational work, based on their technological pedagogical content knowledge. They wanted to develop ICT pedagogy further and faster and took the initiative in various directions, e.g., by using LMS, Internet, whiteboards, online communication, audio and video files and educational software. Also, they believed that change was needed in the school’s organisation to support the development. The school authorities fostered progress at the beginning, but later on were not able to support fully the initiatives of the most active teachers. Nevertheless these teachers carried on as they believed that it was beneficial to use ICT in education and they were convinced of its value. The ICT affordances presented by the teachers is an important determinant of ICT use and this thesis suggests that how they plan and implement ICT in their work is important to its development. Despite this, they believed that the outcome was not what they hoped for and in their view it was not only the school’s authorities and their fellow teachers that slowed down the development, it was also the students’ limited involvement.

The students played a significant role, but in many respect a passive one. They did not make use of all the ICT affordances available to them although they were aware of many of the possibilities and acknowledged their usefulness. Thus it was an effort to involve some of them in many of the options available. The teachers appeared to be the driving force in the ICT development, aiming at involving the students in the whole spectrum of available options although the students seemed to take some of the ICT affordances for granted. The students saw the usefulness and advantage of ICT use and focused on ‘here and now’ utilization, but did not operate in a visibly proactive way. The teachers wanted to offer the students good ICT affordances, but nevertheless, in a rather traditional sense as they were bound to the national and the school curriculum and the school’s organisation of the education programmes.

Drawing on the results and the theoretical background, the author recommends four components that should be explored further. Firstly, the educational component, such as the various rationales for ICT use and favourable beliefs, attitudes and values and pedagogical knowledge that are
fundamental to a successful application of ICT in education. Secondly, the application component, as constant technical development requires relentless innovation and implementation of new possibilities. Thirdly, the training component, ICT tools are continuously offering new possibilities and affordances that both teachers and students need to be trained in to harvest for their work. Fourthly, and finally, the development component, noting that ICT in education is an on-going process that will not thrive without constant support.

It is clear that implementing change is a complex process and in many ways cumbersome. It requires vision, sense of purpose, commitment, dedication and understanding of what education is about and acceptance that the change is both necessary and sensible. It requires a lot of work, especially as it involves change. In this process there is a need of a better cooperation between students and teachers; they all need to be fully aware, able to utilise, and apply new technology in the most effective and creative fashion.
Ágrip

Markmiðið með þessari ritgerð er að öðlast skilning á áhrifum upplýsinga og samskiptataekni (UST) á menntun í upphafi tuttugustu og fyrstu aldar. Sjónum er beint að því hvernig kennarar nota UST í kennislu sinni og hvernig nemendur læra í umhverfi sem styður notkun á UST. Í þeim tilgangi voru skoðuð áhrif UST á viðhorf og skoðanir kennara og nemenda rannsókuð svo og kennslaðferðir.


Útgangspunktur rannsóknarinnar var notkun UST í styðjandi skólaumhverfi og dæmi um framsækna notkun UST í hefðbundnu umhverfi. Um er að ræða tilviksrannsókn (e. case study research), þar sem tilvikkið er einn íslenskur framhaldsskóli, Menntaskólinn í Kópavogi (MK). Skólinn var valinn því hann hafði langa sögu um frumkvæði í notkun UST og kennara sem voru virkri í notkun UST. Þátttakendurnir voru sex kennarar í MK, sem skólayfirvöld völdu, því þeir átti sér sögu um notkun UST í starfi sínu. Nemendur þeirra voru einnig þátttakendur sem og skólayfirvöld.

Rannsóknarþrunningar voru hannadur með það að leiðarljósi að öðlast skilning á áhrifum UST á menntun í upphafi 21. aldarinnar. Þær varða þekkingu kennara og nemenda, viðhorf þeirra, gildi og atferli; þá möguleika sem notkun UST gefur til að virkja nemendur í námi, kennslufraðileg rök kennara stefnu stjórnvalda og skóla á sviði UST. Til þess að fétt eins skýra mynd og unnt var af því hvað var gert í þessu jákvæða umhverfi, voru notaðar bæði eigindlegar og megindlegar aðferðir við gagnaöflun og greiningu. Aðferðirnar fólu í sér viðtöl við átta kennara, sex nemendur og skólameistara MK, athugun í 12 skólafoto, greina dagbækur fimm kennara, greining á gögnnum um notkun á kennslukerfi skólans og eindunum og rafræna spurningakönnun meðal 89 nemenda. Að auki voru skoðaðar einkunnir nemenda og virkni þeirra í kennslukerfinu sem og
upplýsingar af vef skólans og úr opinberum gögnum. Reynsla höfundar af starfi við skólan s.s. við þróunarverkefni nýttist einnig.


Nemendur gegndu mikilvægu hlutverki, en að mörgu leyti voru þeir óvirkir, jafnvel þótt það kunni að hljóma sem mótsøgn. Þeir nýttu sér ekki alla þá UST möguleika sem í boði voru þótt þeir væru meðvitaðir um þá og viðurkenndu notagildi þeirra. Það var því fyrirhöfn fyrir kennaranana að fá þá til að nýta tiltæka valkosti UST. Kennararnir virtust þannig vera drífkrafturinn í UST þróuninni í MK með það markmið að fá nemandur til að nýta sér sem flesta valkosti, en oft virtust nemandur taka möguleika UST sem sjálfþróunum hlut. Þeir sáu notagildi og hagnýttingu UST og löggó áherslu út nýtingu hér og nú, en virtust ekki nýta UST á framsækinn hátt. Kennararnir vildu bjóða nemendum upp á göða UST möguleika, en engu að síður í frekar hefðbundnum skilningi þar sem þeir voru bundnir við aðal- og skólanámmskrá og námsskipulag skólans.

Höfundurinn dregur fram fjóra þætti, byggða á niðurstöðunum og fræðilegum bakgrunni verksins, sem kanna ætti frekar. Í fyrsta lagi, ætti að draga betur fram og skoða menntunarþáttinn. Það felur í sér að gaumgæfa hín ýmsu rök fyrir notkun UST og æskilegar skoðanir, viðhorf, gildi og kennslufræðilegum þekkingu, sem eru grundvallaratriði í árangursríkri beitingu UST í menntun. Í öðru lagi ætti að kanna notkunarþáttinn, en stöðug tæknirþróun krefst hraðar nýsköpunar og nýtingar nýrra möguleika. Í þriðja lagi, er nauðsynlegt að rannsaka þjálfunarþáttinn og hverning honum er sinnt, en UST tæki bjóða stöðugt upp á nýja möguleika og tækifæri sem bæði kennarar og nemendur þurfa að vera þjálfafir í að nýta í starfi sínu. Í fjórða lagi ætti að rannsaka þróunarþáttinn og hverning honum er sinnt, en áhersla á UST í
menntun er viðvarandi ferli sem mun ekki þrífast án stöðugrar nýbreytni og stuðnings við hana.

Það er ljóst að innleiðing breytinga er flókið ferli og að mörgu leyti tímafrekt og þess vegna kostnaðar- og vinnufrekt. Það krefstframtíðarsýnar, markmiða, skuldbindingar, metnaðar og skilnings á því hvað menntun er og viðurkenningar á að breyting sé bæði nauðsynleg og skynsamleg. Það krefst mikillar vinnu, sérstaklega þar sem innleiðing felur í sér breytingu. Í þessu ferli er þörf á mikill samvinnu nemenda og kennara sem þeir þurfa allir að vera fyllilega meðvitaðir um og vera færir um að nýta, og beita nýrri tækni á sem bestan og mest skapandi hátt.
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1 Introduction

Computers and other information and communication technology (ICT) tools form an important part of our daily lives as well as being key factors of the educational system in modern societies. Indeed it can be said that ICT is now an integrated part of many schools in the Western world, although it varies to what extent it is available and used. It is therefore critical to study the development and influence of ICT in education; both, how this new technology is implemented in schools and how effective it is in providing students with opportunities to achieve benefits from their education. In this thesis, research into the use of ICT to facilitate teaching and learning in an upper secondary school in Iceland will be presented, focusing on teachers’ and students’ knowledge, beliefs and values. In this chapter the key terminology is introduced before addressing the focus of the thesis and its objectives.

1.1 Terminology

Analysing the literature on computer technology and the Internet in education shows that many concepts have been used during the years in order to capture its meaning. The different ideas about the use of computer technology will be discussed in Chapter 2, but here a brief discussion will demonstrate some vagueness in the use of many of the frequently used concepts.

To make things still more complicated some words used to describe different applications of computer technology in educational settings can have different meanings, reaching from a rather narrow meaning to broader conceptualizations (Nycz & Cohen, 2007).

In the literature many different concepts or umbrella terms are designated for the use of computer technology in education. For the overall use of computer technology at least three terms are frequently used: information technology (IT), information and communication technology (ICT) and new technology (NT). For learning with some kind of computer technology support, at least fifteen terms could be found in the literature: blended learning, computer-assisted learning (CAL), computer-supported collaborative learning (CSCL), distance learning (which is also used in other contexts), distributed learning (DL), e-Learning, Internet-based learning, mobile learning (m-learning), multimedia learning, net-learning, online learning, tele-learning, ubiquitous learning, technology enhanced learning and Web-based learning.
Other terms that were found, but did not fit in with the two groups already mentioned, were computer-assisted instruction (CAI) and online training focusing on training.

Even though these terms have different meanings and thus imply different emphases, they are partly used as synonyms with a somewhat unclear reference and are thus not particularly helpful in defining a clear focus, or to distinguish different aspects of the use of ICT in education. To find out which of these terms is most commonly used a search was conducted in Google Scholar (scholar.google.is) in March 2008. The search showed that information technology (IT) and ICT were the most commonly used terms, followed by distance learning, online training, online learning and distributed learning (see Appendix I).

There are different definitions of IT, each with a different focus. The Information Technology Association of America (ITAA) provided the following definition on its website:

... the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware (ITAA, 2004, no.p.n.).

The focus of this definition is on the technical aspects of IT rather than the educational aspect whereas the definition suggested by Cox (2004) is more on the use and the application of IT use:

Information technology (IT) is the design, study and use of processes for representing physical, hypothetical or human relationship employing the collection, creation, storing, retrieving, manipulation, presentation, sending and receiving of information (Cox, 2004, p. 67).

If we look at the definition of IT from the Icelandic Ministry of Education from 1996 it has a stronger connection to technology than the definition suggested by Cox above:

... to use appropriate technology for information processing whereby the term technology refers to computer technology, telecommunications technology and electronics (Ministry of Education, 1996, p. 92, translated by the author).
Communication (C) was added to IT to broaden the term, in particular when Internet access became more widespread, adding on new possibilities for communication. ICT in education is used to describe the use of technology quite generally, like the use of computers and the Internet, but IT in education seems to have a narrower connotation and is more related to what students learn to do with technology. In the thesis the term IT in education will not be used as it is considered too narrow for today’s use of technology in education.

In a recent paper Sarkar (2012) describes ICT and underlines the wide scope of the term:

Information and Communication Technologies consist of the hardware, software, networks, and media for collection, storage, processing, transmission and presentation of information (voice, data, text, images), as well as related services. ICTs can be divided into two components, Information and Communication Infrastructure (ICI) which refers to physical telecommunications systems and networks (cellular, broadcast, cable, satellite, postal) and the services that utilize those (Internet, voice, mail, radio, and television), and Information Technology (IT) that refers to the hardware and software of information collection, storage, processing, and presentation (Sarkar, 2001, p. 32).

Loveless and Ellis (2001) clearly demonstrate how it can even be more complicated to describe ICT in education:

The words ‘information and communications technology’ describe a set of technologies with particular applications which vary enormously in purpose and scope within and between subject contexts. The term ‘ICT’ is also accompanied by a set of conceptual understandings that relate to a notion of capability, literacy or ‘how to deal’ with information using technology (Ellis, 2001, p. 2).

The term ICT in education will here be used as an umbrella term to cover the use of technology in educational settings for information retrieval, processing and analysing, and communicating with devices or applications to facilitate activities in education. The above definition shows what a broad reference the term has and how important it is to analyse the different emphasis that its application can have. It will be explained later in the thesis that the present study focuses on particular parts of the wide spectrum of potential application or influence of ICT on education.
Different terms have also been used to describe ICT skills. During the 1980s and the 1990s the term computer skills was used when the focus was on learning how to use computers. The term information technology skills came later when the Internet became more accessible and information processing got more attention. This was followed by the term information and communication skills when communication applications on the Internet became more available. Today the term digital skills or literacy competence might cover the situation best with all the new possibilities to retrieve information and communicate online through different technology applications. Digital skills and literacy are important for teachers and students for involvement in ICT in education and in the literature different working can be found. Jenkins et al (Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009) talks about new media literacies and they emphasis the “cultural competencies and social skills that young people need in the new media landscape” (p. XIII).

In a recent report, Preparing for Life in a Digital Age (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2013) the term computer and information literacy (CIL) is used referring to Fraillon, Schulz and Ainley definition “an individual’s ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in society” (Fraillon, Schulz, & Ainley, 2013, p. 17). It is stated in the report that “there is a common assumption that students are familiar with using ICT, which is not necessarily true” (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2013, p. 3). This indicates that although we call students to day digital native they might not know the preferred skills to make the most of ICT in their education.

Erstad’s (2006) definition of digital skills as “skills, knowledge and attitudes in using digital media to be able to master the challenges in the learning society” (p. 417) will be used as the underlying concept in the thesis rather than information and communication skills. The problem with such definitions is that they may imply an either or state of affairs, i.e. that either one has full mastery of these skills or none at all. It is clear that most people obtain very gradual and most often very incomplete mastery of the soft- or hardware they interact with. Thus they have some digital skills, but it cannot be inferred that these are substantial, let alone full mastery (if that is possible).

Interactive educational environment also has different names, e.g. educational software, cognitive tools for learning, interactive multimedia systems, intelligent tutoring systems. The field is ill-defined, it is not even clear what interactivity is as it can be of many forms and there is a lack of consensus in the discussion (Brown, 2008). Brown’s brief analysis shows how difficult it is
to define a term related to technology in education as increasing computer power and new tools and software are developing all the time. He claims that the discussion has been about the techno-centric perspective of interactive learning environments with an emphasis on instructional designs and theoretical principles, but not so much the content and the human-centric perspective where the social context of learning is in focus. He argues how unhelpful this polarization is and uses a dialogical framework built on learning by doing, by making, by sharing and by telling.

The term pedagogy is central in the discussion of ICT in education. Pedagogy is often referred to as the art or science of being a teacher. The word comes from the Ancient Greek word παιδαγωγέω (paidagogos) which means to lead the child to school. Definitions of pedagogy are also related to classroom instructions, the art, profession, or study of teaching and the study of teaching methods (Mortimore, 1999). Koehler and Mishra (2009), in their definition of pedagogical knowledge, stress the “deep knowledge about the processes and practices or methods of teaching and learning” (p. 64). There has been a debate about using this term as it does not refer to today’s emphasis on learning and the student-centred environment in the educational discussion. Beetham and Sharpe (2007) discuss this and point out that the term pedagogy is no longer strongly connected to children but more to leading or guiding in teaching and they see pedagogy as a dialogue between teaching and learning.

With the new opportunities that technology brings to education, rethinking the definition of pedagogy may be necessary. Are teachers using ICT with the same methods and models of teaching as before or is a new form of pedagogy or a different version of existing pedagogy appearing? Many are sceptical about the use of ICT in education and do not believe it will change how people learn but others believe it will and want to rethink pedagogy (Beetham & Sharpe, 2007). In this thesis pedagogy refers to ways of teaching as well as ways of learning and pedagogy of ICT in education refers to the teaching and learning process with technology as background support.

Teachers’ and students’ knowledge are important concepts in the context of the thesis as these do not only refer to content knowledge but also to pedagogical knowledge and technological knowledge. The theoretical background of the concept, teachers’ knowledge, in this thesis comes from Shulman’s (1987) work into two knowledge fields: teachers’ content knowledge, which refers to the formal academic grasp of the subject field, and their pedagogical knowledge, which is taken to refer (as noted above) to the understanding of how to ensure that the students grasp or master the appropriate content as laid down by the curriculum. He elaborates on teachers’
content knowledge as not only referring to the teachers’ understanding of how something is, or works, but also to the knowledge of the interconnections between concepts within the discipline and thus the wider relevance of different concepts and theories. Teachers’ pedagogical knowledge refers to understanding of how to teach, “...knowledge for teaching” (Shulman, 1987, p. 203), which is taken to refer both to selecting the concepts or issues that should be taught and how they might be taught, i.e. motivated and mastered by the students. Later Koehler and Mishra (2009) added technology knowledge to Schulman’s model but they stress that defining technological knowledge is difficult and can easily become outdated; as the technology changes rapidly, so do the ideas about how it might be used. They build on the term Fluency of Information Technology (FITness) when they conclude that technology knowledge “enables a person to accomplish a variety of different tasks using information technology and to develop different ways of accomplishing a given task” (Koehler & Mishra, 2009, p. 64).

In the thesis it is important to distinguish between the terms beliefs, values and attitudes of ICT use, even though they are all connected. According to Kobella and Warden (1989) “a person has many more beliefs than attitudes and far fewer values than either attitudes or beliefs” (p. X). Attitudes have emotional flavours that can range from positive to negative (Koballa & Warden, 1989) and influence ICT use of students and teachers (Webb & Cox, 2004). Values have more an ethical connection to right or wrong and beliefs can be built on both factual and nonfactual bases that are the rational foundations for attitudes (Koballa & Warden, 1989). The literature has shown that teachers’ beliefs, values and attitudes are influential factors regarding ICT use and Webb and Cox (2004) claim that “...teachers’ beliefs about the value of ICT for learning and the nature of successful learning environments are important in teachers’ pedagogical reasoning” (p. 1). Here these terms will be briefly discussed.

Definitions of teachers’ beliefs in the literature are not very clear and may even indicate certain complexity as it refers both to what one knows (in this case about ICT in education) and what one believes (about that issue) (Prestridge, 2012). Here it is taken to refer to what one thinks is the case (or what is true), such as what is the potential usefulness of ICT; and this holds for both teachers and students even though they may hold very different beliefs. Beliefs can be influenced by personal experiences, feelings and emotional evaluation and is seen as an influential factor in ICT use (Webb & Cox, 2004). In this context Webb and Cox state that:
The beliefs that teachers have about the power and scope of ICT, its new modes of knowledge representation and therefore the different ways of pupils’ learning, will profoundly affect the affordances controlling the learning actions and activities (Webb & Cox, 2004, p. 50).

The concept “beliefs” will be used here in connection to teachers’ and students’ beliefs about ICT potential and use and its pedagogical relevance. In some cases knowledge is used as a partial synonym for belief. Generally, as in the literature, knowledge is taken to refer to the knowledge somebody may have about a subject being taught, but beliefs are taken to refer to the potential use of ICT, e.g. when teaching the subject.

The teachers’ and students’ pedagogical values have an important influence on which of the ICT affordances they think are worth using. Values do both influence teachers’ use of ICT as add on as well as their attempt to change the existing teaching methods (Webb & Cox, 2004). The term values is here seen as what knowledge or beliefs teachers and students let influence their ICT use and their ICT behaviour, and is thus reflected in their attitudes.

Ajzen’s (1988) theory of attitudes and behaviour is relevant to give a better understanding of teachers’ and students’ ICT use. He states that "the attitude toward a behaviour is determined by salient beliefs about that behaviour, termed behavioural beliefs" (Ajzen, 1988, p. 120). Researchers have shown that teachers’ and students’ attitudes influence their use of ICT (Drent & Meelissen, 2008; Albirini, 2006; Demetriadis et al., 2003). Cox, Cox and Preston (2000) refer to Davis, Bagozzi and Warshaw’s (1989) model when discussing attitudes toward using ICT and actual use. Their model emphasizes how attitudes influence people’s behaviour where perceived usefulness and perceived ease of use in combination determine the attitude towards use, which may or may not lead to intentions to use. In this sense attitude is an important influence on behaviour in ICT that will be addressed in the thesis.

Working together is believed to enhance that students’ learning more than working alone (Johnson & Johnson, 2009; Johnson, Johnson, & Smith, 2007). There has not been a complete agreement on the terms collaborative and cooperative learning that are important concepts in this field. According to Jones and Jones (2008) these two concepts overlap and have been defined in a similar way. Technology is offering the opportunity to discuss and communicate without constraints by time and place which adds a new dimension to collaborative and cooperative learning. The term cooperation is used to describe when individuals dividing work between them, are sharing, helping each other but not necessary producing something together or through
interaction during the process (Arnold, Ducate, & Cost, 2012). The term collaboration is used when individuals are working together, interacting and alongside each other to produce a common result (Laal & Laal, 2012). The words collaborative and cooperative learning are used in the thesis in a similar way to describe students working together in their learning process, mostly by the teachers’ instructions or guidance but also from students’ initiative. A similar definition is presented by Arnold, Ducate and Cost (2012), who propose that:

[c]ooperation allows for some independent work of group members, who take responsibility for specific sub-tasks to be assembled into a larger whole at the end. Collaboration, in contrast, does not include such task specialization, and instead requires synchronous work of all members on a variety of aspects of the project” (p. 433).

A similar distinction is made by Kozar (2010) when describing the advantages of collaborative learning and also Mogonea and Mogonea (2014) when describing the characteristics of cooperative and collaborative learning and even though their definition is more elaborate it contains the same essential elements and distinctions.

The term affordance comes from the psychologist James J. Gibson who defined the concept as the action that is possible with an object or an environment independent of whether the action is recognized or not and thus affordances are dispositions of objects, even though this may be debated (Caiani, 2014). The term has become important within cognitive science but during the last two decades the term has also emerged in other but related fields in particular within the arena of human-machine interaction. Different definitions of affordance have emerged and Norman (1988) narrowed the original definition to the actions the actor is aware of. Norman (Norman, 2013) emphasises the use of the term affordance in the perspective of human–computer interaction (HCI) to define recognition of possible actions and now moves the focus to all possible actions an object or an environment can offer to only those the actors perceives. In relation to ICT, Norman’s definition puts the weight on the knowledge of the actor in an educational context, which has been adopted in various educational contexts (McFadden, Ellis, Anwar, & Roehrig, 2014). In this thesis the term affordance is used in connection to a framework proposed by Webb and Cox (2004) for pedagogical practices relating to ICT use. They refer to Gibson’s work and define affordance as what the situation offers the learner depending both on the learner’s capability and the learning environment (see Section 2.5).
1.2 The author’s involvement within the field

The author’s interest has been connected to ICT and education for a long time. With a teacher’s certificate, BS degree in computer science and MA degree in distance and open education and a teaching career, both in upper secondary schools and universities, she has maintained a constant interest in the area. This has led to a very active involvement in the teaching and promotion of ICT in education, inter alia in an advisory role on ICT use at different school levels. This has involved teaching, research, publications and being in an advisory capacity to the Ministry of Education and Culture.

An early example of published teaching material is a Windows booklet with problems to be solved, published by The National Centre for Educational Materials in 1993, and Statistical textbook for upper secondary students, Statistics with computers, published with two colleagues in 2000. Participation within the field of research began in 1993 when she took part in a study that was translating and testing the psychometric properties of three psychological scales to measure computer anxiety and attitudes to computers (paper published in the Icelandic Psychology Journal), and papers on ICT in education have followed. The author has carried out consultancy work for the Ministry of Science, Education and Culture in Iceland, which has, in addition to being an advisor, included conducting surveys for the Ministry on distance education in upper secondary schools, running ICT courses for teachers and coordinating ICT development projects for teachers. Active participation in a number of European, Nordic and Icelandic projects related to ICT in education has been a very important source of new ideas and sustaining interest; currently reinforced by the co-ordination of OWLS (Outcomes that Work for Learners and their Stakeholders), a three-year Leonardo da Vinci Programme (see Appendix X for the detailed lists of relevant works of the author).

To prepare for this study the author participated in the Icelandic research project LearnICT - the use of ICT in learning and teaching (see http://mennta.hi.is/vefir/namust/), which was conducted between 2002 and 2005. In this project, attempts were made to answer questions about the effects of ICT on students and their learning, for teachers and their teaching and for schools as institutions. As a part of the LearnICT project, a study was conducted with an online questionnaire within 14 upper secondary schools in Iceland in 2002. The findings from this study, discussed in more detail in Section 3.4, showed positive attitudes toward ICT use, but that teachers and students were not convinced about its positive influence. This and the fact that there was a considerable lack of research into ICT in education in upper secondary schools in Iceland, encouraged the author to set the focus on ICT at this school level.
A list of publications by the author of the thesis in the LearnICT project are presented in Appendix X. Participating in the LearnICT project motivated the author to examine the situation further and in more detail.

1.3 The aim of the study

In an educational environment there are many factors that influence the outcome of teachers’ and students’ work. There is no doubt that these factors often are both complex and interconnected in a multifaceted way. Therefore it was important to clarify the focus of the study. The main aims of the thesis are to seek understanding of how upper secondary school teachers use ICT in their teaching and how their students learn in an ICT environment. For this purpose it was considered important to investigate the general influence of ICT on students’ and teachers’ beliefs, actions and pedagogy. The ICT technology is not the focus, but rather how students and teachers make use of the ICT learning environment with the opportunities new technology offers.

To achieve this overarching aim, the focus will be placed on five main factors and their relationships, which will guide the literature review in Chapter 2 and will be reflected in the research questions presented in Chapter 4:

- First, in order to understand the influence of ICT on teaching and learning, the focus is on teachers’ ICT use when teaching in an ICT-rich environment. Thus the focus will be on the teachers, the main actors in implementing ICT in the school work, and how their knowledge, skills, beliefs, values and enthusiasm influence their ICT behaviour.

- Second, the focus is on ICT pedagogy, how teachers’ knowledge, beliefs and values shape their ICT pedagogy and ICT use.

- Third, students’ knowledge, beliefs, values and behaviour in an ICT learning environment and how ICT affects their learning will be examined. Students’ beliefs and values influence their ICT learning activity and it is important to understand how or if they benefit from ICT use.

- Fourth, the school authorities’ policy, attitudes and support are important in creating a motivating and positive atmosphere that shapes the use of ICT.

- Fifth, the government’s policy regarding the use of ICT in education in upper secondary schools in Iceland is an influencing factor and the policy is important because it provides the framework or guidelines and influences ICT educational work in the school setting. The infrastructure and the driving forces of ICT in the learning process are related to the policy and support both from government and school authorities.
The last two factors centre on the cultural and the administrative environment that moulds (i.e., inspires, stimulates or perhaps in some cases hinders) the use of ICT in the educational settings.

The overall five main factors investigated in this thesis are heavily dependent on the existence of sufficient infrastructure within the school and the whole society, even though these are not under investigation here. There have to be adequate facilities in schools (e.g. ready access to computers that have the necessary power and software) and IT staff that are accessible to ensure the smooth and effective running of computers and Internet technology.

The aim of the study is to generate knowledge on how students and teachers are using ICT at the beginning of the century in an educational environment that supports use of technology in a systematic way and where computer access is not an obstacle. This study will also give information on students’ and teachers’ beliefs and attitudes toward ICT and how they see it affecting their learning and teaching. An insight into the implication and importance of ICT in education will be provided.

Other factors that are also likely to play a role in this context include the curriculum, the students’ peers, the school community and the family. These are not among the main topics in this thesis, but they will be included in the discussion.

1.4 The time frame of the study

Since 1999 there has been a great increase in computer use at the upper secondary level in Iceland and more and more schools are offering distance learning and distributed education and even blended learning, although some streamlining has appeared following the economic collapse and resulting recession in 2008 (Matthiasdottir, Dal, & Lefever, 2003; Gudmundsson & Matthiasdottir, 2004; Matthiasdottir, Dal, & Lefever, 2004; Matthiasdottir, 2008; Matthiasdöttir, 2010; Jakobsdottir, 2011; Rennie, Jóhannesdóttir, & Kristinsdottir, 2011).

The main aim of this thesis was to investigate whether ICT use had influenced the teachers’ teaching methods and the students’ learning methods in an ICT environment where lack of access to both software and hardware was not an inhibitory factor. This led to a study of students and teachers use of ICT in one upper secondary school in Iceland, Menntaskólinn i Kópavogi (MK) that was chosen for this purpose. This is a case study combining qualitative and quantitative approaches in order to obtain insight into the interaction between ICT, pedagogy, teaching and learning from a number of perspectives and consists of a number of different studies. Table 1 shows the time frame for the
data collection. The preparation period was in 2002 and 2003, the data collection started in 2004 and the main data collection was conducted in 2005 and lasted until 2006. The data collection will be discussed further in Chapters 5 and 6.

Table 1. Time frame for the data collection in the thesis

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* WebCT was the learning management system (LMS) in MK in 2005.

1.5 Structure of the thesis

The current thesis has eight chapters including this introduction. In Chapter 2 a theoretical background to the thesis will be provided. In Chapter 3 an overview will be given of the Icelandic school system, the government ICT policy in Iceland will be discussed, and relevant results from the LearnICT Survey in 2002 will be described. In Chapter 4 the research questions will be introduced and in Chapter 5 the methodology and the design for data collection will be described. In Chapter 6 a description will be given of MK, the upper secondary school that was chosen for this study and the data collected in MK in 2004-2007 will be analysed. Chapter 7 and 8 consists of the discussion of the findings in relationship with the research questions and the theoretical background reviewed in Chapter 2.
2 Background to the study

2.1 Introduction

In this chapter the theoretical background and foundation for the thesis will be introduced and discussed. An overview of the recent debate around ICT in the educational field will be presented with particular reference to the proposed values of ICT for education. First the general issues of ICT in education will be introduced (see Section 2.2) and then the rationale for the use of ICT in education will be examined (see Section 2.3). Ideas relating to teaching and learning with ICT, especially Fox and Twining’s (2006), rationale for ICT in education, will be critically analysed and the impact of new ideas, innovations and changes that ICT has had on education will be reviewed in connection to the ten Brummelhuis and Kuiper (2008) model for driving forces of ICT in the learning process (see Section 2.4). In Section 2.5 Shulman’s (1987) pedagogical content knowledge (PCK) model will briefly be discussed leading to Mishra and Koehler’s (2006) technological pedagogical content knowledge (TPCK) model. The pedagogical framework presented by Webb and Cox (2004), which is one of the main foundations of the thesis, will be introduced and critically discussed.

The terminology was introduced in Section 1.1 and the difference between IT and ICT was discussed. It was decided to use the term ICT although this might be too broad as it involves information retrieval, processing and analysing, and communicating with applications or devices to support educational actions.

2.2 ICT in education

In this section the use and application of ICT in education is reviewed in the context of how it has developed. A short overview will be given of the situation in the 1970s, 1980s and 1990s, but the main focus will be on the beginning of the 21st century. The intention is to bring to the fore the multiplicity of arguments and the diverse approaches to the field. In later sections the discussion gradually becomes more focused and confined to the issues under scrutiny.

The concepts, information society and information age are used to describe a new form of society where ICT supports an immense flow of information and an enormously improved and increased access to any kind of knowledge. The knowledge or information society has been a topic of discussion for a long time,
Ásrún Matthíasdóttir

and Machlup (1962) is among those who started the discussion relating to technology. He claimed that knowledge and information were new forces in the development of society in the USA in the early 1960s. Since then the development of new technology has nourished the discussion of the impact of the flood of information and knowledge in society.

Webster (2002) argues that there is not much agreement on which are the main characteristics of the information society. Castells (2005) emphasises that information has always been central in our society, what has changed are the new capabilities of the recent network technology that offers both constant access to information and much quicker ways of processing and analysing information. He states that “[s]ociety shapes technology according to the needs, values, and interests of people who use the technology” (Castells, 2005, p. 3). Even though information and knowledge have long been emphasised, it is the growing amount, the increased possibilities of access, the potential to analyse and the ability to manipulate, that have developed fast with the help of new technology, simultaneously influencing culture and society. Thus it is argued that the information, in an information society is not new, but the technology, mediating and manipulating it, indeed is. Castells argues that it is the communication and networking with digital technology that is shaping our society today, the network society (Castells, 2005). Furthermore, it is suggested that the environment shapes the use of technology, although at the same time the reaction to the use does influence the development of technology.

This is not totally in line with the UNESCO report, Towards knowledge societies (UNESCO, 2005). In this report, ICT is considered to be intertwined with the development of a society where new technology is a driving force and it is suggested that the “... idea of the information society is based on technological breakthroughs“ (UNESCO, 2005, p. 17). In the report, technology is considered to have an impact on most parts of society, e.g. the economy, work, education, communication and culture, and that the information society is developing into the knowledge society “... a society that is nurtured by its diversity and its capacities” (UNESCO, 2005, p. 17). Thus we have some contrasts in the views on the direction of the interaction between society, technological development and the actual use of technology. On the one hand it is the technology that forms our society, but on the other hand it is our use of the technology that forms our society.

There is no question that ICT has become a part of daily life in the Western world, tying in with the development of the various facets of the information society or the knowledge society, with an increasing demand for citizens who possess good digital skills in the handling of information, or at least information technology. To be able to work with information is considered more important
now than ever in order to succeed at work. Similarly, advanced skills in the use of ICT are even becoming a requirement for taking an active part in society. Increasingly teachers are expected to train young people in desirable skills for the challenges of adult life, which require the competence to work effectively with the new technology (Pachler, 2001).

Over the last four or even five decades, teachers, particularly in the US and in Western Europe, have experienced the opportunity and the pressure to introduce and implement computer technology into their work. New ideas have blossomed and some educators have even envisaged this evolution culminating by technology taking over teaching and solving educational problems (see e.g. Fraillon, Ainley, et al., 2013; Fraillon, Schulz, et al., 2013; Balanskat, Bannister, Hertz, Sigilló, & Vuorikari, 2013; Conole & Alevizou, 2010; Cox et al., 2004).

2.2.1 A glimpse of the 1970s

During the 1960s and 1970s, influenced by Skinner’s teaching machine (1960), the computers were used for individual learning with programs built on instructions and reinforcement, called drill-and-practice exercises, where computer-assisted instructions (CAI) supported individualized learning (Lou, Abrami, & d’Apollonia, 2001). The implementation of computers in education at that time happened rather slowly. Lou, Abrami, and d’Apollonia (2001) concluded that there were three main reasons why. Firstly, the technology was not advanced enough to be easy to use and the programs were limited to “text-based drill-and-practice”. Secondly, teachers feared they would be replaced by the machine and thus were reluctant to participate and thirdly, both teachers and parents feared that individualized learning, based on computer use, would produce individuals lacking social skills. This might explain some of the obstacles, especially with respect to primitive technology, although many other reasons impeded the progress, for example lack of access to technology, lack of technological skills and lack of both support and ICT policy within the educational environment.

At this time learning theories are related to computers and Kemmis, Wright, and Atkin (1977) discuss four paradigms influencing computer assisted learning (CAL): subject-matter, pedagogical, operating system and milieu which have some parallelism with today’s online learning discussion (e.g. Bloomfield, Roberts, & While, 2010; Walsh et al., 2011).

From the 1970s we have the programming language LOGO built on the constructionism philosophy of education. The Turtle, in a LOGO environment, was a robotic creature and later a computer educational program, where the user could control the “turtle” movements and draw shapes on the screen by simple programming (Papert, 1980).
Eng (2005) gives an overview of research into the impact of ICT on learning in the United States, the United Kingdom and Australia between 1960 and 1980. This analysis indicates only a small positive influence of ICT but suggests a need for more in-depth and longitudinal studies.

2.2.2 A glimpse of the 1980s

In the eighties the discussion was more optimistic and forward looking with an emphasis on software development for education and teachers training as foundations for the use of technology in education (Watson, 2006). CAI, connected to behaviourists’ theories of learning, with emphasis on learning simple skills, facts, concepts and theories with the help of software (Dede, 2008), raised high hopes in the 1980s when the PC computers started to emerged into education (Voogt & Knezek, 2008). Ideas about intelligent tutoring systems (ITS), connected to cognitive theories of learning that could become students’ tutors, can be seen in the literature (e.g. Anderson, Boyle, & Reiser, 1985). The government’s policy in many OECD countries endeavouring to secure students’ access to computer and the Internet in schools started in this decade (OECD, 2010). The development of more powerful and lower-priced PCs resulted in more enthusiasm and higher hope for ICT in education. Lack of computers inside classrooms encouraged teachers to let students cooperate in class and use the few computers available, together in small groups, supported by theories and research showing that studying together is an effective way of learning (Lou et al., 2001).

Lou et al. (2001) conducted a meta-analysis of 486 independent findings from 122 studies, carried out in the 1980s and the 1990s, which included about 11,000 students. On the basis of this analysis they claimed that the fear of students’ social isolation in technologically-enhanced education could be overcome and that students could learn collectively with the new technology. The emphasis was on computer-based automated instruction and the need for new educational models was discussed (Reiser, 2001).

2.2.3 A glimpse of the 1990s

In the nineties, access to computers and the Internet became more a part of public life. To mention some milestones from this time the World Wide Web, or WWW, originated in 1990, the Mosaic web browser and the Wiki Web in 1993, the MSN Messenger emerged in 1995, Hotmail in 1996 and Google in 1997 (Tímamót á Internetinu, n.d.). The period from 1993 through to the end of the century is characterised by the growth of the Internet, often referred to as the Internet boom. New technological ICT options gave foundation for new ideas and created optimistic attitudes towards its use in education, but there
were different ideas of how to harness the potential of technology to improve education. There were high hopes for technology in education and we can see in the literature statements such as this one: “Computer-based simulation is one of the most powerful tools ever developed” (Dolence & Norris, 1995, p. 28).

In 1993 Larry Cuban wrote his article *Computers Meet Classroom: Classroom Wins*, where he discusses three scenarios for the next ten years, the *technophile’s scenario* that want “electronic schools”, the *preservationist’s scenario* that want “to maintaining the status quo while improving schooling” and the *cautious optimist’s scenario* that want “slow growth of hybrid schools and classrooms” (Cuban, 1993, p. 191-192). He comes to the conclusion that the last scenario is most likely to be the one that will rule the future. The main reason for slow progress according to Cuban is that technology has not been a central part of the improvement of education, as well as lack of funds, teachers’ preparation and administration policy.

The influence of the new technology was not only apparent in the classroom but also in the field of distance education, which developed rapidly at this time, with new ideas of instructional designs often influenced by constructivists’ principles and knowledge management (Reiser, 2001). Research from this time did not give definite answers of how ICT influenced education. Some showed that students who enrolled in online classes had significantly higher exam grades than on-campus students (Dutton, Dutton, & Perry, 2002). Others came to the conclusion that there were no significant differences if the course materials and teaching methodology were held constant (Russell, 1999). Phrases like *add-on* and *bolt-on* are still used to describe ICT use in education and it has been suggested that teachers must stop looking at ICT as simple transmitters for information and skills (Richards, 2005).

Trend, Davies and Loveless (1999) used the expression the *reality-rhetoric gap* when describing the difference between what is expected from ICT in education and its influence and this gap can be noticed in the literature (e.g. Chalkley & Nicholas, 1997; Mumtaz, 2000; Cuban, 2001). An example of the debate is between Richard Clark and Robert Kozma, where Clark did not believe in media as a motivating and influencing factor, but Kozma thought that the new media could improve learning (Dede, 2008). Both based their arguments on research from the 80s and early 90s.

In the 90s, CAI and ITS where still around and the hopes were high. In the literature we can see statements like “Intelligent tutoring systems have been shown in the literature to be highly effective in increasing student motivation
and learning” (Beck, Stern, & Haugsjaa, 1996). Jonassen (1999) even states that the main use of computers has been CAI and learning from computers, and argues that drill programs are not “the most effective way to use powerful computer technology” (p. 5). In the 1990s learning management systems (LMS) were being developed and were related to CAI methods and behaviourists’ ideas about learning (Dede, 2008).

The teachers are important actors in the ICT development but in the 1980s and 1990s some of them even believed that if we ignore IT, it might go away (Wellington, 2005). This did not come true, computer technology has settled in and the digital revolution is no longer a revolution. ICT has come of age and has become a normal part of the educational environment in the Western world although the implementation, access and use vary.

Thus there were still high hopes associated with the use of ICT in education in the nineties. In the UNESCO report Open and Distance Learning. Trends, Policy and Strategy Considerations (UNESCO, 2002) it was stressed that the development of ICT had brought new challenges and opportunities to education where access and knowledge of technology was needed for everyone to be a member of the knowledge society. The time from 1995–2000 is often referred to as the period of the dot-com bubble where many Internet-based or dot-com companies were established. Their stock prices increased rapidly because many investors believed in the new ICT technology. The bursting of the dot-com bubble in 2000 did not stop the innovation (TimeLine of music and media technology, 2009).

At the end of the last century, technology was shifting fast from analogue to digital technology, development that started with the digital revolution in the 1970s (TimeLine of music and media technology, 2009), and the situation has changed fast, at least in the Western world, perhaps along two dimensions that are intertwined. One is the often dramatic increase in the effectiveness of particular pieces of technology, e.g. computer memory and bandwidth. The other dimension is the emerging of completely new technology and software, e.g. the iMac, Windows 95 and 98, the first web browser and new e-mail programs. PCs, the Internet and the World Wide Web are becoming standard tools in schools, workplaces and people’s homes.

2.2.4 At the beginning of the 21st century

The technological development has probably been faster than most imagined. Access to ICT has increased fast and total communication access paths (analogue lines, ISDN lines, DSL, cable modem, fibre, other and mobile) have grown from 649,55 million in the OECD countries in 1997, to 1,501,8 million in 2005 and 2.080,0 million in 2011 (OECD, 2013). Today’s technological
influences are all around us and ICT is integrating into many facets of education with emphasis shifting from learning to use technology to learning with technology, a movement that had already started with the teaching machines in the 1970s. Software is easier to use and the Internet has become a common tool in the school environment, at least in the Western world. In recent years smaller and lighter equipment that is easier to use have been launched and laptops and mobile technology have developed fast. The price of computer devices has decreased during the years in proportion to their increased capacity and decreased weights.

In 2001 Watson (2001) wrote: “Information Technology is equated with the modern world, economic success and the future; so schools must embrace the technology” (p. 252) signifying the position of ICT in education as in other parts of society. There seems to be a worldwide agreement that ICT should be used in schools (Anderson & Weert, 2002; Bindé, 2005) and some even believe that ICT has already altered education significantly, e.g. with new opportunities to communicate and access to information (Naidu, 2003). For some, ICT has been considered an opportunity for change and progress and there have been great expectations for ICT in education as Volman and Van Eck (2001) note:

Recently, strong arguments have been put forward for the introduction of advanced ICT applications as a means of creating a powerful learning environment. This involves new forms of learning and teaching (transformation) in which students deal with knowledge in an active, self-directed and constructive way, leading to learning results that are more transferable to situations outside school than are the results of traditional teaching methods (Volman & Van Eck, 2001, p. 614).

Broad concepts have been used in the debate on ICT in education and different views have emerged, with both eager optimists and critical pessimists. Three groups of actors are seen in the field of ICT in education. The first two are the optimistic-rhetoric who are seen as the winners and the pessimistic-rhetoric who are often seen as the dinosaurs in the educational system (Nichol & Watson, 2003; Reynolds, Trehearne, & Tripp, 2003). These two are in line with Cuban’s (1993) scenario, technophile’s, preservationist’s and cautious optimists. Then we have the third group of actors, the academic researchers, who have the role of searching for understanding of ICT environment and the influence on the development in education.
Ideas and methods from the 1980s and 1990s are still in the discussion. Since then studies have been conducted into the effectiveness of CAI indicating that CAI is at least as successful as traditional teaching (Jenkins, Goel, & Morrell, 2008). Learning management systems (LMS) from the eighties have developed into numerous different systems with lesson plans, syllabi, discussion forums, file sharing, assignment management, chat, etc. It has been argued that these should be taken over by more personal tools and social networks (Dalsgaard, 2006) with a more student-centred approach. Intelligent tutoring systems (ITS) have gained more notice in connection with new media and many different tools that have been developed build on this ideology (Graesser, VanLehn, Rosé, Jordan, & Harter, 2001).

It is already clear from the above that the discussion of ICT in education has many foci and that the discussion has shifted among different topics as ICT has been used differently in different settings and at different times. As an example, the focus in the literature has been on how to use ICT in education, how much ICT should be used, at what stage in young people’s education and whether it improves the quality of education. Oppenheimer (2003) describes the situation well with this transparent paragraph:

When technology’s boosters look at a computer, they see almost nothing but opportunity, an educational messiah. Technology’s critics, meanwhile see merely danger, a mechanical devil that encourages the death of the humanistic traditions. ... The truth of course has its feet in both sides of the debate (Oppenheimer, 2003, p. xvii).

Bearing in mind the development of ICT during the last three or four decades it is important to gauge its influence on educational development. This influence can be looked at from different angles, from students, teachers, school authorities, governments and other actors in society as will be discussed further in Section 2.4.

Students are using ICT in relation to their school work and we need to know what influence this is having on their learning; both the process and the outcome. What are they doing, assuming the potential is there? It is not sufficient to look only at positive and negative influences of ICT use in a broad sense; we have to look closer at how students use ICT to support their learning (Concannon, Flynn, & Campbell, 2005). We need to ask how students are using the technological potential open to them, the purpose of their ICT use and what ideas they have about the use of ICT in education.

In the first decade of the 21st century, scholars were, more than before, not only convinced that new technology should be used in education, but also saw
it as a serious drawback to exclude technology from education. Despite optimism towards the implementation and integration of ICT in education we still find scepticism at the beginning of the century. For example, Watson (2001), who looked for the reasons for the lack of effective implementation of ICT in education and wanted more focus on pedagogy than technology. Some educators saw new technical opportunities open up for education that have been blocked within the four walls of the classroom, with a group of students and one teacher being responsible for the entire educational process, i.e. lecturing, motivating and guiding students within a strict time frame. Others saw the new technology just as a tool that does not live up to expectations in education just as television failed to do before (Cuban, 2001). Some go as far as Johnson and Dyer (2005) when they state that “[e]ducation systems have failed to keep pace with technological developments and the changing culture of a digital age” (p. 3). A term Luddites has been used to describe those who are critical or negative and may still fight against the new technology (John & Wheeler, 2008).

As has been discussed in this chapter there is not a common agreement that ICT has changed or will change education and many studies have shown that ICT has often been used ineffectively in education (Watson, 2001). Cuban (2001) points out, in his detailed analysis of the influence of technology on education in the USA, how complicated the situation is and emphasises how long it takes for change to take place in the educational system, at least change that teachers are comfortable with. He states: “Although promoters of new technology often spout the rhetoric of fundamental change, few have pursued deep and comprehensive changes in the existing system of schooling” (p. 195). He also points out that ICT may not even have changed the situation much in recent years and is doubtful about the benefits of the use of ICT in education. Many teachers are still doing their work in similar ways as teachers have been doing for the past centuries when they prepare teaching lessons, educate their students and communicate with students, parents and school authorities. Becker and Ravitz (2001) based their study on data from a national survey of 4,100 teachers’ pedagogy and found that teachers with computer skills believed in constructivist pedagogy and were using ICT in the classroom with their students; thus showing much more active use of the computers than Cuban envisaged or thought. They claimed that Cuban did not foresee the development of computers in education, the rapid progress of technology, software and hardware, which has changed the access and use of computers.

There are many factors that can affect the development of ICT in education and access to computers is an important part of them. One computer in a classroom with 20 - 30 students, or even more, does not change the situation,
but how the technology is used can make a difference. Lack of access to computers affects ICT development in education and Watson (2001) emphasises it as one of the strongest inhibiting factors for the development of ICT in education and points out that:

Until there is a ratio of 1.25 machines to every pupil, and every teacher has a personal computer on their own desk, all preferably portable laptops, it is unrealistic for schools to be asked to deliver a balanced ICT using curriculum (Watson, 2001, p. 258).

If students are to be online in the classroom they need to have the right equipment. Kirkwood and Price (2005) suggest from a meta-analysis of data on students’ attitudes towards ICT and their experience of ICT that there has been a change in students’ access to ICT and that access, experience and attitudes varies across subjects and topics.

Research which has been conducted into ICT in education is well described by Baron and Bruillard (2007) where they divide ICT studies into small-scale experiments with narrow focus and larger-scale surveys with broad focus; see also Cox et al. (2004) on this issue. Their view is that research in this area has so far not given conclusive results; the situation is complicated with many ICT activities and different ICT educational environments and we need to know not only what works, but also how it works in connection to different pedagogical concerns or aims.

Wood (2003) is among those who have pointed out the difficulties of evaluating the influence and quality of ICT on education because it is difficult to isolate the influence of ICT from other factors that affect education. He has suggested the use of school-based portraits as a research design and states that “…ICT uses have hardly been tested at or anywhere near the limit” (Wood, 2003, p. 10). He, emphasising that frequency and duration of access is a leading factor in ICT use. On the basis of their review of the impact of ICT in European schools, Balanskat, Blamire and Kefala (2006) claim that the evidence is considerable on teachers and teaching, and students’ motivation. The barriers were often teachers’ lack of ICT skills and lack of access to ICT in the educational system, but the comparison between studies is limited because of different methodologies and approaches in different countries. Tamin et al. (2011) point out that since 1980 over 60 meta-analyses have been conducted, focusing on technology in education with different and specific questions. The studies have provided valuable information, but without answering clearly the important question about the impact of technology on education. They also emphasise “…the need to summarize the literature over the entire history for the issue in question” (p. 17).
One of the large-scale international studies that have been conducted during the last decade is the *Secondary International Information Technology in Education Study* (SITES), conducted by the *International Association for the Evaluation of Education Achievement* (IEA). The SITES study started in 1998 and consists of three independent modules. Module 1 (1998–1999), was a school survey in 26 countries where school principals, randomly selected, were asked to give a description of the use of computer technology in schools. Module 2 (1999–2002), included case studies conducted in 28 countries where data from 174 cases from innovative classrooms were collected (Kozma & Anderson, 2002). Module 3 (2001–2006), was a survey for schools, teachers and students. The conclusions that have been drawn from the SITES data, especially from Module 2, have been positive regarding the influence of ICT on education. Pelgrum (2001) concludes, when analysing data in Module 1, that the main obstacles for the realization of ICT is teachers’ lack of ICT knowledge and skills, and a lack of computers.

One of the main findings from Module 2 was that technology was supporting *innovative pedagogical practices* in the participating countries. Students were working together across school subjects and teachers were working with other teachers, which imply that ICT has had an influence in the classroom. Kozma and McGhee (2003) came to the conclusion, when analysing the Module 2 data, that:

> In this regard ICT is beginning to break down some of the traditional barriers within the classroom—barriers between students, between subject areas, and between teachers and students. But for the most part this change in classroom structure stayed within the classroom (Kozma & McGhee, 2003, p. 79).

Erstad (2006), analysing Module 2 data from Norway, states that ICT use influences the changing of students’ roles where they can depend less on the teachers’ lectures. Among the findings from the SITES Module 3, also known as SITES 2006, was that ICT use depended both on school policies and national curriculum policies and that ICT impact on students was related to teachers’ ICT pedagogy (Anderson & Plomp, 2009).

Another project of larger scale carried out at the period in question was the Learner Experiences of e-Learning programme run by JISC (Joint Information Systems Committee). It was conducted in two phases from 2005-2009 including nine research projects, using mixed method approaches, involving over 200 learners and over 3000 survey respondents. The focus was on students’ interaction and experience of learning with technology. Among findings from phase one was that technology is not just an ‘ad on’ for the students as they
use different options for different purposes and can be called sophisticated users (Conole, de Laat, Dillon, & Darby, 2008). In the final report from this study it is stated that “[m]ost learners, despite access to technology and self-reported confidence, aren’t appropriating the technology they know into their study” (Sharpe, Beetham, Benfield, DeCicco, & Lessner, 2009, p. 23). This indicates that there is much more to ICT in learning than is exploited in school work.

In their study of students’ use and experience of technologies, Conole, de Laat, Dillon and Darby (2008) found eight factors describing how students work with technology. Among those factors were changing working patterns, changing of time and space boundaries, where the computer is the central learning tool used in a personalised way to organise students’ learning.

Pacher (2001) discusses the future of education and the digital culture, and the need to change traditional schooling. He claims that it is time that we move further and not only emphasise old literacy in our curriculum, we also have to move towards other kinds of literacy, i.e. “... media literacy, visual literacy, electronic/informatics and global literacy” (p. 16), and we need to move from “the transmission of information toward analysis, judgement and interpretation within the framework of a school-based education” (p. 16). His ideas of a broader use of ICT to support different literacy are of interest to western educational systems that want to be up-to-date in providing a good education for the citizens of the future. Thus it is not just the technology, the methods, or pedagogy that are at stake, but new content, both in terms of knowledge and skills that are called for by the advent of the ICT. Guðbjörnsdóttir (2010) proposes that “...the new literacies are an important part of the social capital of individuals and interest groups” (p. 9).

Becker and Ravitz (2001) state that teachers, who do not only want to transmit content, but want learning activity to be meaningful to students, are more likely to make students use ICT in the classroom. Snyder (2001) discusses the implication of new media in education and talks about critical crossroads where teachers have the power to influence students’ attitudes toward ICT and states “[a]t the beginning of the twenty-first century, to ignore the cultural and educational significance of the technology is short-sighted” (p. 43). She stresses that teachers must have effective education as their main goal and that ICT can be one of the means to reach that goal if used “... with caution, understanding and scepticism” (p. 43). We must search for ways to use the opportunities technology brings for the benefit of education.

Mishra and Koehler (2006) state that there are three factors that limit the development of ICT in education: 1) too much focus on the technology itself but not on how it is used, 2) lack of theoretical foundation with a large number of case studies that are not giving the whole picture, and 3) the rapid change of technology. Recent studies support this review and indicate that many factors,
both external and internal, influence relatively meagre ICT use in education, e.g. inadequate access to equipment, lack of time for teachers to prepare, insufficient support, doubting attitudes, lack of confidence and beliefs (Fu, 2013). Nevertheless, the hopes were high at the beginning of the century as is reflected in Diana Laurillard’s (2007) words as she discusses new technology in education:

It is an engaging and highly responsive medium; it can gather content according to interest; it can respond to individual needs of pace and level; it fits with the style and forms of youth culture; it can link the classroom to the workplace and in doing so enables teachers to provide much more of what only they can do for their students. Wherever we find an impossible challenge to inclusive educational provision, there is usually a way in which digital technology could make a significant difference (Laurillard, 2007, p. xvi).

One of the recent influencing developments in Europe has been the 1:1 learning initiative which has the main aim to offer better access to new technology and effective learning environment and at the same time to change teaching and learning methods with the help of ICT. The term 1:1 refers to one portable device per one student for his or her learning. In the research report Overview and Analysis of 1:1 Learning Initiatives in Europe (Balanskat et al., 2013) the main beneficiaries from the initiative in 19 European countries is considered to be the increase in portable devises for students, teachers and a number of schools have also got new ICT equipment. The students are believed to be more motivated and the technology seems to have a positive impact on student centred learning. The approach in the 1:1 learning initiative is mainly a top-down or a mix of top-down and bottom up and policy support is in place, e.g. providing guidance and teachers’ training and support at school levels.

Redecker et al (2009) point out that educational and training institutions must react to increasing use of social computing especially among young students and this calls for adjustment of educational work and they must recognise different learning resources and training opportunities.

We cannot leave the first decade of the century without mentioning Web 2.0 or the social Web that can be described as a set of internet practices and services that has given voice to individual users (Crook, 2008). Web 2.0 has been blossoming with its wikis, blogs, podcasts, streaming videos, social search engines, social media and online games. The list is almost endless. This technology and software has offered new dimensions in communication, collaboration and working with online information. The influence on education is still to be seen and fully understood and the discussion of the opportunities
and challenges have been lively (Greenhow, Robelia, & Hughes, 2009; Schneckenberg, Ehlers, & Adelsberger, 2011; Crook, 2012). Conole and Alevizohave (2010) conclude that the “Web2.0 tools provide new opportunities for learning, which complements the general shift away from didactic approaches that dominates current discourse on education”.

Although there have been a number of projects and some research as has been briefly addressed here there seems still to be lack of knowledge about the use and effectiveness of ICT in education (Fraillon, Ainley, et al., 2013). Cox (2013) in a recent paper concludes that teachers and students are still using small range of available ICT opportunities. She points out how difficult is to know what and how students are using ICT and the influence it has on their learning as their access to online material and network communications outside formal settings has grown fast. The out of school learning is not only difficult to research and gain an overview of, it can also generate new inequalities related to the cost of the required tools, software and online applications (Livingstone, 2012).

2.2.5 Summary

A short overview has been given of the development of IT, and later ICT, in education, starting in the seventies with a fairly wide range of ideas ranging from the LOGO philosophy, to drill-and-practice exercises and CAI. The hopes were high in the 1980s with computer-based automated instruction and in the 1990s with a totally new dimension to the use of ICT, i.e. the World Wide Web and the Internet boom. The scope of potential use had increased and opinions about how ICT could or should be used within the field of education were very diverse. At the beginning of the 21st century we see new software and hardware appear quickly and even unexpectedly and access to different types of ICT equipment and tools become more and more common.

These developments had two important implications. Firstly, they meant that an increasing number of students had access to ICT equipment and the Internet at home, which could help with their homework and studies. Secondly, it is likely that the increased access to ICT equipment and the Internet made students more online skilled (Hargittai, 2002; Kuhlemeier & Hemker, 2007) or digital skilled which influenced their ICT use for educational purposes. It was important for the educational system to react to this situation in order to harvest the best methods in motivating students and increase quality of education.

The question, after decades of ICT use within the educational system, is still how to use ICT when access is not an obstacle and how it will affect teaching and learning, but also more generally, school development and the content and
the culture of education. It is also a question of what models work in different circumstances and to what extent the new technology affects educational practice. Can we expect a teaching and learning model that has been effectively used in one situation to be successfully applied to other situations? Or is it as Fullan, Cuttress and Kilcher (2009) state:

The history of educational reform and innovation is replete with good ideas or policies that fail to get implemented or that are successful in one situation but not in another (Fullan, Cuttress and Kilcher, 2009, p. 9).

As has been mentioned, the research topics and goals regarding ICT in education have been diverse and complex, many small-scale studies have been carried out, some nationwide and a few with international outreach. The results in this area have so far not been conclusive (Baron & Bruillard, 2007; Tamin et al., 2011), partly because the questions have not always been clear although some have been positive in showing added value of ICT. The mixture of focus, methods and results underlines the complexity of the situation.

It is nevertheless clear that the ICT infrastructure must be strong both inside and outside school in order to support ICT use in education; staff and students must be prepared for ICT use to support an effective and engaging learning environment for all students and teachers. Even though the conditions are favourable, there is no guarantee of a large-scale successful implementation. In the next section some different rationales for ICT use in education will be discussed. This is one of the points of departures for the present study.

2.3 The rationale for ICT use in education

One of the problems emerging from the previous discussion is the lack of consensus about the reasons why ICT should be used in education. The focus of this section is on the arguments for the beneficial use of ICT in education and will explore to what extent both the computer and the Internet are considered potentially very important in education as a way of accessing and communicating knowledge, developing skills and generally for improving the various aspects of both teachers’ and students’ work.

For decades it has been argued and explained how to make use of the countless opportunities ICT has opened up for education and how it could be ensured that ICT will have positive effects. The expectations are on a continuum from a revolution that solves most educational problems with ICT to the status quo with no effect at all. In between there is the “down-to-earth” vision of everyday teachers seeing ICT as a practical and a convenient tool which makes
their daily work somehow better and easier. The discussion of ICT use in education has been on-going and lively in recent years as outlined in Section 2.2 and many valuable benefits have been enumerated and proposed, but also some potential negative aspects have been discussed. The present discourse, however, centres on why and consequently how and when, to use technology in schools.

The main purposes, justifications and rationales for ICT in schools have been to increase the quality of education and promote educational change as well as preparing young people for the future in the global knowledge society (Haddad, Draxler, 2002; Wagner & Kozma, 2005) and as a “solution to a whole range of social and educational problems” (Buckingham, Scanlon, & Sefton-Green, 2001, p.39). Hawkridge (1989) discusses several categories of reasons, such as social, vocational, pedagogical, catalytic, and cost-effective rationales. Hinostroza et al. (2008) state that one of the common rationales for ICT is to improve teaching and learning, although there is not clear research-based evidence for improvements and there is still an on-going debate in the literature.

Fox and Twining (2006), suggested that 19 different rationales for ICT in education could be found, based on their review of the literature and in connection to the work of others (Dwyer, Ringstaff, & Sandholtz, 1990; Pelgrum & Plomp, 1991; Cuban, 1993; Harris, 1999; Hexel, de Marcellus, & Bernoulli, 1998; Moseley et al., 1999; Cloke, 2000; Cuban, 2001). Their review of the literature was conducted in 2003 as a part of the project Discussing ICT, Aspirations & Targets for Education (dICTatEd). These rationales are of many different types, and show how complex the discussion is of the use of ICT in education. Some terms have been stable, and present in the discussion for a long time, while others have come and gone over the years. Table 2 shows how the Fox and Twinning 19 categories for ICT in education map onto the three categories in Twining’s Computer Practice Framework (CPF) (Twining, 2002) or rationales that fit into the IT category, Learning Tool category and Other category on the Focus dimension of the CPF.

Table 2. Summary of the rationales that mapped on to the IT category on the focus dimension of the Computer Practice Framework (CPF) *

<table>
<thead>
<tr>
<th>Rationales that fit into the IT category on the Focus dimension of the CPF</th>
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<tbody>
<tr>
<td>1. In order to learn IT skills</td>
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<tr>
<td>Integration - learning IT skills (through the medium of other</td>
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<tr>
<td>subjects) (Anderson and Collis 1993 in (Harris 1999)).</td>
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<tr>
<td>As part of the curriculum (Scott et al. (1992) in (Harris 1999)).</td>
</tr>
<tr>
<td>The Computer Practice Framework (CPF): Focus = IT (Twining</td>
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<tr>
<td>2001b; 2002b; 2002c)</td>
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</tbody>
</table>

Rationales that fit into the Learning Tool category on the Focus dimension of the CPF
<table>
<thead>
<tr>
<th>2. As a tool to achieve traditional teaching and learning goals across the curriculum</th>
<th>Infusion - use computer to support learning in other curriculum areas (Anderson and Collis 1993 in (Harris 1999)). As a tool to achieve traditional pedagogical goals (Scott et al. (1992) in (Harris 1999)). Integration of drill and skill and/or other software with other activities (Clements et al (1993) in (Harris 1999)). Pedagogical rationale - &quot;computers may improve the instructional processes and learning outcomes.&quot; (Pelgrum and Plomp 1991 p3.). The Computer Practice Framework (CPF): Focus = Learning Tool (Curriculum Tool), Mode = Support (Twining 2001b; 2002b; 2002c).</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. In order to extend and enrich learning across the curriculum</td>
<td>'Neoprossives' [social constructivists] want learning communities - and see computers as 'mind-tools' that can make this possible (Cuban 1993). Use of problem-solving software and tools (e.g. word processors, Logo, drawing packages) to extend and enrich learning. (Clements et al (1993) in (Harris 1999)). As a major framework for learning in certain disciplines, notably languages (Hexel, De Marcellus and Bernoulli 1998). The Computer Practice Framework (CPF): Focus = Learning Tool (Curriculum Tool), Mode = Extend (Twining 2001b; 2002b; 2002c). To unlock new attitudes and behaviours, hopefully to be transferred to other learning situations (Hexel et al. 1998).</td>
</tr>
<tr>
<td>5. As a catalyst for educational change</td>
<td>Redefining teachers' roles with a move towards resource management and more independent learning by pupils (Moseley, Higgins, Bramald, Hardman, Miller, Mroz, Tse, Newton, Thompson, Williamson, Halligan, Bramald, Newton, Tymms, Henderson and Stout 1999). Catalytic rationale - &quot;the use of computers may accelerate another educational innovation .... the possibility that schools can be changed for the better by the introduction of new technologies&quot; (Pelgrum and Plomp 1991 p.3). The Computer Practice Framework (CPF): Focus = Learning Tool, Mode = Extend (Twining 2001b; 2002b; 2002c). ICT is in fact transforming knowledge itself (Cloke 2000). Hypermedia alters what we can represent and how we can represent it (Twining 2001d).</td>
</tr>
<tr>
<td>8. As a tool to support learners in thinking about their own learning</td>
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</table>
9. In order to provide access to the curriculum for those who might otherwise be excluded from it

The Computer Practice Framework (CPF): Focus = Learning Tool (Mathetic Tool) (Twining 2001b; 2002b; 2002c)

<table>
<thead>
<tr>
<th>Rationales that fit into the Other category on the Focus dimension of the CPF</th>
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<tbody>
<tr>
<td>10. In order to increase productivity in education</td>
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<tr>
<td>Need for greater productivity in education (Cuban 1993)</td>
</tr>
<tr>
<td>11. In order to reduce the cost of education</td>
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<tr>
<td>Cost-effectiveness rationale - reduce the cost of education (Pelgrum and Plomp 1991)</td>
</tr>
<tr>
<td>12. In order to make education more efficient</td>
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<tr>
<td>Help teachers to do their jobs as they do them now (Moseley et al. 1999).</td>
</tr>
<tr>
<td>&quot;Make schools more efficient and productive than they currently are.&quot; (Cuban 2001 p.13).</td>
</tr>
<tr>
<td>13. As a substitute for teachers</td>
</tr>
<tr>
<td>As a substitute for the teacher (Scott et al. (1992) in (Harris 1999))</td>
</tr>
<tr>
<td>14. In order to reward learners</td>
</tr>
<tr>
<td>As a reward [for children] (Clements et al. (1993) in (Harris 1999)).</td>
</tr>
<tr>
<td>15. As preparation for living in a society that is permeated with technology</td>
</tr>
<tr>
<td>Social rationale - preparation for living in a society that is permeated with technology (Pelgrum and Plomp 1991).</td>
</tr>
<tr>
<td>Need to prepare students for the future (and computers are the future) (Cuban 1993).</td>
</tr>
<tr>
<td>16. As preparation for work (employment)</td>
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<tr>
<td>&quot;Prepare the current generation of young people for the future workplace.&quot; (Cuban 2001 p.15).</td>
</tr>
<tr>
<td>17. In order to support and stimulate the country’s economic development</td>
</tr>
<tr>
<td>Information technology rationale - about supporting and stimulating the computer industry (Pelgrum and Plomp 1991).</td>
</tr>
<tr>
<td>18. In order to impress stakeholders (e.g. inspectors, funders, prospective parents/students)</td>
</tr>
<tr>
<td>Opportunistic rationale - attract more students to the school (Pelgrum and Plomp 1991).</td>
</tr>
<tr>
<td>The Computer Practice Framework (CPF): Focus = Other (Twining 2002b; 2002c).</td>
</tr>
<tr>
<td>19. In order to reduce inequalities between students/pupils with differential access to ICT outside formal education</td>
</tr>
<tr>
<td>The Computer Practice Framework (CPF): Focus = Learning Tool (Mathetic Tool) (Twining 2001b; 2002b; 2002c)</td>
</tr>
</tbody>
</table>

*(see http://med8.open.ac.uk/dictated/rationales.php for references in this table)*

Based on this list Fox and Twining (2006) designed an online questionnaire, which they sent to different groups of people by e-mail. The participants were asked if they agreed or not that ICT should be a necessary part of education. They were asked to rank each of the 19 rationales on a seven-point scale and also to rank the three rationales that they believed should be the most important. In June 2005 they had received 5,880 responses and when examining a subset of 2,136 responses from individuals who had specific
educational roles, the most voted rationale was “[a]s preparation for living in a society that is permeated with technology” (p. 1554) and the second was “[i]n order to learn IT skills” (p. 1555). The lowest rated rationale was “[a]s a substitute for teachers” (p. 1556).

Fox and Twining (2006) analysed the data according to the following different role categories – teachers, educators, advisers, parents, and primary teachers, secondary teachers, teaching assistants, primary trainees and secondary trainees. One of their main conclusions was that different groups have different perspectives on what is an important rationale for ICT in education and this diversity can affect the impact of ICT in education. This demonstrates how difficult it is to obtain a general consensus on what ICT is valuable for in the context of education.

In view of the previous review it was decided for the purpose of this study to categorise the 19 rationales of Fox and Twining in order to understand what main aspects or arguments for ICT are being considered in the discussion and the essence of the wide variety of arguments for introducing ICT into education. To accomplish this, the author grouped the rationales into three categories by grouping seemingly related issues together according to the literature.

The content is grouped on the basis of the face values of the rationales. The first category is named *Mastering ICT for education work and future life*, suggesting that mastering is an overall rationale for introducing most ICT tools in education or the more general societal values of ICT. The second category is named *Efficiency or productivity arguments*, which is often emphasised by educational policy makers. The third category is named *Quality of education*, a rationale that is very important in all educational discussion and has been emphasised by those involved directly in education. In addition to the 19 rationales for ICT in schools that Fox and Twining (2006) provided, Table 3 also shows the three categories suggested by the thesis author. These categories will be discussed in the next sections.

Table 3. The list provided by Fox and Twining (2006), suggesting a variety of rationales for ICT in schools, and the three categories by the thesis author

<table>
<thead>
<tr>
<th>ICT should be introduced in schools:</th>
<th>The three categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In order to learn IT skills.</td>
<td><em>Master ICT for education work and future life</em></td>
</tr>
<tr>
<td>15. As preparation for living in a society that is permeated with technology.</td>
<td></td>
</tr>
<tr>
<td>16. As preparation for work (employment).</td>
<td></td>
</tr>
<tr>
<td>17. In order to support and stimulate the country’s economic development.</td>
<td></td>
</tr>
<tr>
<td>18. In order to impress stakeholders (e.g. inspectors, founders, prospective parents/students).</td>
<td></td>
</tr>
<tr>
<td>9. In order to provide access to the curriculum for those who might otherwise be excluded from it</td>
<td><em>Efficiency or productivity arguments</em></td>
</tr>
<tr>
<td>10. In order to increase productivity in education.</td>
<td></td>
</tr>
<tr>
<td>11. In order to reduce the cost of education.</td>
<td></td>
</tr>
<tr>
<td>12. In order to make education more efficient.</td>
<td></td>
</tr>
<tr>
<td>13. As a substitute for teachers.</td>
<td></td>
</tr>
<tr>
<td>19. In order to reduce inequalities between students/pupils with differential access to ICT outside formal education.</td>
<td></td>
</tr>
</tbody>
</table>

| 2. As a tool to achieve traditional teaching and learning goals across the curriculum |
| 3. In order to extend and enrich learning across the curriculum. |
| 4. In order to motivate learners. |
| 5. As a catalyst for educational change. |
| 6. Because of the impact of ICT on the nature of knowledge. |
| 7. In order to fundamentally change teaching and learning. |
| 8. As a tool to support learners in thinking about their own learning. |
| 14. In order to reward learners. |

It should be noted here that one topic, *ICT communication for educational purposes*, is missing from Fox and Twining’s (2006) list of rationales for ICT use in education, which includes communication and cooperation with peers, with teachers, tutors and scholars, with the learning material and with school authorities. The importance of group work and peer-assisted learning was highlighted by Vygotsky (1978) and this has received more recent attention following the development of a large variety of ICT applications and tools for communication, e.g. 3G and 4G mobile equipment, tablet computers and communication software. How this will influence interaction of learning is yet to be seen as we are at the early stages of using social networking in education. Communication and cooperation as a rationale for ICT use in education could therefore be added to the three categories discussed in this section.

### 2.3.1 Mastering ICT for education, work and future life

Five of Fox and Twining’s rationales were grouped under this heading: numbers 1 (in order to learn IT skills), 15 (a preparation for living in a society that is permeated with technology), 16 (as preparation for work), 17 (in order to support and stimulate the country’s economic development) and 18 (to impress stakeholders). One rationale is directly related to learning (1), one rationale is directly related to learning and the curriculum (2), one rationale can be connected to daily life (15) and the others relate to the economic role of education (16, 17 and 18).

The social and vocational rationales for ICT in education have been discussed (Hawkridge, 1991) and the social rationales are well known in introducing IT in education when students have to learn how to use the new technology (Voogt,
Background to the study

2008). In the OECD report *Are Students Ready for a Technology-Rich World? What PISA Studies Tell Us* (OECD, 2005), technology is considered a key factor in the development of investment in education that is considered economically and socially beneficial for individuals as well as a whole nation:

... it has become important for young people to master ICT in preparation for adult life ... Every young person will need to use ICT in many different ways in their adult lives, in order to participate fully in a modern society (OECD, 2005, p. 8).

Labour markets in the OECD countries call for better skilled workers as the lower skilled jobs have been moved to the less developed countries, e.g. to countries in the eastern part of the world, and ICT has even made a whole trade unnecessary, e.g. typesetters. This calls for the development of new learning environments that are challenging and supportive where education systems are efficient in improving learning outcomes.

To be in possession of ICT skills is considered necessary for modern life and must be a part of today’s education and therefore the implementation of ICT in education seems to be inevitable. It is not a question any more of whether the new technology should be used in education; the question is why and then how it should be used in order to benefit students, teachers and all those concerned (Jhurree, 2005). However, in this category we are talking about benefits that are independently valuable, but not only of value as means to master other subjects or skills.

The benefits of ICT are also related to socio-economic factors. Hinostroza, Labbé, López, & Iost (2008) consider the use of ICT becoming a life skill and that job requirements and economic development call for ICT in education. Some authors even claim that ICT is a significant driver of countries’ economic and social development and that ICT-based education can improve development in these fields (Kozma, 2005). Kozma and Schank (1998) argue that technology can support change in education that prepares students for a different world where new or different skills are needed. It is necessary for students and teachers to master the necessary technology to be able to access information in different ways and be able to analyse the information to build up understanding and skills. Pachler (2001) emphasises that we not only have to prepare young people to be active participants in today’s world that is influenced by the new technology but we also have to prepare them for tomorrow’s world and technology which is, as yet, unknown. An essential requirement for economic, political and personal success is “the ability to manipulate information” (Pachler, 2001; p. 15). This indicates that there are several arguments for
introducing ICT into education that are based on the need for adapting to a new environment and preparing for new skills.

2.3.2 Efficiency or productivity arguments

Six of Fox and Twining’s items are here grouped in a category which is characterised by efficiency, i.e. doing what has already been done but more cheaply, or in less time, or showing more success than without the technology. These are items numbered 9 (in order to provide access to the curriculum for those who might otherwise be excluded from it), 10 (in order to increase productivity in education), 11 (in order to reduce cost of education), 12 (in order to make education more efficient), 13 (as a substitute for teachers) and 19 (in order to reduce inequalities between students/pupils with differential access to ICT outside formal education). Part of the reasoning for this categorisation relates to economic gains (11, 13), two are related to the equality campaign (9, 19) and two are related to the idea of learning more and faster (10, 12).

Use of ICT in education has been seen as an opportunity to reduce the cost of education and Hawkridge (1989) considers cost-effectiveness to be one of six main rationales for ICT in education in the Third World. Government policy regarding ICT in education focuses on the need to sustain economic growth by ensuring that students acquire the skills necessary to master the new technology (Kozma, 2005). The main idea is to reduce interpersonal learning relationships in order to reduce staff cost and if students do not have to attend school or school attendance is reduced, school buildings will not be needed as much as today. The development of online LMS has partly been influenced by the idea of changing and supporting communication in education in a cost-effective way, where teachers and students can communicate independent of the school building or school hours. The growing emphasis on distance learning, e-learning and blended learning has also been influenced by this idea of cost-effectiveness (Jung & Lee, 2013).

The OECD report from 2006 describes how the development of ICT has lowered the cost of studying abroad and enhanced international education because students can attend distance education instead of moving to another place to study (OECD, 2006). ICT makes it possible for students to stay at home and study at the same time in a totally different location. However, we must keep in mind that access is one of the main barriers of ICT use, often referred to as The Digital Divide (Warschauer, 2004), and in some countries the lack of access to computers is still a fundamental problem. In a comparative analysis of the use of the Internet and the educational level in 22 countries, Cardoso (2005) came to the conclusion that there is a strong correlation between
educational competency and number of Internet users in all societies. This implies that the new opportunities ICT offers are not open to everyone.

2.3.3 Quality of education

Eight of the Fox and Twining’s categories are here grouped under the heading of ‘Quality of education’, at the level of the classroom, the curriculum or the institution. Now we are moving out of the quantitative dimension to the qualitative. The items are numbers 2 (as a tool to achieve traditional teaching and learning goals across the curriculum), 3 (in order to extend and enrich learning across the curriculum), 4 (in order to motivate learners), 5 (as a catalyst for educational change), 6 (because of the impact of ICT on the nature of knowledge), 7 (in order to fundamentally change teaching and learning), 8 (as a tool to support learners in thinking about their own learning), and 14 (in order to reward learners). Part of the reasoning is related to the intended changes in education (5, 7), improving knowledge and thinking (6, 8) and improving the learners’ learning (3, 4, 14).

Quality of education relates to the goals of policy makers as well as educators, and new technology has been considered to be one of the factors improving the quality of education in Europe (Kozma, 2005; Jhurree, 2005). Hammond (2013) describes in his paper how English governments have emphasised ICT in education for raising the standards supported by evidence (Cox et al., 2003; Harrison et al., 2006). Nevertheless ICT alone is considered “...not enough to bring about significant changes in the quality of education” (UNESCO, 2002, p. 101).

Hawkridge (1989) emphasises the pedagogical rationale where computers are seen as an opportunity to develop teaching and learning and Voogt (2008) states that this now has an impact on the educational policy in many countries. More is needed than just new technology, but all the opportunities that new technology bring about are seen as an important catalyst for the development of education, learning and teaching, in order to assist in the transformation of the educational process. ICT in education may bring hidden opportunities to build up new skills, creativity and capability, even unknown to today’s educators, and too much resistance to changes and fear of the unknown could exclude or set back development yet to come (Heppel, 2001).

2.3.4 Summary

The rationale for ICT use turns out to be a complicated issue as there are many different opinions and a variety of arguments used in defending each rationale. The various arguments for implementation of ICT in education must be clarified for all concerned, especially (but not only) for the teachers who are supposed to be instrumental in using ICT implementation, and for students, school
authorities, parents and others involved - and also for those who want to assess the impact of what has been done, for them it is important to know what the intention was.

Issues emphasised, when discussing the rationales for ICT use in education, are increasing the quality of education, preparing for future life and cost-effectiveness. In this section it has been claimed that a series of prominent arguments for using ICT in education may usefully be divided into three main categories. Firstly, to master education, work and future life (i.e. it is generally useful to able to use ICT). Secondly, to improve efficiency and productivity in education (i.e. ICT facilitates the chores of education) and in the workplace and thirdly, to improve the quality of education (i.e. make education better). This simplification could be helpful to clarify the situation and help those involved to agree with the rationale for ICT use in education. To support effective changes with ICT in education, an agreement and knowledge about the rationale is an important premise.

In the next section the ideas of teaching and learning with ICT will be discussed with an emphasis on items which fall mainly within the third category discussed above, i.e. how ICT may be implemented to improve the quality of education.

2.4 Teaching and learning with ICT

The previous sections highlighted the discussions on the importance of ICT in education and for the world of work. Now effective application of ICT to education and the quality of ICT use will be discussed. It will be argued that in order for ICT to be applied effectively in educational settings to enhance the quality of education, it needs to be introduced within an environment where the necessary infrastructure and facilities are available. If the authorities and school organisations are to be supportive of the implementation of ICT by providing the necessary infrastructure and provide support both in terms of equipment and appropriately qualified staff, the nature and the arguments for their use must be clear.

2.4.1 ICT educational resources

With ICT, both access to and presentation of educational resources has changed with the opportunity to use text, images and sound in multiple ways, giving both teachers and students new tools. Miscellaneous teaching materials give teachers and students various possibilities for educational work. Printed material, a text in a book, maybe with a few photos or drawings, has been the
main source of information for teachers and students for a long time. During the earlier parts of the 20th century, radio and television emerged as new forms for both learning material and the distribution of material, leading to the development of utopian views about possible changes in education (Buckingham et al., 2001). However the reality lacked revolutionary influence on school work although this technology changed access to material and made it more diverse. The educational system did not make a comprehensive use of the new technology, and printed text is still the low-cost option - and it is also the material teachers themselves are trained to use through their own education. Audio cassettes, videos and DVDs seemed to be more frequently implemented in education when they came along, although they may not have lived up to their expectations (Westra, 2010). They are less time-bound compared to special TV broadcast times and can be reused like books and importantly, the teachers still have control over how it is used for educational purposes. Text, images, drawings, graphs, audios, videos, movies, visualisation and animation can be used to reach out to students with different backgrounds, competencies and skills, to capture their interest and enrich their learning experience. Use of text, image or sound is seen as a part of traditional pedagogy and Loveless, DeVoogd, & Bohlin (2001) state that “the new pedagogy allows for revisions to improve the product or changes to make it into new product” (p. 74).

The technological environment is both complex and challenging for both teachers and students and we are just beginning to cultivate an understanding of what the influence will be on education. The possible use of ICT in teaching and learning has been discussed in the literature and has been studied from a number of different viewpoints as technology can be used in many different ways in education (Cuban, 2001; Leask, 2001; Naidu, 2003; Lee S. Shulman, 2004; Webb & Cox, 2004; Mishra & Koehler, 2007; John & Wheeler, 2008; ten Brummelhuis & Kuiper, 2008; Brown, 2008; Plomp, Anderson, Law & Quale, 2009). A number of topics can be mentioned, e.g. to deliver learning material in different formats, to present both teaching materials and students’ projects, for discussions, interaction and communication both asynchronous and synchronous, to assess students’ work and give feedback and to keep track of attendance and students’ work.

ICT has been used as a tool of enhancing existing modes of teaching which may vary from very traditional to very novel modes. Use of ICT in education has different roles and aims, e.g. practical roles, to increase flexibility, to offer interactivity, and to foster both individualised learning and cooperation, even when it relies on rather traditional ways of teaching. The simplest option is to get students to use computers for writing essays, using the Internet for searching for information and references, for handing in school work and to
communicate with the help of e-mail or LMS. ICT can also be used in less traditional ways to support more open educational environments such as distance education, distributed education and blended learning, where the learning situation can be a mixture of online education and traditional face-to-face situations. Collis and Wender (2002) state that:

... the use of e-mail and the use of Web resources is a common phenomenon in the educational practice, where other ICT forms ... are used little or in a much more limited extent (p.31) ... ICT use, in terms of e-mail, word processing, PowerPoint, and the Web, has become standard as part of the teaching and learning process ... ICT had clearly become part of the blend ... (Collis & Wender, p.62).

Interaction with technology has been used for some decades, having its origin in drill programs in the sixties and seventies. Later, progress was made applying artificial intelligence (AI), hypertext, CD-ROM and the World Wide Web (WWW) (Brown, 2008). We no longer rely on one-way communication from the teachers to the students; ICT offers not only two-way communication between teachers and students but multilateral communication both within the school, the educational system and outside it. Classroom walls do not have to be the main frame for educational work, interaction with others is easy with the help of technology and the teacher may no longer be the main source of knowledge.

Teachers and students can use technological tools and software for different purposes related to students’ different ways of learning and teachers’ different beliefs in pedagogical methods. The same tool can be used for instruction, for construction, for inquiry and for communication in an educational setting that can be student-centred, knowledge-centred, and assessment-centred or even community-centred (Brown, 2008). It is not only the educators that can make learning material. The students can now easily create and publish multimedia content, alone or with their peers and with or without the teachers’ guidance.

This situation can be both challenging and frightening for teachers as they have to have a clear picture of the purpose for using different ICT tools and options and feel they need to have an overview of all the options - a formidable task.
2.4.2 Driving forces for ICT in learning

Many teachers are using ICT in their work, some with enthusiasm, others with resistance, but many of them are using ICT in at least some parts of their work. Reynolds, Treharne and Tripp (2003) conclude, when analysing the literature of ICT in schools, that for effective use of ICT there must be a strong policy for ICT use and that it requires teachers who believe that ICT improves teaching and learning. All the same, a strong policy is not sufficient. As several studies have shown, a number of factors influence teachers’ decisions about how they use ICT in the classroom, as suggested by Mumtaz (2000) who concludes after a literature review of teachers’ responses to ICT that “…teachers’ theories about teaching are central in influencing teachers to use ICT in their teaching” (p. 338). According to John and Wheeler (2008) we need good teachers to make good use of technology in order to get success. It is important to build up knowledge of how ICT is related to teachers’ pedagogy and beliefs about teaching and learning in a technologically-enriched environment. We need to know how teachers are using the technological potential open to them and the teachers’ attitudes toward ICT use in education.

The use of technology in education also raises questions about what kind of learning ICT supports and it is connected to the discussion about different methods of learning and how it is related to the content of education which may of course also change radically, inter alia as a consequence of the new technology. Recent literature can be said to be polarised into two areas regarding the conception of learning. On the one hand there is learning as a process where the learner is active in the constructing of knowledge and the searching for meaning and understanding, sometimes referred to as deep learning. On the other hand is surface learning where learning is looked at as an outcome or product, which basically requires a fairly mechanical absorption of knowledge (Lai, Voogt, & Knezek, 2008). These different conceptions of learning influence how ICT is perceived and implemented in education. We have to consider if it is enough to use just simple common technology or whether we need more sophisticated tools to support learning.

A learning environment offering ICT tools gives both the teachers and the learners the possibility of selecting tools to use when they want to use them and they can also choose how to use the tools available to them. The recent debate on tool use in a computer-based educational environment has not been centred on the tools themselves but more on the use of the tools and the influence and effects the use has on learning and teaching. This is related to the discussion about how the tools themselves have an effect on how they are used. Jonassen (1999) states that it is the affordance of the tool that becomes important, i.e. what we can do with the tool when we use it for meaningful tasks. It is not the tool itself that is important, but rather its potential use.
If we look at the tool use from the student’s point of view, Clarebout and Elen (2006) reviewed the literature from 1992 – 2002 and found 22 studies of tool use, what influenced the use of these tools and the influence these had on learning. They concluded that “... tool use seems to be influenced by (1) student characteristics, (2) the kind of tool, and (3) additional advice” (Clarebout & Elen, 2006, p. 406). This indicates that each student uses tools in his or her own specific way and that teacher’s advice could influence how they use the tools.

Ten Brummelhuis and Kuiper (2008) discuss a framework of four main influential factors or forces in the learning process connected to ICT in education. Here they build on the work of Plomp, ten Brummelhuis and Rappmund (1996) and Voogt and Odental (1997). Plomp, ten Brummelhuis and Rappmund (1996) wrote their report aiming at “... improving teaching and learning through the application of ICT” (p.1) in the Netherlands where they stress the significance of the leadership and importance of a vision of education in the future. Voogt and Odental (1997) in their literature review emphasised the need for change in the curriculum where the different disciplines need to be connected as well as the school and the outside world. They saw the focus of instruction moving from teaching a group of students in a closed classroom to focusing on the individual need of each student (see in (Voogt & Pelgrum, 2003).

The four actors in the learning process in the ten Brummelhuis and Kuiper (2008) framework shown in Figure 1 are the teacher and the learner, represented on the horizontal dimension, and the content and the infrastructure, shown on the vertical dimension. The learning process takes place at the point where these dimensions meet, as a consequence of the interaction of the four forces. The school organization and local environment provide the framework for the learning process. Ten Brummelhuis and Kuiper (2008) argue that this framework can be analysed from a number of viewpoints depending on what is considered to be the main driving force in the learning process, the content, the infrastructure, the teacher or the learner. These four driving forces will now be discussed further in relation to ICT-enriched environment looking first at the vertical dimension.
When the **content** is the driving force, ICT is the tool used to introduce material to the student - and learning depends on how the content activates the student in the learning process. The content in a traditional educational environment is related to the curriculum which in turn is *inter alia* influenced by the contemporary society. The content may be delivered by the teachers who have different pedagogical beliefs. Nachmias, Mioduser, and Frokosh-Baruch (2008) state that ICT as a driving force in the information society affects changes both in content and general skills in education. In the international research SITES a change in content was reported following use of ICT and further analysis showed that the content was not new or completely different, but rather a different way of delivering the content that emerged when using ICT (Voogt, 2008). Kozma (2003) comes to the conclusion, drawn from the SITES Module 2, that what matters is not how good the access to technology is or how good the technology is, but rather how it is integrated into the curriculum. Technology that does not fit into the pedagogical needs and school environment will not support innovation of ICT.

The need for more computers and good ICT infrastructure underlies government policies for educational change. When the ICT infrastructure is the driving force in the learning process, ten Brummelhuis and Kuiper (2008) call it *technology push*, related to the idea that technology is the vehicle for educational change. Norris and Soloway (2008) use the term *pervasive*
computing infrastructure to include personal mobile devices, mobile learning environments, network connectivity and special-purpose computer gear. They also state that a pervasive computing infrastructure does not ensure dynamic use of ICT. The main idea is that if teachers and learners have good ICT infrastructure and material, it will increase the use of ICT and support changes in education. Voogt and Knezek (2008) consider technology push related to the educational practice that supports existing teaching and learning methods. Nachmias, Mioduser, Cohen, Tubin, and Forkosh-Baruch (2004) conclude from the SITE data that the ICT support in schools is more important than the number of computers. The situation is complicated, one must have access to technology to be able to use it, but the question is raised, what is acceptable in an educational environment that is a part of the knowledge society? Warschauer (2002) emphasises that the access to ICT must be meaningful, not just access to computers and the Internet. There are many influencing factors that must be considered and access is just one of them.

When the teachers are the driving force in the learning process, ICT is included into all of his/her activities and the extent to which ICT is used is defined by the teachers. The influence it has on the learning process is affected by a number of factors. As ten Brummelhuis and Kuiper (2008) point out, the teacher has more control and responsibility over some learning activities than others. They refer to Simons and Zuylen (1995) when they say that the three main activities of the learning process for the teacher are: preparatory, instruction and regulatory. These activities embrace how the teacher connects ICT into their work. They conclude, supported by research, that efficient use of ICT has a strong connection to teachers’ pedagogical beliefs. The problem is, if the situation is as Beetham and Sharp (2007) argue, that teachers are using technology without considering its influence or rethinking the pedagogy - they just use it.

When the learners are the driving force in the learning process, he or she is actively involved in controlling the learning but still needs support and guidance from the teacher (ten Brummelhuis & Kuiper, 2008). This is related to a student-centred learning environment where ICT may be used to motivate students’ activities. Students can control their study time, place and pace but they have limited control over what they are learning. They have more control over practical situations but not necessarily the content. Distance learning and e-learning are examples of learning environments that offer students more control over their learning than a classroom setting. It is the delivery process that has changed with ICT but the teacher is still in control of the content and the assessment (ten Brummelhuis & Kuiper, 2008).
2.4.3 Summary

In this section, ICT as an educational resource and driving force behind ICT implementation and development has been discussed. ICT is continuously developing and has been used in education as a tool for refining existing methods of teaching and learning, which may vary from very traditional to very innovative modes. It is clear that equipment needs to be replaced and software needs to be updated in order to keep up with the most recent developments. Computers and other equipment need to be properly maintained and serviced with the appropriate infrastructure in place and software suitable for educational purposes must be developed and introduced.

However, it is not mainly the hardware, the software and the infrastructure that influences the use of ICT in education. Skilled and enthusiastic teachers, ICT-linked content and motivated students are important and necessary. Staff need to keep up with their digital skills and attend appropriate courses for their professional development. Effective teaching and learning with ICT does not occur in isolation in the schools but within a context of support from the school organisation and the educational authorities. It is important to understand the driving forces in the development of ICT in education and ten Brummelhuis and Kuiper’s (2008) framework is a useful way to analyse the situation. In their framework the acting forces are the teacher and the learner, the content of the lesson and the learning environment, the school organization and the local environment.

Teachers and students interact with each other and the content and ICT can be seen as a part of the interaction, synchronous or asynchronous, independent or collaborative, where teachers and students communicate, as well as students with students and teachers with teachers. Communication and interaction with content and knowledge is also supported by ICT for students and teachers. The students’ situation is potentially affected by ICT learning environment, they have good access to information and need to have skills to handle information and make use of it in their learning. Students can also make use of technology in diverse ways, collect material from the teachers and search for resources through the Internet and analyse information, work on their projects and hand them in electronically, present their material, organise and hold track of their study material, which may be the most important use of ICT along with communication.

ICT tools can be used for different purposes in education, related to teachers’ different beliefs in pedagogical methods and to students’ different ways of learning, but also to the knowledge of ICT affordances. This situation can change teachers’ roles and be stimulating for teachers - but can also create barriers, as they have to have a clear picture of the rationale and purpose of
using different ICT tools and options before they can make successful use of them. Teachers’ knowledge of the different affordances ICT offers for education is important as Webb and Cox (2004) highlight and their conclusion is that the integration of ICT has been a long and complex process that is still on-going. Teachers play an important role in the productive application of ICT in education and this will be addressed further in the next section.

Thus we can conclude that as the four dimensions or forces ten Brummelhuis and Kuiper (2008) present are all important and we have seen that the interaction of these can be both very complex and very important. The introduction of ICT into education has both highlighted the complexity of the educational arena and added to it in many important respects. The question arises to what extent can we fruitfully specify the various interactions and clarify what are the important variables in the discourse.

2.5  Webb and Cox’s pedagogical framework

Teachers and their ways of thinking and working form an important part of the application and implementation of ICT in education. Koehler and Mishra (2005) built and Shulman theories and model when they developed their technological pedagogical content knowledge (TPACK) model that will be discussed here. Cox and Webb have looked closely into ICT use in education in recent years (Cox, 2003; Cox, 2004; Webb & Cox, 2004; Webb, 2005; Cox & Marshall, 2007; Webb, 2008; Cox, 2008; Marshall & Cox, 2008; Webb, 2009; Webb, Voogt, Cox, Fluck, & Davies, 2011; Webb & Reynolds, 2013). Their framework for pedagogical practices relating to ICT use and their empirical analysis is the main focus of this section, but it starts with an introduction of Lee S. Shulman’s (1986) framework of teachers’ pedagogical reasoning which Koehler and Mishra and Cox and Webb based their frameworks on.

2.5.1  The interaction of technology, pedagogy and content knowledge

Lee S. Shulman, an educational theorist, is known for his work on teaching as a profession and assessment of professional knowledge, and for his theories on pedagogical content knowledge (PCK) (Wilson, 2004). The PCK framework explains teachers’ understanding towards the interaction of pedagogical knowledge and content knowledge when creating effective teaching. Shulman explains the intersection, PCK as
... the most regularly taught topics in one’s subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations - in a word, the ways of representing and formulating the subject that make it comprehensible to others (Shulman, 1986, p. 9).

He stresses that pedagogical content knowledge should be given attention as it recognises the prominent bodies of knowledge for teaching. It symbolises the combination of content and pedagogy and helps us to understand how specific subjects or issues are prepared, represented, and modified by the teachers to meet the different students’ interests and talents. PCK is represented diagrammatically in Figure 2.

![Diagram of Pedagogical-Content Knowledge](#)

**Figure 2.** The two circles of pedagogical knowledge and content knowledge are now joined by pedagogical content knowledge (Mishra & Koehler, 2006, p. 1022)

Shulman builds his theories on philosophical sources and empirical studies on groups of teachers, both experienced and novice, and teacher trainees (Shulman, 1987). He emphasises teaching as “comprehension and reasoning, as transformation and reflection” (Shulman, 1987, p. 13). Shulman does not agree with completely separating ideas on teachers’ subject knowledge on the one hand and the pedagogical knowledge and skills on the other hand. He highlights the teacher’s need for both, i.e. subject knowledge and understanding to be able to teach, as well as being able to select the pedagogical methods that are best suited for different situations and subjects. This creates a very special intersection, where the pedagogy is dependent on the context (i.e. the subject) and the subject being taught is also defined by the context (i.e. the students, and the learning situation). This intersection of content and pedagogy is the field of pedagogical content knowledge (PCK), shown in Fig. 2.2. It shows “the special amalgam of content and pedagogy that is uniquely the province of
teachers, their own special form of professional understanding” (Shulman, 1987, p. 8). Shulman states that teaching knowledge is extensive and that there are different categories of knowledge and knowledge-base and categorizes the ideas of teaching knowledge into seven different groups (at minimum):

... content knowledge; general pedagogical knowledge, ...; curriculum knowledge, ...; pedagogical content knowledge, ...; knowledge of learners and their characteristics; knowledge of educational contexts, ...; knowledge of educational ends, purposes, and values and their philosophical and historical grounds (Shulman, 1987, p. 8).

Shulman’s framework (1987) does not focus on ideas and beliefs but on teachers’ types of knowledge and pedagogical reasoning. He considers pedagogical content knowledge of special interest as it involves both content and pedagogy and says:

... the key to distinguish the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students (Shulman, 1987, p.15).

Shulman (1987) sees it as a challenge for teachers to use the knowledge of the subject and pedagogy to create successful teaching. He presents a framework of pedagogical reasoning and action in a cycle that consists of “comprehension, transformation, instruction, evaluation, reflection and finally new comprehension” (Shulman, 1987, p.15). Gudmundsdottir and Shulman (1987) state that pedagogical content knowledge is the most important source of knowledge for teachers. They see three components of pedagogical content knowledge (PCK), knowledge of the content, the pedagogy and of the learner.

Koehler and Mishra (2005) are among those who have built their work on Shulman’s PCK framework to design a framework for teachers’ knowledge necessary for successful use of technology. They developed Shulman’s PCK framework further as they believe that technology should not be seen as separated from content and pedagogy, but rather as integrated with the other arenas. Therefore they add technological knowledge to Shulman’s framework and develop a new framework, using the term technological pedagogical content knowledge (TPCK, later referred to as TPACK), consisting of three main domains as can be seen in Figure 3: Technological Knowledge (TK), Pedagogical

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Knowledge (PK) and Content Knowledge (CK). TPCK framework emphasises that even though knowledge of technology is a prerequisite for ICT use in education it is not sufficient for effective use; it must be interwoven with pedagogical content knowledge for an effective implementation of ICT.

In Figure 3 we see that the important intersections of TK and CK are technological content knowledge (TCK), the intersections of CK and PK is pedagogical content knowledge (PCK) and of PK and TK is technological pedagogical knowledge (TPK). At the centre are the intersections of all three, TK, PK and CK, which they call technological pedagogical content knowledge (TPCK).

Mishra and Koehler (2006) stress that the foundation for good quality teaching, involving ICT, builds on the understanding of the multifaceted relationship between technology, pedagogy and content. Teachers need to build on the understanding of these complex relationships when they develop their teaching. They state further:

TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help...
redress some of the problems that students face; knowledge of students’ prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones (Mishra & Koehler, 2006, p. 1029).

They emphasise the importance of knowledge, the integration of content, pedagogy and technology, with good teaching; thus the emphasis is on creating something new and not just adding technology onto existing practices. Teachers’ understanding of how to use technology to further the quality of teaching and learning is thus not only built on knowledge of technology. Teachers must identify students’ background and skills and use their knowledge of technology, of pedagogy and their subject matter in order to develop their teaching. TPCK does make it clear that knowledge of technology is a prerequisite for ICT use in education but not sufficient for effective use, pedagogical content knowledge is also necessary for effective implementation of ICT.

Mishra and Koehler’s (2006) framework that highlights the importance of pedagogy and Shulman’s emphasis on pedagogical reasoning leads us to Webb and Cox’s framework for pedagogical practices relating to ICT use.

2.5.2 Webb and Cox’s framework for pedagogical practices relating to ICT use

Webb and Cox (2004) draw on Alexander’s (1992) two aspects of pedagogy: teaching methods and students’ educational organisation (see Section 1.1). They emphasise that understanding of pedagogy changes over time and “…identifying teachers’ ICT-related pedagogies will require examining teachers’ ideas, values, beliefs and the thinking that leads to observable elements in practice” (Webb & Cox, 2004, pp. 236-237). They also agree with Watkins and Mortimore (1999) that over time the concept has become more complex as research knowledge and understanding has become both more detailed and more combined. They refer to Watkins and Mortimore model of pedagogy:

... it offers an increasingly integrated conceptualisation which specifies relations between its elements: the teacher, the classroom or other context, content, the view of learning and learning about learning (Watkins & Mortimore, 1999, p. 8).
Webb and Cox (2004) build their framework for pedagogical practices relating to ICT on Watkins & Mortimore’s (1999) discussion of pedagogy and agree with them that the conception of pedagogy has been changing and has become more complex. They connect their reasoning to Shulman’s model of pedagogical reasoning and draw from Shulman’s theory of pedagogical reasoning.

Shulman’s framework has been criticised for being too teacher-focused and having a strong connection to the theory of cognition where knowledge is seen as fixed and with little focus on learning (Hawkridge, 1989; Banks, Leach, & Moon, 1999). Webb and Cox (2004) on the other hand note the usefulness of Shulman’s framework as explaining teachers’ way of thinking in their teaching process and the knowledge needed for their work. They emphasise the value of Shulman’s framework to guide the focus on teachers’ pedagogical reasoning and preparation of their work. But they note that it does not deal with the students’ thinking processes or students’-teachers’ interactions. Therefore they do not consider it a good tool to analyse classroom activities and developed their own framework, built on Shulman’s framework, with important extensions involving the students.

The term **affordance** has been used in the educational literature, in particular when connecting attributes of technology to education, and it has an important place in Webb and Cox’s work. The notion of affordance, or affordance theories, gained recognition due to Gibson’s work on this concept in 1977 and then elaborated in 1979 in his ecological theory of human perception, which was subsequently adapted in various ways by different theorists (Day & Lloyd, 2007; Hammond, 2009). Webb and Cox (2004) refer to affordance, as described by Gibson, as what the setting offers the learner depending both on the learner’s ability and the learning environment, which includes *inter alia* other students and teachers. Norman (1988) has a different view of affordance than Gibson as he refers to both “… the perceived and actual properties of the thing” (p. 9). This means that affordance may be present even though it is not perceived as such by those concerned, who might perhaps later come to appreciate the possibilities in the setting. Webb and Cox (2004) have connection to Norman’s description of affordance when they focus on how the user perceives the learning environment and emphasise the opportunities ICT provides for the learning environment and the competence of the learner, who may gradually appreciate the potential of the situation, *inter alia* through the guidance of the teacher.

Conole and Dyke (2004) are among those who examine the affordances of ICT and articulate taxonomy of ICT affordances that consist of accessibility, speed of change, diversity, communication and collaboration, reflection, multimodal and non-linear, risk, fragility and uncertainty, immediacy, monopolization and surveillance. They considered whether “application of the concept of affordances might enable better use and understanding of technologies and their application to learning and teaching” (p. 9). However
they see this approach raining a number of questions regarding the value of the concept and if it will be helpful for understanding technology in education.

Figure 4 describes the importance of affordances for the learning environment and the learning outcome (Cox et al., 2003; Cox et al., 2004). The affordances are here divided into four partitions, of which ICT is one, to emphasise the analogy that ICT is not a soloist, it is a part of the symphony orchestra that influences actions and activities to support learning outcomes. The figure underlines that the interaction between affordances provided by ICT, the teacher’s interaction, other pupils and other resources, that must be identified in order to understand how different affordances can support teaching and learning. The importance of the teachers’ input must be stressed; they are the actors in the learning process and their expectations of ICT affordances can influence their planning of the teaching.

Webb and Cox (2004), when working with Shulman’s (1987) framework in connection to ICT in education, recognize that when ICT is used in education, knowledge of affordance is needed when deciding what kind of ICT to use. It is important to note that affordance, potential for use, does not ensure any particular use, it only invites the opportunity. Thus affordance may go unnoticed or unharnessed.

Cox and Webb edited a report *An investigation of the research evidence relating to ICT pedagogy* (Cox et al., 2004) for the Department for Education and Skills (DfES) in the UK. The report was based on a review of over 350 published papers and reports in addition to a number of case studies from a
range of primary and secondary schools. The main aim of the study was to recognize ICT’s impact on attainment and to investigate if the findings from the literature were connected to effective ICT use in schools. They conclude that the pedagogical beliefs and values of the teachers are the essential influential factors in ICT use and that the effects of ICT on students’ attainment is related to teachers’ subject knowledge and their familiarity with how students understand the subject. Cox and Webb (2004) note that there is a lack of extensive knowledge of ICT resources for education and therefore all the opportunities that ICT offer are not used. They state that:

Excellent software, reliable hardware and resilient networks, important though they may be, will have no effect on attainment if teachers are not enabled and educated to use these resources appropriately (Cox et al., 2004, p. 84).

Teachers must be able to use ICT tools appropriately in their work in connection to their subject, and their pedagogical beliefs are important in modelling ICT learning opportunities. Webb and Cox (2004) work further with the literature review in order to identify aspects of teachers’ pedagogies and practices and to look at trends in the understanding of ICT use in education. They use the term affordances when they describe what “the learning environment offers the learner” (p. 238). On the basis of their analysis they propose “a framework for examining pedagogical practices based on an analysis of the nature of pedagogy as revealed in the literature” (Webb & Cox, 2004, p. 235). Furthermore they suggest that ICT needs to be an integral part of this framework. In order to formulate this integration they discuss Shulman’s integrated framework of pedagogical reasoning and action, which focuses on comprehension, transformation, instruction, evaluation and reflection and they state:

Shulman’s model provides a description of the processes that teachers engage in when they are planning, teaching and evaluating their lessons and schemes of work (Webb & Cox, 2004, p. 238).

In Shulman’s framework a selection of teachers’ knowledge is identified as what the teachers need in terms of pedagogical knowledge, curriculum knowledge and knowledge of the learners to use in their teaching. Webb and Cox (2004) also argue that values and beliefs of the principal actors in the teaching process, i.e. of both teachers and students, should be added to Shulman’s framework to design a multidimensional framework for pedagogical practices relating to ICT use. This addition to Shulman’s framework is shown in Figure 5. Each process in the framework has an underlying complexity and the
left-hand side of it is mainly based on Shulman’s TCK framework. Their framework includes teachers’ and students’ knowledge, beliefs and values which they take with them to the educational environment. In the Webb and Cox framework, the teachers’ knowledge, beliefs and values leading to pedagogical reasoning, lesson plans and behaviours are on the left side and students’ knowledge, beliefs and values that are affecting their behaviour are on the right side. The teachers and students work, in relation to the affordances, leads to learning activities. The final or exit point is the students’ knowledge, understanding and skills. The framework shows data flow, processes and storage related to pedagogical practice at a particular moment. Knowledge, beliefs and values that teachers and students bring with them will change over time and impact on all elements of the framework.

Figure 5. Framework for pedagogical practices relating to ICT use (based on Webb & Cox, 2004, p. 239)
Although it might be said that this framework would be the same with or without ICT, it is useful for analysing teachers’ and students’ work in educational settings. It emphasises pedagogical practices and does not directly add technological knowledge to Shulman’s framework as Mishra and Koehler (2007) do. The notion of affordances which Webb and Cox bring to the picture emphasises that in the new environment, now characterised by ICT, lies the potential for new approaches but this potential must be harnessed, based on the knowledge beliefs and values of the actors participating in the process.

The teachers use their pedagogical understanding to make lesson plans where they choose what techniques and methods are most likely to facilitate their students’ learning of a given content, i.e. material and skills. Teachers’ knowledge, beliefs and values affect their pedagogical reasoning and this all is connected to the lesson plan the teacher constructs and his/her behaviour. The affordances that the learning environment is offering influences the teachers’ and the students’ behaviours. All this comes together in the affordances of the learning situation and the process is the learning activities, which build up students’ knowledge, understanding and skills. Teachers’ and students’ behaviours are fundamental in the ICT affordances and learning activity in Webb and Cox’s framework and Webb (2005) suggests that the teachers and their pedagogical approaches are the critical factors in the use of ICT in learning and teaching. She concludes from the results of two large-scale studies in the United Kingdom (UK) on ICT in primary schools, that:

... teachers’ beliefs about teaching and learning as well as their understanding of the affordances provided by different types of software are important in their pedagogical reasoning (Webb, 2005, p. 245).

Webb and Cox (2004) discuss three ways for teachers to facilitate their students’ learning in connection with their framework:

- by providing them with the affordance
- by increasing the degree of affordance provided by ICT, for example by prompting students to predict the results of a simulation;
- by giving students additional information about an affordance, for example by explaining and demonstrating a feature of software (Webb and Cox, 2004, p. 239).

Webb (2005) works further with the term affordance with an emphasis on ICT and learning science in schools and comes to the conclusion that ICT can offer a variety of affordances that facilitate the learning of science. When it comes to preparing ICT use to promote students’ learning she stresses the teacher’s important role and says:
The challenge for teachers and curriculum developers is to understand the potential of these affordances to support other innovations such as cognitive development, formative assessment and new science curricula (Webb, 2005, p. 732).

There is still a need for teachers to develop their ICT use and interweave it with the learning environments and pedagogy. In this framework, affordances in connection with ICT relates to access to ICT, educational material, novel circumstances and new ways of doing science. An ICT-enriched educational environment offers teachers a variety of possibilities to provide affordances that are likely to benefit students’ learning activities. They can provide different ICT affordances for different subjects and for different groups of students. This may increase the scope of the learning situation where the teachers can encourage students to work with ICT and employ it in their learning. They can, for example, encourage students to go beyond an Internet search and work with data and information and utilise software for rewarding learning activities. Here we come to the teacher’s choice to add information about an affordances when they are informing students about new software and online features. This might motivate the students to look further and make the most of ICT options.

The precondition for the foundation for ICT use is the teachers’ ICT knowledge and skills but, not less importantly, the students’ knowledge, skills, beliefs and values which are also essential as the students can bring new ICT knowledge and skills into the classroom.

2.5.3 Summary

The main theoretical foundation for this thesis has been discussed in this section starting with briefly introducing Shulman’s framework, which is used as a platform for further developments. His PCK framework focuses on teachers’ types of knowledge and pedagogical reasoning (Shulman, 1987). Mishra and Koehler’s TPACK framework (2006) was introduced, describing how they weave technology into Shulman’s PCK framework. Their extended framework can be helpful to identify the nature of knowledge that teachers must have in order to integrate ICT into their teaching. It emphasises the intersection between technological, pedagogical and content knowledge, which is considered to be a new kind of knowledge, where the interaction with technology creates a new type of knowledge base. Mishra and Koehler believe that their theoretical “…framework about the relationship between technology and teaching can transform the conceptualization and practice of teacher education, teacher training, and teachers’ professional development” (Mishra & Koehler, 2006, p.1019) as well as impact on future educational research. The TPACK model is also useful to understand the relationships among teachers, students, content,
technologies, and practices (Archambault & Crippen, 2009). Chaia and Limb (2011) give an interesting example of how TPCK reflects in a teacher’s everyday work:

Mathematics teacher needs to understand the key concepts of statistic (content knowledge), operate Excel software (technological knowledge) and craft an authentic problem for a particular group of students (pedagogical knowledge) in order for him/her to engage students in ICT-enhanced problem-based learning (Chaia & Limb, 2011, p. 5).

Webb and Cox’s (2004) framework for pedagogical practices relating to ICT use were introduced and examined and their emphasis on the term *affordance* discussed. Webb and Cox’s framework includes teachers’ knowledge, beliefs and pedagogical reasoning and practices, and also students’ knowledge, beliefs and practices. They refer to Gibson’s affordance as the action option available but in order to harness the potential of ICT, it must be perceived by the actors involved, therefore beliefs and attitudes of the actors become critical. Norman (1988) emphasises that the potential of ICT does not guarantee its use. Affordances are also related to the capability of the learner in the ICT learning environment and may affect the use of ICT as well as the teachers’ values and beliefs in ICT use. Although Webb and Cox (2004) refer to Gibson, it can be stated from their framework and discussion that they are inclined towards Norman’s meaning assigned to affordance as they emphasise both the potential and a visible action. Teachers’ knowledge, beliefs, values and pedagogy influence their behaviour and ICT affordances and how the students make use of this affordances, but students’ knowledge, beliefs, values and behaviour also have influence. This was the background for the discussion about how ICT has an impact and influence on teaching and learning. Their framework is a useful addition to the previously discussed frameworks for understanding teachers’ pedagogical practices and supported the preparation of the thesis research questions and the analysis of the data. Webb (2009) emphasises further that the whole educational environment influences the affordances, i.e. the teachers, the students, other educational resources and the interaction in the learning process.

Teachers participate in pedagogical reasoning when they prepare, apply and reflect upon their use of ICT and when the prospective use of ICT is considered in the context of risks (e.g. student capabilities, maturity, quality of available resources), teacher and school goals, cost of competing priorities and opportunity’s. Pedagogical reasoning provides opportunities for teachers to accessing equipment, infrastructure and support, following procedures and so on. The concept of pedagogical reasoning is situated at the centre of the Webb and Cox’s (2004) framework that guided this thesis.
2.6 Summary of Chapter 2

A short overview of the development of ICT in education in the three last decades of the last century has been presented in this chapter and the situation at the beginning of the 21st century was more generally discussed in relation to new opportunities that new technology provides. Although ICT is widely used in education there remain sceptical voices among educators about its usefulness, and there isn’t an agreement about if and how ICT can improve education. Research has been diverse ranging from large studies with an international focus to small and narrowly focused studies. The research methods have been different, both quantitative and qualitative, comparing ICT use with traditional education settings, as an example (Baron & Bruillard, 2007). The difficulties in measuring the influence and benefits of ICT use in education were discussed.

Many researchers have discussed the weaknesses in educational ICT research. Cuban (2001) highlighted the complex relationship between technology and social practice and called for more research on the matter. Important questions have been raised about the difficulties in measuring the beneficial effects of ICT; although ICT may have had valuable influence in education it could be difficult to pinpoint (Underwood, 2004). Different methods have been used in different studies and the results have not been homogenous or in one direction. It has been difficult to see the trend of influence or find one common theme. Baron and Bruillard (2007) point out that although a large number of scientific studies of ICT in education have been conducted over the past few years it has been difficult to control the ICT activities they are measuring. As stated before different research methods have been used, there have both been experimental studies with limited number of students involved and large surveys with many participants - and there is still a lack of conclusive evidence of what works with ICT in education (Baron & Bruillard, 2007). The emphasis in the literature has been on reflecting on the influence and benefits of ICT for teaching and learning, for the schools’ development and the educational system but not least the pedagogy (Beetham & Sharpe, 2007). Livingstone (2012) describes the situation well when saying:

Obvious difficulties in here is the lack of clarity over different types of ICT and, more importantly, in how they may mediate or scaffold different stages in the learning process. (Livingstone, 2012, p. 20).

The rationales discussed by Fox and Twining (2006) for ICT use in education were introduced and mapped onto three main categories; mastering ICT for education and work, efficiency or productivity arguments and quality of
education. Ideas of teaching and learning with ICT were approached along with questions about how to use ICT in education and the potential importance of ICT as a tool. This showed very clearly how wide the general field is and how important it is to narrow the focus to one particular aspect; in this study, the use of ICT for enhancing the learning experience of students. Ten Brummelhuis and Kuiper’s (2008) framework was found to be very useful when the driving forces of ICT in the learning process were discussed, the content, the infrastructure, the teacher and the learner. They emphasise that the use of ICT is embedded in a very forceful and complex social environment.

Mishra and Koehler (2007) TPACK framework was introduced with its emphasis on the intersection and relationship between technological, pedagogical and content knowledge. This is believed to be useful to understand factors related to ICT use, where technology was added to Shulman’s (1987) framework with similar argumentation as Shulman added pedagogical content knowledge to pedagogy and subject knowledge framework. They argue that technology is not a simple add-on but interacts in a complex way with pedagogy and content.

Webb and Cox’s (2004) work, similarly based on Shulman’s framework, was described and discussed which emphasises the affordances ICT offers and how the teachers and students make use of it, but very importantly on the basis of their knowledge beliefs and values. They highlight the importance of teachers’ knowledge of the affordances ICT is offering for learning and how favourable and motivating different ICT affordances can be for students. They conclude that this situation affects the complexity of teachers’ work and state:

The need for teachers’ professional development is clear but enabling teachers to adapt their pedagogical reasoning and practices in response to learning opportunities provided by ICT is likely to be a very difficult and complex process (Webb and Cox 2004, p. 278).

Affordance is important in Webb and Cox’s discussion where they refer to Gibson, but also lean towards Norman’s (1988) description when they highlight the opportunities ICT provides for the learning environment and how the user perceives the learning environment.

The framework initially developed by Shulman, but extended and elaborated both by Mishra and Koehler (2007) and Webb and Cox (2004), guided the theoretical framework for the proposed research. In the next chapter the relationship to ICT in education in Iceland will be discussed.
In Chapter 3, the influence of ICT in Icelandic education will be discussed thoroughly in terms of policy, administration, the National Curriculum and daily work of teachers and students, all of which have put pressure on the system to adopt the new technology, both as a tool and as content.
3 The Icelandic focus

3.1 Introduction

This chapter is about the infrastructures for ICT, ranging from the school system to government policies, and then results from a survey conducted under the LearnICT project in Iceland will be described briefly. First, a short description will be given of the Icelandic system of education. The legal and political responsibility for the educational system in Iceland is held by the Icelandic parliament. The Ministry of Education, Science and Culture sets the structure and policy for the school system and is responsible for the National Curriculum Guidelines for the first three school levels, the pre-, primary- and upper-secondary levels and quality issues for all the stages of the system. The government policy regarding ICT in education will be outlined here with emphasis on the time after 1996 when the first policy paper for ICT in education from the Ministry of Education, Science and Culture was published.

Secondly, the findings from a pilot study conducted in 2002 in connection to the LearnICT project are discussed briefly as the author participated in the project as a preparation for this thesis. Another study from the LearnICT project will be discussed more thoroughly in Section 6.3.1.

3.2 The Icelandic educational system

The educational system in Iceland consists of the following four levels:

- Pre-Primary Schools (Icelandic or ic. leikskólar) are for children between one and five years. Local municipalities are responsible for preschools, the government is responsible for the quality assessment and the parents usually pay a part of the operating costs. Most children attend preschool or 91% of two-years old and 95% of three- and four-years (Upper secondary schools, 2010).

- Compulsory School (ic. grunnskóli) consists of primary and lower secondary schools, ten years in total, in a single structure for children from six to 15 years. Since 1996 the local municipalities are responsible for primary schools, the government is responsible for the quality assessment and almost 100% of children attend (Upper secondary schools, 2010).

- Upper-secondary school (ic. framhaldsskóli) is for students over 15 years old or after they have finished compulsory education. The students in upper-secondary schools can choose between preparation for university
in a four-years programme and take the matriculation exam (ic. studentspróf), or attend a variety of specialized vocational and occupational programmes which can last from one to five years. Upper secondary schools can be divided into different categories depending on the schools’ emphasis, e.g. grammar schools, comprehensive schools, industrial-vocational schools and specialised vocational schools. Some schools offer both preparation for the matriculation exam and vocational studies. Around 94% of 16 year old students registered for upper secondary school in Iceland in 2009 (Upper secondary schools, 2010). The school being researched in this study is at this stage in the system.

- Higher education (ic. háskóli) is for students who have passed the matriculation examination, usually from the age of 20, and offers traditional university degrees and diplomas (The Ministry of Education, Science and Culture, n.d.).

The main focus in this thesis is on the upper secondary school where most of the students are between 16 and 20 years old. This age group overlaps with first year university students in most Western European countries, where it is more common for students to finish the matriculation examination at the age of 18 or 19.

3.3 Government policy in Iceland related to ICT from 1996 to 2008

3.3.1 Introduction

The origin of computer use in Iceland goes back to 1964 when the first computers appeared in Iceland (Benediktsson et al., 2005). Use of ICT in Icelandic education has been evident since around 1980 when computers was first introduced in schools, at workplaces and in people’s homes. The Ministry of Science, Education and Culture established two advisory committees on computers in schools in the 1980s and both emphasised the use of computers in teaching and learning (Macdonald, 2008).

Many people saw new possibilities in new technology that could be a breakthrough for education and change teaching and learning. After 1990, when distance education, with the help of technology, came along and the Internet started to receive attention, the discussion was lively and computer technology was believed to influence teaching and learning methods (Arnardóttir, 2007).

The Ministry of Education, Science and Culture in Iceland has on three occasions, in 1996, 2001 and 2005, published policy papers regarding ICT in
education. In addition the Icelandic government published a policy report about ICT in Iceland (“Vision of the information society,” 1996) and established a Project Steering Committee on the Information Society that has cooperated with the Ministry of Education and other Ministries (Verkefnisstjórn um upplýsingasamfélagið 1997 - 2003, n.d.).

In this chapter the focus will be on the content of the three Ministry of Education, Science and Culture publications and on government policy after 1990. Examples will be given of the implementation of the policy, especially after the first two publications. The focus is set on this period and on upper secondary schools as these form the background for the development of ICT use in education in the timeframe of this thesis.

3.3.2 1996-1999. In the power of information

The aim of the government policy published in 1996 was to increase the use of ICT in the educational system. From 1995-2002 the development was pushed forward by the Minister of Education, Björn Bjarnason, who had a strong personal belief in the potential of ICT and formed a clear policy of promoting the use of ICT in education in the country. In 1995 three committees where established to make recommendations for the Ministry’s policy on ICT. The joint goal of the three committees was to disseminate the Ministry’s policy on ICT to the school system. The outcome of the committees’ work was published in a policy statement, In the power of information (ic. Í krafti upplýsinga) and includes the Ministry’s policy for use of ICT in education and culture for the years between 1996 and 1999 (Í krafti upplýsinga [In the power of information], 1996). The booklet lists 30 essentials for the implementation of ICT in education, including the use of ICT to improve the nation’s education, good teachers’ education and retraining for teachers, and the development and production of multimedia educational material. The need for sufficient access to computers and the Internet in classrooms, working areas and offices is emphasised.

In the booklet other topics are mentioned such as copyright issues, definitions of ICT concepts, ideas for experimental projects in education and finally issues of international collaboration in the use of ICT in education. In the report the following definition of IT is given:

The use suitable technology for information processing. Technology refers to computer technology, telecommunications technology and electronics (Ministry of Education, 1996, p. 92, translated by the author).
It is stated in the booklet that there will be more continuity in the schools’ curriculum and it is presumed that more emphasis will be placed on students’ independence in searching for information and more project work as they get older. Furthermore it is stated that more emphasis will be placed on cooperation between students. They will be expected to learn from each other and build on each other’s knowledge while working together, and to take collective responsibility for their work (Í krafti upplýsinga [In the power of information], 1996).

When the booklet is examined further it is difficult to find a detailed description of how exactly ICT should be used by teachers and students. The phrase “educational material” is frequently used and the emphasis is on the support of the development of material that makes use of new possibilities with multimedia. Support and training for teachers is stressed and it is suggested that each school’s organisation and timetable should be reconsidered, with the use of ICT in mind. It is very clear from the booklet that students should be able to use the Internet for information collection and be able to work with data and put forward their solutions with the help of ICT. How exactly they should gain these skills is not clear from the booklet. One paragraph in the booklet is of special interest:

In Icelandic homes thousands of children and teenagers are sitting in front of computer screens and learning about countries and history, organisation of societies and human communication. CDs with miscellaneous knowledge are at their fingertips and they engage in simulation games that can show a variety of causal relationships. The knowledge these students gain and their abilities to draw conclusions, search and get an overview, is of little help in school. We have to find ways for schools to take advantage of what is outside and inside the school walls and help students to put in context all the knowledge and extract it (Ministry of Education, 1996, p. X, translated by the author of the thesis).

This quotation shows a strong belief in computers as a source of information and knowledge that will train young people in required skills, but it also shows a doubt about knowledge gained outside the school building and whether or how schools can make use of this knowledge.

In the first issue of Tölvuheimur (1995), an Icelandic journal of computer technology, it is stated that more than half of the Icelandic population owns a computer (Tölvuheimur, 1995). According to the journal, 51.4% of the Icelandic population were using computers at that time, mainly at home (34.1%) and at work (26.9%), but only 10.7% were using computers at school (Tölvunotkun á
Íslendi þá og nú, 2006). This indicates that the situation was a bit overestimated in *In the power of information*, but the survey supported the need for more emphasis on integrating computers and ICT in the school system.

At the same time as *In the power of information* was published, a new National Curriculum (*Menntamálaráðuneytið*, 1999) was developed, based on the Upper Secondary School Act No. 80, 11 June 1996 (The Ministry of Education, Science and Culture, 1996a). The new national curriculum was in effect from 1st June 1999 and the schools were expected to implement it in the years between 1999 and 2000. Schools could postpone it for a year, but the curriculum was intended to be fully implemented during the school year 2003-2004. Since 1999 the new national curriculum has been updated and new versions of the general part, and some additions, have been put online since 2004. The revision of the curriculum in 1999 was carried out in the context of the policy reflected in the document *In the power of information*. It was made clear that learning how to use computers should no longer be a subject on its own but computer use should be integrated in all subjects and all teachers should, in fact, be computer teachers. The aim was for students and teachers to use technology for educational purposes in class as well as outside class. The use should be related directly to students’ work in a variety of ways, e.g. practical project work, search for resources, communication, and collaboration with other students and teachers. It was suggested that the teachers could use technology to prepare their teaching, in the classroom, and for communication with students and fellow teachers (*Menntamála-ráðuneytið*, 1999).

Since 2007 the national curriculum has only been available online and not in printed form. Later additions and updates do not contain any real changes in the role of ICT in education. The new Upper Secondary School Act Nr. 92 was approved on the 12th June 2008 (The Ministry of Education, Science and Culture, 1996b). In this law the upper secondary schools are given some independence and opportunity to organise students’ learning independently, but this will not be discussed further here as it does not affect the time period examined in this thesis.

It can be said that some of the 30 ICT essentials from *In the power of information* were implemented in the years between 1996 and 1999 or even until 2001, when the next policy paper was published, and here some examples will be given. In 1998 the Ministry of Education presented a four-year developmental project in IT called *IT pilot schools* (*Menntamálaráðherra opnar fréttaskrif nemenda á Netinu á slóðinni www.mbl.is/utskolar, 2003*). Out of 23 applications to take part in the project, six schools were selected; three upper secondary schools and three primary schools and they were subsequently called IT-schools. The upper secondary schools in the ICT-project were
Fjölbrautaskóli Suðurlands (FS), Fjölbrautaskólinn við Ármúla (FÁ) and Menntaskólann á Akureyri (MA). A main emphasis (among others) of the project was to design and develop the project’s website, IT-school website (utskolar.is), which contained information and news about the project. The website IT-school was closed down in 2005 due to technical problems and mistakes, but in 2001 the following could be found on the IT-school website where the goals of the ICT pilot schools were set forth:

ICT pilot schools should work on the progress of ICT in teaching, learning and school work and their task should be as follows:

1. Develop methods for use of ICT in teaching and other school work.
2. Develop methods for training staff and students in use of ICT.
3. Share with other schools their experience and knowledge of ICT use.
4. Give advice about the designing and publishing of educational software and supervise experimental teaching with the software.
5. Train new teachers with an emphasis on ICT. (Utskolar.is, 2002, translated by the author)

The schools could vary the emphasis within each of these areas while implementing the project. They also had a responsibility to motivate other schools to use ICT in education. The emphasis was different between the schools but a common emphasis was on teachers’ training in ICT, providing laptops to teachers and encouraging students to buy laptops.

From an evaluation report of the ICT-schools project from 2002, the main conclusion was that the schools, although they were different and approached the project in different ways, had gained from their participation in the project. ICT facilities had been developed, teachers’ computer skills had improved and ICT was used in a variety of ways in the schools by both students and teachers. The project was informative for the participants who gained more realistic ideas about ICT in education and their experience and knowledge could be shared with other schools. There was a common agreement in the school that the project had supported the ICT implementation and development in each school and put the ICT use onto a new level (Jónasson, Dofradóttir, & Blöndal, 2002). From this report it is clear that this project had a positive impact in a variety of ways for the different schools.

In the Spring of 2000 the Minister of Education, in cooperation with upper secondary schools, started to prepare and design online software called Inna, an online information system for all upper secondary schools in Iceland. Inna was developed in cooperation with the company Skýrr hf. (later Advania) and
The first version was available and used by a few schools in the autumn of 2001 and by most of the upper secondary schools in the Spring of 2002. The software is useful for students, teachers and other school staff. It gives an overview of students’ educational progress, students’ timetables, attendance and grades, and parents of students younger than 18 are also allowed access to the system by law (Ministry of Education, 2002; Andrésson, 2006). In 2013 Inna is still in use in most upper secondary schools.

Other project from this time, the Iceland Consortia for Electronic Subscriptions (“About the Iceland Consortium,” 2011) was potentially important for education to have an easy access to information. This service started as an online website in 1999 and a service agreement was established in 2002 between the Ministry of Education, Culture and Science and the National and University Library of Iceland to run this project with countrywide access to various national and international databases. This agreement was renewed in 2006. In addition, all other Icelandic universities, health and research libraries, public libraries and secondary school libraries take part in running this service. The website Hvar.is is used as a portal for these services. It can be stated here that this was a very ambitious project and might even be called a unique service for a whole population of one country that changed access to online recourses for schools, companies, organisations and individuals in Iceland. In 2013 Hvar.is is still in use. It should be noted that the special department for ICT in education, which was established in the Ministry in 2000 to support the implementation of ICT in Icelandic schools, was closed down in 2006 and ICT projects were distributed among different departments at the Ministry (Pálsdóttir, personal communication, 2 September 2007).

3.3.3 2001-2003. Advantage for the Future

Government policy for 2001 to 2003 can be found in a 12-page booklet: Advantage for the Future: Project Plan for e-Learning 2001-2003 (“Advantage for the future: Project plan of the Ministry of Education, Science and Culture for e-learning 2001-2003,” 2001) published by the Icelandic Ministry of Education in 2001. A longer version in Icelandic was also put on the Internet (“Advantage for the future: Project plan of the Ministry of Education, Science and Culture for e-learning 2001-2003,” 2001). In this booklet no attempt is made to evaluate the implementation and success of the former policy from 1996. The emphasis of this new policy was on a new vision and new ways of using the advantages of the Internet as an information utility and data information service for education, for the distribution of educational material and for communication. Communication should be established between students, teachers, school administrators, parents, employers and all who have some relationship with
education. The phrase “will be” was widely used in the booklet to describe what was believed would be the outcome.

The emphasis that was placed in this policy was also on the use of online tools to support e-learning, distributed learning and distance learning. Distributed learning was seen as a method where traditional teaching methods and distance learning methods are mixed together with less formal classroom teaching that may give students new opportunities (Ministry of Education, 2001a).

The focus was on continuing education and ICT retraining programs for teachers and co-operation with other countries in the field of e-learning. A special chapter is on educational content with an emphasis on educational software, digital libraries and the quality of educational material (“Advantage for the future: Project plan of the Ministry of Education, Science and Culture for e-learning 2001-2003,” 2001).

It is easy to follow some of the policy’s implementation on new and better computer equipment. As an example is the FS-net (Háhraðanet fyrir framhaldsskóla og símenntunarmiðstöðvar á Íslandi [High speed net for upper secondary schools and lifelong-learning centres in Iceland], n.d.), a fast-running data transport network for schools, which was established in 2002. In February 2003 all upper secondary schools and the lifelong-learning centres in Iceland were connected to the FS-net to support teaching and learning. The FS-net has 100 mb/s transmitting speed and connects 60 institutions together. The Ministry of Education prepared this project with the company Skýrr hf., in cooperation with the Icelandic phone company (ic. Landssími Íslands). Skýrr ran the FS-net for the first four years but since 2008 the phone company Vodafone has been running the net.

In the year 2001, the Ministry of Education, Science and Culture, started to work on a website called the Educational Gateway (www.menntagatt.is) in cooperation with the company Hugur hf. (later HugurAx and Advania). The website was launched in the end of February 2003. The main purpose was to offer effortless access to educational information and services on the Internet. The Educational Gateway was, from the beginning, open to everyone and includes an educational objects database and the national curriculum database with a specialised search engine. The website also offered news and information related to education, public online discussions about education and access to a learning management system (LMS) called IntraLearn. Figure 6 shows how the Educational Gateway was organized in order to interact with different topics and websites with five areas (highlighted in bold in the figure): e-marketplace, studies and teaching, innovation, communication and content
dissemination with easy links to Icelandic websites, namskra.is, hvar.is, inna.is and landskerfi.is, as well as other educational websites.

The establishment of the Educational Gateway was an ambitious act that gave open access to a variety of information related not only to ICT in education but also education in general. A good opportunity was made available for teachers to search for useful and supporting material and information, but the use of the gateway was a disappointment to the ministry (Pálsdóttir, personal communication, 2 September 2007). The reasons are not clear, the gateway might not have been successfully introduced to teachers, the information might not been as relevant as expected and, as with all new databases, it needs time to grow and become well-known and recognised. A teacher who visited the gateway in 2002 might not have found as much useful material as he could one or two years later. The Ministry of Education redesigned the website in 2011 and now its focus is on information for students who have finished compulsory education and need to select and apply for further education. Its current content is thus far from the original idea behind its construction.

The establishment of a new upper secondary school, Fjölbrautaskóli Snæfellinga (FSN), in 2004 is related to the government’s emphasis on ICT in education. The school building is designed with the ideology of distributed learning and all the educational work builds on this ideology. The establishment of FSN has influenced other upper secondary schools that are offering educational opportunities in the format of distributed and distance learning.

The growth of distance education in upper secondary schools in Iceland after 2000 is also related to government policy. The number of distance-learning students in 2001 was 801, in 2005 it was 2,574 and in 2008 the number was 4,782 - which was 16.3% of the student population at that level (Upper Secondary Schools, 2010).
From 2000 to 2002 the Ministry of Education offered all upper secondary school teachers a 60-hour course in ICT use in education. The author of this thesis organised this course and emphasised, using online teaching methods to run the course, that the teachers became acquainted with a new form of teaching and learning. Out of 30 schools, 19 offered this course for their teachers.

3.3.4 2005-2008. Risk with responsibility

A new government policy was published by the Icelandic Ministry of Education, Science and Culture in 2005 in the 48-page booklet *Risk with responsibility: policy for ICT in education, science and culture 2005-2008* (2005). As in the booklet from 2001, no attempt is made to evaluate systematically the implementation of the former policy but stated:

... those policy papers have been carried through systematically in cooperation with the Iceland’s governmental IT task force. In the past five years half a billion Icelandic krona have been spent on the Ministry’s ICT projects (Risk with responsibility: policy for ICT in education, science and culture 2005-2008, 2005, p.6).

No explanation or overview is given in the booklet on how this was done or how the money was spent, on what projects, software, hardware or other ICT related things.

The new policy aims to look holistically at ICT in education, culture and science, where the main focus is on access to the information society, ICT infrastructure, digital content, new opportunities and innovative practices, ethics and safety. An attempt is made to analyse the status of ICT in different areas without any direct reference to research, data or projects. A list of objectives is presented; this is followed by a list of action plans for each area. In the booklet, Icelanders are said to be well prepared to be involved in the future development of the international knowledge industry, with good access to computers and online opportunities, but it is concluded that computer information literacy and computer skills need to be strengthened even further to support the development.

It might be suggested that these high ambitions were to some extent an inspiration of the approach taken in this thesis, i.e. what would be examples of ideas, views, content and working methods of teachers who were notably the front-line users of ICT. More options are mentioned of how ICT could be used for information distribution, e.g. in sports, in health issues and democratic discussion. Special emphasis is put on the Icelandic language with ideas of
development of Icelandic software, language technology and research in the field. The infrastructure is also in the spotlight, assuming high speed and wireless networks and support of projects to implement and activate ICT use in schools and cultural institutions. Digital television is mentioned in connection to e-government and e-democracy and that the Icelandic Library Consortium should increase the access to scientific and scholarly databases. Grants and rewards are often mentioned, as are the cooperation of private and public companies and institutions in ICT development. There is more emphasis on culture in this booklet than the previous two booklets.

Some examples can be found for the implementation of the ICT policy in relation to education in Iceland in 2005-2008. The Educational Gateway has been used by the Ministry of Education, Science and Culture over the years to advertise and introduce new projects. In 2006 the Minister of Education, in cooperation with the Project Steering Committee, advertised grants for making interactive online learning material with the emphasis on teaching English, Danish, Icelandic and mathematics. Sixteen projects received support and the results were introduced at a conference at the Icelandic University of Education in October 2007. Description of the material could be seen at the Educational Gateway and the material should be free for the public to use for at least one year after it was ready. The project Vefþulan (website reader), aimed to design online software to read Icelandic text on the screen (for those who have difficulties reading from the screen), was supported by the Ministry of Education. In May 2006, an application form for enrolment in upper secondary schools in Iceland was opened online at the Educational Gateway website and this online form has subsequently been used for all applications at this school level.

More examples can be found. In 2005 the Ministry of Education established a group to work on standards for systems used in the educational system. Since 2006, one day a year (usually in November) has been named as the Information and Technology (IT) day in Iceland. In recent years, the Prime Minister's Office (PMO) has organised a conference and other events on this day each year, in cooperation with companies and the IT society (Opið uppá gátt hjá ríki og sveitarfélagum [Wide open at the state and municipalities], 2011). Now, in 2013, the ICT issues in Iceland are governed by the Ministry of the Interior.

The National Centre for Educational Material (NCEM) is run by the government and its main purpose is to publish learning materials for primary and secondary schools in Iceland (students from 6-16 years old). NCEM has made a considerable effort of making a variety of high-quality online material available on their website and on CDs but in some subjects there is still need for more e-material. Some of the material from NCEM for teaching the Icelandic
language and mathematics can be used for first year students at the upper secondary level, especially those who have not done so well at the lower level. The Ministry of Education and Culture has supported and financed, on a small scale, the development of online material for upper secondary schools over the years and made a special campaign in 2005 and 2006. The emphasis was mainly on material for teaching Icelandic and mathematic (English information, n.d.).

More examples related to the ICT policy can be mentioned. Distance-learning education continued to grow at this school level from 2005 to 2008 and the number of students increased from 2,574 students in 2005 up to 4,782 students in 2008 (Upper secondary schools, 2010). From 2007-2010 three new upper secondary schools with emphasis on ICT use to support new teaching methods started in Iceland, Menntaskóli Borgarfjarðar (MB) in 2007, Framhaldsskólinn í Mosfellsbæ (FMOS) in 2009 and Menntaskólinn á Tröllaskaga (MTR) in 2010, and also a college department at Patreksfjarðar in 2007. Since then ICT has been used to support education in small villages around Iceland so students can stay longer at home, e.g. a college department at Hvammstangi in 2012 and at Hólmavík in 2013, using distributed learning methods.

3.4 LearnICT Survey in 2002

An important background to this thesis was a research project conducted between 2002 and 2005, LearnICT, where the presence of ICT in the Icelandic school system was investigated. The project was a co-operative research project of three Icelandic Universities where an attempt was made to answer questions about the consequences of ICT for students and their learning, for teachers and their teaching and for the school as an institution. As a partner in this project the author of this thesis took part in a study with online questionnaires that was conducted in 14 upper secondary schools in Iceland in 2002. Two online questionnaires, one for students and one for teachers, were designed for this purpose and the Outcome software was used for collecting data online. It was thought to be an appropriate way for data collection to use methods based on computer technology in a project concerning the use of ICT in education. Three main topics were covered in the questionnaires as well as background information:

- Access to computers, Internet and related items.
- Students’/teachers’ attitudes to the use of computers in their learning.
- Experience of and attitudes toward distance learning and distributed education.

(Matthiasdottir, Dal, & Lefever, 2005)
The response rate was lower than expected for the students - just 24.5% (2093 out of 8575), and 47% (423 out of 906) for the teachers. One must bear in mind that the low response rate does limit the opportunity to generalise the response patterns. However, answers from just over 2000 students, or 12% of all students in upper secondary schools in Iceland at that time, and answers from 423 teachers, or 27% of all secondary school teachers in Iceland in 2002, should give some idea of ICT use in education in upper secondary schools in Iceland. It is clear, however, that the scarcity of data severely limits the conclusions drawn. In addition, even though this is not known either, it may be assumed that the respondents were, on the whole, those interested in ICT. Thus patterns indicating weaknesses related to ICT might be taken more cautiously than those indicating strengths.

The research from 2002 indicated that ICT had partly been integrated into the upper secondary school environment in Iceland at the time. It was relatively common to use the Internet for both students and teachers, but interestingly the students were not keen on using ICT for communication related to their studies. The attitudes towards ICT use were overall positive but neither teachers nor students were convinced that ICT helped students in their learning; both the teachers and the students claimed that it gave them new opportunities, but how much it helped them was not clear in their minds at that time. This gave the impression that the ideas about the use of ICT and its implications and influences were not clear. Some common or low-level ICT features were widely used, e.g. word processing, PowerPoint slides and sending school-related material with e-mail.

The use of LMS had started at that time and organisation of the teaching had been influenced by ICT but new opportunities, e.g. discussion threads and interactive exams, were not widely used. ICT had changed communication between teachers and students as the students could send questions and assignments at any time to the teachers. ICT skills were not considered an obstacle for active use but the use was more haphazard outside the class because students’ access to computers in class was not satisfying in all schools, with many students feeling that the access to good materials was insufficient. This led to a rather simple and monotonous use of ICT in classes, with PowerPoint slide shows as the main tool. It was considered by teachers that more online material for learning with ICT was needed to support them and that students were eager to use ICT (Matthiasdottir et al., 2004).

The author’s experience of taking part in the LearnICT project and the results of the survey made it clear that more research was needed in order to investigate the complicated ICT educational environment. But what was already
emerging was the gap between the potential or affordance of the use of ICT and its actual use. But, this was not seen to be a problem as both the students and, to some extent, the teachers had a rather limited view of how the technology might be harnessed, i.e. of its potential use. There was no question that a deeper and more thorough and multifaceted approach (and data) was necessary to understand the situation, as will be described more clearly in Chapter 4 and be discussed further in Chapter 5.

3.5 Summary of Chapter 3

In this chapter the focus was set on Iceland with a brief description of the Icelandic educational system at the time of the collection of data for the thesis. Icelandic Government policy on ICT in education was shown to emphasise access to the information society and the wide use of ICT in education. Evidence of this can be found in the National Curriculum 1999 based on the Upper Secondary School Act No. 80, 11 June 1996, three policy statements in 1996, 2001 and 2005, the establishment of ICT committees and by government funding for the development and support of ICT projects.

The policy by the Ministry of Education on the use of ICT in education in Iceland from 1996 to 2008 was analysed in this section and an attempt made to draw out the main points and emphases in connection to what has been done. The emphasis in the beginning was on the ICT infrastructure, hardware and software, and access to ICT. Later on, the emphasis moved over to ICT use as the access improved. Given the policy documents, the establishment of a special office, and the support of a yearly conference and developmental projects, it may be concluded that the arena of ICT had a rather unique status relative to other curricular arenas within the ministry, for nearly a decade from 1995. Distribution of educational material and communication with ICT in education was supported to promote implementation of ICT. In the last published policy from 2005, an attempt is made to look holistically on ICT in education, culture and science with a focus on access to the information society, ICT infrastructure, digital content, new opportunities and innovative practices, ethics and safety. No new policy of ICT in education has been published since 2005, which indicates that support and implementation of ICT in education no longer has a strong focus at the Ministry of Education or, at least, the focus has changed.

Many ideas are presented in the policies of the Ministry and examples of implementations have been given above but no report could be found on the overall impact of this policy. The realization of the policy depended on financial support and it can be said that considerable money was spent in this field but it is always a question of how much is enough. Drawn from the information in this chapter it can be stated that the ministerial effort was ambitious and well supported for nearly a decade, particularly rhetorically by policy documents.
and pointed support by the minister, but also in material terms by relevant infrastructures and financial support. From analysing the implementation of the ICT policy it can be suggested that the golden age of ICT in upper secondary schools in Iceland was during the period that started in 1998 when the IT pilot schools project commenced, with a highpoint in 2004 when the upper secondary school Fjölbrautaskóli Snæfellinga (FSN) was opened.

The author took part in the research project LearnICT, supported by the Icelandic Centre for Research (RANNIS), which influenced and inspired the preparation of this thesis. The LearnICT project showed that more research was needed in order to investigate the ICT educational environment. It also indicated that a multifaceted approach was needed in order to gain a further understanding of this complicated topic.

In light of the author’s three categories of Fox and Twining’s rationales for ICT use (see Section 2.3), the ICT policy by the government of Iceland emphasised at the beginning, mastering ICT for education, work and future life, and later on, efficiency or productivity arguments. However, overall it was about the quality of education.
4 Research questions

In the previous chapters it has been shown that there are several important reasons for introducing and implementing ICT in education. There have been high expectations of ICT in education among school authorities and teachers. It can be asserted that ICT in education is a topic of some importance as ICT is already widely used inside and outside the classroom for educational purposes and also at the administrative level in schools. Integration of new computer technology into education has developed from teaching how to use the technology, to using it in most subject areas in order to facilitate teaching and learning, and presently as a very important tool for communication and exchange of information. There are nevertheless some doubts about the actual influences and changes that ICT has made to educational environments and practices and the situation needs to be more fully understood by those who engage in education and subsequently explained not only to students and teachers but also to parents, school authorities and policy makers. This is of particular importance in order to facilitate the continuous journey on the path of upgrading and innovation that the technology affords and, to a certain extent, demands.

Previous research has shown credible evidence of the positive impact of ICT on learning and the changing of teaching methods, but also that negative attitudes towards the use of ICT still exist among educators and learners (Naidu, 2003; Eng, 2005; Cox & Marshall, 2007). As discussed in Chapter 2 there is a need for more research in this field and Cox and Marshall (2007) point out that there is a “...need for a thorough, rigorous, and multifaceted approach to analysing the impact of ICT on students’ learning” (p. 60). We need to accumulate and refine our knowledge in order to promote continuous re-implementation and successful unremitting influence of ICT on education. It is necessary to understand both how ICT is viewed by students and teachers and also to know more about the nature and the effects of ICT use and the implications for teachers’ and students’ work in order to gain a better understanding of ICT in education.

Studies of ICT in education have used a variety of different designs and methods that range from large international studies like the SITES to small local studies, and the methods have been both qualitative and quantitative as discussed in Chapter 2.
The theoretical background of this thesis is derived from the following four main frameworks as discussed in Chapter 2 and is linked to the five main aims that were put forward in Section 1.3.

1. **Fox and Twining framework.** Firstly, from Fox and Twining’s (2006) rationale for ICT use in education, presented in a list of 19 items, which the author of the thesis narrowed to three categories: Mastering ICT for education work and future life, efficiency or productivity arguments, and quality of education.

2. **Ten Brummelhuis and Kuiper framework.** Secondly, the ten Brummelhuis and Kuiper’s (2008) framework of driving forces of ICT in the learning process will be used to examine the main influential factors in Mentaskólinn í Kópavogi, the school in focus, as their framework gives a useful overview on the impact of different driving forces for the ICT use, both at governmental and school level.

3. **Mishra and Koehler TPACK framework.** Thirdly, the Mishra and Koehler framework emphasis is on the intersection and relationship between technological, pedagogical and content knowledge and will be used to stress that technology is not a simple add-on but interacts in a complex way with pedagogy and content.

4. **Webb and Cox framework.** Fourth, from Webb and Cox’s (2004) framework for pedagogical practices relating to ICT, that introduces a framework for relating conceptions of the principal actors (teachers and students), the curricular implications of ICT, the actions of the actors and, very importantly, the distinction between the affordance of the technology and its use. Their framework guided both the research questions and the analyses of the data. Webb and Cox’s (2004) framework has a background in Shulman’s pedagogical content knowledge (PCK) framework as it explains the teachers’ understanding of the interaction of pedagogical knowledge and content knowledge. Among those who have built on Shulman’s work, as discussed in Chapter 2, are Mishra and Koehler, with their technological, pedagogical, content knowledge framework (TPCK). In Mishra and Koehler’s TPCK framework, technology is in fact added to Shulman’s framework.

   In the previous chapters, the literature review shows how complex the issue is - from developing the general idea about what ICT in education means, to mapping some of the ideas into practice and implementing them. It has been suggested that in order to better understand ideas about ICT practice and their implementation in education, the framework outlined by Webb and Cox (2004) may serve as a useful guide for framing the research questions for the thesis.
Their work draws on a comprehensive review of the literature, fits in with the focus of the study and connects the ideas of those who implement the curriculum, the teachers, and the major participants, the students, and also the potential of the ICT environment. They also, very importantly, emphasise the difference between the uses afforded by ICT that is in some sense implicit in the technology, and its visible use.

The focus of this thesis is on the influence of the use of ICT on teachers’ teaching and students’ learning, when access to ICT is not an inhibitory factor for the integration of ICT, and the school policy also explicitly supports the use of ICT. Of interest in this thesis is to understand how knowledge, vision and ideas about the use of ICT have been translated into practice. The intention is to describe an educational setting where ICT was ambitiously used in order to gain insight into what is achieved if essential supporting factors are in place.

1. To understand some of the driving forces and the importance of the infrastructure of the implementation of ICT (see also points 4 and 5 in Section 1.3).

2. To examine the influence of ICT use on teaching and learning, among teachers who were enthusiastic about its use, in a school where ICT was widely supported (see also point 1 in Section 1.3).

3. To examine enthusiastic teachers’ knowledge, beliefs and values concerning ICT and those of students in an ICT educational environment (see also point 2 in Section 1.3).

It is clear that the governmental policy in Iceland has been to implement ICT into education as discussed in Chapter 3. In Iceland, as mentioned in Chapters 1 and 3, some studies have already been conducted at the national level. Influenced by these studies, it was decided to narrow the approach to one upper secondary school, where the sources of data would then be the situation in the classrooms closely related to pedagogy, decision making and policy. The school in focus here, Menntaskólinn í Kópavogi, followed the Ministry’s policy and aimed at providing a good ICT environment both for students and teachers, as discussed in Chapter 3.

Based on Webb and Cox’s (2004) framework, the research questions shown in Table 4 were developed. Five specific research questions have been identified, three relating to the teachers and two to the students.
Table 4. The research questions in connection to Webb and Cox’s framework

<table>
<thead>
<tr>
<th>Webb and Cox’s framework</th>
<th>Teachers</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge, beliefs and values</td>
<td>What are teachers’ knowledge, beliefs and values in their ICT use in an Icelandic upper secondary school?</td>
<td>What are students’ knowledge, beliefs and values in their ICT use in an Icelandic upper secondary school?</td>
</tr>
<tr>
<td>Pedagogical reasoning</td>
<td>What are the teachers’ ICT pedagogical reasoning and behaviours?</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Behaviour, affordances, learning activities</td>
<td>What learning ICT activities and affordances do teachers utilise?</td>
<td>How do students use the ICT affordances accessible and what are their ICT learning activities and behaviours?</td>
</tr>
</tbody>
</table>

Having noted the importance of the institutional framework and the institutional leadership in moulding the implementation of ICT, e.g. in the work of ten Brummelhuis and Kuiper, one research question that is not directly related to Webb and Cox’s framework was added:

- What are the influences of government and school policies and the ICT infrastructure of the development of ICT use?

The research questions have a multifaceted nature where understanding of the influence of ICT in education at the beginning of the millennium is the goal. The technology itself is not under inspection here; the main interest is to understand how ICT, when used by people who believe that its use is interesting and beneficial, affects teaching and learning within a supportive environment. The learning environment is not the main focus, even though it clearly matters, but rather the teachers and the students, their knowledge, beliefs and values and how they make use of the learning environment with all the opportunities new technology may offer. In order to answer these five research questions, the author used a mixture of quantitative and qualitative methodologies which will be discussed in the next chapter.
5 Methodological Approach

5.1 Introduction

Designing research and selecting the appropriate methods calls for an overview of different methods that have to be considered and evaluated in the context of the research, the main objectives of the research and the research questions. Other factors also have an influence on the design such as ethical issues, politics, cost and available resources. The design structures the research and makes sure that its major parts address the research questions. The educational environment is a highly complex phenomenon with multifaceted influences and is surrounded by different forces that are often diverse. Investigating and understanding ICT in education is a complex task (Watson, 2006) that both calls for a broad perspective and a narrow direction. Therefore it is important to consider the epistemological basis of the thesis in order to reveal the implication of the methodological choices for the research.

The present chapter outlines how the research was approached, starting with a short overview of the main trends in research methods in education and the design of this research. The design of the research and which methods were chosen and developed will be discussed and an overview of the study’s methodology will be given followed by a description of sample selection and data collection. A more specific description of the data collection and the data analysis in each part of the research will be given in Chapter 6. This is a certain break with tradition, but was deemed to make a better connection between the description of the various methods used and the description of the data than would have been obtained by describing all the methods in a separate chapter.

5.2 Research approach

Today, research in education is becoming increasingly interdisciplinary, multifaceted and vibrant, calling for the understanding of various possibilities of research designs and methods that promote collaboration between traditions and for combinations of methods (Johnson & Onwuegbuzie, 2004). The objective of this thesis was to focus on the effect of the use of ICT on teachers’ teaching and students’ learning and to understand how knowledge, vision and ideas about the use of ICT have been integrated into school work, especially where high and focused ambition was behind the effort made. What developments would take place and what would it mean in practice to
introduce ICT to a school? The essence of the study was an exploration of what would happen and what was behind the ensuing activity in an educational setting in terms of ambitions and ideas.

A case study was considered to be the best approach for the purpose of the research as the goal was to understand the complex situation of ICT in education with the aid of multiple sources of evidence. By adopting this approach one would be able to have a broad perspective, expecting influence from many different directions but at the same time a focused inquiry. A case study is a research design that has a long history in social research, especially in France, and being promoted by the Chicago School in the United States (Gerring, 2006). According to Merriam (2009), case study is an important design to use in educational research:

Because of its strengths, case study is a particularly appealing design for applied fields of study such as education, social work, administration, health, and so on. An applied field's processes, problems, and programs can be examined to bring about understanding that in turn can affect and perhaps even improve practice. Case study has proven particularly useful for studying educational innovations, evaluating programs, and informing policy (Merriam, 2009, p. 51).

Yin states that case study “is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 2003, p. 13). Yin perceives that the key characteristics of case study are multiple data sources and the collection of data and analysis are driven by theory, even though only one sort of data could, in principle, be used. A case study research strategy is useful in situations when “a ‘how’ or ‘why’ question is being asked about a contemporary set of events, over which the investigator has little or no control” (Yin, 2003, p. 9).

Noor (2008) emphasizes that “Case study is not necessarily intended as a study of an entire organization. Rather it is intended to focus on a particular issue, feature or unit of analysis” (p. 1602) and as such to support the understanding of complex real-life activities. The use of case studies in real-life situations invites a rich and general description of the phenomenon studied. Noor argues that a case study is an appropriate method when the aim is to get a holistic view of a progression or complex real-life events and the use of many sources of evidence. This supports the author’s decision to use case study as a research approach, strategy or design. It is a research design in the sense that it guides the attempt to understand what features emerge in an educational
practice and what moulds them. Thus the exploration of the situation is largely descriptive, but explanatory to the extent that attempts are being made to figure out what are the moulding factors.

But choosing the design is not without its problems as it may have serious weaknesses that must be kept in mind. The case study design has been criticised for lack of scientific firmness, reliability and generalizability (Johnson, 1994) and considerable debate can be found in the literature (Gomm, Hammersley, & Foster, 2000; Flyvbjerg, 2006). The main problem is that it does not invite firm conclusions about what determines, stimulates or hampers what emerges in a given situation.

An accepted way of categorising research paradigms in educational research is to use, on the one hand, distinctive quantitative research frameworks that are based on analysis of numerical data and, on the other hand, qualitative research models based on analysis of narrative data; they are discussed as if they were mutually exclusive. The coexistence of the two approaches has led to debates among researchers but has also generated new ideas and new approaches. Johnson and Onwuegbuzie (2004) talk about quantitative and qualitative purists who focused on the differences between the two orientations. Ercikan and Roth (2006) believe that to split research methods into these two categories, which they call polarizing, could be limiting and confusing - and may even lead to incomplete research findings. They emphasize that the research questions studied should be in focus and appropriate methods selected, which might be basically in either of these two categories but could, perhaps, be in both. Fraenkel and Wallen (2005) stress that quantitative and qualitative approaches can and should be used together but they also point out that it can be difficult to use two kinds of approaches at the same time. They say it is a waste of energy to discuss which method is better and agree with Bogdan and Biklen (1998) that different methods apply to different questions and topics: “Without a doubt there are certain questions and topics that the qualitative approach will not help you with and the same is true for quantitative research” (p. 39). This emphasises that the research question should guide the research methods and designs. The nature of the research question and its context is important and a variety of tools with broad perspectives are needed in educational research (Fraenkel & Wallen, 2005).

Following the debate about the best method the third research paradigm, mixed method design, has gained more attention in the last 15 years. Mixed methods are believed to have first been used in 1959 by Campbell and Fiske when studying the validity of psychological traits (Creswell, 2002). As the name implies this design is based on more than one method and includes collecting and analysing data with both quantitative and qualitative methods (Hanson,
Creswell, Clark, Petska, & Creswell, 2005). Johnson and Onwuegbuzie (2004) discuss the use of quantitative and qualitative mixed research methods and see the opportunity to build on the strengths of each method and learn from their traditions to reduce weaknesses. They emphasise how mixed research methods combine “quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (p. 17). When discussing the strengths of mixed method design, they also mention the possibility of increasing the generalisation of results and stronger evidence for a conclusion. They also acknowledge problems, because it can be difficult for a researcher to master knowledge of multiple methods and gain skills to use different methods, as well as how expensive and time consuming it can be to use mixed methods. Fraenkel and Wallen (2005) are among those who are convinced that mixed methods have certain strengths by giving a more holistic picture of the circumstances. However, they see similar weaknesses as Johnson and Onwuegbuzie where the researcher must be trained in many methods. They state that there are difficulties regarding mixed methods paradigms and that there is much diversity of these in existence.

Johnson, Onwuegbuzie and Turner (2007) list 19 definitions of mixed methods research in their paper where they analyse and discuss with leaders in the field. This underscores, perhaps, that the terminology is sometimes diffuse and the terms paradigms, design, strategy and method are not always clearly distinguished. This multitude of definitions led them to the following definition that will be used in this thesis:

Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration (Johnson, Onwuegbuzie, & Turner, 2007, p. 123).

This definition refers to mixed methods research as a type of methodology and research: “A mixed methods study would involve mixing within a single study; a mixed method program” (Johnson, Onwuegbuzie, & Turner, 2007, p. 123).

Today, the mixed methods research design is quite well established and has received increased interest from researchers, as it has emerged in a variety of related paradigms and strategies (Onwuegbuzie & Combs, 2010). Different approaches can be seen in recent papers e.g. Leech, Dellinger, Brannagan, and Tanaka (2010) who explore how to evaluate mixed methods research. Sharp et al. (2012) discuss mixed methodology in a recent paper where they want to fill
a gap in the literature regarding sampling selections. Their argument supports the selection of mixed methodology in the present study as they state:

Indeed, the complex nature of the social world requires a more fluid understanding and application of the relationship between philosophical paradigms (assumptions about the social world and nature of knowledge), methodology (the logic of inquiry), and methods (techniques of data collection) (Sharp, 2012, p. 36).

Yin (1994) and Stake (1995) recognized at least six sources of information in case studies: documents, archival records, interviews, direct observation, participant-observation, physical artefacts; all of this was found relevant in this study. The developments which this thesis describe and investigate are complicated and in order to answer the research questions and capture complexity of the phenomenon, the mixed methods approach was chosen using both quantitative and qualitative data. It was believed that this would produce richer information and give a better understanding of the research problems and provide better answers to the research questions than a single type of data, which would give too limited or narrow understanding of a highly complex phenomenon. Therefore it was decided to review documents, interview and observe the participants in a natural environment, both directly and indirectly (using log data), but also to use questionnaires. It was believed that a case design and combining qualitative and quantitative approaches would enhance the possibility of obtaining insight into the interaction between ICT, pedagogy, teaching and learning in an upper secondary school in Iceland.

5.3 A case study as a research design using mixed methods

A case study design was selected with mixed methods approach for data gathering. Yin (2003) defines five components of research design that must be included in a case study: questions, propositions, unit of analysis, linking data to propositions and criteria for interpreting the findings. The research questions have been discussed in Chapter 4 with the emphasis on what and how, with the flavour of exploratory studies, exploring one single case, i.e. MK, where no explicit propositions are put forward. But, to an important extent, the research questions beginning with ‘what’ act as propositions guiding the focus of the study (see Table 4). Unit of analysis addresses the definition of the case. It was decided that the case was one upper secondary school, MK, which was selected because both teachers and students had good access to computer technology and ICT use was expressly supported by the school authorities. MK authorities, teachers and students were identified as the source of data along with the Icelandic government’s ICT policy. The government’s ICT policy was thought to give the background and frame for the ICT implantation and development in
MK, the school authorities were assumed to manage and regulate the ICT development. It was also assumed that the MK teachers and students, who were asked to participate in the study, were active ICT users and were likely to provide the information needed to answer the research questions. The data were linked directly to the research questions in this study. Using both quantitative and qualitative data was believed to assist in exploring the case, quantitative data were thought to capture the behaviour of teachers and students and the qualitative data to give more information of their knowledge, beliefs and values. The criteria for interpreting the findings was to use descriptive statistics for the quantitative data and to use different methods for different qualitative data as the data would be text based, interviews and computer files.

As different methods were used for data collection in the thesis, the validity and reliability is different for different sets of data, but looking at the research problems from different points of view is meant to assist in raising the validity. That is why a multiplicity of approaches was used, which is termed triangulation. Parts of the data collection were carried out in natural settings in class and as Hoyle, Harris and Judd (2001) state this “... can lead to greater external validity of research results ... can also contribute to construct validity” (p. 363). The researcher’s behaviour is unlikely to change the behaviour of the participants in natural settings. On the other hand in natural settings there can often be factors that the researcher cannot control and affect the results and this may reduce the reliability of the data.

Creswell (2002) categorises mixed-method designs into three types: the triangulation design where quantitative and qualitative methods are used simultaneously, the explanatory design where the quantitative method is used first followed by the qualitative method and the exploratory design where the qualitative method is first used followed by the quantitative method. His categories were used as a guideline for describing the mixed-methods design used in the present study where both the triangulation design and the explanatory design were used as Figure 7 shows. The triangulation design refers to quantitative methods for data collection with a questionnaire, analysing log files of LMS use and the students’ grades, followed by qualitative methods using data from interviews and diaries. The explanatory design used consisted of quantitative methods that were used to visit classrooms with a checklist and qualitative methods that were used for interviewing the participants and collecting their diaries at the same time.
Analysing the quantitative data helped to clarify the research problems and to prepare for the qualitative data collection with interviews with the headmistress, the teachers and the students, and diaries from the teachers. Part of the quantitative data collection (e.g. classroom observations) was an ongoing process for three years as well as part of the qualitative data collection (e.g. following government policy and the development in the school).

5.4 Data collection

At the early stage of this thesis a group of eight MK teachers was chosen to be interviewed in cooperation with the headmistress of MK. The teachers, who were asked to participate in the study, had a long history of using ICT and the school authorities had identified them as active ICT users. The selection will be described in this section and more thoroughly in Chapter 6.

The preparation started in 2002; the data collection started in the autumn 2004 and was an ongoing process with the main data collection being in 2005. The data collection was carried out in three different phases with both sequential and parallel approaches.

The first phase was a preparation with both qualitative and quantitative methods and consisted of the following:

1. Literature review.
2. Collecting information about the government’s policy.
3. A pilot study under the LearnICT project included a group interview with five MK teachers, which was used as a source of data in this research (see Section 6.3.1).
4. Selecting which school to approach for the research and collecting relevant information about its ICT policy and circumstances.

Figure 7. The research design

Quantitative

- Questionnaire for students
- Classroom observation
- Students’ grades
- Log files for students’ LMS use

Qualitative methods

- Interviews, diaries and external data analysis
- Triangulation design
- Explanatory design
5. Designing of the research.
6. Getting relevant permission.
7. Selecting teachers and students.
8. Group interview with five teachers.

This phase was believed to give information for the theoretical foundation of the thesis and to clarify the circumstances and the educational environment at the upper secondary level in Iceland.

In the second phase quantitative data were collected using the following four different methods:

1. Classroom observations using predesigned checklists (see Appendix V and VIII).
2. An online survey among the students using a specially designed questionnaire (see Appendix VI).
3. The school authorities provided students’ grades in encrypted format
4. The school authorities provided log-files from the school’s computer system in encrypted format showing the frequency of LMS contacts.

This second phase was believed to give information about the ICT affordances, classroom actions and learning activities, teachers’ and students’ knowledge, behaviour, beliefs and values concerning ICT use, and the influence of ICT and its integration into the school’s work.

In the third phase qualitative data were collected using the following two different methods:

1. Interviews with six teachers, six students and the school’s headmistress (see Appendix II, III, IX).
2. Teachers’ diaries (see Appendix IV).

The third phase was expected to give more in-depth information about the ICT affordances and the teachers’ and the students’ behaviours, beliefs and values in relation to ICT use. An interview with the headmistress gave information about the school’s policy and the implementation of ICT in the school.

Table 5 gives an overview over the preparation of the thesis and the data collection in the three phases of the research, with a short explanation of the methods and main aims. A more detailed description will be given in Sections 5.4.1 to 5.4.3 and Chapter 6.
### Table 5. Overview of the data collection and the three phases of the research

<table>
<thead>
<tr>
<th>Year</th>
<th>P.</th>
<th>Method</th>
<th>Main aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-2004</td>
<td>1</td>
<td>Preparation. Taking part in a pilot study in the LearnICT project. Conducting online surveys and literature review. Gathering information on government ICT policy from 1990. Select the school (MK) and gathering information regarding its ICT policy and other relevant material. Get permission for the research.</td>
<td>Prepare the study and set the focus. Get an overview of the literature of ICT in education and the knowledge base in Iceland. Identify theoretical models suitable for the research. Set the research questions, design the research methods and prepare the data collection. Get an overview of the Icelandic government’s and the school’s (MK) ICT policies.</td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td>As a part of the LearnICT project, a semi-structured interview was conducted with a group of five MK teachers. Analysing the interview.</td>
<td>To gain understanding of MK teachers’ use of ICT and their attitudes towards ICT in their work. Preparation for further interviews.</td>
</tr>
<tr>
<td>2004-2005</td>
<td></td>
<td>Design the research and select methods for data collection. Cooperate with the school (MK) and contact the teachers who would participate in the study. Preparing selection of students.</td>
<td>To prepare the quantitative and qualitative studies.</td>
</tr>
<tr>
<td>2005</td>
<td>2</td>
<td>Quantitative study with an online questionnaire. Eighty nine students participated, average age 18.5 years, 45 (52%) males and 42 (48%) females (two did not report their gender).</td>
<td>To understand MK students’ use of ICT, knowledge, beliefs and values.</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td>Log files showing students’ LMS use provided by the school.</td>
<td>To obtain information about how active students were in using LMS.</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td>Students’ grades provided by the school.</td>
<td>To understand the relationship between LMS use and students’ grades.</td>
</tr>
<tr>
<td>2005-2007</td>
<td></td>
<td>MK classrooms observed using a specially designed check list.</td>
<td>To gain insight into the use of ICT in the classroom and teachers’ and students’ behaviour. Get information on learning activities with ICT affordances.</td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
<td>Qualitative study with a semi-structured interview with six MK students.</td>
<td>To understand MK students’ use of ICT and their attitudes and beliefs towards ICT in their education.</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td>Qualitative study with a semi-structured interview with six MK teachers.</td>
<td>To gain understanding of MK teachers’ use of ICT, behaviour and attitudes towards ICT in their work.</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td>Five MK teachers’ diaries collected.</td>
<td>To gain a better understanding of MK teachers’ use of ICT when preparing teaching and in the classroom.</td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td>Semi-structured interview with the MK headmistress.</td>
<td>To obtain information about MK’s ICT policy and an overview of the history of ICT use in the school.</td>
</tr>
<tr>
<td>2004-2014</td>
<td>1</td>
<td>On-going literature review and monitoring development in government and MK ICT policy.</td>
<td>Understand pedagogical models and gain knowledge of research in the area. Monitor the development of ICT in education and following discussion of research methods in the area.</td>
</tr>
<tr>
<td>2013-2014</td>
<td></td>
<td>Compile, summarize and finishing the thesis.</td>
<td></td>
</tr>
</tbody>
</table>
In the following sections the first phase of the study will be described only partly as it has already been presented in Chapter 1-3, but phases two and three will be described in more detail. The data collection will be described more thoroughly in Chapter 6 as well as the relevant data analysis.

5.4.1 Phase one

Phase one was the preparation phase where the research was designed, the focus set for the research questions, and the method for data collection and analysis decided. The literature review was conducted with the use of libraries and online sources. Information about government policy was obtained from the Icelandic Ministry of Education, Culture and Science’s website, from booklets and reports. The author of this thesis had been working for the Icelandic Ministry of Education, Culture and Science on different projects and committees since 2000 and during that time followed closely the government actions regarding ICT policy. The ICT policy for education in Iceland from 1996-2008 is described in Chapter 3. The author participated in the LearnICT project 2002 – 2005, where she took part in studies in upper secondary schools using an online survey and a group interview with MK teachers. The LearnICT project and the results from the online survey have been described briefly in Section 3.4 and the analysis of the group interview will be described in Section 6.3.1.

The aim of the thesis is not to give a representative description of the population of all Icelandic upper secondary school teachers and students and their ICT use. The main aim is to offer a glimpse of the ICT world of teachers and students by describing ICT use and the knowledge, beliefs and values of teachers and students who are active ICT users at the beginning of 21st century. This supported the decision to use a convenience sample, and choose one school to focus on in order to get more in-depth information. It was decided to select one upper secondary school, MK, which was among the leading schools in ICT use in Iceland at that time. ICT was believed to be used productively in the school, which had a clear policy that ICT should be intertwined in all teaching and learning in the school, access to ICT was good, teachers had their own laptops and had been offered a number of courses in ICT and every student was expected to have his/her own laptop. MK is situated in the town Kópavogur, near the capital city Reykjavik, in Iceland.

The author had good information about the circumstances of ICT use in MK after working there from 1996 to 2001 as a computer systems administrator and a teacher in computer science and mathematics, taking part in encouraging and implementing ICT in the school, and assisted teachers and students in ICT use. After leaving MK the author coordinated two government-funded developmental projects in MK called Distributed learning (see Section 6.2.3)
and ran a government-funded 60-hour course on ICT use in education for all teachers at MK. This gave the author an opportunity to support ICT implementation in MK and have an influence on the teachers’ and the students’ ICT use. The experience of working in the school and taking part in the ICT developmental projects gave the author an inside knowledge of ICT use at the school and this was used as a source of information about the circumstances in the school and is described in Section 6.2.

The Icelandic Data Protection Authority was contacted in 2004 to ask if the research needed permission but that was not deemed to be the case. Subsequently, the MK’s headmistress was contacted and asked for permission and cooperation (see Appendix XI). The headmistress was very positive towards the research ideas and offered all the help she could provide.

The aims of the study were to obtain ideas about good practice, i.e. understand the process and its outcome when the conditions are favourable. It was therefore decided to recruit a few ICT-skilled teachers at MK to participate in the study. They were a biased sample as they neither represented the entire population of MK teachers nor the entire population of upper secondary school teachers in Iceland but were a convenience sample as they were both available and easy to access. In spite of this they were expected to supply information that served the purposes and objectives of the research. In cooperation with the school authorities, a group of five teachers were selected to participate in a group interview in 2004 in connection with the LearnICT project. The data from the group interview has not been presented before. The main criteria for selecting these five teachers was their pioneering work in using ICT in their teaching at MK during the previous years. They had also taken part in an ICT project called Distributed learning project (see Section 6.2.3) and taken ICT courses and attended ICT conferences provided by the Ministry of Education, Culture and Science. They were all experienced teachers who had been using ICT in their work for some time and were active users of ICT both in preparation of teaching as well as in teaching.

After analysing the group interview from 2004 it was decided in 2005 to go ahead with individual interviews with MK teachers to get more thorough information. The five MK teachers who took part in the group interview were asked to be interviewed individually but two of those were not available for the individual interviews because they were on sabbatical leave. In cooperation with the school authorities three more MK teachers where recruited. It was considered sufficient for the purpose of the study to interview individually six teachers because they represented the ICT pioneers in the school. The author knew that they were active ICT users because she used to work with them and the school authorities confirmed this. The teachers came from different subject areas and satisfied the criteria mentioned above.
The literature review, information on the authority’s policy, experience from the LearnICT project and information of MK supported the design of the research. The research questions have been discussed in Chapter 1 and 4 and the design of the data collection methods was described in this chapter, but will also be described in Chapter 6.

5.4.2 Phase two

In this phase, working on the literature review on ICT in education and collecting information on the authority’s ICT policy continued. To get an overview of how teachers and students in MK were using ICT it was decided to visit classrooms and observe their use of ICT. It was believed that classroom observations could supplement and support the author’s understanding of ICT use in MK. Two checklists were designed especially for this purpose by the author built on her experience of ICT use in education and guided by the literature. One was to observe the students’ work with ICT in the classroom (see Appendix VIII) and another one to observe the teachers’ work (see Appendix V). The teachers’ checklist had one main category, 1) teaching with ICT, where 21 items were listed, e.g. show assignment solutions and slide presentations and 2) something else. The students’ checklist had two main categories: 1) learning with ICT, where twelve items were listed, e.g. using LMS and interactive exam and 2) entertainment with ICT, where ten items were listed, e.g. surfing the Web and listening to music. A few other items were listed on both lists, e.g. starting the computer. The checklists were tested by visiting four classrooms in 2004. In the years 2005-2007, thirteen visits were made to MK classrooms for data collection by the author’s students at Reykjavik University (RU). In the classrooms visits the teachers and student used of ICT was recorded every 5 minutes and they could be using more than one ICT option from the checklist at the same time at the time of the rating. The procedure and data analysis is described in Sections 5.4.4, 6.3.4 and 6.4.2. The purpose of the research was not only to get information about the teachers’ and the students’ behaviour in the classroom but also to investigate the attitudes of the students who were active ICT users in their learning in this ICT-supportive environment. It was decided to use an online survey and interviews for this purpose.

The six teachers who were individually interviewed were asked to select a class where ICT was actively used and to ask their students to participate in an online survey. Once again this was done in order to maximize the potential use of ICT. The author had to trust the teacher’s evaluation of their own teaching when selecting the appropriate class to look at. A specially designed online questionnaire built on the LearnICT survey (see Section 3.4) was used. It consisted of 13 questions, two questions about gender and course, two
questions about the frequency of e-mail and Internet use, six questions regarding use and attitude to ICT with in total 79 items, and three were open questions (see Appendix VI). Before using the survey, 10 MK students were asked to answer it for validation. The questionnaire was administered to the students and the teachers asked all students who attended their classes in one week in the Spring 2005 to answer the questionnaire (see Appendix VI). Eighty nine students, 45 (52%) males and 42 (48%) females (two did not report their gender) participated - all who attended class at the time the teachers invited the students to complete the survey. The content of the questions and the data analysis is described in Section 6.4.1.

To obtain information about how the students were using the LMS, log files from MK’s computer system regarding the student’s activity in the system were analysed. The log files were data files with information about when each student started and finished using LMS and how often each one connected to the LMS during the selected period. During the Spring semester of 2005, log files from 13 courses that were taught by the six teachers were provided by the school and subsequently analysed. The school authorities provided students’ grades for the same 13 courses. The school authorities made sure that no personal information was traceable by using only numbers that were not connected to students’ ID numbers.

5.4.3 Phase three

In Phase three the work on the literature review and collecting information about both MK and the Icelandic government’s ICT policy continued. Qualitative research methods were used in order to gain a better understanding of the participant’s beliefs, attitudes and behaviour and to obtain more in-depth information about the circumstances of ICT use at MK. For the purpose of the research questions, semi-structured interviews were conducted and diaries collected in this phase of the research. A semi-structured interview gives both the opportunity to let the interviewed person talk freely and the interviewer to guide all the interviews into the same channel.

In the interviews with the teachers some general questions were asked, with the main aim of getting information about how each one of them was using ICT, the influence of ICT on their teaching and their attitudes and personal views of their work (see Appendix III). After the interviews the teachers were asked to keep a diary for five days to describe their ICT activity in teaching. Five of them did so but one was not actively using ICT at the moment as his students were in practical training and not attending regular classes, so he did not write the diary.

The six teachers then asked their students to volunteer for being interviewed and six agreed to participate; they were all from two of the
teachers. It was decided that the number of students was sufficient for the purpose of the study because the students came from different areas of study and were at different ages. The interviews were semi-structured with some general questions, where the main aim was to get information about the use and influence of ICT and the students’ behaviour, attitudes and their personal views of ICT use in their school work (see Appendix VII). The students were interviewed one by one in a quiet room at the school.

The students were also asked to keep a diary for one week but only one did so. It was not considered appropriate to use methods like rewards to encourage more students to keep a diary. The idea was to get students to voluntarily keep a diary and, as they were not willing to do so, no further action was taken. This diary was not used in the data analyses in the thesis.

The headmistress of MK, Margrét Friðriksdóttir, was interviewed to obtain information about the school’s organisation and its ICT policy. In 2005 when the main data collection was conducted in MK, the headmistress was on a sabbatical leave so the interview was not conducted until 2006 when she came back to work. The interview was recorded in her office in the school and written down and subsequently analysed and was used mainly in Section 6.2 to give a description of the school and the school’s ICT policy.

5.4.4 Description of the data analysis

As shown in Table 5 and described in Section 5.4 both qualitative and quantitative methods were used in the study. The framework for the data collection and the analysis, building on the work of Fox and Twining (2006), ten Brummelhuis and Kuiper (2008), and Webb and Cox (2004), has been described in Chapter 2. Mixed methods of analysis were used to analyse the data. The quantitative data were analysed with the SPSS statistical program and was descriptive.

Cohen, Manion and Morrison (2007) claim that there is no right or wrong way of analysing qualitative data and they recommend the “principle of fitness for purpose” (p. 461) when qualitative data are analysed. By this they mean that the researcher decides not only the methodology and design but also the suitable analysis for the content in the research project. In this thesis it was decided to present the analysis of the interviews by issues or themes but at the same time to report individual phrases and sentences to “keep the flavour of the original data” (p. 463).
Analysis of text (e.g. policy papers, government websites, reports and MK website) in this thesis can be described as systematic and with iteration, meaning that that data were collected gradually and then analysed in connection to the development of other data collection and analysis. While collecting data from different sources as has been described in Table 5 and especially in Section 5.4.1 the text was analysed more than once in order to obtain information in the light of other data collected. The research questions and analysis of other data guided the search and selection of data. The main goal for searching, selecting and using text based data was twofold. On the one hand, to look for information to understand better the implementation and development of ICT in Icelandic education built on the government policy and the implementation and development of ICT in MK. On the other hand, to obtain a good grounding for the literature review and build up an adequate knowledge of literature and theories relevant to the topic of ICT in education.

**Interviews**

The data were analysed parallel with the data collection. All the interviews were recorded and transcribed and then analysed in order to search for common elements in order to create the issues or themes related to the main aims of the thesis, its theoretical background and the research questions. The data were thoroughly read and coded manually by searching for similar topics that were repeated. Emphasis was put on coding and to categorise data by the topics the participants talked about. Then the coded data was first grouped into themes in relation to the research questions introduced in Chapter 4. The themes were then compared and regrouped, combined and constructed.

As an example of the analysis of the individual interviews with the teachers, the data were first split into three themes: 1) knowledge, beliefs and values, 2) pedagogical reasoning and 3) behaviour, guided by the Webb and Cox (2004) framework. Some of the data appeared in more than one theme as they described (for example) both knowledge and behaviour of ICT use. Further coding indicated themes related to ICT, e.g. ICT influence, LMS, different software, communication, teachers’ roles, students’ needs, best practice examples, communication, access, responsibility, cooperation, assessment, feedback, online assignments, changes, group work, organisation of class hour, organisation of the school, barriers, encouragement, motivation, inspiration, online discussion, time, deep learning, development, interdisciplinary work and online material. After regrouping and renaming the themes, the analysis ended with the following five themes: Teachers’ ICT use, usefulness of ICT, ICT learning material, effect and influence of ICT, communication and interaction, and will be discussed in Section 6.3.2.
The same method was used to analyse the group interview with the teachers where the analysis ended in the following five themes: Teachers’ ICT use, teachers’ attitudes to ICT use, teachers’ attitudes to students’ ICT use, communication with students and between students, and future development of using ICT which will be discussed in Section 6.3.1. For the students’ interview the themes were: Practical aspects, communication with teachers and students, learning and ICT, information search, and attitudes to other students, which will be discussed in Section 6.4.5.

**Survey**

The online system used for the survey gave a data set that could be transferred into the SPSS statistical program for statistical analysis. Descriptive analysis was used to describe the main features of the data.

**Classroom observations**

The classroom observation was carried out according to a predesigned checklist that gave numerical data which was converted into a spreadsheet. The total number of recorded options and the most frequent used options were calculated (See Sections 6.3.4 and 6.4.2).

**Log-files and students grades**

The log-files gave numerical data with information of how often the students visited the LMS. SPSS was used to analyse the data and after examining the data it was decided to show the mean number of hits and max and min in each course for the students and the time when they started to use LMS (here, number of hits is how often the student goes into the course in the LMS). Student grades were also numerical data put into SPSS and the correlation between grades and the number of LMS connections (hits) were calculated.

**5.4.5 Ethical issues**

Ethical issues were considered in the whole process of the research. The main ethical issues were to maintain confidentiality and anonymity of the participants in the research and to minimise possible interruptions when collecting data. Normal behaviour of researchers and participants is essential when collecting data in natural settings and therefore it was important to provide as normal a setting as possible during classroom observations and interviews in order to minimize inaccurate or false answers of the participants.

The participants in the research were teachers and students at MK and the headmistress of MK. The purposes and aims of the different studies were explained to the participants, who all took part on a voluntary basis. No rewards were offered and all information was gathered with informed consent of the participants.
The questions in the interviews and in the student survey were not about sensitive matters and therefore the study did not fall under the Icelandic data protection law. Therefore it was clear that no permission was needed other than from the school’s authorities and the participants. The student questionnaire was put online and answered anonymously and therefore was not traceable. As stated before, the school’s authorities gave access to data in the LMS’s log files and the students’ grades, and secured anonymity so the information was not traceable.

The observation in the classrooms was intended to capture the students’ and the teachers’ work in a natural setting and this was prepared by the author in cooperation with Reykjavik University (RU) students, who took part in the observation in the classes, and the MK teachers who participated in the research. The RU students were asked not to discuss what they saw in the classroom to persons not working in MK and the anonymous checklist was not traceable and was believed not to contain any personal or sensitive information.

In order to establish a trustworthy atmosphere between the participants and the interviewer a quiet room at the school was chosen to conduct the interviews. All the interviews were transcribed by a RU student who did not have any contact with the interviewed persons and was informed about confidentiality and accuracy in her work.

Anonymity and confidentiality are important in all research but the school itself, MK, was well known for its ICT implementation so it was not considered possible to keep it anonymous. The ICT pioneer teachers in MK were chosen from a group of around 100 teachers and it may be possible to recognize some of their work and personal characteristics in the data analysis. This problem was discussed with the teachers and they were not promised anonymity, although an emphasis was placed on keeping their identity hidden as far as possible, e.g. with false names, in the data analysis. The students’ answers to the survey, their log files of LMS use and their grades were anonymous and not traceable to individuals by the author of the thesis. The participation of the teachers and the students in the interviews was not anonymous and therefore confidentiality was important to ensure that their identities were not traceable.

All data were stored securely and open only to the investigator in order to prevent misuse by third parties and all information that could connect data and persons was deleted.

The author’s involvement in the ICT implementation in MK in the years 1996-2001, her role as a supervisor of courses for the MK teachers and a project leader, needs to be discussed. It was believed that it would support the preparation of the thesis to have this experience and knowledge and the
relationship to the school and its staff. It would give an additional insight into the ICT educational environment at MK and in that way support the choice of the school for the study. The problem, however, is that the author had, due to this involvement, perhaps a possible vested interest in the positive flavour of the ICT enterprise in MK. This was kept in mind during the writing up of the data. Parts of the data were quantitative and can be described and interpreted irrespective of a bias. This relationship between the author and the data, should however, always be kept in mind. Thus, although this state of affairs could interfere with her judgement of the situation it was believed that the advantages were greater than the disadvantages.
6 Data collection and results

6.1 Introduction

In this chapter the results from the data collected in MK will be described. The methodological issues were discussed in Chapter 5 and an overview given of the data. Because of the multiplicity of the methods used it was believed to be more coherent and readable to describe the methods and the results together in this chapter, rather than having these in separate chapters.

A mixed-methods design was used with both qualitative and quantitative methods. This included a questionnaire, classroom observations, log files from the school’s computer system, students’ grades, interviews and diaries. In cooperation with the school authorities, eight teachers and their students were asked to participate in the main study (interviews and a questionnaire) and seven more teachers were added for the classroom observations. The methods used for the selection of participants are described in Chapter 5.

Three frameworks, which are all described in Chapter 2, ten Brummelhuis and Kuiper’s (2008) framework, Mishra and Koehler’s (2006, 2008) TPCK framework and Webb and Cox’s (2004) framework were used to guide the data collection and the data analysis.

Data were collected from the school authorities, the teachers and the students using the following methods:

- Gathering information about the ICT implementation, use and development at MK, the school in focus:
  - The school website
  - Interview with the headmistress
  - The author’s experience from ICT development programs in the school
- Gathering information about MK teachers’ knowledge, behaviour, beliefs and values related to ICT use and their pedagogical reasoning and behaviours:
  - Group interview: A group of five teachers was interviewed in the preparation process for this thesis.
Individual interviews: Six teachers were interviewed individually using a semi-structured interview.

Observation: Teachers’ ICT behaviour in eleven classrooms was observed using a checklist of ICT use.

Diaries: Teachers’ diaries of their ICT use were analysed.

- Gathering information about MK students’ knowledge, behaviour, beliefs and values related to ICT use in their study:
  - Online questionnaire: A questionnaire was designed and administered online to a group of students.
  - Individual interviews: Students were interviewed using a semi-structured interview.
  - Observation: Students’ ICT behaviour in classrooms was observed using a checklist of ICT use.
  - Log file recordings: Students’ frequency of LMS contacts was retrieved from the school’s computer system’s log files.
  - Grades: Students’ grades were provided by the school and connected to their LMS use.

In this section, data from the different parts of the thesis will be presented and analysed starting with MK, followed by data obtained from MK teachers and students.

6.2 Menntaskólinn í Kópavogi (MK), an upper secondary school in Iceland

6.2.1 Introduction

The LearnICT survey in upper secondary schools in Iceland in 2002 was a pilot study with a rather low response rate, especially among the students, but it gave some ideas of the circumstances of ICT use at that time as described in Section 3.4. The LearnICT project influenced the designing of this study and guided the focus: investigating how an ICT environment affects the teachers’ teaching and the students’ learning in an upper secondary school in Iceland.

When searching for a candidate school, MK was considered to be a good option. The school had announced in 2000 that they were implementing a comprehensive laptop use and the author’s knowledge of the school as a former teacher, computer systems administrator and ICT expert from 1996 to 2001, supported the choice.

MK was established in 1973, with 125 students, as an upper secondary school situated in a primary school building called Kópavogskóli, in the town of
Kópavogur adjacent to Reykjavík, the capital of Iceland. In 2005 it had become a comprehensive school in its own building with 1300 students and around 100 teachers. From the beginning the school emphasised preparation for the matriculation examination, but from 1996 the school has also offered vocational studies with hotel management, catering and tourism as main specialities (“Ágrip af sögu skólans [Brief history of the school],” 2007).

The school has, over the years, been active in the development of the use of ICT in education and has been offering obligatory and voluntary courses in practical computer use and did, for a time, offer a special study programme in computer science to prepare students for computer science study at a higher level.

6.2.2 Development of ICT use at MK

Following the new curriculum in 1999 and the policy booklet í krafti upplýsinga (Í krafti upplýsingu [In the power of information], 1996) there were discussions at teachers’ meetings and among MK authorities of how to respond. The outcome was that the emphasis in MK should be on using ICT in all courses and classrooms, developing the computer facilities for teachers and students with a wireless connection and providing training courses for the teachers in ICT use, e.g. Word, Excel, PowerPoint, LMS, various multimedia programs and teaching methods. The years from 1999 to 2001 were used to adjust the school’s curriculum to the new situation with an emphasis on ICT use. Laptops were bought for the teachers; first in 1999 for the ICT pioneers and teachers were encouraged to go to ICT conferences and courses. Two years later all teachers were encouraged to attend a 60-hour course in ICT use in education offered by the Ministry of Science, Education and Culture and received a laptop after finishing the course. The author of the thesis organised this course and ran it for teachers in 19 upper secondary schools in Iceland during 2000-2002.

A five-year ICT policy for the school was implemented in 2001 with an emphasis on the systematic development of the use of ICT in all school work. The teachers were asked to develop their teaching with the use of ICT, supported with the LMS. It was decided to encourage all first year students preparing for the matriculation exam to have their own laptop and since then it has been the school’s policy that each student has his/her own laptop. According to educational law in Iceland, the school could not make it obligatory for students to have laptops but, as mentioned on the school website, it is assumed that students will have their personal laptop when they enrol as the teaching is based on ICT use (Upplýsingastefna [ICT policy], 2007).
At the beginning, only a small number of teachers were ready for this new development, many were not very skilled in computer use and some had doubts about the usefulness of ICT in education. The school supported the teachers by offering ICT courses in Word, Excel and LMS (called WebCT at that time) free of charge and with technical and pedagogical support, as well as providing them with laptops. Suitable facilities were also made available in the school.

Although the headmistress and the school authorities had an understanding of the increased workload for the teachers who were developing ICT use in their teaching, i.e. they had to re-design their courses around ICT use and start teaching in a different way, there was not much room for support or reinforcement in the form of less teaching obligations or higher salaries. The school offered support from technical staff, and pioneer teachers were given a special role to assist and supervise fellow teachers. The teachers were encouraged to apply for yearly funds from the government for developmental projects and for making relevant ICT-supported educational material.

Some ICT developmental projects were on-going at MK after 2000 and influenced a new school policy that was introduced for the years 2006-2010 where the course was set on five main themes: learning environment, good service, good hardware and software, responsibility and security, innovation and results. The emphasis was on computer skills and information literacy, teachers’ digital skills, pedagogy for computer supported learning, online learning material, less paper use and ICT use in assessment. In the innovation and results part, changing of working procedure is mentioned and new ways of teaching e.g. distance education and distributed education, and evaluation of the ICT use in the school.

Around the year 2000, all new students at MK were obliged to take a course in ICT use, called UTN 103, that gave 3 credits (an average student should take 17.5 credits per semester) but later this course was only offered on a voluntary basis. It was believed that students had sufficient ICT skills for educational use when they entered the school and would learn new skills by using ICT in their school work. Since 2002, the school had access to Inna (online information system), it developed its own website (www.mk.is), and all students and teachers had access to the LMS (WebCT at that time). According to Icelandic law, parents of students aged 16-18 years can access Inna where they can follow their children’s attendance and grades. At the time of the data collection, around 90% of the students had laptops; all the teachers had laptops, and fast wireless connection was available everywhere in the school building. Smart boards (interactive whiteboards) were in almost every classroom and teachers and students were given assistance from technical staff and also from the pioneers in the teachers’ group.
In the MK policy it was emphasised that ICT is a tool for education to develop new teaching and learning methods. Computer skills and ICT literacy of students and teachers is essential for their daily work with the support of learning management systems. One of the school’s main goals was to prepare students for work and life in an international information knowledge society of the future. The school authorities wanted to support the teachers with training in ICT use and supervision to assure that they could use and follow the fast development of new ICT technology. Emphasis was on the pedagogy of computer supported education with project work, individual and group work and problem-based learning. Online learning material and projects should promote desirable skills, e.g. students’ independence in knowledge building as well as skills in teamwork and cooperation (Friðriksdóttir, personal communication, August 25, 2006).

In 2005 it was the headmistress’s view that the teachers were now prepared for further development. It had taken up to five years to get all teachers involved in using the LMS enthusiastically and now the school could proceed with developing ICT in education more actively.

6.2.3 Distributed Learning in MK

The Headmistress of MK stated that the ICT implementation and its development improved after 2000 when the laptops were introduced in the school. A few years later the pioneers in the teachers group, influenced by discussions about distributed learning, wanted to go further and look at what inhibited more use of ICT in the school and what should be emphasised for faster development. At the time, discussions about distributed education and distributed learning were lively among educators, but their definitions were not made explicit. The project was called Distributed Learning in Menntaskólinn in Kópavogur (DLMK) and the main aim was to gain a better understanding of distributed learning, to collect information about its implementation in Iceland and to investigate how distributed learning could be used in MK (see Section 3.3.3). DLMK ran actively from 2004 to 2006 with a small funding from the Ministry of Education, Science and Culture and from the school authorities. The DLMK group, consisting of 15-20 teachers, looked into what other schools in Iceland where doing at the time, both at the primary- and secondary school level; an architect was consulted about changing the use of the school building; the school’s specialists in timetable design gave advice and a specialist from the Ministry of Education, Science and Culture consulted the group. The group went on a one-day trip to the upper secondary school at Snæfellnes, Fj öldbrautaskóli Snæfellingsa (FSN), where both the building and educational work had been designed around the use of distributed learning and e-learning from the outset.
In the Spring of 2005 the DLMK group introduced the following ideas to the school teachers and the school authorities at a meeting in the school:

- The school work should be organised as distributed education with 25% of the class hours designed as open hours in an open working space.
- A special area of the school building, called A-wing, should be changed into an open working space for students. This would mean new furniture, removable whiteboards and good access to electricity as well as acceptable development in technological equipment in the school.
- The group recommended that the school’s library be developed as a main source for information retrieval, along with the Internet – and even relocate it in a part of the building called the A-wing.
- In open hours, the students could choose what subjects they worked on and different teachers would be working in the open space at different times. The teachers would have an authority to order students who were not working properly, to attend open hours.
- In the seventh week of the semester (out of 15) all teachers would give mid-term evaluation (assessment) of students’ work. This should not be based on written exams but on students’ work so far, attendance and how hard they had worked on projects. The grading would be threefold: satisfactory, needs to work harder and insufficient.
- Teachers should be offered more courses in the use of ICT and LMS with a special emphasis on producing interactive projects.

After a discussion at a teachers’ meeting, the majority of the MK teachers decided they were not ready to work further with these ideas of distributed education. They claimed they were not ready for changing the school’s organisation completely. It was discussed whether this could be done for the first year students as a starting point but this was not agreed either. The school authorities encouraged teachers in DLMK group, as well as others, to keep on working on these ideas, they offered more courses in ICT use and especially in LMS use, but major changes of the school organisation, timetable and the building were not possible at that time. This was a disappointment for the DLMK group, but they reflected on the reaction from fellow teachers and the school authorities and came forward in the Spring of 2006 with the following plan to prepare the school for further development:

- The new ideas about changing teaching methods connected to the use of ICT need more introduction and promotion in the teachers’ group, as well as building up their confidence related to ICT. Teachers need
courses on ICT use and ways of teaching with ICT but also personal support with their day-to-day work.

- Students’ parents need an introduction to ICT opportunities and as many of them are not familiar with new teaching methods afforded by ICT. The school should prepare a short course for parents in subjects like cooking, mathematic or language with the use of LMS. This would be a good way of introducing ICT in education for the parents.

- A new policy for ICT in the school is needed; support of school policy and school authorities is the foundation for change. The policy should be implemented in cooperation with the teachers.

The school authorities responded by supporting those who were willing to develop ICT use further by offering courses and technical support, but no fundamental change was made.

### 6.2.4 Summary

From this short description of MK in this section it can be stated that the school was an ICT school where technology and access was not an obstacle for developing ICT use in education and the teachers were relatively well trained in ICT use. It is clear that some MK teachers would have liked to see ICT use develop more speedily, and to see the school’s authorities come forward with more focused ideas and make ICT-supported distributed learning a formal policy in the school environment. There was an eager group of teachers who believed that ICT use could be better and faster implemented in their work and they wanted to see more essential changes, not only in the classroom, but also more generally in the organization of the school. It is also clear that some of the teachers needed more time to adjust to a new environment and to implement active ICT use in their work, despite the policy of the school and the support given to all the teachers. Development of ICT use in MK was an on-going project, with many opportunities where the organisation of the teaching and the school building were among many exciting challenges for the school staff.

The development in MK can be divided into three phases:

1. The first phase was before 2000 when the school was offering computer courses and study programmes. The school was following the national curriculum but there was not much emphasis on the overall use of ICT. The school was also following the growing interest in ICT use in education and was accumulating a wider range of hardware and software in the school. Among the teachers there was a growing interest in ICT use in their work.
2. The second phase was the period from 2000 to 2005 when it was decided to put an emphasis on ICT use in the school. Laptops were bought for teachers, students were asked to bring their own laptops and the school tried to ensure that hardware and software were up-to-date. The teachers had opportunities to attend ICT courses and conferences and development programmes. Eager teachers were pulling the wagon with support from the school authorities but when they wanted to move faster, other teachers and the authorities did not agree.

3. The third phase was after 2005 when most of the teachers had started to use the LMS and were implementing ICT use in their work but no changes were made in the organisation of the school. The current status of ICT use in MK today will be briefly reported at the end of the thesis.

When implementing new ideas in education it is always a question of how to go about it. In MK the school authorities took the lead in 2000, supported by the pioneer teachers in ICT use and in cooperation with the other teachers. They emphasised the use of LMS and ICT in classes but they were not prepared for the consequences that increased ICT use could have for the school’s organisation and the use of the school building. They were progressive and innovative at the beginning of the second phase but to some extent they did not follow the fast development of ICT use in the outside world.

6.3 Teachers’ point of view

In this section an analysis of data related to the teachers’ use of ICT in MK will be presented. At the initial stage of this thesis a group of MK teachers were chosen to be interviewed in cooperation with the headmistress of MK. The teachers, who were asked to participate in the study, had a long history of using ICT and the school authorities had identified them as active ICT users. The author of the thesis was also convinced that they were active ICT users, evidenced by her personal experience of working at the school for five years between 1996 and 2001.

To better understand the teachers’ use of ICT in the classroom it was decided to interview them both in a group and individually and furthermore ask them to write a diary about their ICT use in teaching. They were also asked to accept visits of observers to their classrooms to rate both their and their students’ ICT use in the classroom, which all of them accepted.
In this section, first the group interview with the MK teachers will be described, and then the individual interviews followed by the teachers’ diaries and classroom observations.

6.3.1 Interview with a group of MK teachers in 2004

As mentioned in Chapters 1, 3 and 5, the author took part in the LearnICT project in Iceland between 2002 and 2005 and part of the project was interviewing a group of MK teachers in 2004. In Section 5.4.4 the qualitative data analysis was described and an example given of the coding.

6.3.1.1 Method

Participants

As described in Section 5.4.1, five MK teachers were selected for a group interview in cooperation with the MK authorities. The teachers were all experienced teachers who had been using ICT in their work for some time. The five teachers were contacted and asked to participate and the research design was explained to them. They all agreed and were willing to cooperate. Their real names will not be used in the thesis but a brief description will be given of their experience, using aliases. Despite this, it is anticipated that their identities may be traced if the effort is made.

The five teachers who took part in the group interview were two women, Emma and Kristín, and three men, Tumi, Gunnar and Njáll. Emma was a foreign language teacher with extensive teaching experience at the upper secondary level and had been honoured for her work with ICT in education. Kristín was also a foreign language teacher and had been teaching for over 10 years at the upper secondary level. She had been assisting other teachers in the use of ICT and offering them courses about LMS. Tumi was a mathematics teacher with much experience of teaching both at the lower and the upper secondary level. He had specialised in using an interactive whiteboard (IWB) in his teaching. Gunnar was an Icelandic language teacher with extensive teaching experience at the upper secondary level. Njáll was a vocational teacher with much experience from the private sector and had been teaching at MK for some years and was a pioneer in using ICT in vocational teaching at MK.

Instrument

The group interview with the teachers was semi-structured and short guidelines were prepared in advance where the main focal points for the interview are listed (see Appendix II).
Procedure
A semi-structured group interview with five MK teachers was conducted in December 2004. The interviewers were the author of this thesis and two lecturers from the former Icelandic University of Education, now a part of University of Iceland, Michael Dal and Samuel C. Lefever, who gave their permission for the use of the data in this thesis. The data from this interview had not been used in the LearnICT project or for other purposes. The interview took place in a quiet classroom at MK, lasted for 45 minutes and was recorded and transcribed. The group was asked open questions and was encouraged to talk freely about ICT in their work.

6.3.1.2 Results
The transcription of the interviews was analysed, grouped into themes, compared and regrouped, combined and constructed, in order to answer the research questions as described in Section 5.4.4. The analysis resulted in five themes that will be described here: teachers’ ICT use, teachers’ attitudes to ICT use, teachers’ attitudes to students’ ICT use, communication with students and between students and future development in ICT use. An example of an assignment using ICT, which the foreign language teachers described in the interview, is provided at the end of this section.

Teachers’ ICT use
ICT can be used in many ways in the classroom. It can be used with traditional classroom teaching methods, e.g. distributing material, but it can also be used in association with less traditional methods, e.g. online discussion and interaction. Some ICT tools are commonly used and accepted, e.g. word processing and the Internet, but others are hardly used, e.g. online discussion (Collis & Wende, 2002, Matthiasdottir et al., 2003).

The teachers who were interviewed in this study were all active users of LMS; they used it for organising the courses and the teaching, to prepare the teaching and for classroom work. They used the LMS for distributing material, e.g. course schedules, teachers’ notes, and for communication. They put students’ assignments in the system and expected the students to hand in their solutions, projects and exercises via the system. Most or even all teaching material was, already in 2004, in digital form, either in the LMS or at other online sources.

Websites, outside of the school’s LMS, were frequently used, sites designed for teaching and information distribution and even the teachers’ own websites. The foreign language teachers mentioned especially websites that gave access to a number of media, e.g. magazine and radio. Gunnar, the Icelandic teacher, pointed out that some of the teachers’ websites were a little bit out-dated and
he believed that LMS was gradually used instead and was becoming the main source for online communication in the school's work. Njáll, the vocational teacher, collected students' online work in the LMS over the semester, especially projects, and gave other students in the same course access to them, with the intention that students would learn from each other.

The teachers' use of technology and online opportunities varied. Kristín, the foreign language teacher, emphasised how she used interactive listening exercises and interactive exams. Emma, the other foreign language teacher, said that they did not use course books any more, except some books with novels and short stories. The foreign language teachers prepared audio files with exercises and exams and students could choose if they wanted to listen to the teacher’s reading the text while working on the exercises and taking the exams. All other material was now online in LMS, either from the Internet or from the teachers, and they were experimenting with photos, audios, videos and text. Kristín and Emma mentioned software (Respondus and Studymate) that was especially designed for making material with text, audio and video and made the designing of interactive exercises and assignments easier for teachers. The students used online options frequently in class and even made videos of themselves speaking foreign languages to train their verbal skills.

Tumi, the mathematics teacher, emphasised that pencil and paper were still highly regarded in mathematics teaching, but claimed that the teaching was moving more and more in the direction of integrating ICT into the classroom work. The interactive whiteboards (Smart board) and Excel were great tools, in his opinion. He mentioned programs that showed a graphical calculator on the interactive whiteboard and a drawing program (Fdraw) that was especially made for geometrical drawing and functions. He also mentioned an Icelandic teaching program (Rasmus) with mathematics examples and guidelines. Tumi said that he saved Smart board writings and drawings from the class sessions and placed them on the LMS so they would be accessible for the students whenever they wanted. He mentioned especially one of the statistics courses where Excel was used for all work, exercises and projects, and students used LMS to hand in projects and exercises. He saw the computer as a tool to use in mathematics teaching whenever appropriate. He used it now and then, sometimes every day and sometimes not for some period of time, all depending on the subject and the relevant ICT options he was familiar with.

This description of the group interview shows that the teachers felt they were actively using ICT in the classroom, that it was their working tool. Even this small sample of teachers indicates that ICT use varied greatly between subjects. The differences in ICT use that appeared between these five teachers can be based on many factors such as different access to different kinds of
online material and programs in the different subjects, and the teachers’ different teaching styles. The teachers’ online material was mainly within the LMS and not on their own websites. LMS offers many options for teachers and does not require the same specialist skills or knowledge needed for making and maintaining powerful websites.

Teachers’ attitudes to ICT use

Previous research indicates that ICT use in education depends on many different factors and one of these is teachers’ attitudes toward ICT that can vary from very positive to very negative (Cox & Marshall, 2007). All the teachers interviewed were positive towards ICT use in education as was expected, due to their selection; all but one believed that ICT had changed their work. Tumi was an example of an enthusiastic ICT user, he saw himself taking part in a development. Although the technology had not taken over his work he did not see how he could turn back. His enthusiasm was clear; ICT use gave him new opportunities to motivate the students. He believed it was the teacher’s duty to introduce new possibilities of technology to their students as it could make them work more efficiently. He believed he was a better teacher now with the use of ICT:

It is more fun [now] than before to stand in front of students and experiment on these new Smart boards ... I think I am maybe inspiring more students, encouraging them, because I think this is fun ... you can use this neutral tool whenever you want ... when it is useful it is unique and it is our duty to teach students all the possibilities [ICT offers] (Tumi, group interview, 8.12.2004).

This indicates that ICT can offer teachers new ways of teaching, which makes their work more enjoyable because they can utilise it to motivate their students. ICT use seems to be related to the teachers’ view of their role as teachers, and Tumi believed that one of his roles was to introduce ICT to students in order to motivate them. It must be noted here that the teachers were not discussing how ICT could change the curriculum or the content, their focus was on their methods of teaching and how the students utilised the ICT affordances.

Gunnar, the Icelandic teacher, was using the LMS and was considered to have a positive attitude toward ICT, but in the interview he turned out to be rather sceptical in his views of ICT use in the classroom and even felt that nothing had changed. In his view, the laptop was just like an expensive typewriter: “I think I teach the same way I did 15 years ago“. He admitted though that he had not been using many of the opportunities that ICT offered and mentioned especially interactive exercises and online quizzes. He knew it
would take time to start and prepare exercises and he also knew that they could be saved and reused in order to save time but somehow this knowledge did not increase his use of ICT in teaching at that time. He knew of many opportunities, had good access and could get support, but was not sure if it was the subject [Icelandic] or he himself that were to blame for not using ICT more in his work. In his experience it took one or two semesters for new students to realise that they should use the computer to support their study and not only for entertainment. He had experienced that some students did not have enough ICT knowledge to use common software in class. The other teachers in the group encouraged him to move on and gave him some good ideas of projects he could use, e.g. writing SMS message to get students to realize how differently they could use the language in different media or circumstances.

The other teachers explained how they had experienced their teaching developing from being too much one-way dissemination from the teachers to the students, i.e. they had gradually moved from teacher-centred teaching to more student-centred teaching. The development in recent years has been towards more individualized education or student-centred teaching and learning, placing more emphasis on students working on projects and assignments where the teacher is more in the role of a supervisor or a tutor, rather than a classical lecturer (O’Neill & McMahon, 2005).

The teachers’ answers and discussions in the interview indicated that ICT use had influenced the teaching methods of at least four of the five of them. With ICT in the classroom they felt they were clearly moving from teacher-centred learning to more student-centred learning with the student, with the focus on his/her needs, expectations, abilities and interests. For the foreign language teachers, the content of their teaching was also affected, but this seemed to be less so for the mathematics and Icelandic teachers.

**Teachers’ attitudes to students’ ICT use**

Teachers and students can use ICT in different ways, but students’ use is partly guided by the teachers’ requirements and affordances. ICT helps not only the teachers to organise their work but also the students. In the courses Emma was teaching, the students received all the material online at the beginning of the course and could decide themselves when and in what order they did the work on the material. They planned three or four weeks ahead and had to take the responsibility of finishing everything on time. Njáll felt that the students, with the use of LMS, were better aware of their status in the learning process than before with the use of LMS. They realized better what they had done and not done and had a better overview over the work that had to be done in the course than before because the course schedules were available in LMS at the commencement of the course. Emma believed it was all about the assignments,
how they were built on ICT by using different media and online formats and how they motivated the students. She claimed that the students noticed the difference between exercises using ICT properly and exercises which did not. Also, she claimed that when the students asked questions, they wanted good feedback, not simply straight answers and if they were right or wrong. They said to her, “one does not learn anything from those [exercises]” if there is no proper feedback. She felt that the students put more effort into online assignments and Njáll said he received fewer really bad assignments from students than before.

Emma and Njáll realised how helpful the new technology could be for dyslexic students, it could help them to organize and manage their work and they claimed that spellchecking programs had done miracles for those students. Computers could read texts for the students and they could listen to online recordings when working on assignments or taking exams. They were certain that these opportunities had changed some students’ lives. Emma told a story of two students (boys) who claimed they now tried to solve problems and exercises that previously they would have skipped because of the long text they had to read before they could try to work on them. Now they could read and listen at the same time and that encouraged them to try.

Kristín was convinced that ICT offered a good opportunity for hard-working students, it could give them more opportunities to practice and they could go faster through the material when they had access to it all from the beginning of the semester. She was, however, worried about students who were not taking an active part in the study:

I find it [ICT] a bit difficult to carry on when you have students that have little interest, then they do not use this technology we have. They do not bother to open a dictionary on the Web and other similar options group interview (Kristín, 8.12.2004).

The comments from the interviews suggest that teachers had different experiences of how ICT helps students. They claimed that it was not only practical and efficient for the students to use ICT, it could also help them learn, although they made different use of the ICT affordances the teachers offered them. All students can work on their assignments and projects at their own speed if the material is easily accessible online, they do not need to follow the group in time or in class. This is of course possible without ICT support, but the teachers thought it was more convenient with the LMS.

Online educational material, e.g. further reading, support material and educational programs, can be useful for all students that have an interest in using what is offered. ICT seems to have changed considerably for some of the
students, in terms of efficiency, amount of learning through interaction and even by being used as a working tool, e.g. for reading. Although ICT can be beneficial for students with study problems as well as hard working students, they do not all seem to use the advantages new technology offers. This indicates that ICT had changed the situation for teachers who wanted to encourage their students in their studies, but it was still difficult for the teachers to reach out to those who were not interested or motivated.

**Communication with students and between students**

Much communication exists in education and research has shown that student-student interaction is important and therefore their collaboration should be increased in the learning process (Cox, Abbot et al., 2004). Communication in education can be among teachers, between teachers and students, among students and with the learning material. Communication with ICT has become easier in many ways in the last decade as it is easy to send an e-mail, use LMS, Skype or other online options to communicate.

Emma believed she communicated more with students than before and Njáll considered the communications to be different and more useful than before. Kristín and Emma were certain that there was not at all less communication in the classroom than before, meaning that the use of ICT had increased communication between teachers and students, by being added on to what was before. Emma mentioned online discussion of a novel or a movie where she, as the teacher, could better follow the students’ discussions online and notice how active each student had been. Njáll noted a difference between younger and older students, he sent the student group an e-mail and then realised that the older students did not read the e-mail for days but the younger ones read it and replied right away.

The teachers claimed that students had, over the years, been complaining about how problematical it could be to get a group together to work on projects outside school hours. They felt that group work was easier with ICT when students could work together without being at the same place at the same time. The teachers believed that students were more positive now when they were asked to work together in groups. Kristín was sceptical about how much cooperation there was, in fact, when students were splitting assignments into smaller parts where each one worked on his/her part and sent it to the others. The intention was to foster cooperation but she was not convinced if it did so and thought that it might even not be related to ICT at all. Emma, Tumi and Njáll believed that although the students split the work like they did, it put a lot of pressure on each one to do his/her job, i.e. peer pressure, and it was easy for them just to send an SMS to remind the others to do their job.
Students used online options for communication when they needed and mainly for practical reasons, although they could meet teachers in class during the week. Online discussion among students was blossoming when it was required by the teachers but they were not active in reflecting on the learning material online when it was not required. Online communication between teachers was not mentioned.

**Future development of using ICT**

The teachers were very enthusiastic in discussing the future development of ICT use in MK. They visualised opening up the classroom with open workspaces and interdisciplinary teaching as future prospects that ICT could easily support. They saw many opportunities with open spaces with learning cafés and working areas for students. They wanted to have fewer obligatory class hours and more hours where many teachers from different subjects would be present in an open space, offering assistance and guidance to students in an ICT-rich environment. They wanted the students to decide which teacher they needed to consult and to work more online independently or with fellow students. More material could be online and online communication could be used more actively. They saw the teacher as a tutor using ICT for different teaching methods for supporting students with different learning methods. In connection with different learning styles, where some students preferred more noise than others, they saw different spaces allocated to students who wanted to work in a quiet environment and those who did not mind to work in a “noisy” environment.

More cooperation with schools abroad is considered preferable in Iceland and the foreign language teachers saw more online communication like MSN or Skype as an exciting tool in language teaching where students could speak online with foreign-speaking students abroad.

The teachers saw many opportunities for the use of ICT in their classroom but at the same time they were aware of some important hindrances. To build up teaching with ICT is time consuming when teachers have to rethink the teaching, reorganise their courses and make some, or even all, of the teaching material themselves and most of the online assignments. Kristín and Emma had many ideas of how they could use ICT in different and new ways, plenty of new assignment ideas that could stimulate the students in using options such as audios and videos, but lack of time, *their* time, seemed to be one of the main obstructions for further implementation of ICT. The group also saw the traditional school timetable, and the building with a number of closed classrooms, as obstructions for change as it hinders interdisciplinary studies, group work and cooperation between different subjects.
More support from the school authorities and collaboration with parents was also mentioned. The teachers claimed that parents as a group were rather doubtful and even against new methods in teaching and the phrase “to teach as I was taught” was mentioned as a common phrase among parents. Some ideas of how to enlighten parents about the use of ICT in education were brought up, e.g. a course in LMS for parents, to introduce to them how it could be used in education. It was agreed that the school authorities supported ICT use in the school but the teachers would have liked to see things move faster forward. They wanted more communication, different working methods, different materials (especially in languages), and different organization of the teaching. They were influenced by the distributed learning ideology (see Sections 3.3.3 and 6.2.3) and wanted to change the organisation of the school work and believed that ICT could support these changes.

**Example of assignment**

In this section an example from one of the foreign language teachers is presented to demonstrate what kind of ICT affordances the teachers offered the students. In their language courses all audio material was in the LMS. The students had eleven online audio exercises to go through during the 15 weeks semester and they could listen up to three times to each exercise and take an online exam after listening. The online exams gave the students feedback to improve their performance. The eight highest/best grades of the eleven exams were used as a part of the student’s final grade for the course. The same format was used for online videos; they could watch and take online exams three times after each video. The students had a number of days to complete each of the exercises and could decide themselves if they had done enough or if they wanted to try again.

The teachers felt that assignments in this form had increased the quality of the students’ work. They could monitor each student’s progress, which gave a much better view of their learning process than one final exam at the end of the semester. The teachers said that among the students this was called learning-exercises and they claimed that the students agreed with the teachers that they learnt much more now than when they just took one final exam at the end of a course.

Kristín and Emma believed that this type of exercise was good for active students and gave them very good grades, but Kristín was concerned that not so many boys used the opportunity to retake exams to train themselves and get higher grades. Emma agreed but said:

> It is of course they [students] who have no intention to learn, they do of course not learn more from this than they have done before. But it is really easy to point out to them that they have done almost
nothing when you look it up [in the system] ... so it is very easy to see and show them everything and let them face it (Emma, 8.12.2004).

This shows how the teachers can follow students’ activities and intervene if they are worried about their progress. Somehow the teachers had the feeling that they could not motivate all students; it did not matter if they used ICT or not.

The assignment described here offers the students an opportunity to organise and control their own learning in an easy way with ICT; they can evaluate themselves and improve their results. For the teachers, this offers a better opportunity to monitor each student’s work.

6.3.1.3 Summary

This group interview gives an insight into how teachers can use ICT actively in the classroom, both to support their teaching and the students’ learning. From this small group there are indications that the teachers were using different methods but because of the smallness of the group it cannot be argued that the differences are related to the subject they taught, their different teaching methods or other factors. The teachers’ attitudes and beliefs are clearly a sign of change in teaching methods from teacher-centred teaching to more student-centred teaching, and ICT was a strong influencing factor in this development.

The teachers that took part in the group interview were chosen as they were believed to be active ICT users, but it turned out that one of them was not very eager to use ICT. He was somewhat sceptical and not a very experienced ICT user, although he seemed to be familiar with many ICT options. His experience of the students’ attitudes and digital skills seemed to have influenced his teaching behaviour and ICT use. It is of interest as to why he was considered to be an eager ICT teacher and suggested to be interviewed by the MK authorities. He represents a group of teachers who were positive toward ICT use, knew about many ICT options, but did not use them as they could.

The others in the group were quite eager and positive in their teaching behaviour with ICT. They believed that ICT had offered them opportunities to change their teaching and had slowly changed their role as teachers, but they were disappointed that they could not reach out to all students. They had high hopes for the future progress in ICT use and influence and wanted faster development supported by ICT use but at the same time they were aware of the main hindrance, their own time.
6.3.2 Individual interviews with six MK teachers in 2005

To obtain more information about MK teachers and ICT it was decided to interview six teachers individually in Spring 2005.

6.3.2.1 Method

Participants

Six teachers were interviewed, five women and one man. The six teachers were chosen for being interviewed in cooperation with the MK authorities. They were all experienced teachers who had been using ICT in their work for some years and with over 10 years of teaching experience. How they were selected was described more thoroughly in Chapter 5. Their real names will not be used in the thesis.

Three of the teachers, Kristín and Emma, the foreign language teachers, and Njáll, the vocational teacher, took part in the group interview in 2004 described above in Section 6.3.1. Two of the teachers who took part in the group interview, Tumi and Gunnar, were on leave when the individual interviews were conducted and could therefore not be interviewed. The three additional participants, Anna, Sunna and Sigrún, will be introduced here. Anna was a foreign language teacher with extensive teaching experience at the upper secondary level and had been honoured for her work with ICT in education. Sunna was a natural science teacher with over 10 years’ experience and had shown a special interest in using educational videos and programs in her teaching. Sigrún was a mathematics teacher and had been teaching in both primary and secondary schools for over 20 years before she came to MK two years previously. She had shown a special interest in using a spreadsheet program in her teaching.

Instrument

The interviews were semi-structured. The author of the thesis prepared short guidelines (see Appendix III) in advance where the main focal points were listed. The purpose of the interviews was to gain information about the teachers’ knowledge, beliefs, values, pedagogical reasoning, behaviour and affordances in an ICT educational environment.

Procedure

The individual interviews were conducted in Spring 2005 by the author of this thesis. Each interview lasted on average 30 to 40 minutes and took place in a quiet classroom at MK. The interviews were recorded, transcribed and analysed soon after they were taken as has been described in Section 5.4.4.
6.3.2.2 Results

The transcription of the interview was analysed as before, grouped into themes, compared and regrouped, combined and constructed in order to answer the research questions. The analysis of the individual interviews resulted in five themes: teachers’ ICT use, usefulness of ICT, ICT learning material, effect and influence of ICT and communication and interaction.

Teachers’ ICT use

The outcome of the individual interviews showed that the teachers were all active ICT users as expected. They all mentioned the period between 1996 and 2000 as the beginning of active ICT use in their own teaching, which they had been developing and improving since then. What limited their use of material for teaching and on-line tools depended on what was available to them at the time and what they were familiar with. The teachers started slowly by using basic tools and software and most of them had gradually been increasing the integration of ICT into their teaching over the years. They used LMS for organising their teaching and students’ work, for distribution of material, communication and to monitor the students’ progress. Common software in use was Word, PowerPoint and Excel and they prepared interactive exercises; most of them knew how to make audio files, websites and basic animations. Interactive whiteboards were also used because they were available in most classrooms in MK.

The choice of ICT tools and options in the classroom seems to depend partly on the subjects being taught; different tools seemed to be useful for different subjects although some were commonly used for all subjects. Sigrún, the mathematics teacher, used PowerPoint and Excel frequently in class, along with interactive whiteboards and graphical calculators. The foreign language teachers, Kristín, Emma and Anna, used interactive exercises and quizzes more often, and also online chat, audio and video files. They also used e-material that came with the text book and material on the Web, e.g. online dictionaries, media websites and all kinds of online databases related to daily life in different countries. They mention software for creating and managing exams to use in LMS, and software that offered teachers simple templates for creating Flash-based activities and games.

Anna mentioned that she had not used the interactive whiteboard often and had the feeling that it was too small, but believed that she might not have realised all the opportunities it offers. Sunna, the science teacher, used PowerPoint frequently and mentioned how PowerPoint and the Internet have changed the opportunities to show photos, graphs and illustrative figures. She also used natural science videos and animations particularly about the Icelandic geography. Njáll, the vocational teacher, emphasised online distribution of his
own teaching material as there was a shortage of online teaching material in Icelandic in his subject. He used short video clips and made an effort to train the students in searching the Web for information.

The teachers expressed interest in wider ICT use and were curious to get acquainted with new options, but claimed that lack of time was the main obstacle. Emma felt that the school authorities were doing their best in supporting teachers’ ICT use, e.g. by employing staff for support and offering courses, but Kristín said she would like fewer teaching obligations, i.e. fewer class hours, while preparing courses with substantial ICT use.

It can be stated from this description that the teachers were active ICT users and had the skills to select different tools for different subjects and different aims. At the same time they were aware that there were many other ICT options available that they had still to learn how to use in their work, they were searching for new and good ideas of ICT use, and they needed new ideas. However, the pioneers’ enthusiasm was not enough; they wanted more time and support for ICT implementation, both for individual teachers and for the school itself. The teachers wanted to see faster progress and were eager to proceed and develop their ICT use further with more online material, projects and assignments built on ICT.

Usefulness of ICT

Teachers’ understanding of the ICT tools and their expectations of the usefulness of ICT influenced their use, but it is important that they believe in the usefulness of ICT in order to implement it (Cox & Marshall, 2007). All the teachers interviewed emphasised how more convenient it was to organise the teaching and learning with the use of ICT and LMS. It made a difference for them because it was convenient and easy. With LMS they could organise the teaching, make schedules for whole courses and put all the material online as well as communicate and monitor students’ activities and progress. They felt that one of the main advantages of LMS and ICT was to be more easily able to organise the courses, both as complete courses and also in smaller parts. The teachers emphasised the usefulness for them and the students as Njáll said:

I found it [LMS] very useful for me ... to get the organising frame for the curriculum and the teaching methods ... For the students you can say that this has been useful for them in a similar way. That is, they have all the material well organised and can access it when they want to, and it is much easier for students to follow the schedule; all timeframes and project deadlines are ready. Good support (Njáll, individual interview, 11.02.2005).
It was not only the teachers who benefited, but also the students, who had an easy access to timetables, the syllabus and the learning material. It also offered the teachers an opportunity to follow students’ work and see if they had used the options offered to them in the LMS. Sunna emphasised the practical use of the LMS and Emma’s comment is a good example of the teachers’ attitudes toward LMS, where it is not only for practical use but also to support teachers’ pedagogy:

I feel it is important to have a learning management system to take care of the teaching, to help me with the pedagogy. I need to be able to say “Hi dear Guðmundur, it is not strange that you are doing badly, see how often you have been on [the system], you have not read this and that” (Sunna, individual interview, 18.01.2005).

Kristín claimed that with the LMS the students replied more quickly and she believed that the ICT environment was more motivating for students and that she could get more attention. One of the examples she gave is the following:

Now, they hand it [assignments] in via LMS and we label it in a special way [in LMS] and the students get the assignments back and have to correct them. What we notice with this is that we are more willing to write comments when they hand it in via LMS than when it was on paper. We could have used this when everything was on paper but this is an arrangement which better encourages the students. We can see the difference in the writing, how this has had much influence (Kristín, individual interview, 21.01.2005).

She mentioned especially the use of WebQuest lessons (inquiry-oriented lesson for Internet use (Dodge, 2007)) she designed about German football that seemed to capture the boys enthusiasm. She had not changed the assignments so much; it was the organisation of the learning, and the possibility to get instant feedback, that seemed to motivate the students.

The foreign language teachers mentioned how they linked together material for the students over a certain period of time, e.g. one to three weeks at a time. They called these learning packages, or sessions, where they put together different e-learning material, e.g. text, photos, animations, audio files, exercises, projects, quizzes, and they timed when each part was available for the students to work on and when it closed down. They could set rules for the students, e.g. what part of the material they had to finish before they could proceed to the next one and how often they could take each quiz.
The teachers agreed that most of the students were using the ICT options they were offered in each course. They pointed out that teachers are not alone in the classroom and it is important that the students are also active ICT users if the use of ICT was to have positive influences. Everything was online and ready for the students whenever they wanted to learn. It was easy for the students to access material and follow the progress of the courses, and easy for the teacher to maintain and develop the courses. Njáll mentioned especially that the ability to time the material and ease of communication were the main advantages of LMS over use of ordinary websites.

Kristín was a bit worried about students who did not bring their laptops to class and said this was sometimes a problem in higher levels of study. She claimed that the students said they did not need the laptops and did not bother to bring them along:

But I expect them to have their laptops and when I, for example, use LMS and put it on the whiteboard and those that do not have laptops take longer to handwrite. But those who have computers can just sit down immediately and start answering in the laptop ... I see that as time goes on more [students] take out their laptops (Kristín, individual interview, 21.01.2005).

Emma was also worried about another group of students, the vocational students, who seemed to have less experience with ICT in their study and complained about the cost of a laptop. She claimed that as time goes by the students see the usefulness:

... the curious thing happened when we had been doing interactive vocabulary exercises for a week, then the number of laptops suddenly grew rapidly (Emma, individual interview, 28.01.2005).

Njáll said that the students often started the semester without laptops but they soon realised how useful it was to bring them along and their attitudes changed rapidly:

I noticed before they had computers, then they were fighting about who should write down and then they went to the library to get books and they did not bother so much. It was not exciting. I feel this has totally turned around. Change of attitudes and they do bother much more and think this is fun. They see the results right away and that keeps them going (Njáll, individual interview, 11.02.2005).
Sigrún was using a spreadsheet when teaching statistics to beginners and said that the students used to be negative in this course because of the enormous amount of hand writing and drawing. She claimed that they were much more positive, as it is easy to calculate and draw graphs using computer programs, it gave much more possibilities for graphical presentations and experiments than the calculators the students used to have.

This indicates that when the teachers educate the students about ICT use, they realize the usefulness of bringing the laptop to class and use it properly. They believed that students became more positive toward using ICT when they realise how it could be used and what they were gaining with the new technology and it could change their attitudes toward the subject. As in the group interview, the teachers emphasized the usefulness of ICT - and especially LMS - for organizing the school work and communicating with students. They wanted to integrate ICT into all teaching and learning, into the content of subjects, teaching practices and students’ educational culture. Let Sigrún have the last words here: “I am excited about using the new technology. I feel it is necessary. I think it is good” (Sigrún, individual interview, 14.03.2005).

**ICT learning material**

Students’ learning material, e.g. assignments, exercises and projects, is of importance when ICT use in education is reviewed. The projects described by the MK teachers were of different kinds in different subjects and among different teachers, whether they use ICT or not. Sunna, Sigrún and Njáll used rather traditional projects for their students where ICT was mainly used for resources, presentations and distribution of material. They were slowly increasing the use of other options, e.g. online exams and interactive white boards. The foreign language teachers, Kristín, Emma and Anna, in addition to what has been mentioned before, seemed to use other options more frequently, e.g. audios, videos and online exams, and connected ICT use to all assignments for students.

It seemed to be a strong tradition among the upper secondary school teachers in Iceland to produce additional learning material, or even learning material for a complete course, and the teachers who were interviewed had all been developing material over the years, both with and without ICT use. The teachers had spent a lot of time on making material, especially when transferring courses over to online format, but they agreed that it had always been like this, it would always be a lot of work to design something new, whether it was online or not. The teachers agreed that there was a lack of Icelandic online learning resources for upper secondary education and for teachers to produce their own online material was time consuming and expensive. Also they wondered if they might not be qualified to do so, e.g. have the programming skills needed or good enough ideas. The material they were creating was often supplementary material related to books on the students
reading list with the emphasis on using ICT and exercises, quizzes and projects where students used the Internet to search for material.

The teachers emphasised the students’ project work and assignments both inside and outside the classroom, both small and big projects and online quizzes, where students worked on their own or in groups. They knew that good projects motivate students and designing projects that make use of ICT is one of the options for this purpose or as Emma said:

... we have realised that this is not about making smart WebQuest where everything is working well, it is about them doing the projects, they [the projects] do not need to be fancy, it is about getting them [the students] to go about or out of the project, to collect the raw material and make their own material out of it, their own presentations (Emma, individual interview, 28.01.2005).

The teachers were convinced that students’ project work with the use of ICT was a good opportunity and that ICT could be used not only for simple things like distributing text files but also for interactive projects, Internet searches, data analyses and creating results. The foreign language teachers talked about two kinds of projects, they called them interactive projects where the students were interacting with different programs and computer-supported projects where the students used ICT to search for material and use computers to create solutions.

Research has shown that feedback on students’ work is important and students want detailed and quick feedback of good quality and are much more likely to read online feedback than written (Lunt & Curran, 2010). The MK teachers’ experiences were in accordance to this, that feedback was important for the students and LMS offered them the opportunity to give online comments and with interactive quizzes or projects, feedback and guidance could be given instantly. They emphasised how motivating this was for the students and the students could use the feedback to decide themselves if they had acquired the knowledge and skills needed. Kristín described this clearly when she said:

I think the projects have not changed much. It is the feedback that comes earlier, more stimulating (motivating)... it is the same about books and computers, the projects must inspire (be motivating) (Kristín, individual interview, 21.01.2005).

Students’ computer skills and knowledge of software is an essential factor in ICT use. Emma stressed that she had sometimes to teach students how to use ICT alongside teaching them the language; they didn’t know how to use simple options in common software. This could even become problematic when learning to use the software was too overwhelming as Sigrún said:
They are doing everything in Excel. And the problem is that they drown a little bit in the technology and the concepts get lost. This is mainly project work and they have to learn everything, they are learning so much new, [not only] how they get through the assignments. They have to learn so much in Excel to get going that they forget the concepts ... they get carried away with learning Excel and forget the concept they are supposed to be learning. It is difficult to make them stop and think (Sigrún, individual interview, 14.03.2005).

Here the use of Excel was moving the attention away from the mathematics that was to be learned in the course, but all the same they were also learning new skills in Excel that could be considered a part of learning mathematics. In a way, the students were gaining something by acquiring Excel skills on top of mathematics skills but in the beginning, the time it took to train students in using special software could be frustrating for the teacher who had a curriculum to follow and a strict timeframe.

The curriculum and the study material were ready and comprehensible for the students when they looked it up on LMS, the access was easy and there were a lot of milestones for them to check if they had understood the subject and got the required knowledge and skills. The teachers were aware of the importance of students evaluating and assessing all the e-material they found online and as they taught them to search for material they trained them to evaluate what they found. The teachers agreed that ICT-based assignments and projects could encourage students and motivate them. To make a successful ICT assignment was time consuming and lack of time could be an inhibiting factor in implementing ICT in education.

**Effect and influence of ICT**

The teachers were keen to provide a good and supportive ICT environment for the students and were enthusiastic in their search for opportunities to implement ICT in education. Students are a heterogeneous group and the teachers were well aware that ICT could have a different influence on different students. The teachers often mentioned the practical and supporting influence of ICT and Sigrún gave an example of how beneficial it was for students to use graphical mathematics programs for calculating, especially to plot graphs:

> I feel it is important, because when they are plotting a graph, they need to see how it looks. They are always making mistakes but if they see how the graphs look, they can examine this all .... It is possible to go faster and deeper instead of wasting time in drawings ... Therefore I feel it is necessary for them to have this in
front of them ... When they see it graphically then they understand the concepts quicker (Sigrún, individual interview, 14.03.2005).

ICT is here supporting students’ understanding of the subject and gives them more time to concentrate on its content.

The teachers often mentioned the good influence of the ICT options they were offering, and especially on good and average students. Students who were motivated and positive toward learning seemed to have a lot of opportunities to learn with ICT and could decide for themselves how fast they moved on or, as Sunna said:

... if they are efficient and want to put effort in it they will be more successful and have more possibilities to train themselves. So this is a good opportunity for good students (Sunna, individual interview, 18.01.2005).

The ICT options provided by the teachers offered students the opportunity to move on as fast or as slow as they wanted, gave them feedback and helped them to realise how they were doing. This supported more independent study for those students who wanted to take more responsibility for their school work.

It was recognizable from the interviews that the teachers believed that their teaching methods and roles had changed and that the change was more noticeable among the teachers who had built up their ICT teaching over many years. The teachers discussed how ICT had affected, motivated and supported their wishes to change their teaching methods. They wanted to develop and improve as teachers and ICT offered them new possibilities and supported their development. They claimed that ICT had changed the teacher-student relationship; as teachers, they had become more like tutors, coaches or trainers than omniscient lecturers. They believed they were moving further away from the teacher-centred situation with rather passive students to student-centred education with more active students. Emma described the circumstances well when she said:

We are into much more student-centred teaching now where the responsibility is with the students. The responsibility for project work and so on is with them and they are more active, participating in the organisation of how they will succeed ... they [the students] must evaluate themselves and decide how to proceed (Emma, individual interview, 28.01.2005).
It was not only ICT that matters and Emma emphasised the relationship between technology and pedagogy. The outcome in her mind was that more learning takes place using ICT or as she said: “I see much more efficiency in the classroom and, in all, much more work is done. More accomplishment from more students than before”, but the new emphasis in pedagogy is not totally based on ICT as Kristín said:

I could have this teaching format without the ICT, but I feel that ICT has strengthened it a lot. They [the students] are themselves collecting information and have to organize their work (Kristín, individual interview, 21.01.2005).

ICT had influenced the development of the teachers’ role; it has given the teachers an opportunity to change their work. The foreign language teachers, especially, were convinced that they had changed their work. Although ICT has not changed all students into motivated students the teachers felt a more positive atmosphere among them and claimed it was because they could see their progress simultaneously.

Kristín felt that the projects and the assignments the students were working on had a great influence and could be used to motivate them. Some projects did not work for all students but some seemed to work for most of them or as she said:

... many projects are so engaging that you see even the least efficient students go along. So I can respond to more students. For example I had Web Quest about football....they were working all the time. They were very keen on it. It was the same some days ago when they were playing all kinds of games related to vocabulary (Kristín, individual interview, 21.01.2005).

ICT can support students’ learning and Njáll was convinced that learning with ICT made a difference for students with learning disabilities:

... if the material is the ICT or online it is different, I am not quite sure what the explanation is. The material is on the Website. There is no book. It is a lot of short bits, no books, only these chapters and sessions and it seems to suit them better. Somehow, it is more convenient for them to take the project and work on it and then read, to remember, study, and take an exam (Njáll, individual interview, 11.02.2005).
Emma agreed with this and emphasised how much some software can support writing and also some audio files. She believed that with ICT, students have more opportunities to learn how the language is used in real life and it might encourage them to speak the language later on.

The teachers emphasised that they could not do much for students who didn’t bother at all and did not want to take part. They tried to motivate them and claimed that ICT was an important medium to encourage students and it seemed to affect most of them.

The teachers were worried about the group of students that seemed to have no interest in learning or taking part in school work and were at risk of dropping out of school. The fact is that the upper secondary schools in Iceland have to accept all students who apply so the student group can be very diverse in interests, skills and abilities. Some are good learners and motivated to learn but others are not. Some of them have learning disabilities but others have just no interest in school work. It must also be kept in mind that teachers’ work is limited by many factors such as the curriculum, the learning material available, the assignments and the ICT affordances. Lack of knowledge or ideas about how to proceed can also hinder progress and gives them limited space to develop the ICT learning material for different kind of students.

The teachers implied the ICT gave them new possibilities to develop as teachers and change their teaching methods. They saw clearly how ICT could support students-centred teaching and were quite pleased with the ICT implementation in MK, although they felt it might go faster. At the same time they were concerned and even disappointed that they could not reach out to all students.

**Communication and interaction**

The teachers said that students were used to sending them e-mails with questions and queries concerning the school work. They felt that communication in the classroom was the same as before and although students attended classes four times a week, online communication was also important for them or as Kristín said:

I think it is more communication with students, not less communication in the classroom, that has not changed ... they are sending e-mail to me on LMS... What I feel convenient is that they contact me if something is wrong. I can say that the communication is more frequent on an individual basis (Kristín, individual interview, 21.01.2005).
The teachers said that online discussion was frequently used, especially in language teaching and the teachers felt it was convenient to see who were active and who were not, they could follow the students’ discussions and give them comments. They felt they were better aware of what the students were doing and Emma said:

I find it nice when kids who have had communication difficulties in the classroom are better in online discussion (Emma, individual interview, 28.01.2005).

Sigrún saw more online communication as a good opportunity to motivate students but she was at the same time worried that some students could be passive and reluctant to participate. They were active sending her questions in e-mail but she said she would like to see more online discussions between the students where they would put forward their questions and thoughts and answer each other. Sunna had been planning to encourage online communication in relation to the subject but she was not quite sure of what kind of assignments would be the best to use for that purpose.

Group work was a standard part of teaching and learning methods in MK and the teachers considered it important to use ICT to support the students’ group work. Kristín said:

... yes, it is easier to ask them to work in groups outside the classroom than before. Before they had to meet at the same place at the same time but now they don’t (Kristín, individual interview, 21.01.2005).

6.3.2.3 Summary

It can be stated that the positive attitudes toward the use of ICT in education, of the six teachers who were interviewed, is based on their ICT skills as well as their experience of teaching in an environment that emphasises the use of ICT with good access to technology and technological support. The teachers believed in ICT in education and were still developing their use of ICT and looking for new possibilities when they were interviewed, but they also realised that they were bound to the past and might not see all the possibilities that ICT was offering.

The teachers were convinced about the usefulness of ICT, especially for efficient and hard-working students, but they also saw a new world open up for students with learning disabilities. They saw how simultaneous online feedback motivated the students where they could follow their progress and take more responsibility of their study. They believed that ICT supported communication,
especially between students, but also between students and teachers, and this had built up more positive attitudes toward group work among the students.

The teachers claimed they had made the most of their teaching material online and that ICT was a normal part of their work. They wanted to have more time to spend on developmental work and more support from the authorities. They were not only thinking about their own teaching, they were also thinking about how all students could make use of ICT to support their learning and how easily the subject could be connected to the world outside the school. This gave the students more opportunity to learn, not only what was expected from them but also new and even different things they found during their search online. In a way the subjects regulated how ICT was used. Some software was commonly used by all teachers and students but the difference appeared in the assignments and the projects the students were given.

The teachers clearly saw their role moving toward being tutors in an ICT educational environment. They also felt that ICT had supported them in changing their roles as teachers and given them new possibilities to develop as teachers.

6.3.3 Teachers’ diaries

In order to follow up the individual and group interviews with the MK teachers and to get better information about their ICT use in class, they were asked to write diaries regarding their ICT use in class.

6.3.3.1 Method

Participants

Five of the six MK teachers who took part in the individual interviews, three foreign language teachers, one mathematics teacher and one science teacher, wrote diaries. As mentioned before, one teacher did not write a diary as his students were in practical training and not attending regular class at that time. The teachers have all been introduced before in Sections 6.3.1.1 and 6.3.2.1. Their aliases are Kristín, Emma, Anna, the foreign language teachers, Sunna, the natural science teacher, and Sigrún, the mathematics teacher.

Instrument

In the diaries the teachers were asked to state the date and time for each course and what they were doing in the classroom, what ICT tools they were using and how they used them and for what purpose. They were also asked to reflect on their ICT use. The teachers’ checklist had only one category, teaching, and consisted of 21 items, e.g. show assignment solutions and slideshow (see Appendix V).
Procedure

The five MK teachers who were interviewed individually wrote diaries for two weeks about their ICT use in class in the Spring of 2005. Each diary was written in a Word document and e-mailed to the author of the thesis. In the diaries, the teachers described in more detail than in the interviews how they were using ICT, without much reflection on their work. Subsequently the content of these diaries were analysed.

6.3.3.2 Results

The analysis of the diaries did not give the same themes that emerged in the interviews because in the diaries the teachers were emphasising different things and giving more detailed reports of their ICT behaviours. The three themes that appeared were: teachers’ ICT use, different use in different classes and teachers’ worries.

Teachers’ ICT use

The teachers’ diaries gave a picture of the activity in the classrooms and indicated that in most of the classes the majority of the students, who had their laptop with them, used ICT and described a broad range of ICT activity in class; the teachers were using different media to show the students learning materials and wanted the students to use ICT in their work. The teachers had prepared beforehand a lot of ICT material for teaching and assignments for the students to work on, both in and out of the class. They made Word files and PowerPoint shows with explanations and exercises. They used the Smart board for teaching and saved the work for the students. They made audio files for the language students. Online quizzes and exercises were commonly used as well as flash cards and Web Quest. They had also collected website addresses to use as support material for the students when searching for resources. Video films and video clips were used as well as online dictionaries in language teaching. Special educational programs were mainly used in mathematics teaching.

LMS was used for the distribution of material and the online information system Inna was used to record class attendance. When class hours started they used Word or PowerPoint slides, with the help of a projector, both to show the agenda for the class hour and for formal teaching. The teachers described work with ICT in the classroom where students were working with different tools, sometimes on their own and sometimes in small groups. The teachers used miscellaneous tools in their teaching in addition to the use of LMS, Inna, Word and PowerPoint and two teachers (language) mentioned the use of Smart boards. The common process was that after 10–30 minutes of teacher’s input, the students worked on a variety of projects and assignments, usually with some help of ICT, and prepared presentations of their work.

Once or twice a week students gave presentations, usually with PowerPoint shows and websites. The foreign language teachers mentioned especially that
they offered students the opportunity to use other forms of presentations, e.g. newspaper forms from Publisher and video films, but the students were not eager to do so. They seemed to feel more comfortable with the tools they were used to at that time, e.g. Word, PowerPoint and websites.

Most of the time, technical problems did not seem to affect the teaching and it was only mentioned three times in the diaries, e.g. the Internet connection was down and some students had problems with their laptops, especially when downloading large audio and video files. Emma was describing typical problems in the classroom:

Showed students how to open audio files in LMS, some had to update the player and the Explorer program [on the computer] and things like that ... Some needed more assistance and had to go to the computer service [in the school]. Many forgot their headphones and all mine were in use. It was enjoyable to watch their reaction when they could themselves control how often and how much they had to listen. They really liked to get instant replay of their answers, a bit stressful at the beginning but promising (Emma, diary, January 2005).

It took time to start new tools and that worried the teacher, but when they were running everyone was pleased, both the teacher and the students.

**Different use in different classes**

The teaching methods, teachers’ roles and ICT use were different between classes. From the teachers’ descriptions it can be said that the work with ICT in the classroom did not only depend on the main subject (language or science) but also on the curriculum for each course. The same teacher could be teaching four or five courses in the same subject at different levels and the use of ICT seemed to be quite different for the different courses.

Sigrún, the mathematics teacher, kept a diary of her teaching in two classes with different curricula where one class, statistics study for second year students, was mainly based on students’ work in Excel but the teacher used slide shows and material on the Internet as she described:

Students were working in groups on their research project. Most of them were looking for numbers at the Statistic Iceland website [to use in Excel] (Sigrún, diary, January 2005).
In the other mathematics class, discrete mathematics for fourth year students, ICT was not as much integrated with only some use of slide shows, a graphical calculator and Word when students were writing essays as she said:

... then students worked on [exercises in] the book. We use the calculator to solve these problems and I showed them where the functions are in the calculator; I told them about the functions in Excel but as all of them had calculators, they used Excel only rarely (Sigrún, diary, January 2005).

The students were familiar with graphical calculators and may not have seen the reason or need to switch over to Excel. They choose to use tools that were most common and most convenient for them.

Sometimes the teachers were active in controlling the students’ work almost all the time as Kristín, the foreign language teacher, described:

Showed them in LMS how they get back the writing exercises that I have sent them. They have to correct them and send back to me before Friday. Showed them slides with common mistakes and made them tell me how to correct the sentences. Reminded them of the exam in verbs tomorrow and went with them through a list of verbs that is in LMS ... rehearsed possessive pronouns by going fast over a slide I used last week and let them work on the workbook. In the end they went in LMS and did an interactive exercise on the same subject (Kristín, diary, January 2005).

Here the teacher was guiding the students as a group with use of ICT most of the time but in the end they worked individually on an interactive exercise.

In other classes that Kristín taught, students were mainly working in groups most of the time and the teacher were going around assisting them and helping them on an individual basis or in groups. In many classes the students were working both with ICT and the text book or other material on paper like Kristín described:

They listened to page 20 from an audio file and then read the text [by themselves]. I asked them questions from the text ... introduced possessive pronouns with help of slides and asked them to go to the exercise book and work on exercises. In the end I let them take notes from page 21 (Kristín, diary, January 2005).
Teachers’ worries
In the diaries the teachers were describing the teaching in the classroom where they were confident in their use of ICT and had integrated it into the classroom work. They did not express worries about the use of ICT, they were worried about how the students were doing in the learning process and still saw the same problems as before with students who were not actively participating in the classroom work and were not interested in learning.

Sunna, the science teacher, was worried about uncontrolled and even inappropriate use of laptops in class and emphasised how she controlled the use. When she was showing material on the white board and wanted students to discuss it, she asked them to close their laptops:

I choose this method [to control the use] because only a few of my students [first year students] can handle the freedom of open access to computers to take notes. They become absorbed in MSN and do not participate in class. I think they have enough material in the course book and on LMS. When I introduce things they should take part in the discussion to understand the material and do not need to take notes (Sunna, diary, January 2005).

Most of the students were working on what they were supposed to do in class for most of the time, but for some of them attention shifted to other things now and then. Laptops can offer new and exciting opportunities that can be a temptation for students and divert their attention from school work to entertainment on the Internet. This questions the responsibility of the teacher and of the learner.

Emma, a foreign language teacher, mentioned especially how she used Word text that she displayed on the wall in a large format so it was easy for all the students to read. Then she used different colours for words she added in the text with the help of the students and also used the tools in Word Toolbar and the electronic pen in the Smart board to emphasise words she was working on. She was convinced that this was a good method, especially for dyslexic students.

Anna was afraid of letting the students use only the laptop for writing essays (free writing) as they might go to the Internet to look for text and use copy and paste excessively without learning much from it. They might also get help from someone in the family if they wrote it at home. To prevent this she sometimes let students use paper and pencil to write essays in the classroom. She wondered how teachers could let the students’ practice free writing with the use of ICT, without having to worry about plagiarism.
ICT use does not solve all problems in education, it offers new possibilities that some students make the most of, while others don’t and do not welcome new opportunities at all.

6.3.3.3 Summary

The MK teachers used a variety of different ICT tools in different subjects, they had prepared a range of ICT material and organised the teaching and learning with ICT integrated in the whole teaching and learning process. ICT was a normal tool for them and it was used for different reasons in different ways in different classes. They had various methods to control ICT use, sometimes they asked the students to follow their guidance and explanations closely, sometimes they asked them to close the laptops but sometimes they let them control their own work. They wanted to control the class work but at the same time they wanted the students to take responsibility of their learning. They expressed how pleased they were with ICT in the classroom but the same old problems were still there as Emma explained quite well:

They keep on listening and it is unbelievable to see how much the students have improved and how interested they are in listening compared to my previous experience. Many students do not do homework properly, but that is not new news and not at all connected to ICT use. It has [always] been difficult to get students to read at home and also to listen although they have always had CDs with listening exercises, exercise books and correct answers in the library (Emma, diary, January 2005).

The teachers were worried about plagiarism and they were disappointed that all students didn’t make full use of the affordances they were providing.

6.3.4 Classroom observations

To get more information about how ICT was used in class, it was decided to visit MK classes and observe the teachers’ ICT activity and ICT affordances. The main purpose of the classroom observations was to get information about what ICT applications the teachers were using in class and how it influenced their work. The results of the observations will be described and analysed in this section.

6.3.4.1 Method

Participants

The six teachers who were interviewed individually were asked if they were willing to have RU students observing their ICT use in classes. As the six teachers could not accept more than 1-2 visits per semester, the school authorities were asked to appoint seven additional teachers who were actively using ICT in the classroom for this purpose. They were considered active ICT users in their work.
by the MK authorities and gave permission for observational visits to their classes. Although there are additional teachers it will not be attempted to distinguish between the two groups of teachers.

**Instrument**

As described in Section 5.4.2 two checklists were designed by the author for the classroom visits, one aimed at teachers and the other at students to record their behaviour in class. The author of the thesis visited MK classes four times to test the checklist before they were finalised. The checklist consisted of 25 items. The first two items were ‘start the computer’ and ‘start programs/web sites’ and they were followed by 23 items in two categories; teaching 21 items and something else two items (see Appendix V).

**Procedure**

As mentioned before, the author of this thesis is an assistant professor at Reykjavik University (RU) and taught a course named *ICT in education* between 2004 and 2006. One of the students’ assignments in the course was to visit classes in MK and record the use of ICT. The MK teachers were informed of the aims of the visits and asked to introduce the visitors to the class without letting them disrupt normal classroom work. The RU students who visited the classrooms were trained for the visits by the author. They were given guidelines on how to introduce themselves to the teacher, of proper behaviour when observing in the classroom, the importance of being as neutral as possible, and how to use the checklist. The RU students visited classes in small groups (2-3 students); one of them had the checklist to observe the teachers’ work with ICT, while the others had a checklist to observe students’ ICT behaviour. The MK teacher’s ICT behaviour was recorded every five minutes for one class hour (60 minutes) starting 5 minutes after class started and rated on the checklist, in total 11 times for each teacher. The behaviour that was rated was supposed to indicate when the teacher was using specific software, e.g. Word, Excel or PowerPoint, an online option of the LMS, or other ICT options. Following the visits the RU students handed in reports with the checklists that were subsequently analysed. The RU students gave their permission for the use of their results in this thesis and in total there were 20 observation visits, recording the teachers’ work in the classroom.

6.3.4.2 **Results**

The total amount of observations in the 20 classes lasted 1,200 minutes of teaching time, and the ratings were recorded 11 times for each teacher in each class, or 220 times. It must be noted that the results show how the teachers used ICT in class every 5 minutes when the recording was done and they could be using more than one ICT option at the same time at the time of the rating.
At the beginning of the class hour, all teachers were recorded turning on their computer and two had to restart during the 60 minutes of observation.

The option that was most often recorded was assisting students or 126 times by ten teachers. One teacher was recorded assisting students 11 times in one class hour, three were recorded doing so 10 times and on average they were recorded assisting students 6.76 times. This is in accordance with what the teacher said in the interviews in Sections 6.3.2 and 6.3.2. The options that were never recorded in use were: Show other websites, show own website, use sound files, show films/videos, use online discussion/forum, MSN and recording material. The options that were recorded once in use were: Surfing the Web, download, the school website, technical problems; e-mail was recorded two times. Five teachers were recorded once doing something that was not on the list.

Figure 8 gives an overview of other teachers’ ICT activities and behaviours during a one hour class. The figure shows that 65% (13) of the teachers were using LMS and just over half of them were showing projects, submitting a project and starting program/web site. Other options were used by fewer teachers at the time of the recording. The recordings of use of educational programmes does support teachers stating that there was a lack of educational material online but it does not confirm it, as there might be material that they are not using at the time of the recordings. It is notable that slide shows were only used by three teachers and totally recorded four times, and it was unexpected how many options were never or rarely used. It is difficult to state that this is inconsistent with the interviews as a teacher might not find it wise or convenient to use many ICT options in one class hour. But on the other hand it raises the question whether more ICT options could be used in their classroom teaching.
The data from the classroom observation indicates that the teachers were offering the students different ICT activities in class, some software was used a number of times during each class hour, e.g. for showing projects, and some used rarely, e.g. slide show and Smart board. It is of surprise how rarely Smart board is used as the school had invested in Smarts board in almost every class room and Tumi, the mathematics teacher did emphasise in the interviews how useful it was (see Sections 6.2.2 and 6.3.1). The rare use of slide show does support the information from the interviews with the teachers where they emphasis students working on assignments and projects. Neither the less this is more infrequently than could be expected from the teachers interviews and diaries. It must of course be noted that a similar observation at other times, e.g. at the beginning of the semester, might have shown a different pattern, but it is nevertheless the case that neither the teaching of the use of programmes, nor the use of such programmes, figured prominently in the class periods.

6.3.5 Summary and conclusion of teachers’ data

This section started with a description of an interview with a group of five MK teachers that was conducted in 2004 as a preparation for the thesis. The group interview was a useful method to capture the teachers’ ideas of the importance of ICT in their work. It gave an insight into MK teachers’ and students’ use of ICT and what possibilities the teachers saw of ICT use in the near future. The group interview encouraged the author to proceed to get a clearer picture of the circumstances of ICT use and follow the group interview with individual interviews with six MK teachers. These interviews gave the author an
opportunity to follow up on each teacher’s answer and, by that, getting more substantial personal views from each of them. Analysing diaries from five of them also gave more in-depth information about their ICT use along with the observations in their classrooms. Using different methods for data collection gave the author an opportunity to get an overview from different angles and supported the aim of understanding ICT use in education.

It can be stated that the teachers’ attitudes were based on their ICT skills as well as their experience of teaching in an environment that emphasises the use of ICT and offers good access to technology. The teachers were skilled ICT users with a good knowledge of how to implement ICT in their work, they believed in the usefulness of ICT in education and saw clearly the value for good and average students but emphasised the importance of ICT also for those with learning difficulties. They used different projects and online options and believed that different content called for different ICT use. The school’s LMS had become the norm in ICT use; online material was used more frequently and even instead of printed material, and automated feedback was commonly used.

The teachers’ use of ICT can be classified into three categories:

1. Traditional tasks done more easily with ICT, e.g. distributing material and information.
2. Traditional tasks done differently with ICT, e.g. organising the teaching, using videos for training verbal skills, spellchecking, online dictionary, PowerPoint slides, WebQuest, flash cards and interactive whiteboard.
3. Doing new things with ICT, e.g. online assignments, online discussion, interactive exams with instant feedback, online books and other digital material, audio files inherent with exercises and exams.

These three categories match with the author’s classification of Fox and Twining (2006) rationales for ICT use; categories one and two are especially aiming at mastering ICT for education work and future life and category three is targeting better quality of education.

The teachers had a clear idea about the importance of motivating the students, and their experience over the years supported their belief that ICT use could help. They wanted the students to be able to choose how they learned and be able to control their learning speed and believed that feedback could be motivating. Feedback could be given in different forms and served different purposes. It could simply confirm if a student’s answer/solution was right or wrong but it could also give guidance on how to solve problems. ICT was seen as offering good support and to help dyslexic students, although these teachers were a bit disappointed that they were not as successful as they had
hoped to be in motivating the less able and the less interested students. The classroom observations supported the teachers’ description of their work, with the emphasis on motivating the students to be the active force in the learning process.

The teachers had made most of their teaching material online and ICT was becoming a normal part of their work. The teachers believed in ICT in education and were constantly developing the use of ICT and looking for new possibilities. One teacher claimed that there are a number of possibilities that teachers do not notice because they are so bound to the past.

They wanted to have more time and support for their work but they were not only thinking of their teaching. They wanted to look further than the classroom, they wanted to proceed and change the organisation of the teaching in the school. This group was interested in changing into more distributed or blended learning where students would not be as bound to a fixed timetable all day/days but could decide for themselves which teacher to contact and what project to work on. Most of the teachers mentioned the school timetable as the most limiting factor for the use of ICT in the school. To change the timetable was a question of school policy more than a question of money, in their opinion.

They saw hindrances that might slow down the progress. ICT had been a popular subject among politicians and public officials, but the teachers felt it was not followed with enough supporting actions. They felt that encouragement from the government was often more words than actions. They also felt that the school authorities could give more support. It is both a question of supporting changes and also of financing them. To make changes is time consuming and the teachers would have liked to have more time to work on integrating ICT. They wanted the extra time to be acknowledged and to get some reward for all their extra work.

From the visits to the classrooms it is clear that the MK teaches were active ICT users and offered the students different ICT affordances, but their main emphasis was on assisting the students in their learning process. It is clear that the class sessions were working sessions, rather than teaching sessions in the more traditional sense.

Teachers’ beliefs and behaviours are related to barriers and stimulation that are both external and internal. External and internal barriers and stimulation that were observed in this study are summarised in Table 6 in order to give an overview of the teachers’ attitudes. To develop ICT use further it is important to overcome the barriers and to support stimulating factors.
Table 6. Teachers’ ICT barriers and stimulations, external and internal

<table>
<thead>
<tr>
<th>External barriers</th>
<th>Internal barriers</th>
<th>External stimulations</th>
<th>Internal stimulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of support from school authorities for further changes</td>
<td>Disappointment because of the slow development</td>
<td>Students’ success</td>
<td>Internal desire</td>
</tr>
<tr>
<td>Lack of special online resources</td>
<td>Distress as ICT had not been the magic wand to motivate all students</td>
<td>Support from fellow teachers</td>
<td>Believe in changes with ICT</td>
</tr>
<tr>
<td>Lack of time</td>
<td>Lack of ideas</td>
<td>Technical support from the school</td>
<td>Knowledge of the ICT technology</td>
</tr>
<tr>
<td>Lack of interest and motivation of students to engage in new technological methods</td>
<td>Lack of new ideas</td>
<td>Digital training</td>
<td>Willingness to change the pedagogy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Follow new ideas of ICT use</td>
<td>Imagination, creativity and understanding of students’ needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New software and hardware</td>
<td></td>
</tr>
</tbody>
</table>

The MK teachers who took part in this research generally believed that ICT use in education was built on their knowledge about their subject and their pedagogical content knowledge. They criticised the school authorities in that they wanted more support and more time for the ICT implementation, but they were not very critical with regard to their own work with ICT. They gave the impression that all ICT use in education was good, the more the merrier, but that one could always do better.

6.4 Students’ point of view

One of the main research questions that guided the data collection concerned the students’ behaviour, knowledge, beliefs and values in an ICT-gratifying school environment. In this section the data related to the MK students will be presented and analysed in connection with their LMS use. First, the results from the survey will be presented; second, the results from observations of the students’ ICT use in class, third, the results from an analysis of log files from the school’s LMS and students’ grades and finally the interviews with students.

6.4.1 Survey conducted in MK

In 2005 a survey was conducted among MK students in order to get information about their ICT use and values and attitudes toward ICT. As described in Section 5.4.2., the six MK teachers who participated in the study asked their students who attended their classes in Spring 2005 to answer an online questionnaire (see Appendix VI).

6.4.1.1 Method

Participants
A total of 89 students were approached for the study and all of them agreed to participate and answer the questionnaire, the average age was 18.5 years,
Data collection and results

ranging from 16-20, 45 (52%) males and 42 (48%) females (two did not report their gender). This reflects the gender proportion in MK at the time, 48% males and 52% females (Upper secondary schools, 2010). The students were asked to state what course they had in mind when answering the questionnaire and 42 choose Natural Science, 16 Danish language, 14 Geography, 10 German language, 2 Social Science and 1 Maths. Two did not specify the course they had in mind.

Instrument

A questionnaire was designed especially for this survey in order to address the research questions. The focus of the questionnaire was the use and usefulness of ICT in education in different settings. It was based on the questionnaire used in the project LearnICT (Matthiasdottir et al., 2003) and consisted of 13 questions, two of which have already been mentioned, i.e. questions about gender and course. Two questions were about the frequency of e-mail and Internet use. Six questions had a number of items or options the students could select from, in total 79 items, and three were open questions. The questionnaire is shown in Appendix VI but the content of the questions are described here below:

- Two items were about the frequency of e-mail and Internet use rated on a five point scale between often every day and never (q. 3 and 5).
- One item was about e-mail use where students could rate more than one of eight options. In addition the students could report other options (q. 4).
- One item was about the use of LMS with six possible options, each one rated on a three point scale between often every day and never. In addition the students could report other options (q. 6).
- One item was about Internet use outside LMS with 12 possibilities that all were rated on a four point scale between often every day and never. In addition the students could report other options (q. 7).
- One item was about the use of different methods of technology and programs in the classroom with 16 possible answers, each one rated on a three point scale between often and never. In addition the students could report other options (q. 8).
- One item was about the usefulness of the 16 ICT options in question eight, each one rated on a four point scale between very useful and useless. In addition the students could report other options (q. 9).
- One item was about the use of different ICT options outside the classroom with 17 possible answers, each one rated on a five point scale between often every day and never (q. 10).
Three items were open questions asking what the students considered most comfortable with the ICT use, the teachers use of ICT and whether the teachers had modernised their teaching using ICT (q. 11, 12 and 13).

Procedure

The study was an open e-mail survey activated on 27th April 2005 in an online system called Outcome, software especially designed for online surveys, and closed four weeks later. The six MK teachers who participated in the study sent the URL of the online questionnaire by e-mail to their students in selected classes and asked them to participate. The online questionnaire was in Icelandic and was translated into English in this thesis by the author. The survey was anonymous. The Outcome system automatically collects data from the respondents and the researcher receives reports in a Word format and raw data in an Excel file that can be transferred to SPSS format, the program used for statistical analysis of this data.

6.4.1.2 Results

Figure 9 shows how many students used the Internet and e-mail in their learning. All of the 89 students claimed to be using the Internet sometimes in their learning and almost all (86; 97%) said they used it every day or often every day. The majority (80; 90%) of the students used e-mail sometimes in relation to their learning and 37 (42%) used it every week or more frequently. Thus the results indicate that students used the Internet frequently in their learning but they were not using e-mail as frequently for that purpose.

Figure 9. The students’ use of the Internet and e-mail in their learning
Figure 10 shows how the students used e-mail in their learning. They claimed to use e-mail most frequently to hand in projects to the teachers (72; 81%) and almost half of the group (41; 46%) claimed to send questions to the teachers by e-mail. It is of interest that e-mail was not frequently used to send questions or to communicate in other ways with fellow students.

When asked if the students had something else to report one student answered and said that he/she received assignments from the teachers by e-mail.

Table 7 shows how the students used LMS both in school and out of school. Just over half (48; 55%) of the students claimed they collected material from the teachers weekly or more frequently. Only 18 (21%) claim to use interactive exams/exercises and hardly ever sent e-mail to fellow students or participated in online discussions with the help of the LMS.

Table 7. How frequently students use different options in the LMS both in school and out of school

<table>
<thead>
<tr>
<th>Activity</th>
<th>Weekly or more frequently</th>
<th>Less frequently</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect material from the teachers</td>
<td>48 (55)</td>
<td>30 (35)</td>
<td>9 (10)</td>
</tr>
<tr>
<td>Take interactive exams/exercises</td>
<td>18 (21)</td>
<td>49 (57)</td>
<td>19 (22)</td>
</tr>
<tr>
<td>Hand in projects to the teachers</td>
<td>12 (14)</td>
<td>66 (78)</td>
<td>7 (8)</td>
</tr>
<tr>
<td>Send e-mail to teachers</td>
<td>6 (7)</td>
<td>41 (48)</td>
<td>39 (45)</td>
</tr>
<tr>
<td>Send e-mail to fellow students</td>
<td>2 (2)</td>
<td>16 (20)</td>
<td>64 (78)</td>
</tr>
<tr>
<td>Take part in online discussions</td>
<td>1 (1)</td>
<td>7 (9)</td>
<td>75 (90)</td>
</tr>
</tbody>
</table>
When asked if the students had something else to report considering LMS use, 25 replied. Half of them (12; 48%) said they had nothing to report but a third (8; 32%) mentioned the course calendar as one said: “To look at the calendar to watch what is going on, especially if one is sick”. Two (8%) mentioned to check grades for projects and assignments and get links to websites for their learning, and to look at slides from the teachers and check what was going on in the course was also mentioned.

Table 8 shows the students’ use of the Internet in their learning outside LMS. Search engines were commonly used as nearly three quarters (60; 71%) claimed to use international search engines every week or every day and a little bit fewer (51; 60%) said they used the national search engines. Around half (39; 48%) of the group said they were looking for source material for essays or other projects. Around forty percent of the group were frequently handing in projects to teachers using the Internet (35; 42%), collecting material from the teachers (32; 39%) and looking for further reading material in foreign languages (32; 39%).

Table 8. The students’ use of the Internet (outside LMS) in their learning

<table>
<thead>
<tr>
<th>Activity</th>
<th>Every week or every day</th>
<th>Less frequently</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use international search engines</td>
<td>60 (71)</td>
<td>24 (28)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Use national search engines</td>
<td>51 (60)</td>
<td>27 (33)</td>
<td>6 (7)</td>
</tr>
<tr>
<td>Look for source material for essays or other projects</td>
<td>39 (48)</td>
<td>43 (52)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Hand in projects to the teachers</td>
<td>35 (42)</td>
<td>20 (24)</td>
<td>28 (34)</td>
</tr>
<tr>
<td>Collect material from the teachers</td>
<td>32 (39)</td>
<td>29 (35)</td>
<td>22 (26)</td>
</tr>
<tr>
<td>Find further reading material in foreign languages</td>
<td>32 (39)</td>
<td>41 (49)</td>
<td>10 (12)</td>
</tr>
<tr>
<td>Find further reading material in Icelandic</td>
<td>30 (36)</td>
<td>46 (56)</td>
<td>7 (8)</td>
</tr>
<tr>
<td>Take interactive exam/exercises</td>
<td>29 (35)</td>
<td>32 (39)</td>
<td>22 (26)</td>
</tr>
<tr>
<td>Send e-mail to fellow students</td>
<td>22 (26)</td>
<td>31 (37)</td>
<td>30 (36)</td>
</tr>
<tr>
<td>Send e-mail to teachers</td>
<td>15 (18)</td>
<td>38 (46)</td>
<td>30 (36)</td>
</tr>
<tr>
<td>Get information from national databases</td>
<td>8 (10)</td>
<td>33 (40)</td>
<td>42 (50)</td>
</tr>
<tr>
<td>Get information from international databases</td>
<td>7 (8)</td>
<td>30 (37)</td>
<td>45 (55)</td>
</tr>
</tbody>
</table>
Only five students mentioned other possibilities in the use of the Internet outside LMS, they searched websites that the teacher had referred to when working on essays, used e-mail and played computer games.

Table 9 shows what ICT options the students were using in class in the course they had in mind when answering the questionnaire. Many (67; 82%) students were active in using LMS and about half (39; 48%) of them searched for information on the Internet. Between 35 and 41 per cent (29-34) claimed they used e-mail, slide presentation programs, interactive exams and word processors in the classroom. A large proportion (57-62; 70–82%) of the students claimed they never used multimedia disks, online chat, software for image/picture processing, DVD films, teacher’s websites, computer games and mobile phones.

Table 9. The students’ use of different ICT options in the class room (in the course they had in mind when they answered the questionnaire)

<table>
<thead>
<tr>
<th>Option</th>
<th>Often N (%)</th>
<th>Seldom N (%)</th>
<th>Never N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning management system (LMS)</td>
<td>67 (82)</td>
<td>11 (13)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>Information search on the Internet</td>
<td>39 (48)</td>
<td>30 (37)</td>
<td>12 (15)</td>
</tr>
<tr>
<td>e-mail</td>
<td>34 (41)</td>
<td>41 (50)</td>
<td>7 (9)</td>
</tr>
<tr>
<td>Slides presentation program</td>
<td>30 (37)</td>
<td>33 (40)</td>
<td>19 (23)</td>
</tr>
<tr>
<td>Interactive exam</td>
<td>30 (36)</td>
<td>37 (45)</td>
<td>16 (19)</td>
</tr>
<tr>
<td>Word processor</td>
<td>29 (35)</td>
<td>35 (43)</td>
<td>18 (22)</td>
</tr>
<tr>
<td>Online chat (e.g. MSN, Skype)</td>
<td>10 (12)</td>
<td>14 (17)</td>
<td>58 (71)</td>
</tr>
<tr>
<td>Spreadsheet</td>
<td>8 (10)</td>
<td>28 (34)</td>
<td>47 (56)</td>
</tr>
<tr>
<td>Educational software</td>
<td>8 (10)</td>
<td>26 (32)</td>
<td>48 (58)</td>
</tr>
<tr>
<td>Multimedia disk</td>
<td>7 (9)</td>
<td>17 (21)</td>
<td>57 (70)</td>
</tr>
<tr>
<td>Computer game</td>
<td>6 (7)</td>
<td>12 (14)</td>
<td>66 (79)</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>6 (7)</td>
<td>9 (11)</td>
<td>67 (82)</td>
</tr>
<tr>
<td>Discussion forum</td>
<td>3 (4)</td>
<td>29 (36)</td>
<td>49 (60)</td>
</tr>
<tr>
<td>Software for image/picture processing</td>
<td>2 (2)</td>
<td>19 (23)</td>
<td>61 (74)</td>
</tr>
<tr>
<td>DVD films</td>
<td>2 (2)</td>
<td>18 (22)</td>
<td>62 (76)</td>
</tr>
<tr>
<td>Teachers’ website</td>
<td>1 (1)</td>
<td>19 (23)</td>
<td>62 (76)</td>
</tr>
</tbody>
</table>

When asked if they were doing something else when using the Internet in class only three students replied and mentioned watching videos with teaching material, online discussions with fellow students and playing Solitaire.

Table 10 shows how the students were using different ICT options outside class hours, at home or in school. Almost all (77; 99%) who answered claimed they were using the LMS often and most (66; 84%) of them said they used e-mail often. Many used information search on the Internet and Word processor
often (59; 76%; 48, 61%). Just over half of the students used Interactive exams and online chat often (44; 56%; 42; 54%) and around one-third used mobile phones and slide presentation programs often (27; 35%; 26; 32%). Few said they were often using teachers’ websites (14; 18%), software for image/picture processing and multimedia disks (12; 15%).

Table 10. The students’ use of ICT for learning outside class hours at home or in school but not in the class (items are listed in the same order as in Table 9)

<table>
<thead>
<tr>
<th></th>
<th>Often N (%)</th>
<th>Seldom N (%)</th>
<th>Never N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning management system (LMS)</td>
<td>77 (99)</td>
<td>1 (1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Information search on the Internet</td>
<td>59 (76)</td>
<td>15 (19)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>E-mail</td>
<td>66 (84)</td>
<td>11 (14)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Slides presentation program</td>
<td>26 (33)</td>
<td>35 (45)</td>
<td>17 (22)</td>
</tr>
<tr>
<td>Interactive exam</td>
<td>44 (56)</td>
<td>28 (36)</td>
<td>6 (8)</td>
</tr>
<tr>
<td>Word processor</td>
<td>48 (61)</td>
<td>20 (26)</td>
<td>10 (13)</td>
</tr>
<tr>
<td>Online chat (e.g. MSN, Skype)</td>
<td>42 (54)</td>
<td>17 (22)</td>
<td>19 (24)</td>
</tr>
<tr>
<td>Spreadsheet</td>
<td>20 (25)</td>
<td>36 (46)</td>
<td>23 (29)</td>
</tr>
<tr>
<td>Educational software</td>
<td>17 (23)</td>
<td>23 (30)</td>
<td>36 (47)</td>
</tr>
<tr>
<td>Multimedia disk</td>
<td>12 (15)</td>
<td>30 (37)</td>
<td>37 (47)</td>
</tr>
<tr>
<td>Computer game</td>
<td>21 (26)</td>
<td>20 (25)</td>
<td>39 (49)</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>27 (35)</td>
<td>12 (15)</td>
<td>39 (50)</td>
</tr>
<tr>
<td>Discussion websites</td>
<td>14 (18)</td>
<td>31 (40)</td>
<td>33 (42)</td>
</tr>
<tr>
<td>Software for image/picture processing</td>
<td>12 (16)</td>
<td>25 (32)</td>
<td>41 (52)</td>
</tr>
<tr>
<td>DVD film</td>
<td>19 (24)</td>
<td>29 (37)</td>
<td>31 (39)</td>
</tr>
<tr>
<td>Teachers website</td>
<td>14 (18)</td>
<td>21 (27)</td>
<td>43 (55)</td>
</tr>
</tbody>
</table>

* Often is the sum of often every day, every day and every week.

To get a better overview of how often the students used the different ICT options in class and outside class, at home or in school, the often columns from Table 9 and 10 were merged in Figure 11. Figure 11 shows that more students used ICT options outside class than in class, except for slide presentation programs. The LMS, e-mail, and information search on the Internet was used by 76-99 per cent of the students outside class but by 41-82 per cent in class.
Table 11 presents the students’ ratings of the usefulness of the ICT options they said they were using in their learning. Nearly all of them claimed that e-mail (80; 97%), interactive exams (77; 95%), LMS (78; 94%) and information search on the Internet (75; 93%) were the most useful options. Many (64; 80%) claimed slide presentation programs and word processors (61; 75%) were very useful. Educational software was also considered useful (47; 60%) and DVD films (40; 50%), but just over half (65; 57%) of the group considered mobile phones useless.
Table 11. The usefulness of the different ICT options for learning according to the students (items are listed in the same order as in Table 9)

<table>
<thead>
<tr>
<th></th>
<th>Very useful*</th>
<th>Not very useful</th>
<th>Useless</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Learning management system (LMS)</td>
<td>78 (94)</td>
<td>2 (2)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Information search on the Internet</td>
<td>75 (93)</td>
<td>4 (5)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>e-mail</td>
<td>80 (97)</td>
<td>2 (2)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Slide presentation program</td>
<td>64 (80)</td>
<td>16 (20)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Interactive exam</td>
<td>77 (95)</td>
<td>4 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Word processor</td>
<td>61 (75)</td>
<td>15 (19)</td>
<td>5 (6)</td>
</tr>
<tr>
<td>Online chat (e.g. MSN, Skype)</td>
<td>35 (44)</td>
<td>26 (32)</td>
<td>19 (24)</td>
</tr>
<tr>
<td>Spreadsheet</td>
<td>34 (47)</td>
<td>27 (38)</td>
<td>11 (15)</td>
</tr>
<tr>
<td>Educational software</td>
<td>47 (60)</td>
<td>19 (24)</td>
<td>13 (16)</td>
</tr>
<tr>
<td>Multimedia disk</td>
<td>32 (40)</td>
<td>32 (40)</td>
<td>16 (20)</td>
</tr>
<tr>
<td>Computer games</td>
<td>10 (13)</td>
<td>20 (25)</td>
<td>50 (62)</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>16 (20)</td>
<td>18 (23)</td>
<td>46 (57)</td>
</tr>
<tr>
<td>Discussion websites</td>
<td>34 (43)</td>
<td>26 (33)</td>
<td>20 (25)</td>
</tr>
<tr>
<td>Software for image/picture</td>
<td>22 (28)</td>
<td>35 (44)</td>
<td>22 (28)</td>
</tr>
<tr>
<td>processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVD film</td>
<td>40 (50)</td>
<td>21 (26)</td>
<td>19 (24)</td>
</tr>
<tr>
<td>Teachers website</td>
<td>34 (42)</td>
<td>29 (36)</td>
<td>18 (22)</td>
</tr>
</tbody>
</table>

*Very useful and useful were added together and called very useful.

To get a better overview of the students’ use of different ICT options and how useful they claimed those options were, the very useful column from Table 11 was added to Figure 11 and showed in Figure 12. Figure 12 shows that the students seemed to be convinced of the usefulness of many of ICT options although they did not claim to use all of them frequently. The school LMS was used frequently and also considered very useful. Information search on the Internet and e-mail was considered very useful also and used rather frequently outside the class but not in the class. Interactive exams were also considered very useful by most of the students (95%) but only used by 55% outside class and 36% in class. Slide presentation programs and word processors were considered very useful by many students (80%) although they were not so frequently used, especially not in the classroom. Educational software and DVD films were examples of ICT options that were considered useful by much higher proportion of the students than claimed to be using them often.
To gain a clearer picture of how the usefulness of LMS use was related to the frequency of LMS use the answers every week or every day from Table 8 and the answers very useful from Table 11 are added together in Table 12. Table 12 suggests that practical LMS options like collecting material from the teachers (69; 90%) and handing it back (72; 95%) were claimed useful and frequently used as well as taking interactive exams/quizzes/exercises (60; 78%). To send e-mail to the teachers was also rather frequently used (35; 59%), but the students didn’t frequently send e-mail to fellow students (18; 24%) or take part in online discussions (8; 11%).
Table 12. The use of LMS, both in class and outside and its usefulness

<table>
<thead>
<tr>
<th>Usefulness</th>
<th>Daily or every week N (%)</th>
<th>Less frequently N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect material from the teacher</td>
<td>69 (90)</td>
<td>8 (10)</td>
</tr>
<tr>
<td>Hand in projects to the teachers</td>
<td>72 (95)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>Take interactive exams</td>
<td>60 (78)</td>
<td>17 (22)</td>
</tr>
<tr>
<td>Send e-mail to teachers</td>
<td>35 (59)</td>
<td>32 (41)</td>
</tr>
<tr>
<td>Send e-mail to fellow students</td>
<td>18 (24)</td>
<td>56 (76)</td>
</tr>
<tr>
<td>Take part in online discussions</td>
<td>8 (11)</td>
<td>66 (89)</td>
</tr>
</tbody>
</table>

To get further information of the usefulness of Internet use related to the frequency of the use the answerers every week or every day from Table 8 and very useful from Table 11 was put together in Table 13. Table 13 shows that many (56; 76%) students who claimed that search machines on the Internet were useful were also active users of search, but only half (38; 50%) of those who said it was useful to look for source material for essays or other projects were actively doing so. It is quite common for students to search for material for school work but just 40-50% of those who considered it useful were using this option every week or daily. Around half of the students never searched for information in foreign or Icelandic databases although they considered it useful. It is also of interest that over one-third of the students who considered it useful to send e-mail to fellow students and teachers claimed they never did. We have to bear in mind that the students were attending class hours up to 6 times a week for each course and had the opportunity to meet other students and might not see the need for using e-mail although they considered it useful. The results are similar regarding the collection of material from the teachers and handing in projects; it was considered useful but about one-third of the students said they did not use it.

Table 13. Students’ use of Internet (outside LMS) and the usefulness of different ICT options

<table>
<thead>
<tr>
<th>Usefulness</th>
<th>Daily or every week N (%)</th>
<th>Less frequently N (%)</th>
<th>Never N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use international search machines</td>
<td>56 (76)</td>
<td>17 (23)</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Use national search machines</td>
<td>47 (61)</td>
<td>24 (31)</td>
<td>6 (8)</td>
</tr>
<tr>
<td>Look for source material for essays or other projects</td>
<td>38 (50)</td>
<td>38 (50)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Hand in projects to the teachers</td>
<td>31 (41)</td>
<td>19 (25)</td>
<td>26 (34)</td>
</tr>
<tr>
<td>Find further reading material in Icelandic</td>
<td>30 (41)</td>
<td>40 (52)</td>
<td>7 (9)</td>
</tr>
<tr>
<td>Find further reading material in foreign languages</td>
<td>32 (41)</td>
<td>36 (47)</td>
<td>9 (12)</td>
</tr>
<tr>
<td>Collect material from the teachers</td>
<td>30 (39)</td>
<td>25 (33)</td>
<td>21 (28)</td>
</tr>
<tr>
<td>Take interactive exams</td>
<td>27 (35)</td>
<td>30 (40)</td>
<td>19 (25)</td>
</tr>
<tr>
<td>Send e-mail to fellow students</td>
<td>22 (29)</td>
<td>28 (37)</td>
<td>26 (34)</td>
</tr>
<tr>
<td>Send e-mail to teachers</td>
<td>14 (18)</td>
<td>35 (46)</td>
<td>27 (36)</td>
</tr>
<tr>
<td>Get information from national databases</td>
<td>8 (11)</td>
<td>31 (41)</td>
<td>37 (48)</td>
</tr>
<tr>
<td>Get information from international databases</td>
<td>6 (8)</td>
<td>29 (38)</td>
<td>42 (54)</td>
</tr>
</tbody>
</table>

170
There were three open questions at the end of the questionnaire that the students could answer in their own words. The first question asked what was most convenient about ICT in their studies. Most (69; 78%) of the students answered this question and 39 (57%) mentioned LMS, as these examples show:

I find LMS very convenient in my learning but searching the Internet is also good for some projects like essays and we also have Word in which you do all your projects.
I find it convenient to be able to get everything that I have to do in my learning from one place [the LMS].

Some (12; 17%) of the students mentioned word processing and other options were mentioned, such as being able to send projects from home, not having to write with a pencil, being able to see their grades on-line and the material from the teachers, or as two of them said:

I find this all very useful and it makes my learning easier.
To get material and all projects in the computer makes it is easy to maintain and save them.

Only one (1.4%) student was negative and said he/she found LMS boring.
The next open question asked if the students thought the teachers were using the ICT in the best way possible and if they thought something was missing. Many (64; 72%) replied and many of them (49; 77%) gave positive answers and comments or as these said:

Yes, it is used very much or at least in the courses where it is relevant.
Yes, yes. It is surely possible to use computers more but this is fine.

Although students gave positive answers some gave also negative comments at the same time like these two:

I think teachers use the computer technology nicely but they could learn to use it better.
Yes, most of the time, some are too lazy to learn how to use it properly.

Fourteen (22%) students gave negative comments and six of them claimed that the teachers needed more training or as one said: “Some teachers do not use this well enough or do not know how to use the technology properly”. Two (3%) complained that teachers overused the ICT and one (1.5%) claimed that there was no need for computers; they failed all the time.
In the last open question the students were asked if they believed the teachers’ use of ICT made the teaching more up-to-date. Many (65; 73%) of the students answered this open question and 40 (62%) of them said ‘yes’ and phrases like good, convenient, up-to-date and useful were used or as three of them said:

Yes, I feel this is very up-to-date and useful.
This is clever and some teachers know very well how to [use ICT].
Maybe up-to-date is not the right word; they are just using what they have to make the subject more interesting and easier for the students to understand.

Eight (12%) said no and three (4.6%) said I don’t know. The rest (14; 22%) were both positive and negative like this one:

Yes and no, this is just very comfortable and well done from the teachers’ side.

One (1.5%) student was really negative in his/her attitude:
What looks like up-to-date is basically stupid because the computers can disturb you a lot and it is also not convenient and boring in the long run to do endless online projects every day.

6.4.1.3 Summary
The students who participated in this survey were active users of LMS and the Internet in their learning. They searched for information, collected projects from the teachers and handed in their work online. Their uses of ICT options were different inside and outside class and almost all the options were used more frequently outside class. They used e-mail less frequently and mostly for practical things, for example, to hand in projects to the teachers, but not so much for communication with fellow students. The students considered many ICT options useful but they did not use them all very frequently. E-mail and interactive exams were considered the most useful options and e-mail was frequently used, especially outside class. Interactive quizzes were not so frequently used as only about one-third of the students were actively using them on the Internet and just 20% claimed to use them in LMS. Teaching programs and DVD films were also an example of options that were considered useful but not frequently used. In the students’ answers to the open questions, many of them considered the LMS convenient. They also claimed that some of the teachers used ICT properly although they believed that some of them could use it more frequently.
6.4.2 Classroom observations

To get more information about how ICT was used in class it was decided to visit MK classes and observe the students’ ICT activity and ICT affordances. The main purpose of the classroom observations was to get information about what ICT applications the students were using in class and how it influenced their work. The results of the observations will be described and analysed in this section.

6.4.2.1 Method

Participants

The participants were MK students and to select them, the six MK teachers that participated in the interviews (see Section 6.3.3) were asked if they were willing to allow RU students to observe ICT use in their class. They all accepted the visits. In addition, seven other MK teachers who were considered to be active ICT users by the MK authorities also gave permission for observational visits to their classes. In total 92 students in 20 classes visits were observed.

Instruments

As described in Sections 5.4.2 and 6.3.4 two checklists were designed by the author for the classroom visits. The students’ checklist consisted of two main categories, 1) learning, where eleven objects were listed, e.g. using LMS and interactive exams, and 2) entertainment, where nine objects were listed, e.g. surfing the Internet and listening to music. A few other objects were listed, e.g. starting the computer and technical problems (see Appendix VIII).

Procedure

The procedure was the same as is described for the recording of the teachers’ behaviour in Section 6.3.4. Each of the RU students recorded the work of two or three MK students every five minutes for one lesson, or for 60 minutes. Following the visits the RU students handed in reports with the checklists that were subsequently analysed. The RU students gave their permission for the use of their results in this thesis and in total there were 20 classrooms visited, recording the behaviour of 92 students or on average 4.6 students in each class.

6.4.2.2 Results

The total amount of observations in the 20 classes lasted 1,200 minutes of teaching time, and the ratings were recorded 11 times in each class or 220 times. It must be noted that the result shows how the students used ICT in each recording and they could be using more than one ICT option at the same time. At the beginning of the class hour, 66 students were recorded turning on the computer, the others had it on already and 25 students had to restart their computer again during the 60 minutes of observation. In 55 recordings 23 students were not using their computer. Working on projects was recorded 310 times by 59 students and use of the LMS recorded 231 times by 59 students.
All options on the list were recorded but less than 10 students were using blog (4 students, 6 hits), online discussion/forum (4 students, 18 hits), Inna (6 students, 14 hits), the school website (9 students, 11 hits), students’ websites (9 students, 16 hits), working in other software (9 students, 16 hits), DVD – video (9 students, 57 hits) and Music (9, students 52 hits). Technical problems were recorded 20 times by 12 students.

Figure 13 gives an overview of students’ other ICT activities and behaviour during a one-hour class. The figure shows that 59 were recorded surfing the website 197 times, 22 were recorded playing games on 88 occasions and 19 were taking notes on 82 occasions.

The observations in the classroom show that some of the students were multi-tasking and switching easily between applications while working on projects, getting information from the LMS and taking online exams or using other programs. From the records it is clear that the students were active using the different ICT options and the trend was a good learning activity at the beginning of the class, but at the end or the last 10 - 15 minutes the students were more active doing something else.
6.4.3 Log files from the learning management system (LMS)

In order to obtain better understanding of how the students use the LMS, information about their use, not only their own evaluation of the use, but also data from the MK computer system, the MK authorities provided a file, named log file, with information about the students’ use of the LMS.

6.4.3.1 Method

Participants

Students in the 13 courses that have been studied in this thesis were selected for further analysis of their LMS use. This was done in cooperation with the MK authorities.

Instrument

Log files from the school’s computer system are files with information about when the students started and finished using LMS in each course and how often they logged into LMS, named ‘hits’ here. The log files were not traceable to individual students and the teachers of the courses were not indicated.

Procedure

The LMS log files were provided by the school authorities for the time period between January and May 2005 and analysed by the author of the thesis. The courses were: Dan102, Dan103, Dan203, Dan222, Dan262, Dan293, Dan303, Jar103, Nat113, Nat123, Ger403 and Ger503. Here Dan stands for the Danish language, Jar is for geology, Nat is for natural sciences and Ger is for the German language.

6.4.3.2 Results

Figure 14 shows the average number of LMS use for the students in the 13 courses. LMS use was very different between courses where the average number of hits ranged between 30 and 382 hits. Students in two Danish courses were both the most active (Dan103) and the least (Dan193) active. The course Dan 103 was a first year obligatory course for students who were starting a four year program for matriculation examination and Dan 193 was a course for vocational students starting up to a five-year program in their trade.
Figure 15 shows the maximum and minimum number of hits in LMS for the students in the same courses as in Figure 14. The use of LMS was very different between students in the same course and between courses or from one to 1050 hits. Two courses had the most active students, Danish 103 where hits ranged between 311 and 535 and German 503, where hits ranged between 99 and 198. In other courses some students connected to the LMS on fewer than 10 occasions in the whole semester. This shows that in the same course there are both active students who make use of the LMS and students who are not so active in using the LMS.
The semester started in the beginning of January and it was expected that all students would log into LMS in the first two weeks of the semester and stop using it around the end of the semester in May. To investigate this, data from five Danish courses were analysed. Table 14 shows the proportions of students who started to use LMS in the different months of the semester. As Table 14 shows, the beginning of LMS use differed between courses and a part of the students in DAN 102 and Dan 222 started later than students in other courses. Even 4% of the students in Dan 222 did not start until in May at the end of the semester, when the teaching was finished and the exam time was on.

Table 14. The proportion of the students’ starting to use LMS in the Spring semester in 2005

<table>
<thead>
<tr>
<th>Course</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan 102</td>
<td>73%</td>
<td>25%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Dan 222</td>
<td>50%</td>
<td>42%</td>
<td>0%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Dan 103</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Dan 203</td>
<td>91%</td>
<td>1%</td>
<td>7%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Dan 303</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Dan 262</td>
<td>89%</td>
<td>5%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

6.4.4 Use of LMS and students’ grades

In order to assess if a relationship was to be found between the students’ performance and their LMS use, information about their grades were collected. The MK authorities provided a file with information of the students’ grades which was compared with the information of the LMS use.

6.4.4.1 Method

Participants

The students’ grades for 12 courses were analysed. These courses were the same as were analysed for their LMS use. The information was not traceable to individual students and the teacher of the course was not indicated. The courses were: Dan102, Dan103, Dan203, Dan222, Dan262, Dan293, Dan303, Jar103, Nat113, Nat123, Ger403, Ger503.

Procedure

The information about the grades was provided by the school authorities for the Spring semester of 2005 and analysed by the author of the thesis.
6.4.4.2 Results

Table 15 shows that in one course, Dan 102, there is a high significant correlation (0.72) between actively using the LMS and getting good grades. In five courses there is moderately significant correlation (0.29-0.56) between the use of LMS and grades, but in six courses the correlation is not significant.

Table 15. Correlation between grades and number of LMS connections (hits)

<table>
<thead>
<tr>
<th>Course</th>
<th>N</th>
<th>Males (%)/ Females (%)</th>
<th>Mean age (SD)</th>
<th>Correlation (grade x hits)</th>
<th>Average grades (SD)</th>
<th>Average hits (SD) (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan102</td>
<td>40</td>
<td>32 (80)/8 (20)</td>
<td>18.3 (2.7)</td>
<td>0.72***</td>
<td>4.1 (2.5)</td>
<td>259.9 (219.6) (0-1050)</td>
</tr>
<tr>
<td>Dan103</td>
<td>13</td>
<td>4 (31)/9 (69)</td>
<td>17.5 (0.7)</td>
<td>0.21</td>
<td>5.9 (1.5)</td>
<td>380.5 (58.0) (311-535)</td>
</tr>
<tr>
<td>Dan203</td>
<td>124</td>
<td>60 (48)/64 (52)</td>
<td>17.6 (1.3)</td>
<td>0.40***</td>
<td>6.0 (2.0)</td>
<td>363.6 (201.1) (2-951)</td>
</tr>
<tr>
<td>Dan222</td>
<td>27</td>
<td>18 (67)/9 (33)</td>
<td>24.5 (9.0)</td>
<td>0.38*</td>
<td>5.0 (2.2)</td>
<td>111.3 (152.8) (0-627)</td>
</tr>
<tr>
<td>Dan262</td>
<td>16</td>
<td>11 (69)/5 (31)</td>
<td>31.3 (5.0)</td>
<td>0.44</td>
<td>5.3 (2.2)</td>
<td>241.3 (213.0) (6-766)</td>
</tr>
<tr>
<td>Dan293</td>
<td>15</td>
<td>8 (53)/7 (47)</td>
<td>17.1 (0.5)</td>
<td>0.48</td>
<td>6.0 (1.1)</td>
<td>22 (29.1) (0-94)</td>
</tr>
<tr>
<td>Dan303</td>
<td>33</td>
<td>4 (12)/29 (88)</td>
<td>19.1 (1.1)</td>
<td>0.49**</td>
<td>7.2 (2.2)</td>
<td>208.3 (107.7) (54-554)</td>
</tr>
<tr>
<td>Jar103</td>
<td>31</td>
<td>19 (61)/12 (39)</td>
<td>19.0 (1.1)</td>
<td>0.31</td>
<td>7.3 (1.7)</td>
<td>92.4 (47.7) (22-222)</td>
</tr>
<tr>
<td>Nat113</td>
<td>43</td>
<td>23 (54)/20 (46)</td>
<td>18.5 (2.1)</td>
<td>0.19</td>
<td>6.2 (1.8)</td>
<td>162.6 (85.5) (20-489)</td>
</tr>
<tr>
<td>Nat123</td>
<td>79</td>
<td>47 (60)/32 (40)</td>
<td>18.2 (1.9)</td>
<td>0.35**</td>
<td>5.2 (2.3)</td>
<td>78.7 (59.0) (0-276)</td>
</tr>
<tr>
<td>Ger403</td>
<td>19</td>
<td>12 (63)/7 (37)</td>
<td>20.5 (1.2)</td>
<td>0.56*</td>
<td>5.4 (2.0)</td>
<td>284.9 (166.0) (14-701)</td>
</tr>
<tr>
<td>Ger503</td>
<td>9</td>
<td>0/9 (100)</td>
<td>20.3 (0.9)</td>
<td>-0.16</td>
<td>7.8 (1.0)</td>
<td>150.0 (33.8)(99-198)</td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01, ***p<0.001.

In many of the big courses there an impressive significant correlation between LMS activity and students grades. The correlation in itself does not allow inference on causal relationship between LMS activity and course performance. It is possible that it simply reflects that good students are active students, also in the use in LMS.

6.4.5 Interviews with MK students

In order to get more information about the MK students’ ICT knowledge, beliefs, values and behaviour it was decided to interview them individually. The author decided to ask the six MK teachers who participated in this study to assist in selecting students they believed to be willing to be interviewed by the author of the thesis as they knew what classes and student groups used ICT extensively in their learning. The teachers asked the students to participate but the request turned out to be rather unpopular among the students and they were not eager to be interviewed. In the end, six students volunteered to participate. Their real names will not be used in the thesis but a brief description given of each of them.

6.4.5.1 Method

Participants

Six students from language and science classes volunteered to participate, four males and two females. The male students were Baldur, a 16 years old natural
science student and Jón, Bolli and Emil, all 17 year-old social science students. The females were Guðrún, a 17 year-old social science student, and Nanna, an 18 year-old nature science student.

**Instrument**

The interview with the students was semi-structured and the author of this thesis prepared short guidelines (see Appendix VII) in advance where the main focal points were listed in order to guide the interview.

**Procedure**

The six MK students were interviewed individually by the author of the thesis in February 2005. The interviews took place in a quiet room at MK. They were recorded and subsequently transcribed. The students were asked some open questions and were encouraged to talk freely about ICT in their learning. Each interview lasted about 20 minutes.

**6.4.5.2 Results**

The transcription of the interview was analysed, as before, grouped into themes, compared and regrouped, combined and constructed in order to answer the research questions. The analysis of the individual interviews resulted in the six themes: *practical aspects, communication with teachers and students, learning and ICT, information search,* and *attitudes to other students.*

**Practical aspects**

The students were all active users of ICT and LMS was the main tool for receiving material from the teachers, organising the learning and for communicating with teachers and sometimes other students. They said they were frequently getting assignments and sending solutions to the teachers, taking interactive exams or quizzes. Here they seem to describe more use of interactive exams than in the survey (Section 6.3.1).

The students used the laptop to search for information on the Internet, write essays and work on projects and assignments, make slide shows and organise their learning. They saw technology as a tool for helping them in their studies with the use of common office software and the LMS. Nanna, Bolli, Baldur and Jón mentioned the calendar in LMS as a very important tool to follow the course schedule and see what was going on in the course. Baldur mentioned that sometimes teachers were late in placing material online and some of the students were not looking at it all the time so they neglected what was going on. They liked the teachers to organise everything in the courses and put the schedules on the LMS. They claimed it was a great advantage for them and emphasised the practical use. This confirmed the results from the survey, the teacher view (see Section 6.3.2) and the classroom observations that the
students were active ICT users in their learning process and that the LMS was frequently used.

Four of them, Nanna, Guðrún, Jón and Bolli, mentioned how much quicker they were writing on the laptop than on paper, but their main emphasis was on how good it was to organise their learning or as Bolli commented:

... you don’t use all this paper. You have it all in one place. I am maybe not the most organized person but this helps me to have everything in one place and I know where it is. You can access it wherever you are; you can go out to the country, go to LMS and do the assignments. You don’t have to worry about forgetting or losing something (Bolli, individual interview, 12.04.2005).

The students were active ICT users and clearly saw the usefulness of ICT in everyday school work which is in accordance with the results of the survey. They wanted well-organized teachers who provided good support to them; with the schedule online it made it easy to follow the coursework. They liked to have everything ready in advance; they didn’t like last minute changes on the schedule. They placed demands on the teachers and wanted them to be active ICT users for the benefit of the students.

**Communication with teachers and students**

The students met the teachers 4-5 times a week in class and could discuss things and ask questions. All the same, they claimed online communication could be useful to send enquiries and files to the teachers and fellow students. They emphasised that LMS offered online discussions both real time and asynchronous and e-mail could also be used. All the students claimed they communicated with the teachers via e-mail, mainly to hand in their work. They rarely sent questions to the teachers although they thought it was a good opportunity to be able to do so if they missed class or when the school was on short holidays as Baldur said:

...only rarely, if it is winter break and we have a project to do, then I send him an e-mail, otherwise I just talk to him [in class] (Baldur, individual interview, 12.04.2005).

This is in line with the survey, the students were not often chatting online or sending e-mail in the classroom but those options were more frequently used outside the classroom.

Internet search and communication with e-mail and MSN was frequently used when the students had to work together. Guðrún, Jón and Bolli mentioned
using MSN Messenger to send other students asking for notes if he/she had missed class. Jón spoke especially about using MSN when he was working with a person who he did not know well. All the students emphasised that the group had to meet when working together in order to start the work. After that, each one did his/her part in the project, they sent their parts between them via the Internet and tried to meet to finish the work as Nanna explained:

We were in Geology class working on a group project and could not finish it. Then we divided the rest [of the work] between us and sent the files between us. But I like it better when you meet and work together, but we use the ICT to work on projects (Nanna, individual interview, 12.04.2005).

The students called this type of work co-operation and group work although most of the work was done on an individual basis, with some communication through the Internet and little face-to-face contact. The students were using online sources and sharing material online but not really working together online. They did their part of the work and sent it to others but did not seem to discuss each other’s work or reflect on it.

The students were frequently using the Internet for communication, but it was more often not related to their learning. They welcomed and used the online communication via LMS and e-mail, but they didn’t seem to need it frequently in relation to their learning as they could meet other students and the teachers in school.

Learning and ICT
The students were all active in using the most common software in the school, i.e. LMS, word processor and presentation programs, and some of them were using spreadsheets, online quizzes and online communication. They liked to receive material from the teachers online, take notes in class using the laptop, search the Internet for resources when doing assignments and organising their learning with the help of the LMS. The use of ICT seemed to be dependent both on the subject and the teacher. In some subjects, like language studies, ICT was used frequently, also in social sciences, but less frequently in mathematics and science. This is supported by the information from the LMS log files, where the average number of hits (use) in the LMS was highest in the language classes.

In subjects where ICT was not frequently used, the use seemed to be more dependent on individual teachers. Nanna mentioned two mathematics teachers, one being a frequent user of LMS and the Smart board while the other hardly used it. She mentioned active use of ICT in chemistry classes where she was used to working in Excel while Jón would have liked to see more of ICT use.
in his chemistry class. He said he would especially like to see more use of the Smart board in class because he likes to follow the teacher without taking notes at the same time, as he said:

... when the teachers use the Smart board I do not have to write it down in the book; just get it on the Internet. I find it very convenient, you can just see how the teacher does it, [you] do not have to spend time on it yourself and find out [how to do] (Jón, individual interview, 12.04.2005).

The students saw the advantages of ICT and Bolli was convinced that he was learning differently. He could do all the writing much more quickly with the laptop, he read as much as he could from the screen but he said he still preferred books as the laptop was too big and heavy to carry.

Discussion forum was mainly mentioned in language and social science classes where the online forum was used every week, but one of the students, Emil, said that he had still not taken a class that used online forum. The online discussion was related to the learning material and the students considered it a fine tool as Jón said:

I used it [online discussion] in English class last year; it was a discussion about a book. It was fine, it was fine to use. It was more convenient than answering questions in class. You could speak about what you wanted. But you could go a long way from the questions or discuss them in more detail; it gives you more freedom than discussions in class (Jón, individual interview, 12.04.2005).

Then online chat was mentioned, but not essentially for discussions, more to exchange information and ask for assistance, e.g. in project work. The students said that interactive quizzes or tests were frequently used, especially in language classes and it was highly appreciated by them. This is in line with the survey where the usefulness of the interactive quizzes was clear. What is noticeable from the survey is that the use was not according to claimed usefulness.

The students were keen to evaluate themselves and liked to take the exams again and again until they got 10 out of 10. These quizzes were not always a part of the course’s assessment; they were often only interactive practice tests or as Bolli said:
We use it a lot, then you can see right away what you get and the teacher does not have to mark them and you know where you stand ... I try to use it as often as I can ... I know it is there and use it to prepare for exams ... it is very convenient ... learned a lot (Bolli, individual interview, 12.04.2005).

The students emphasised that they had changed their learning. They followed the teachers, but took fewer notes. The search for material was much quicker on the Internet; they claimed to write faster when working on essays, projects and questions. Furthermore, organising their studies was more convenient and it was easier to follow the course schedule when online. They described how they used online material to support their learning, as Jón said:

... in history, I write much faster [with computer] than writing longhand text on paper. It is very quick and not boring to answer questions in history. There are many questions and one is quick because you are not answering on paper (Jón, individual interview, 12.04.2005).

The underlying tone was that ICT makes the learning much more convenient; the students claimed it was easy to organise the learning and follow the course schedule, easy to access material and communicate, and if they took online exams or quizzes they got the results right away. At the same time the students realized that they had to be active in taking part in the learning process. This is not only about students’ access to all the material; it is also about following the schedules of the courses, working on the content and being active in enhancing their knowledge and competence.

**Information search**

The Internet was a source of information for the students and was used frequently when they were writing essays and working on projects, as well as when they were looking for more knowledge related to the different subjects. They liked the opportunities to get material for their learning as Emil said:

I think it [the Internet] is good, it is a good media. Better than going to the library, [You] can just click on one page and then you have good material. It is easy to go to a search page, write a search word and look at pages that pop up and we even talk about “googling” instead of using the Icelandic word *leita* for searching (Emil, individual interview, 22.04.2005).
The students were well aware of how great a resource the Internet can be because it contains information about almost any subject they can think of, and with good access. At the same time they expressed worries about the information they found on the Internet and were aware of that everything that is on the Internet must be evaluated before it is used. This is a quote from Baldur, who was the most sceptical one:

... when you are working on an essay, for example about a person and you go to a search page and search for material, then there is lot of material that people have made up. Not right references ... I feel it is better to have it in a book. Some believe everything that is on the Internet (Baldur, individual interview, 12.04.2005).

Guðrún mentioned that more sites with Icelandic educational material were needed, especially that there was a lack of Icelandic material about Icelandic writers, lyrics, songs and bands.

The interviews and the survey do confirm that the Internet had become one of the main sources of information for the students, to search the Internet was a daily routine and it had contributed to their learning activities.

**Attitudes to other students and ICT**

Students’ use of ICT in education can be different for different reasons, with some liking to use it more often than others. The students reported how they used ICT but also how other students used it. The students were worried about what their classmates were doing and four expressed strong feelings about the situation. They felt that other students were just playing games or using MSN for chat when they should be learning or as Nanna said:

I feel that students have less concentration than before. Many lose attention and go to play Tetris or something ... when you are in class and the teacher is muttering at the whiteboard, then everyone just plays computer games. It would be good to close the access to many sites on the Internet ... so the kids don’t spend so much time on the Internet (Nanna, individual interview, 12.04.2005)

They wanted the teachers to take more control over the use of the laptops and the Internet in class and tell them to stop using it when they were supposed to listen to the teacher. But they realised that the situation was not much different than before or as Emil said:
... they are the students who do not bother with learning ... You can always find something to do; this is not more disturbing and not more temptation. Either you learn or not, just like that. It does not matter what you have (Emil, individual interview, 22.04.2005).

In the end it is the students’ own responsibility to learn and it is possible that LMS, with all the material from the teachers, may give them a false sense of learning. All the material was available on LMS so they could relax and they did not even have to take notes. Baldur was worried about his fellow students getting spoiled and lazy when they got all the material from the teachers, but all the students interviewed realised that they had to be active and take part in the learning process, as Nanna said:

The teacher gives us a PowerPoint file before class and you can have it on the white board and also in front of you [on the laptop]. And if the teacher comes with extra comments you can write it in the notes window but it is, however, necessary to observe [the teacher] (Nanna, individual interview, 12.04.2005).

It is not enough just to collect the learning material; one must be actively engaged in the learning process, read, listen, watch, write, search, communicate, discuss, reflect and work with the learning material.

The students had strong opinions about how other students should or should not behave and were aware of that ICT could distract them because it seemed to be easy to mix school work with other activities. They knew they could use ICT for fun but they believed it didn’t limit their use of ICT for learning although they were concerned about other students.

### 6.4.6 Summary and conclusion of the student data

ICT knowledge, beliefs, values, attitudes and behaviours were investigated using five different approaches and both qualitative and quantitative methods. The survey gave information about what ICT options the students were using and how they evaluated the usefulness of the different options; the interviews gave a more comprehensive insight into their attitudes, knowledge, beliefs and values. Classroom observations showed the students’ behaviours and the log files, information of LMS use and the students’ grades gave a more holistic picture of their learning behaviour. The interviews and the classroom observations described the students’ behaviour in class as well as their attitudes to ICT. It should be noted that using classroom observation emphasises the usage within a particular class, using the survey gave information of the students’ ICT knowledge, use and attitudes, using the
interview gave more detailed insight into the students ICT use, knowledge, beliefs and values and the grades indicated the effect of LMS use. The interviews gave a qualitative picture with important themes that identified the students’ use very differently from the quantitative data.

The MK students who were approached in this study were willing to answer the questionnaire; the answering rate was 100%. The class observations did not seem to disturb their work but they were not very willing to be interviewed individually for the purpose of this thesis. They were not eager to reflect upon their own work with ICT and implied there was nothing to reflect on. Those who were interviewed gave the impression that ICT was nothing that needed to be discussed, it was available and they used it for their learning benefit. If it could help them more they wanted more of it. For them ICT had become a normal part of the school environment just like the teacher, the classroom and the curriculum; they did not see the reason why they should reflect on it. They did not see ICT as an innovation or something special - which is very different to the views of the teachers who participated in the study.

The MK students approached were active in using ICT in their learning and the results indicate that they used the LMS, online search and e-mail, both inside and outside class. The uses of ICT options were different in and out of class and practically all the options were used more frequently out of class. The students realised how useful many ICT options could be, although they were not using them frequently in their learning, e.g. e-mail, interactive exams and spreadsheets.

The students knew how to use ICT tools, especially for practical purposes, but their picture of how ICT could support their learning or how they could use ICT effectively to support learning above practical issues were not so clear for them. They accepted the teachers’ ICT affordances, ICT use in the classroom and they did not have strong feelings about new ICT use and options. They wanted all the teachers to be at similar levels in the ICT use, or as the most active ICT teachers were, but felt that this was not the case. They placed demands on the teachers’ ICT use and wanted them to be well organized with as much material as possible online. They wanted the teachers to be active ICT users for the benefit of themselves but the group who were approached did not have any new ideas of how ICT could support their learning. Their main concerns were that the teachers should take more control over laptop use in the class but at the same time they believed themselves to be responsible users.

The log files gave information about when students started to use the LMS and how frequently. In most classes they started to use LMS at the beginning of the semester and used it frequently over the semester, although the average frequency was different between classes and subjects. This could be related to
Data collection and results

Teachers’ affordances and their demands on ICT use in different classes and is in line with answers in the interviews, where both students and teachers reported different ICT use between classes, even in the same subject.

Online communication, as e-mail and LMS options, was used by all students and they emphasised the practical use when not being able to attend school or for group work outside class. Taking part in online discussion in relation to their studies was not frequently reported.

The different methods for data collection gave largely a similar picture of the ICT use in MK, but there were notable differences, which was probably partly due to the different samples. As an example, in the interviews the students described themselves as active ICT users and said they were frequently getting assignments and sending solutions to the teachers, taking interactive exams or quizzes. In the classroom observation, LMS and interactive exams or quizzes were also frequently used. In the survey the use of interactive exams or quizzes was not reported as frequently used, but LMS, online search and e-mail were frequently used.

Students’ attitudes and behaviours are influenced by barriers and stimulations that can be both external and internal. External and internal barriers and stimulations that were observed in this study are summarised in Table 16 in order to give an overview of the students’ attitudes.

Table 16. The students’ ICT barriers and stimulations, external and internal

<table>
<thead>
<tr>
<th>External barriers</th>
<th>Internal barriers</th>
<th>External stimulation</th>
<th>Internal stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of technology, hardware and</td>
<td>ICT can easily diffuse the student</td>
<td>Useful for organisation of their</td>
<td>Good digital skills</td>
</tr>
<tr>
<td>software</td>
<td>’s focus in their learning</td>
<td>studies</td>
<td>Makes learning convenient and</td>
</tr>
<tr>
<td>Lack of learning resources in</td>
<td>Lack of motivation to actively</td>
<td>Makes tasks related to learning</td>
<td>easier</td>
</tr>
<tr>
<td>Icelandic</td>
<td>participate in the learning (ICT)</td>
<td>easier</td>
<td>Positive attitudes to ICT use</td>
</tr>
<tr>
<td>process</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overall the students who were interviewed were active and positive in their use of ICT, they emphasised the practical usage and positive influence on their learning. They claimed that ICT made their studies easier; they were quicker to write and search for resources. They considered ICT a helpful tool for communication, organisation, and for tracing on-going activity in the courses. They had a lot of opportunities for using ICT and they could use them when it suited them. The students believed that ICT was having a positive and helpful impact on their learning; it had changed their learning in a convenient way. Emil summarised this well when he said:
Why not ... I use the laptop as a helping tool ... I find it very convenient, much easier to organise my notes and everything I have. It is easier to get access to material from the teacher...the teacher puts old exams and material there and we can use it to prepare for exams. When you have got the keyboard skills you are much quicker to take notes and can also skip writing notes in the class and just listen to the teacher, he will send you the slides. You can just take a few notes instead of writing it all up, it is convenient (Emil, individual interview, 22.04.2005).

Despite the affordances offered by the ICT circumstances in the school, this comment reflects a very pragmatic and fairly low-key use and attitude, which can be said to dominate the general picture obtained. Thus a major impression from all the different sources of data from the students is one of efficiency and convenience, making traditional tasks easier and organization less cumbersome. There were examples of new kinds of tasks but they were definitely not in the foreground. Also, despite the general positive attitude and high general level of use of ICT exhibited by the students, there were certainly very notable differences, both between the students and the different courses, even courses taught by the same teacher. The students certainly reported different use in different subjects and also between different teachers in the same subject. There were individual differences in the ICT use among the students, both in attitudes and in actual use. Some saw clearly the benefits while others where more neutral in their attitudes. The general level of use varied greatly, the relative use of the different tools, the frequency of use, the time the students started to use various tools such as the LMS, and thus the individual user profiles.

The students did not have any comments regarding how the teachers could use ICT in a different or a new way. They wanted them all to be active using ICT but had no new ideas on how ICT should be used in education. They were concerned that other students might not be using the technology in a proper way for learning purposes and also wanted the teachers to take more control over the students’ use of laptops in class.
6.5 Summary of Chapter 6

In this chapter the data collection described and results presented, first for the MK teachers and then for the MK students. Different research methods gave different information as summaries in the Sections 6.3.5 and 6.4.6, and the data together gave good in-depth information about the use of ICT in MK and the teacher and students’ knowledge, beliefs and values and behaviours. The findings indicate positive attitudes of both teachers and students toward ICT use in education based on their ICT skills as well as their experience of working in an environment that emphasises the use of ICT with good access to technology.

The participants did not complain about their lack of ICT skills but the teachers were worried about the time they had to spend teaching the students specific ICT skills needed for their study in some classes, e.g. to use spreadsheets. The students claimed that not all teachers were well-prepared to use ICT or did not use it as much as they could. This was, in a way, supported by the teachers’ comments and both teachers and students reported different use in different classes, even within the same subject. This shows the importance of the assignments and the projects the students were working on. If ICT is a supporting tool the students must have a reason and a need to use ICT in their work. The teachers gave examples of how successful some assignments and material had been, e.g. WebQuest, interactive listening exercises, online exams and use of spreadsheets. They also gave examples of successful projects that motivated students with learning disabilities but were disappointed that they could not reach out to all students, especially not those who were not so eager to study.

The ICT barriers for teachers and students have different roots but lack of resources seems to be a common barrier for both groups (see Table 6 and Table 16). The teachers felt disappointed that they had not been able to grow or blossom in their endeavours in the way they wanted and could not now, any more than before, motivate all students. The students took ICT for granted, just as a tool for them to use in their daily school life. The motivations were also different although the convenience feature was a common element. The teachers had a desire to use ICT and believed in the changes the use could support, the students were willing to use teachers’ affordances to make their life as students easier.

The teachers participating in the study, with one exception, were eager to use ICT and had a strong belief in how it could and had changed their teaching. They spent a lot of time preparing to intertwine ICT into their teaching and the students’ learning, and were searching for new methods and material. They emphasised that ICT use had to be from various viewpoints to help different
students and how important it is to motivate and activate students with the help of ICT. They saw obvious influences on ICT use on good and average students but wanted to have more success with inactive students. ICT had not turned out to be the magic wand they were hoping for but it had given them possibilities to develop and change their teaching.

When interpreting the results one must bear in mind that the students’ use of ICT options in their learning may be dependent on the teachers’ affordances, what the teachers wanted them to do, demands and the nature of the assignments and the projects the students were working on. The students had a practical focus on ICT use and wanted the teachers to support their learning with organised and active ICT use. They might not have a clear view of how ICT supports learning but they knew it could be useful and used what was available and at hand. Convenience was a common aspect among both the teachers and the students.

The data obtained from the two groups, the teachers and the students, were very different at the ideological level. The teachers wanted to change the way education or teaching was carried out, whereas the students wanted life to be more convenient and efficient. At the pragmatic or practical level the difference was smaller. The principal effect of using ICT, whether seen from the teachers’ or the students’ perspective, was quite similar, i.e. convenience and efficiency, even though this statement is an oversimplification.

Some of the ICT options mentioned in this chapter could be classified as non-interactive and quite traditional as taking notes and writing text while other options make full use of the potential of the ICT environment as interactive exams and online communication. Some ICT options support the learning process while other options are used while learning. Some ICT options were used frequently by the MK teachers and students and should be looked at as traditional while others were thought of as very useful but not used in accordance to that belief.
7 Discussion and interpretation

7.1 Introduction

The purpose of the research was to gain a deeper understanding of the issue of ICT in education in a situation where ICT is widely supported. It is a particularly complex field, due to the different interpretations of the concepts used, and the different views people have of the usefulness of ICT in education. A number of factors related to ICT use in education were reviewed, analysed and discussed in the thesis. A case study with multi-method approaches with different studies was conducted in order to answer the research questions. In this chapter the main findings and implications are discussed in the light of the theoretical section, focusing on a number of theoretical frameworks and the research questions. First we look at general trends and two main conceptual frameworks describing the development of ICT use in education that were emphasised in Sections 2.3, 2.4 and 2.5.

Fox and Twining’s (2006) overarching rationale for ICT use in education and ten Brummelhuis and Kuiper’s (2008) driving forces of ICT in the learning process were the starting points that lead to the research question:

1. What are the influences of government and school policy and the infrastructure of the development of ICT use?

Then the thesis turns to its main focus on the teachers’ and students’ ICT use, in connection to ICT pedagogy. The research was conducted in one upper secondary school in Iceland, Menntaskólinn í Kópavogi. The theoretical background was primarily based on two sources, both derived from Shulman’s (1987) conceptual framework of pedagogy, the framework proposed by Webb and Cox (2004) for pedagogical practices relating to ICT use and the Mishra and Koehler’s (2006) technology pedagogical content knowledge (TPCK) framework. This led to the following research questions, which are essentially two questions, one pair for the teachers and one pair for the students:

2. What are teachers’ knowledge, beliefs and values regarding ICT use in an Icelandic upper secondary school?

3. What are those teachers’ ICT pedagogical reasoning and behaviours? What ICT learning activities and affordances do they utilise?

4. What are students’ knowledge, beliefs and values regarding ICT use in an Icelandic upper secondary school?

5. How do those students use the ICT affordances accessible and what are their ICT learning activities and behaviours?
It should be reiterated here that the data gathered for this study was mainly and intentionally from eager ICT teachers in MK and their students, in order to investigate the frontiers of the innovative effort of ICT use. The attitudes of other teachers, less interested in using ICT in education, were not investigated further.

7.2 The implementation of ICT in an Icelandic upper secondary school

The focus in this section is on the influences of government and school policies and the ICT infrastructure on the development of ICT use in education?

In MK the ICT implementation started in fact in the 1980s with an early emphasis on the use of computers in educational work, where a number of teachers took an initiative to promote ICT in their teaching. This underscores how deep the roots of the project are. Later, the government policy in 1996, with emphasis on intertwining the quality of education and the mastering of ICT for education, and the new National Curriculum in 1999, encouraged the school to go further. An important step was taken in 2000 when it was decided by the MK governing board, in close liaison with the teachers, to provide teachers with laptops, put wireless connection in the entire school building and encourage the students to bring their own laptops. In order to support the ICT implementation the teachers were offered ICT courses for preparation, and they took part in ICT developmental projects and ICT conferences. The MK authority’s goals for the ICT implementation can be summarised in, a) getting the technology into the school (for both students and teachers), which was quite a step at that time and very costly, and b) to introduce the basic concepts and knowledge of ICT use to the teachers, for most of whom this was a major effort to utilise.

The MK’s policy and the attitudes of most of the teachers went hand-in-hand with the implementation of ICT. From the interview with the headmistress it may be inferred that although the ICT policy was in place in 2000, it took up to five years to get the majority of the teachers actively involved in making at least some use of ICT in their teaching. Some of the teachers implemented ICT in their work with active use of the LMS and the Internet while others just did the minimum adjustment with almost negligible LMS use (see Sections 6.2 and 6.3.1). This clearly illustrates the length of time it takes to implement ICT in education, even though it is supported by the government, school policy, a technologically well-equipped environment and preparation of the teachers. The study also indicates how difficult it is to assess the extent and quality of use in absence of very clear criteria against which to judge the changes intended, and these were not in place. Tondeur, van Keer, van Braak, and Valcke (2008)
claim that school policies are often not fully utilised, and that ICT integration is often not accomplished in a systematic way in schools. They emphasise a collaborative approach of the school authorities and the teachers in this context. They also argue, based on their own study and others (Hughes & Zachariah, 2001), that the influence of clear ICT school policy culminates in teachers using ICT more regularly in their classroom.

The findings imply that MK was, in a way, a successful ICT school as the corpus of the teachers had embraced the general idea of using ICT in education, according to the headmistress. MK can also be described as a flourishing ICT school where ICT use was common and applied in most school work. The school was successful in the sense that all the teachers had good conditions to use ICT and the students were encouraged to bring their laptops to school. The ICT pedagogy, the vision and objectives for improvement were in agreement within the school’s staff, but the level of enthusiasm was definitely not equal among all the teachers. The headmistress believed that most of the teachers were using ICT appropriately in their educational work, but a majority of the teachers were not eager to speed up the ICT development, although they used ICT up to a certain level (see Section 6.2.3). This is in line with Cuban (2001) when he argues how complicated the implementation and development of ICT is in education. There was also a group of teachers who were eager and ambitious in their ICT use and some of them took part in this research. They were enthusiastic to take the development to another level and wanted not only to use ICT in class but also to change the organisation of the school and the timetable (see Section 6.2). This underscores the difficulty to get everybody to tow the same line.

Fullan’s (2007) suggestion that “success it not just about being right; it is about engaging diverse individuals and groups who are likely to have many different versions about what is right and wrong” (p. 40) may be invoked to indicate that MK was on the right track in implementing ICT as all teachers were using ICT although they were not all completely following the school’s and the government’s policy. Without a clear measure of the spectrum of ICT use this is difficult to establish, even though it may be a fair claim.

The ICT development in MK did not stop when most of the teachers had started using ICT in their work. The headmistress believed that the teachers had been given good ICT support - or as good as the school’s capacity allowed for continued development. The keen teachers who participated in this research did not complain about lack of daily support from the school authorities as such. They received support to start the ICT use, daily attention to technical problems, but they nevertheless wanted more support for continuous and faster development and they felt, in particular, that structural changes were
needed. This relates both to the physical environment and the organisation of the school work.

According to the headmistress, many teachers at MK have worked hard to implement ICT into their teaching and the group of pioneers that took part in the Distributed learning development projects, discussed in Section 6.2.3, wished for more support from the school authorities to enable them to get further on and broaden their ICT use. They believed that organisational changes and rearrangements were needed; a typical school building has many corridors and class rooms that do not support interdisciplinary education, today’s ICT use and active cooperation among teachers and students. As reported in Section 6.2.3, the participants in the interviews did not feel the school authorities responded to these pioneers’ request as the majority of the teachers were not ready for the changes at that time. There was a conflict between a group of eager and ambitious ICT teachers and the rest of the teachers who were more cautious and not ready for major changes of the timetable and reorganizing of the school building to support more intensive ICT use. They were not ready to ‘open up’ the classroom and the MK school authorities were therefore not ready to make changes, and probably could not have done so.

The resistance to further change was a disappointment for the ICT pioneers who felt a backward slide in the development of ICT use in MK. They wanted a shared vision to be more than just using ICT in closed class rooms and for homework and a shared commitment to integrate ICT further. They felt that the school authorities were not allowing initiatives from the active teachers to fully blossom and in that sense the ICT use, even by the most ambitious teachers, was partially constrained.

In MK a long-term plan for further implementation of the policy for ICT influencing educational change had not been developed at the time of the research. In other words, how to get further than the very important initial stages of ICT use in the classroom was not planned in advance. It seems as if the affordances of the new technology in MK was somehow taken to be implicit in the tools, and sensible ICT use would unfold as soon as it was in place. Teachers are considered the main actors in educational change (Fullan, 2001; Sarason, 1993; Shulman, 2004; Fullan, 2007; Hargreaves & Shirley, 2009) along with school authorities. For school policy to have an influence in the classroom the teachers must have similar values (Kennewell, Parkinson, & Tanner, 2000). ICT innovation in schools can start with pioneers among the teachers that lead the way and often get some of the fellow teachers to join them. But if the innovation is going to be embedded into the whole workplace then the entire school community must take part. In order for substantial changes to take place and be sustained they need support from the teachers, the students, the school
authorities and the school environment. The development in MK was in line with this.

Integration of technology into the teaching process builds on many factors and teachers’ knowledge of a range of technologies and the affordances related to their pedagogical beliefs and reasoning are among those factors. Research has suggested that teachers’ pedagogical reasoning influences teachers use of ICT (Becker & Ravitz, 2001; Beetham & Sharpe, 2007; M. Cox, Abbot, et al., 2004; Zhao, Pugh, Sheldon, & Byers, 2002) and as Wood (2003) says that:

... any beneficial impacts of ICT and new pedagogical practices on learning can only be expected when the constraints imposed on the teacher-learner relationship by institutional goals and practices are brought into alignment with those required for innovations in practice (Wood, 2003, p. 4).

The implementation of ICT in MK was successful to a certain extent, but the strategies to further direct educational changes were not thoroughly planned. Therefore the important elements of using ICT as a fruitful and novel tool for teaching and learning were not seen as a crucial part of the strategy, even though, according to the headmistress, most staff members probably agreed that this was the aim. When the first two steps in MK (getting technology into the school and introducing the basic concepts and knowledge of ICT) had been taken it might have been believed, both by the authorities and the majority of the teachers, that the goals had essentially been reached. The MK authorities wanted changes also to be undertaken in cooperation with the majority of the teachers and this seems to have slowed down the development, at least according to the enthusiastic teachers.

The development in MK fits well with the discussion in the literature and especially the ten Brummelhuis and Kuiper’s (2008) framework for driving forces of ICT in the learning process. At the beginning the driving forces in MK were operating through the ICT infrastructure with the technological push, were ICT was the tool to introduce material to students and motivate them. Later the teachers became the driving force with their interest in developing ICT use and taking part in developmental projects. All the teachers who participated in this study, except one, believed in the beneficial impact of ICT and had developed new teaching methods and changed their work accordingly, but this was not supported by the majority of the teachers. Most of the teachers participating in the study believed from the beginning that ICT could help them develop their pedagogy and change their teaching (see Sections 6.3.1 and 6.3.2). They included ICT into most of their activities and defined the ICT affordances they wanted to offer the students. The teachers were aiming at a
more student-centred learning environment with the help of ICT and this supported the students to evolve as a driving force as they were more actively involved in controlling their learning with supervision from the teachers (see Section 6.4.3). All this was, at the same time, in line with the school environment, the school and government policy and supported by the fact that the students were bringing their own laptops to school. Although there were some signs of a more student-centred learning environment with the use of ICT in MK to motivate students’ behaviour and giving them more control over their own learning (see Sections 6.3.1, 6.3.2 and 6.4.3), the teachers were still in control of the teaching and the learning. They were the strongest driving force of ICT use in MK.

The main conclusion is that at the beginning of the century MK was a promising ICT school that supported ICT educational environment. As time went by the implementation of ICT continued, but the school authorities and the majority of the teachers were not ready to go beyond a certain point, they were not ready to make major organisational changes in order to develop ICT use further and faster. This is in line with other research findings that stress teachers’ need for significant support with ICT integration (Lai & Pratt, 2004; Hays, 2007), not only at the beginning, but during the whole process and this should be stable all the time. It is not sufficient to start implementing change; change will progress continuously only with steady support. Thus the teachers need unbroken support to develop already initiated familiar ICT options, to introduce new ICT opportunities and to use technical devices in order to develop their ICT pedagogy further. There needs to be cooperation between school authorities and teachers to foster progress, but sometimes the authorities have to take the lead or support the initiative taken by those in the frontline, and take the work to a new level and introduce new order of things, even when there is not agreement among all teachers. There is a necessity for continuous educative leadership for ICT integration (Webber, 2003). Thus, while there was genuine support from the school leadership in MK, it did not sustain the proactive initiative taken at the beginning and, in particular, did not venture to make organisational changes that the most active teachers felt were necessary.
7.3 ICT knowledge, beliefs and value

Now the focus will be placed on the two research questions addressing the teachers’ and the students’ knowledge, beliefs and values regarding ICT use in an Icelandic upper secondary school.

The teachers in the study had positive attitudes towards ICT use in a very general sense. That is why they were asked to participate in the study. The interviews and diaries showed that teachers who have sufficient knowledge of ICT in education and are active users of ICT in their teaching have a strong belief in the positive influence of ICT on their teaching and on the student’s learning. They believed that ICT provides opportunities for changes in their teaching from teacher-centred teaching to more student-centred learning and they believed that through ICT they could improve their learning process. They saw ICT as a potentially powerful tool for change in their work. Apart from using ICT in a practical way to organise teaching and learning, the MK teachers wanted to use ICT for collaboration and communication, to orient student work and to support knowledge building with realistic, independent activities that made the students more responsible for their learning. The teachers saw a clear change in their role as teachers. They believed that ICT supported changes in their teaching that gave them more opportunities to take notice of students’ individual differences in order to improve their learning. They were not just using ICT; they were considering its influence and rethinking the pedagogy. The MK teachers’ rationales for ICT use match two of the three categories from Fox and Twining’s (2006) list (see Section 2.3), that is quality of education and students mastering ICT for education, work and future life. The organizational and motivational aspects of ICT use in education among these teachers are clear in this study, but the efficiency or productivity arguments are not often mentioned, and then mainly in relation to students who are eager to learn and those who have some learning problems (see Sections 6.3.1 and 6.3.2).

Turning the focus towards the students, generally there has been a growing understanding of the importance of students’ attitudes towards ICT use in their learning and its influence on ICT use (Marshall & Cox, 2008). The attitudes of the MK students approached in this study were not exclusively positive; there were some voices of concern in the interviews, not of their own ICT use but of other students’ use that the teachers did not keep under control (see Section 6.4.5). There were also complaints about not all teachers being as active ICT users as they should (see Section 6.4.5), which again brings up the importance of coherence among the staff for change to be effective. The students supported ICT use in a general sense, but they were mostly passive, but generally ready, receivers and although they reported in the interviews that some teachers could use ICT more, they were not pushing them in the direction
of further development. It can also be concluded from the interviews that although the students know how to use ICT in their learning, they did not consider ICT to be something remarkable and unique, they simply saw ICT as a useful tool and therefore they used it. The general conclusion is that the students believed in the usefulness of ICT and emphasised its practical contribution.

Webb and Cox’s (2004) framework emphasises the important components of the ICT pedagogical practice at any given time and they make it clear that the teachers’ and students’ knowledge, beliefs and values are important but also that they are changing all the time. Technology is also constantly changing and the MK teachers tried to follow the rapid technological development and to implement new options into their everyday teaching. They explored the prospect of ICT for learning and felt they had to be innovative and not afraid of trying out new options. Webb (2002) notes that “…it is important for teacher not to be overwhelmed by trying to master all the details of software but to focus on the main features of types of software and how to find information about the detailed techniques” (p. 253). The teachers in question did not get paid extra for their enthusiasm; it was not just included in their normal working day, it was a larger part of their lives. From the interviews it can be concluded, that as intensive ICT users, they also had to have the confidence to integrate ICT into their work. Sometimes they thought they had seen it all but realised that they were wrong in the sense that ICT development does not stop. There were new opportunities, not only in new software and hardware, but also in unused opportunities afforded by the ICT tools they already had (see Sections 6.3.1 and 6.3.2).

Most of the MK teachers approached in this study had integrated different ICT software and hardware into their teaching, e.g. laptops and interactive whiteboards, the Internet and LMS as Sections 6.3 and 6.4 shows. For them ICT was neither just a tool for distribution of materials nor administration. They did not see ICT as an add-on tool and not just an extension of what they used to do. It was clear from the interviews that they thought firstly of the educational applications of ICT and secondly of the technology itself. They realised that because of the continuous development of software it was not important to learn to use all software and hardware but rather to have the attitudes and willingness to use ICT in general. Some decades ago the research focus was on technically effective integration of ICT into education but since the 1980s the focus has shifted more toward studying attitudes and abilities (Marshall & Cox, 2008; Cox, 2008) as well as observing ICT learning actions, behaviours and skills. Cox and Webb (2004) have emphasised the importance of researching teachers’ beliefs and behaviours in order to understand their ICT use. This study reveals that for teachers to use ICT in a productive way they have to believe in its usefulness, be creative and innovative.
The technological knowledge of teachers and students was not seen as a hindrance as such in the study but the teachers wanted to have more time to develop their ICT use, search for new software and implement it into their work. The students were well aware of the usefulness of different ICT options but their use did not always match with what they claimed was useful (referring to Figure 12). The teachers and the students approached in this research had knowledge of how to use ICT in education, they believed that it was good to use ICT and they were convinced of its value.

7.4 ICT pedagogical reasoning

The focus will now be shifted to the research questions: What are those teachers’ ICT pedagogical reasoning and behaviours? What ICT learning activities and affordances do they utilise? We will start with ICT pedagogical reasoning.

Koehler and Mishra (2006) emphasise, with their Technological Pedagogical Content Knowledge (TPCK) framework (see Figure 4), that teachers’ knowledge of content, pedagogy, and technology interact in a complicated way. The MK teachers understood the concepts of their subject (content knowledge), how to operate the tools they were using (technological knowledge), and their classroom practice was tailored to the different student groups (pedagogical knowledge) (referring to Chaia and Limb’s example in Section 2.5.1). All this is reflected in their use of ICT affordances and shaped the learning activities in the classroom as emerged in the different studies in this thesis (e.g. Sections 6.3.2 and 6.3.3). It can be said that the interactions described in the TPCK framework were the main determinants in the ICT development of the MK teachers. It is clear, especially in the interviews, that the teachers’ technological knowledge influenced their pedagogy and the educational content, and encouraged them to aim for further pedagogical changes. The interactions in the TPCK framework appeared in the MK teachers’ work, the technological content knowledge (TCK) in the teachers’ knowledge of what ICT tools fit the different contents, the pedagogical content knowledge (PCK) in the teachers’ knowledge of how to use different ICT tools for different content and the technological pedagogical knowledge (TPK) in their knowledge of how to use the different ICT tools. Finally, it can be said that their TPCK appeared in the various ways they presented the content with ICT using their knowledge of pedagogy and technology with the awareness of alternative teaching strategies that ICT can support.

The influence of the content on technology and pedagogy emerged in the teachers’ interviews, and even more in the students’ interviews, where they described how differently ICT use appeared in different courses. Different
content calls for different ICT use, e.g. language and mathematics, but the ICT options available also fit differently to different contents. This is in line with the Koehler and Mishra (2006) TPCK framework as the teachers’ knowledge of technology, pedagogy, and content and their interaction links and reflects in their work. The teachers search for ICT affordances, which is in line with the content, and they implement what they think is best for the student group at any given time. The MK teachers’ pedagogical knowledge was embedded in their teaching practices, the possibilities afforded by the technology, and the students’ activities. This is in accordance with Webb and Cox’s (2005) suggestions that the teachers and their approaches are the critical factors in the use of ICT in learning and teaching.

The teachers were using their knowledge of technology to develop their teaching in connection with the students’ backgrounds and skills, which Koehler and Mishra (2009) highlight as an important foundation for ICT development in education. This also highlights the importance, as evident in the interviews, that the teachers must have knowledge of the all three components, the pedagogy, the content and the technology.

7.5 ICT behaviours

The MK teachers in this study harnessed the usefulness of ICT to the extent that they laid out the courses, planned the semesters, and had all projects and assignments ready within the LMS (see in particular Sections 6.3.1 and 6.3.2). They wanted to use ICT to offer students good learning material and well planned tasks and assignments, i.e. good affordances, but nevertheless, in a rather traditional sense as they were bound to the national and school curriculum and the school organisation of the education programmes.

It was easy for them to have an overview of each course with LMS and when the teaching started they could easily follow the students’ work, they offered them a lot of course material using ICT, some compulsory and some not (see Sections 6.3.1 and 6.3.2). Eager students could work with the extra material autonomously, online or not, and at their own speed, go fast one day and slow the next one, and students that needed extra training could gain from this. Nevertheless, it was up to the students to make use of all the ICT affordances offered to them and as the survey reveals in Section 6.4.1, their use was mainly using rather traditional tools, e.g. word processing and e-mail. At the same time as the teachers used ICT to support learning, they were worried that not all the students were motivated or interested in taking an active part in the school work. The teachers encouraged them to take advantage of the ICT environment, sometimes with good results but not always. ICT had not proven to be a magic tool which enabled them to reach out to all the students, as was reflected in the interviews.
The findings, especially from the interviews and classroom observation, indicate that the learning environment at MK was multifaceted and the use of ICT was different in different classes and also out of classes; all options that students were asked about were used more frequently outside the class, except slide presentation programs. The classroom observations showed different use of ICT in different classes but most of the time student are following the teachers’ presentations and taking part in project work. Students studying the same content in different classes reported different ICT use, which clearly depended on the individual teacher’s behaviours. The ICT use had a strong relationship to the teacher’s ICT affordances and demands. This is in accordance with Webb and Cox’s (2004) assumption that the ICT affordance is quite different for different subjects and here it is even different in the same subject with different teachers. This also supports findings from many researchers on how complicated the implementation of ICT is in education (Baron & Bruillard, 2007), what works in one situation does not have to work in others (Fullan et al., 2009). Athanassios (2012) present a good example of the situation where 14 interesting studies are described and 10 of them can be classified as small-scale studies with less than 36 participants, and only 2 having over 100 participants. The main emphasis in the studies was to test different software and methods to fill the knowledge gap as regards new types of learning but without transferring the knowledge into big-scale research projects. This example suggests that more needs to be done to obtain research evidence, which can be translated into practice.

It may also be inferred from the interviews and diaries that the MK teachers wanted to influence their work with ICT in class, and they also wanted the students to become independent in their work, to work alone or in groups developing their abilities, knowledge and skills. They wanted the students to be able to work at their own speed, learn, at least partly, using their own methods and strengthen their personal characteristics. Their goal was to enhance certain skills related to the subject matter and to support deeper understanding of the learning material and they saw ICT as an important tool to support this learning process. The students were not as much bound to the classroom as before and they did not have to follow the group; they could work on different projects at their own speed. The teachers believed that their work and role had changed with the support of ICT; it had opened up new possibilities for them to make progress in their work and even make their work more enjoyable. In the interviews and diaries they described how they had changed their classroom practices and were offering more activity to support learning with ICT. In their mind there was no way back, ICT was there to stay and improve their work; it was, they felt, integrated in their way of teaching. Their role was that of an educator who asks the questions: What do you know? What more do you want to know? What can you do? How can you operate in different ways? How can I assist and support you?
As was expected, the MK students approached in this study claimed that ICT use was practical, pleasant and appealing. To use computers was not new for them; they seemed to have good digital skills and ICT abilities to use what was available at any time. They saw ICT as a normal part of the school environment and their learning process, ICT was a tool that made their learning easier and even more challenging, e.g. to evaluate themselves (see Section 6.3.2). In the interviews the students did not express innovative beliefs in ICT or give comments loaded with eagerness. When ICT was available, they used it for their everyday learning profit. ICT was not challenging for them, they had knowledge of and believed in the use of ICT but their knowledge of recognised technologies for learning was limited, it can even be said that their ICT comfort zone was rather limited. The negative aspect was mainly, as mentioned before, regarding other students’ ICT use and teachers who could be more active ICT users.

Some MK students were extensive ICT users to support their learning, to find and work with information and for communication in a complex and changing learning environment as the survey and the interviews show. This is in line with Conole, de Laat, Dillon and Darby (2008) who found out that students’ use and experience of technologies “...are immersed in a rich, technology-enhanced learning environment and that they select the appropriate technologies to their own personal learning needs” (p. 511). ICT has brought a different freedom to students where they can have more control over their learning, without and away from the guidance and guardianship of their teachers (John & Wheeler, 2008). The MK students were using this freedom in a practical way to make the learning process more easy and convenient. This is further in agreement with Conole, de Laat, Dillon and Darby (2008) who concluded that “students are adept at finding and manipulating relevant information and synthesising across different information sources and use a variety of communication tools to support their learning needs” (p. 519).

Using online options for communication can be easy and convenient; students can send queries to teachers and other students at any time. This opportunity can increase the communication but it may also change the nature of the communication. Online communication offers all students an opportunity to participate at their own speed and can give them time to reflect and look for resources. There is less time pressure; students do not have to give comments here and now online, like in the classroom. With online communication it may be easier for the students to follow each other’s work and contribution. It is easy to follow students’ contribution and also obvious if they do not participate online. Nevertheless, it is a different kind of communication and cooperation to send a file or a message between fellow students than it is to sit together with them and work together on a project. Some students may be more active online but others may be more active face-
to-face and using both methods may meet the needs of the broader student group but also train them in different types of communication.

This brings up the issue of the all-or-none aspect of the discourse in ICT, whether it has to be used all the time, in all subjects and in all circumstances by all students. It is now clear from the literature that different levels of use are determined by circumstances and people may decide its appropriateness.

The teachers wanted the students to work together on projects and cooperate, with or without ICT. The interviews echoed how practically-minded the students were and how they saw the usefulness of ICT in group work, especially out of class. They wanted to use ICT and to meet face-to-face but their description of the online group work did not give a picture of collaboration, reflections and discussions. It was more like putting together pieces in a jigsaw where each person came with his or her part in a project, irrespective of whether it fitted or not. It was a sensible sharing of workload but the final processing of the group work was often missing. This was not in line with the teachers’ idea that there should be more group work and communication among the students with the support of ICT. This kind of schoolwork can of course be done with or without ICT but maybe the use of ICT encourages this kind of jigsaw work. The students were given the responsibility to manage group work and they organised it practically, at the price of co-operation and teamwork, by just splitting the work between themselves with little cooperation. Group work in education is supposed to foster co-operation and teamwork but in a way ICT use in MK seemed to foster more independent or individualised work as it appeared and developed. Both the teachers and the students reported their concern about this. This raises the question of how group work with ICT should be organised and implemented in order to foster communication, cooperation, interaction and peer-work. It also brings attention to the fact that the use of ICT may call for different things being taught instead of traditional material; perhaps students now have to be taught to use ICT effectively in group work in order to achieve the aims intended by the teacher.

The results from the different studies presented in this thesis give a picture of teachers who apparently tried hard, based on their technological pedagogical content knowledge. They wanted to develop ICT pedagogy further and faster and believed that change was needed in the school’s organisation to support those changes. They wanted to break free from the classroom. Nevertheless, the outcome was not what they hoped for or aimed at and in their view it was not only the school’s authorities and their fellow teachers that slowed down the development. The students played a significant role, a passive one, even though it sounds a contradiction in terms, as they did not make use of all the
ICT affordances available to them, although they were aware of its usefulness. Thus it was an effort to involve some of them.

There is an important incongruence between the teachers’ beliefs, attitudes and behaviours and that of the students, and these appear to reflect their different roles in the educational process which emerges - especially in the interviews. The students saw ICT as a normal part of their school work, the usefulness is clear and they use ICT when needed but they have no strong feeling regarding how to use this in a new or innovative way. It is just a tool to make their learning more convenient. As noted in Section 7.3 the teachers believed that their teaching was more student-centred than before with the help of ICT. They wanted to support group work but also independent learning. The students wanted the teachers helping them plan their learning and give them good guidance. They did not see the teachers as co-learners. The teachers believed in changes supported with their ambitious ICT use, the students took the ICT affordances for granted.

The MK teachers who participated in this study realised they had to be positive toward new ICT opportunities and to teach their students to be receptive to new software and methods to support their learning. They were not only thinking of training the students to use ICT, as was the role of all teachers in the National Curriculum from 1999; they saw it as an important tool for mastering the subject being taught. Being an intensive ICT user seems to be a lifestyle or a cultural approach; one devotes oneself entirely to ICT use as an integral part to the endeavour of learning, it is, in an important sense, a question of culture or even devotion or enthusiasm.

7.6 ICT affordances and learning activities

We now turn to the next research questions: How do the students use the ICT affordances accessible to them and what are their ICT learning activities and behaviours? What are those teachers’ ICT pedagogical reasoning and behaviours? What ICT learning activities and affordances do they utilise?

Webb and Cox (2004) discuss three ways for teachers to facilitate their students’ learning (see Section 2.5.2) and it can be concluded that MK teachers do both provide students with ICT affordances, e.g. online material, Smart board use and assignments based on Internet use, and are increasing the degree of affordances provided by ICT, e.g. by monitoring new online opportunities and trying to implement them into their work (see especially Sections 6.3.2 to 6.3.4, 6.4.1, to 6.4.3). When it comes to giving students additional information about an affordances it can be said, from the interviews with the teachers and the students, that MK teachers were active in pointing out additional ICT resources for the students but often it was up to the students
if and how they used them. Here we come to the point of how much control and responsibility the teacher should have over the students’ learning or modes of operating. MK teachers in this study wanted more student-centred learning and in a way the lesson plans and assignments were supporting student-centred learning but they were also bound to the classroom, school timetable and the organisation of the school. The dominant arrangement was still of a traditional setup, with one teacher working with many students where the teacher organised and distributed knowledge, students responded and reflected, and the teacher evaluated and commented on their behaviour. They use ICT affordances to give the students more control over their work but the general framework was the same as before, which means that they were using partly the same teaching methods, even if the organisation of the learning process had changed.

With ICT in the classroom, MK teachers were creating affordances they had not been able to present before and had to be prepared for new ideas and unexpected reactions and even different solutions and results from what they expected or aimed at. They saw the different ICT opportunities in connection to different content as was described in the individual interviews. As experienced ICT teachers, they were actively monitoring the ICT development and spent a lot of time and effort in motivating the students to utilise the ICT affordances with innovations and opportunities (see Sections 6.3.2 and 6.3.3).

The findings, particularly from the interviews and the survey, suggest that the MK students were certainly using the ICT-enriched learning environment available to them in a variety of ways and they used suitable ICT tools for their learning needs. They had become accustomed to being able to access learning material, search for information and contact and communicate with teachers and fellow students when needed or necessary. Their choices of tools were, to some extent, related to the teachers’ ICT affordances and their demands on ICT use. Most of the students were convinced that the different ICT options were useful even though they did not use all the options frequently. Of particular interest is that in the survey their use of e-mail was unrelated to their attitudes to the usefulness of ICT in education.

The classroom is a place for learning in many different ways. Many of the ICT options and affordances mentioned in this thesis are not just for learning, although they support the learning process, e.g. searching online for material, sending email or submitting projects online. Students’ behaviours in class are mainly dependent on the lesson plan, the teachers’ affordances and demands but also the students’ own knowledge, beliefs and values. It was clear from the interviews that the students welcomed the different ICT options and realised how useful they could be, although they used some of them more often than
others. Outside class, students may have been more at ease to use whatever ICT tools they wanted and they seemed to be quite active, according the outcome of the questionnaire study.

Projects and coursework are important parts of teaching and learning and the MK teachers saw many opportunities in using ICT to offer new and different assignments for the students. They felt they were innovative in their work and looked for methods and creative projects that built on ICT and motivated and engaged the students in their learning, interaction, and knowledge construction. There was a variety of ICT use in different settings. It is nevertheless a problem to find criteria which can be used to assess the innovative aspect of the work. The teachers may, in some instances, have been using the technology to do things they would have done similarly without the technology, whereas in other cases they were truly doing something novel or visibly using ICT to engage the students in ways they could not have done otherwise. As an example, the foreign language teachers used a greater variety of ICT options while the mathematics teachers seemed to use more restricted options but believed they were heading in the direction of more ICT use (see Sections 6.3.1, 6.3.2 and 6.4.5). The innovation of teachers using the interactive whiteboard is quite different from teachers offering students online quizzes and both are different from a teacher encouraging collaborative learning with ICT support. The MK teachers in the study were assisting students to process information, solve problems and present their understanding. They all had the clear aim of activating the students with ICT, inspiring them, and regulating their learning. WebQuest lessons, where the students searched for information about German football, with the aim to learn German, is an example of innovative class work. Another example is assignments where the students read, watched or listened to material and then could take online exams up to three times, in order to master the content, before they progress (see Section 6.3.2).

ICT was used for communication but e-mail was not used as frequently as the LMS for learning purposes and mainly for communication with the teachers and fellow students. It is difficult to assess their relative importance as both could be used equally in many instances. Students handed in projects and sent questions or files to the teachers and fellow students but they did not use online communication much for discussions and reflections; it was mainly used for practical reasons like receiving and distributing learning material. Online communication for learning purposes did not seem to be popular among the students and maybe the explanation is that they met the teachers and fellow students in class many times a week. Today, new developments of applications on the Internet are supporting more communication that might have a strong influence in the classroom but in this study the students did not see
communication with the teacher, with help of technology, as a very important part of their learning. Communication with the teacher and fellow students was mainly of a practical nature.

The teachers were using different ICT tools to support and explore how they should organise students’ work in light of their own interest in changing their own teaching habits. They planned carefully the ICT use and provided as good affordances as they themselves believed they could at that time but not only for classroom practice but with the students’ whole learning process in mind. The students took ICT and teachers’ affordances for granted and saw ICT as a normal tool in their learning environment that made their learning more convenient and helped them in organising their studies. This may even have encouraged them to minimise their own input and contribution and may even lead to unhealthy dependence on teachers’ affordances, hinder students’ own optimal creative use of the new technology, and result in lost opportunities for maximising their knowledge, experience and skills.

In the perspective of Webb and Cox (2004), teachers in MK had ICT knowledge and believed that the use of ICT was beneficial and the scope it opened up really influenced their pedagogical reasoning and behaviours. They had clear goals of using ICT and they tried to be consistent in their endeavour to use ICT. They built up an ICT affordances for the students to support learning activities, with the aim of motivating them to learn and enhance their learning in every way. They believed, perhaps somewhat superficially, i.e. without solid theoretical or empirical backing, that ICT use in general would influence students’ knowledge, understanding and skills in a positive way. They used their knowledge and experience to select ICT tools that they believed would provide affordances to empower the students’ learning experiences but they were disappointed how slow the ICT development was inside the school as it slowed down their own progress.

With ICT environments the teachers are providing different learning opportunities for students and the affordances are influenced by teachers and students. This could be found in the interviews where the teachers and the students described different ICT use and this was confirmed in the classroom observations and the teachers’ diaries. This implies that the teachers’ affordances are an important determinant of ICT use; it is not mainly the students’ digital skills and access to ICT. This analysis of the situation in MK is supported by John and Baggott La Velle (2004) who found that ideologies of different subject areas affect the ICT use and how teachers’ own private affordances influence their teaching.
7.7 Webb and Cox reconsidered

The Webb and Cox framework was used both to guide the research questions and to analyse the data according to the theoretical background of the thesis. Their framework has proved to be an important tool for getting more information and understanding of the complex situation of ICT in education. The data were analysed with reference to the main parts of their framework to get a clear picture of ICT in education, especially the teachers’ situation as it emerged in the data. With reference to these, there seems to be an inconsistency in the model.

Reflecting on Webb and Cox’s (2004) framework in light of the present study has raised some questions regarding the data flow in the framework, teachers’ working process and the hindrances for ICT use. In Webb and Cox’s (2004) model teachers’ knowledge, beliefs and values and pedagogical reasoning come before the lesson plans, followed by teachers’ behaviours and the affordances. First, teachers plan the lesson which is meant to guide their teaching and then they connect the plan to the ICT affordances in the framework. Thus the ICT is not positioned in the model to affect the teaching plan right from the beginning. Nevertheless, the analysis of MK teachers' support how the Webb and Cox framework describes the "real" situation with ICT in teachers' work. Thus the work processes described in the framework are in line with traditional teaching and thus in effect support that "no" fundamental change occurs in the curriculum due to ICT. The technology simply becomes an "add-on" in the educational process. The framework could therefore be used to explain why ICT has not been integrated fully into education; ICT comes too late in teachers’ working process.

If teachers start by selecting the content, the method and assignments and plan their work accordingly, and then look for ICT options as Webb and Cox’s (2004) framework suggests, there will be relatively little change in the influence of ICT in education. Can we then expect ICT to flourish in the teachers’ work if the ICT affordances are not influencing the teachers’ pedagogic reasoning and lesson plans from the beginning? This is also the point essentially made by Mishra and Koehler (2006) suggesting that the technology, content and pedagogy all go hand-in-hand. If ICT is to change what and how teachers teach, they have to select resources and ICT affordances from the beginning of their working process. To integrate ICT in education cannot be the standalone process as it has been. It is not about planning around the technology, it is about using ICT affordances to support teaching and learning in a very general and probably a very novel way. To do so, teachers need to take ICT affordances into account right from the very start of their educational planning.
In a project for ICT education for teachers, *the Teaching Teachers for the Future* (TTF) in Australia (Romeo, Lloyd, & Downes, 2012) the emphasis is on connecting ICT use to The National Professional Standards for Graduate Teachers and using Mishra and Koehler (2006) TPCK framework for creating digital resources. The focus is on connecting digital resources and tools into teachers’ planning process from the beginning (see also http://curtin.tttf.webs.com/). The results of the TTF project still remain to be seen, but the ideology is in line with the MK teachers’ description of their working process. Thus it would be ideal from this perspective if a slightly changed version of the Webb and Cox model, with the ICT affordances coming at the very initial stages, correctly described the teachers’ planning process.
8 Concluding remarks and recommendations

8.1 Introduction

This study focused on the overall introduction of ICT in the classroom and its use in education. It is less about the technical applications used. The data gathering and analysis gave useful information of the situation in one ambitious Icelandic upper secondary school at the beginning of the 21st century. At the same time it evoked new questions related to the new technology, and such questions will continue to raise, such as: Is the access to new technology at any time going to be a big obstacle for ICT use in education? Do we constantly need “new” tools and “new” software into the schools e.g. smartphones, iPads, Kindles and others yet to come? How will the schools be able to offer students the relevant integration of this new equipment before the equipment is outdated? Are we still in the same situation as Watson and others were discussing at the beginning of the century (see especially Section 2.2.4)? They were calling for more focus on pedagogy than technology and at the same time pointing out that without good access, ICT use will be limited or not well-adjusted ICT use. Are we like dogs chasing their tails? Will we never catch up with new technology and ICT methods?

Fullan (2000) is not optimistic when he says “...education system and its partners have failed to produce citizens who can contribute to and benefit from a work that offers enormous opportunity, and equally complex difficulty finding one’s way in it” (p. 7). He emphasises that large-scale changes cannot be accomplished if teachers, headmasters or headmistresses, and other school authorities identify only with their own close environment; all stakeholders are needed to support successful changes.

Introducing change in education is a complex process that develops at many levels, e.g. in the classroom, in the teacher’s work, at the school level and in the government policy. Fullan (2007) suggests that there are at least three perspectives to consider when realizing new things in education: “(1) the possible use of new or revised materials (i.e., instructions resources such as curriculum materials or technologies), (2) the possible use of new teaching approach, (i.e., new teaching strategies or activities), and (3) the possible alternation of beliefs (i.e., pedagogical assumptions and theories underlying particular new policies or programs)” (p.30). This has strong connection to Webb and Cox’s framework discussed in Chapter 2.5.2., which suggests new
affordances connected to Fullan’s themes one and two and their related emphasis on beliefs as suggested in theme three.

It can be concluded that the Icelandic governmental ICT policy from 1996-2008 focused on all of Fullan’s three components. MK teachers in the study had a strong focus on ICT learning material at the beginning of the ICT implementation; they adopted a somewhat new teaching approach with ICT that influenced their beliefs and made the changes meaningful for them. Although some of the methods are still perhaps “doing the same thing” as before, they were in the process of reforming the teaching and learning. The change went slowly and is probably on a small scale compared to the optimistic ideas and policies at the beginning of the century but it was clear that the teachers being studied were very genuinely interested in using ICT to change the way they educated their students. They wanted to change their educational work with the help of ICT. Thus they were chosen as the most enthusiastic teachers in a school that had positioned itself as a leader in the field, in order to get an idea about what might be the maximum change obtained in such as setting and how it might be described. The general impression, from this study and other material available on the Icelandic system, is that the more general development of using ICT in education, both in this school, but importantly, even more so in the upper secondary school system generally, was limited.

8.1.1 Improved students’ involvement and participation

ICT is already a normal part of students’ learning environment and they want to make the most of it when it is convenient for them and within the framework they are used to. They take teachers’ ICT affordances for granted, welcome new opportunities but are not innovative or searching for new solutions. There needs to be better integration between students and teachers and more deliberate proactive efforts made in the application of the new technologies in the learning process. This will involve the students being motivated to become more proactive in utilising opportunities for applying ICT in their studies. The students had, in general, good ICT skills and might have known about many options that could enhance ICT use in education. The teachers should make the most of the students’ ICT knowledge, beliefs and values for the better of education and make a more concerted effort in harnessing their potential knowledge. However the students vary in their competence and attitudes, as do the teachers.

In order to maximise the benefits of the new technologies, it is important that teaching is an interactive process. It involves both teachers and students being fully aware, able to utilise, and able to apply new technology in the most effective and creative fashion. It is not simply a matter of teachers providing
the students with the resources and the material required, the students have to meet the teachers midway by being actively involved in ICT use, relevant to their studies. This requires motivation, initiative, creativity, and even a change in attitudes. This means that students must not simply be passive recipients of the learning process, including the involvement and participation of ICT use. But this study indicates that it is not a simple matter to engineer the students’ proactive participation.

The teachers who participated in the study were eager to reflect and comment on their ICT use, behaviours, attitudes and pedagogical reasoning and almost all of them fought for the use of ICT in the school. At the same time the students were not so eager to reflect on their ICT use and did not have strong opinions about the matter. This lack of interest and motivation was clearly evident in the current study; it could be described as a *laissez faire* or a neutral attitude. Less information could be collected from the students than had been anticipated (i.e., they were generally reluctant to be interviewed and did not want to keep a work diary). The interviews and the keeping of diaries required the students being able and willing to reflect on their ICT use in their learning process. In the current study the students gave basic accounts of their learning with ICT, but there was generally absence of reflective and interactive accounts of their practice.

Teachers’ and students’ motivation for ICT use is important and should be explored further. In future research it is important to obtain a more reflective account from the students about their ICT learning. This involves approaching the students with methods that motivate them to participate and give information about their learning process when using ICT. The approaches that were used in this study could be used in future research, but special emphasis must be made on recruiting more active involvement of the students with more structured methods or simple rewards. Different methods may give more relevant information such as video recordings, case studies and focus groups.

### 8.1.2 Menntaskólinn í Kópavogi today

This thesis and the studies it builds on has developed over the years and during this period ICT, that is the background to the research, has developed. To obtain information about how and to what extent the ICT progress in MK has followed this development the author visited MK and discussed the matter informally with the headmistress.

The headmistress reported that since 2005 the development of ICT in MK had not been fast and only a few major changes in ICT use have been made since the collection of data for this thesis. The teachers in general have gradually been implementing ICT into their teaching and in that sense could
now be called skilled ICT users. The LMS has been changed to Moodle and some
time was needed for staff and students to adjust to the new system. Now they
are about to stop using Smart boards as still newer technology is taking over
and the school has tried its best to update hardware and software but funding
has been limited. The headmistress’s beliefs are that with new ICT
opportunities, e.g. mobile devices as tablets, notebooks, smartphones and
social media, there will be a new wave in ICT use, a new upswing, that is driven
by a grassroots movement as the present initiative comes from the MK
teachers. She mentioned especially three on-going developmental projects;
two of them have strong connection to the project *Distributed Learning in
Menntaskólinn in Kópavogur* described in Section 6.2.3:

- First, one wing of the school building is undergoing changes where a
  number of classrooms will be merged for an ICT centre instead of the
  library with emphasis on digital material, high-speed internet
  connection and good working space for group work, all of which is
  intended to facilitate ICT integration into the school work. This seems to
  be in line with what the MK teachers who were interviewed wanted to
  happen.

- Second, a new interdisciplinary project-driven course with substantial
  use of ICT where new opportunities for online group work are utilized
  and a group of teachers are teaching together the same group of
  students. The teachers’ work is built on the idea of the teacher as a
  facilitator, who does not have to be a specialist in the content of
  students’ projects but be able to guide and support their work. The
  course uses both a traditional lecture hall and a number of classrooms
  are used for group work. The ideology, organization and implementation
  of this course have awakened an interest among other teachers in MK
  who want to put some of the ICT methods used into practice within their
  own courses, e.g. use of Google-software. Therefore, in the autumn
  2013 there was a course offered for all MK teachers on how to use new
  online opportunities.

- Third, ten iPads were bought in 2012 to support the enthusiastic
  teachers and a pilot project commenced. The idea was that the iPads
  would be used by ten teachers and they would be able to connect,
  wirelessly, to the projectors in the classrooms but this did not work as
  well as planned as the technology was not in place. Now she believed
  the problem has been solved and the use seems to be as practical as was
  expected.

From this interview it can be concluded that history is repeating itself in MK
in the sense that teachers are pushing for the use of new ICT options in their
work, and a new group of pioneers have appeared. It will be interesting to
follow the development in MK over the next few years and see if the author’s recommendations in this section, derived from the present study, may be of use for them.

8.1.3 For the future

It is clear from the current results and the ever-changing ICT technical development that a strong focus of change is needed if the change itself is going to be sustained. This provokes the question of what can be done to support better ICT use in education and its on-going development. What do we need in order to sustain the development? Is it fair to say that it is the government’s fault that ICT has not met the expectations or is it the schools’ or the teachers’ ICT pedagogy that are the main impending factors? Also, in what way do the students and their circumstances affect ICT use in education? In the future it is important to find ways to overcome the barriers to change, but how can this be achieved?

In the light of the discussion in the earlier sections of this thesis, and on the basis of its results, it is evident that there are ample reasons for change in education by harnessing the affordances of ICT. But then the dynamics of change within a system of education must be understood; enthusiasm by a few, even if they are very able enthusiastic operators, is by no means sufficient. Thus the author’s recommendations, in light of the theoretical background, the work reported and discussed in the thesis, point to the following components that need exploring:

1. **Educational component**: Consensus about the various rationales for ICT use and favourable beliefs, attitudes and values and pedagogical knowledge are fundamental to a successful application of ICT in education. But beliefs may rest on perceived affordances rather than possible ones which must also be opened up. This involves ensuring that staff and students are cognizant of the potential benefits of continually improving and developing their ICT understanding and use. From the discussion of Fox and Twining (2006) and others and the affordances notion emphasised by Webb and Cox (2004) and others (see discussion on affordance, especially in Sections 1.1 and 2.5), it is clear that this is a very complex discussion. But it seems very worthwhile to have a thorough discussion about these intricate issues in order to facilitate a more systematic introduction of new ideas such as about ICT. It became very clear in the thesis how important it is to introduce ideas such as those put forward in the TPCK model and the model by Webb and Cox, albeit with the modifications to the model proposed above (ensuring the ICT component right from the start). It would be worthwhile to
investigate what difference this would make also to the less enthusiastic, in particular as the emphasis would be on pedagogy and the subject in addition to the technology, but not only on the technology per se.

2. **Application component:** Training is not enough for changes to be implemented in the workplace. It is essential that the new knowledge and training opportunities are regularly applied and updated; here gain referring to affordance inherent in the ICT environment and not only the parts being perceived. This requires the mind-set of pioneers who are constantly searching for new approaches, both with what they already have and with new ICT options. This also requires time. There is no final stage, because constant technical development requires constant innovation and implementation of new possibilities.

3. **Training component:** Both staff and students need to be provided with the time, training and technical resources in order to keep constantly up-to-date with ICT developments. ICT tools are continuously offering new possibilities and affordances that both teachers and students need to be trained in to harvest for their work. In many instances, both teachers and notably students have been taught to use the varieties of technology in novel ways. It is no longer the case, if it ever was, that just knowing how to start a computer ensures its proper use in all domains. This facet of ICT, not least with respect to the students, has possibly not received enough attention and probably has to be taken much more seriously than has been done in the past. The competence of students and the monitoring of their actual ICT use should be given much more attention, both in research on ICT use and in teaching. The students in this study did on the whole use the ICT in the ways expected, but generally nothing beyond that. Perhaps the teachers have to allocate some serious amount of teaching time to this in order to ensure that all students master ICT competently in the way the teacher expects. It is not sufficient that some of them do. Thus some of the time saved by teaching the subject in the traditional way may have to be used teaching the use of the ICT.

4. **Development component:** It is important to understand why changes in education with ICT support have not been as expected or hoped for, even within very favourable conditions. This study indicates that the development of ICT in education needs to be an on-going process that will not thrive without constant support. It cannot be expected that after initial implementation the development will continue on its own accord and reach some final stage. This most probably also applies to all kinds
of changes and not only to changes related to the use of ICT. The change investigated in this thesis seems to have been carried out by a group of enthusiasts, some of whom were interviewed. It seems very important to understand better the role of such a group, how it interacts with its peers and how it can be supported. One could imagine that very little would happen without such a group. If that is the case, it should be a potential strategy for school leadership to select projects for development that have been initiated by such groups; there could be many different ones. This needs to be explored by further research.

It is clear from the above that implementing change is a complex and in many ways a cumbersome process. It requires vision, purpose, commitment, dedication and understanding of what it is about and acceptance that it is both necessary and sensible. But even this may not guarantee success. But it is definitely a lot of work, especially as it requires change.

8.2 Methodological strengths and limitations

The general theme of this study is that the influence of ICT use on teaching and learning in a learning environment where ICT is widely supported and accepting is a complex subject to explore. Examining ICT-related topics can be very time dependent because ICT use and digital skills continually change as new applications, materials and ideas appear and this can change the affordances, e.g. in the classroom. As has been discussed in the literature review, different ICT situations in different school systems, different schools and different class rooms, influence research outcome in this area. A compromise is reached where schools use similar software and hardware over a long period of time, e.g. common office software, LMS and laptops, so research can be done in a relatively homogeneous environment. This will be difficult to reach in reality; there is an on-going development in the technical world of which the educational world has little or none control over.

The main strengths of the thesis are the use of the mixed-method research design and the variety of data collected. It was believed that this would produce rich information and give a worthwhile understanding of the research issues and provide better answers to the research questions than a single methodology design. Among the aims of the study was to open up perspectives and avenues and the research design was assumed to corroborate that aim. It was anticipated that combining qualitative and quantitative approaches would support the possibility of obtaining insight into the interaction between ICT, pedagogy, teaching and learning in an upper secondary school in Iceland. The
data collected in this study were collected over time and was made to add up to a coherent set of data as discussed in Chapter 5. Thus the design was not planned from scratch but developed over the course of the study with the aim of obtaining a more holistic picture. Thus the design lacks coherence and the data collected extended over considerable time which is a disadvantage.

The group interview with the MK teachers was a useful method to capture their attitudes of the importance of ICT in their work. It was useful to explore their ideas, obtain in-depth information and see their reactions and communication. The individual interviews with the teachers and their diaries gave more detailed information about the main research questions regarding teachers’ knowledge, beliefs and values in their ICT use and their pedagogical reasoning and behaviours. The visits to the classrooms and the log files of the students’ use of the LMS gave additional information about the learning ICT activities and the affordances the teachers utilise.

The student survey gave an overview of the use of different ICT options and students’ attitudes supported by the classroom visits, analyses of LMS log files and students grades. The students were surprisingly uninterested in being interviewed, but the few that were willing gave a useful insight into their knowledge, beliefs and values as well as their ICT behaviours. But the lack of participation is seen to be a serious weakness and again raises the problem of external validity.

In the interviews with the students it transpires that they were critical of the use (or lack of use) by some of their fellow students. This did not come up in other data in the study and brings up the issue whether there are important perspectives or information that has been neglected or absent from the study. It is of course impossible to say, but is an important issue.

The author’s previous relationship with MK, the school in focus, was considered both a strength and a limitation. A strength, because the author knew the organisation of MK and the development of the ICT implementation in the school. This gave a good insight into the situation in the school and provided very important background for formulation of the research questions and choice of research methods. A limitation might be considered to be the personal relationship to the MK staff as a colleague for some years and the participation in cultivating the ICT environment in the school, especially in the years before 2001, which might influence judgements about progress being made. This was considered acceptable because the author had left the school some years before the research started and although she had organised distributed learning projects in MK it was not viewed as a serious limitation for the collection and analysis of the data in the study. This may have produced bias towards positive judgment about the initial phases of the ICT projects, but
perhaps overly negative judgements when discussing the instances where progress was below expectations. But these weaknesses of the study have been on the table during the process of going through the data and drawing conclusions.

It may also be considered limiting to the research that a part of it was dependent on self-report of the participants and a relatively small sample of students and teachers as examples of those who were at the forefront. It may also be considered strength of the study that the questionnaire was adapted from a previous larger study of ICT use in schools in Iceland but the author of the thesis took part in that study and was one of the authors of the questionnaire. The students were selected because they attended ICT classes and answered the survey in class so that the data were considered reliable. Christensen and Knezek (2008), in their review of research methods related to the use of ITC in education, come to the conclusion that self-reported surveys are frequently used and should be accepted.

For a variety of reasons it has taken a long time to analyse the data and write this thesis which could be a limitation for the utilisation of the results. As technology develops fast, the work on this thesis has, in a way, been like a snowball with new layers of ideas and opportunities. But the main aim of the study was to gain a deeper understanding of the issue of ICT in education and it is believed that the results are not outdated as the development in education is not as fast as in technology and today many issues could be gained from the results as they are not bound to the use of specific technology options. It is also important to note that the study did not centre on a particular technology but the issues that come up when adapting the ICT used at the time to education.

8.3 Significance of the study

The present study is one of the most comprehensive studies of the introduction and development of ICT use in the Icelandic upper secondary sector. It shows that progress was made among number of enthusiastic people in quite a favourable setting. But it also showed that despite the activity shown on many of the measures being used within an environment that was at least in relative terms, very supportive of the development being worked on the progress was somewhat pedestrian. But there were no clear indications that the course of the development was much different from what has been found in studies elsewhere.

The findings of this thesis are thus taken to have provided a better understanding of the implementation of ICT in education, and the influence of ICT on teaching and learning and even educational change in general, at least in Iceland but most probably applicable to other settings. It shows an example of the clear development of ICT in a supportive learning environment but also
the limitations characterising these development and the barriers the teachers and the students faced. The findings of this study is believed to add to the knowledge in this field, not only in Iceland but most likely also internationally, by describing a situation in a school with a generally motivated atmosphere and support regarding ICT use, but still with somewhat limited progress even among the front guard. The current study is important for decision makers in education, especially for pedagogical purposes where the aim is to support change and to achieve high-quality education. The results make a contribution to understanding the use of ICT in education and should be of interest for policy makers who want to support the development of ICT in education or even other innovative practices. The most energetic ICT practitioners investigated here were in many respects successful, but their success was confined to change ways of operating within a very traditional setting which did not change during the period studied. It is also very doubtful if the changed taking place were to be sustained wither among the teachers of the students.

The study has shown that in order to obtain a positive influence of ICT in education it is necessary to analyse factors that may ensure its effective use, or may hamper its implementation and limit its potential use both for teachers and students, and these extend outside the classroom. The results indicate that there are numbers of external and internal barriers as well as potential stimulants for ICT use (see especially Sections 6.3.5 and 6.4.6). A shared understanding of the rationales for the ICT use in education is important, right from the beginning, for the success of the implementation and is not sufficient that it is shared only among the enthusiastic few. Fox and Twining’s (2006) discussion of the rationales for ICT use pinpoints how complicated it can be and thus imply the necessity for clarifying these for each institution. This is reflected in the different views of different groups, as reported in the present study, to the prospective changes ICT brings to education.

There is a pressure on schools and educators to keep up with the enormous technical developments. It is difficult, if not impossible, for most schools, let alone individual teachers, to keep abreast of the fast growth in software and hardware, which may in turn influence quite dramatically what one wants to teach and how. It is suggested that the notion of affordance may be very useful in this context and the various taxonomies used to elaborate on the term suggested may help to specify or to clarify the situation at hand. There are many different technological aspects of the new technology that should be attended to, but it is also important to note that in addition to the technological affordances, there are the social and educational affordances as well. Thus
these technological changes are only a part of a changing world for the teacher who also has to follow what happens in his or her special field, in the pedagogical ideas in the field and now also the changes especially inspired by the technology; attention has to paid to the content knowledge (CK), the pedagogy (P) and the technology (T) and the interaction between all of them, referring now to the TPCK model. It requires constant attention, regular up-to-date training of teachers and students, financial resources, belief in the value of ICT for education and support from school authorities and governments. But it is also clear that the beliefs and attitudes must be in the direction of educational change, otherwise the current practices will simply be entrenched. Ten Brummelhuis and Kuiper’s (2008) four main influential factors for ICT in the learning process show that the focus must be at many levels and therefore the stimulation factors such as support, encouragement, time for development and monitoring are important and should all be attended to (see Sections 6.3.1 and 6.3.2).

Mishra and Koehler’s (2006) framework used in this study describes the intertwining of important components with technology in the educational process and the study supports these connections. Furthermore, the very useful framework put forward by Webb and Cox (2004), which brings in cultural elements related to attitudes and dispositions, raises a question about how the data flow is, especially in teachers’ work and when ICT and the connected affordances need to be taken into consideration in the learning process. The model by Webb and Cox has been a major inspiration for the study, but nevertheless it is suggested that their model should be modified in order to allow the ICT affordances to play their role very early in the planning of teaching.

It is hoped that some of the results of the study and the recommendations, both for further research and practice suggested in Chapter 7 will be followed up.

A MK student description of a classroom incident will be the final quote in this thesis as it describes well the conflicting situation ICT can create in the classroom and emphasises the importance of harmony across the board when developing new cultures in education.

The teacher was lecturing about [topic] and showing slides with photos. I decided to Google for more information, found some interesting sites and was scanning while listening to the teacher. Suddenly the teacher was standing in front of me and asked why I was not following her presentation. What are you doing? I could
see on her face that she thought she had caught me. As I quietly answered that I was looking at sites about [this topic] I wonder if her face expressed disappointment, she even wanted to have a look at my screen. What is the problem with her? I am 18 and I am here to study with the help of my computer and the Internet (Nanna, individual interview, 12.04.2005).
References


Menntamálaráðherra opnar fréttaskrif nemenda á Netinu á slóðinni
www.mbl.is/utskolar [The Minister of Education opens news writing of
Ministry of Education. Retrieved from http://old.ma.is/ma/frettir/
Textasidur/utskolar.htm

raduneyti.is/ utgafuskra/

Merriam, S. B. (2009). *Qualitative research: a guide to design and

knowledge: A framework for teacher knowledge. *Teachers College Record,
108*(6), 1017–1054.

knowledge (TPCK): Confronting the wicked problems of teaching with
(Eds.), *Proceedings of society for information technology & teacher
education international conference 2007* (pp. 2214–2226). Chesapeake,
VA: AACE.

on Innovation and Technology (Ed.), *Handbook of technological
pedagogical content knowledge (TPCK) for educators* (pp. 3–29). New
York, NY: Routledge for the American Association of Colleges of Teacher
Education.

of the independent activity based on collaboration and cooperation.
*Procedia-Social and Behavioral Sciences, 127*, 184–188.
doi:10.1016/j.sbspro.2014.03.237

learning*. London: Paun Chapman SAGE.

Moseley, D., Higgins, S., Bramald, R., Hardman, F., Miller, J., Mroz, M., … Stout,
and communications technology for literacy and numeracy in primary
schools*. University Of Newcastle.

Mumtaz, S. (2000). Factors affecting teachers’ use of information and
communications technology: a review of the literature. *Technology,
Pedagogy and Education, 9*(3), 319–342.

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Tímamót á Internetinu [Turning point on the internet]. (n.d.). Síminn. Retrieved from http://www.siminn.is/servlet/file/ADSL_T%C3%83%C2%ADmal%C3%83%C2%ADDNA.pdf?ITEM_ENT_ID=125270&COLLSPEC_ENT_ID=8


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References


Appendix

Appendix I

Most commonly used words found by Google Scholar search, March 2008.

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<th>Word used in search</th>
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<tr>
<td>Information and Communication Technology (ICT) in education</td>
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Appendix II

Guideline for interviewing a group of MK teachers in 2004

Can you give a short overview of your ICT use?
Is ICT better or does it change anything?
What happens with ICT?
Does ICT support more responsibility/activity among student?
Can students have more control over their study with ICT?
ICT influence, have you changed your teaching methods?
What about your role? Has it changed or developed, has ICT influenced your role? How does ICT influence students? What is your opinion?
Are students learning in a different way? Is it different than before?
What about not so able or less interested students? Is ICT supporting them?
What about communication with students related to their learning? Have they moved into communicating via computers or not, are they communicating more or less than before?
What about assignments, are they better than before? Do students put more afford into their assignments?
What about communication between students, communication and cooperation? Have you notice any changes?
Distributed learning, can you describe?
Should we end with a ICT dream, future dream, what is your dream?
Appendix III

Guideline for the individual interviews with MK teachers, the main focal points.

Can you describe briefly your use of ICT in your teaching?
Is ICT used both to distribute material and to get material from students, can you describe this?
If you use the interactive Smart board, can you tell me how you use it?
What influence do you feel ICT is having on your teaching?
What about arrangement and organisation?
What about motivation for students, how do you see ICT in that respect?
Can you describe the role of ICT in preparation for your teaching, is it different?
Do you feel ICT has influenced your role as a teacher?
What about student-centred teaching or more individualised teaching, does ICT have a role there?
What about group work?
Can you describe ICT use in connection to very able students and not so able students?
Can you describe the benefit of ICT use in education?
Is there any difference in teaching different subjects or years? Can ICT be more part of the teaching in different subjects?
Monitoring students’ learning, what is the ICT rule?
ICT and communication with students, can you describe it?
How is the working atmosphere in the classroom when you are using ICT?
Students learning, do you see ICT influence there?
The future of ICT in education, can you discuss your view?
Appendix IV

Guideline for teacher’s diary writing
Can you please write a diary for a week describing ICT use in your teaching; you can use this format if you want.

Class 1, group x, course xxx, Day xxx, Time xxx
ICT use at the beginning of the class... and then... Next I....

Class 2, group x, course xxx, Day xxx, Time xxx
ICT use at the beginning of the class... and then... Next I....
Appendix V

Checklist for classroom observation, the teacher’s part.

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</tbody>
</table>

**Start the computer**

**Start prog./Web**

**Teaching**

- Inna
- LMS
- Slide show
- Submit a project
- Show a project
- Show assignments solution
- Show other websites
- Show own website
- Teach to use prog.
- Use educational program
- Use sound file
- Show film/video
- Use online discussion/forum
- e-mail
- Surfing the Web
- Recording material
- MSN
- Download
- School web
- Assist students
- Use Smart board
- Something else, what

**Work in other programs**

**Technical problems**
Appendix VI

Questionnaire for MK students.
1. Gender Male Female
2. Course (you have in mind when answering the questions)
3. How often do you send e-mails related to your study? If the answer is never, please go to question 5.
   - Often every day, every day, every week, less, never
4. If you use e-mail in your study, please mark how you use it. Mark more than one item if relevant.
   - To write/send questions to the teacher
   - To write/send questions to fellow students
   - To make e-mail list
   - To look for information related to my study
   - To communicate with the teacher
   - To communicate with fellow students
   - To hand in projects to the teachers
   - Other, then what?
5. How often do you use the Internet in your study? Here count everything you do on the Internet, e.g. LMS, e-mail, Google. Often every a day, every day, every week, less, never
6. If you use the LMS, please mark how you use it and how much. Here the use can be both in the school and outside the school.

<table>
<thead>
<tr>
<th></th>
<th>Every day</th>
<th>Every week</th>
<th>Less frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>To collect material from the teachers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To e-mail the teachers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To send e-mails to fellow students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To take online exams/exercises</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To hand in projects to the teachers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To take part in online discussion</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. How do you use the Internet in your study? Here, it is other than the LMS.

<table>
<thead>
<tr>
<th></th>
<th>Every day</th>
<th>Every week</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>To collect material from the teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To e-mail the teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To send e-mails to fellow students</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>To take online exams/exercises</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>To hand in projects to the teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To take part in online discussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To find further reading material in Icelandic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To find further reading material in foreign languages
To look for source material for essays or other projects
To use national search engines
To use international search engines
To get information from national databases (e.g. Gegni and Greini)
To get information from international databases (e.g. Web of Science and ProQuest)

If you use the Internet in your study in different ways than mentioned above, please write it here.

8. Now I ask you about the lessons in the classroom. Which of the following is used in the classroom, in the class you are referring to when you answer, and how often is it used?

<table>
<thead>
<tr>
<th>Tool</th>
<th>Often</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning management system (LMS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e-mail</td>
<td></td>
<td></td>
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<tr>
<td>Word processor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spreadsheet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teachers' websites</td>
<td></td>
<td></td>
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<tr>
<td>Slides presentation program</td>
<td></td>
<td></td>
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<tr>
<td>Interactive exams/exercises</td>
<td></td>
<td></td>
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<tr>
<td>Information search on the web</td>
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<td></td>
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<tr>
<td>Discussion forum</td>
<td></td>
<td></td>
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<tr>
<td>Online chat (e.g. MSN, Skype)</td>
<td></td>
<td></td>
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<tr>
<td>Software for image/picture processing</td>
<td></td>
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<tr>
<td>Multimedia disk</td>
<td></td>
<td></td>
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<tr>
<td>DVD films</td>
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<td></td>
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<tr>
<td>Educational software</td>
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<tr>
<td>Computer game</td>
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<tr>
<td>Mobile phone</td>
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</table>

Other, then what?

9. What do you think about the usefulness of the following items? Are they useful in your study?

<table>
<thead>
<tr>
<th>Tool</th>
<th>Very useful</th>
<th>Rather useful</th>
<th>Of little use</th>
<th>Useless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning management system (LMS)</td>
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<tr>
<td>e-mail</td>
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<tr>
<td>Word processor</td>
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<tr>
<td>Spreadsheet</td>
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<tr>
<td>Teachers' websites</td>
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<tr>
<td>Slides presentation program</td>
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<tr>
<td>Interactive exams/exercises</td>
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<tr>
<td>Information search on the web</td>
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<tr>
<td>Discussion forum</td>
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<tr>
<td>Online chat (e.g. MSN, Skype)</td>
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</tbody>
</table>
10. Now I ask you about the use of the computer at home or in school outside class. Which of the following do you use for your homework and how often?

<table>
<thead>
<tr>
<th>Software for image/picture processing</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Multimedia disk</td>
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<td>DVD films</td>
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<td>Educational software</td>
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<td>Computer game</td>
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<tr>
<td>Mobile phone</td>
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<tr>
<td>Other, then what?</td>
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11. What programs are you comfortable with, when using ICT? Is it the word processing, LMS, outside LMS or something else? Please answer with one sentence.

12. Do you think the teachers are using ICT in the best way? If you feel that something is missing, what would that be? Please answer with one sentence.

13. Do you think the teaching where teachers are using computer technology is very modern way because of the computer systems? Please answer with one sentence.
Appendix VII

Guideline for interviewing MK students individually, the main points.

1. Can you describe briefly your use of ICT in your study?
2. What influence has ICT had on your study?
3. What are you using?
4. Can you describe how you use online material and options?
5. Can you describe how you use online communication?
6. Can you describe how you use online discussion?
7. Do you think that ICT has influenced your study?
8. Can you describe in what way
9. Do you think that ICT has influenced the organisation of your study?
10. Can you describe in what way
11. Do you think that ICT has influenced your learning style?
12. Can you describe in what way
13. Can you give example of assignments where you have used ICT?
14. Do you consider that you learn differently with ICT?
15. Can you describe in what way
16. Can you give an example of cooperation with other students using ICT?
17. Do you think the role of the teachers and students have changed with more use of ICT?
18. Could you describe the teachers’ use of ICT?
19. Can you give an example of what they could do more/better/new?
20. How do you see the future use of ICT in your education?
Appendix VIII

Checklist for classroom observation, the students’ part.

<table>
<thead>
<tr>
<th>Date</th>
<th>Subject</th>
<th>Female/Male</th>
<th>Time</th>
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**Learning**

- Start the computer
- Start prog./Web
- Using LMS
- Work on a project
- Material from the t.
- Take notes
- Look for resources
- Interactive exam
- DVD - video
- e-mail
- Read from the screen
- School Web
- Inna
- Something else

**Entertainment**

- e-mail
- MSN
- Surf the Web
- Download
- Games
- DVD
- Music
- Blog
- Student org. web
- Something else

**Technical problems**

- Work in other programs
- Technical problems
- Did not use the computer
Appendix IX

Guideline for the interview with MK headmistress, the main focal points.

Can you describe briefly the beginning of ICT use in MK?
How has the development been after 2000?
Can you describe the ICT policy in MK?
How has the ICT implementation been going?
How would you describe the situation now?
What influence do you believe ICT has had on teachers’ teaching and students’ learning?
What do you think has been useful in supporting and stimulating ICT use?
What do you think have been the barriers?
How do you see the future?
Appendix X

The author has published the following papers and reports related to the LearnICT project:


Other relevant publication since 2005


12. See more at www.ru.is/asrun
Appendix XI

Letter to the headmistress at Menntaskólinn í Kópavogi (MK)

Reykjavík 02.11.04

Dear Margrét Firðriksdóttir

I have been working on my PhD on information and communication technologies (ICT) in secondary schools under the supervision of Jon Torfi Jónasson at University of Iceland.

To collect data on the situation in an Icelandic school, I decided to go to Menntaskólans í Kópavogi (MK) as MK has systematically the planned use of ICT in education. Previously, I have received good cooperation with MK e.g. by conduction a questionnaire for students in 2002 and the visits of my students from the Reykjavik University (RU) in the Spring terms, both of these tasks related to the preparation of my doctoral dissertation.

The purpose of this letter is to request further cooperation with the school administrators, teachers and students in your school in the coming winter. The intention is that I visit the school with your permission and conduct a short questionnaire, speak with administrators, teachers and students, as well as getting to sit in the classroom and observe what goes on.

It is possible that my students in RU will also help me to collect the data as appropriate. Efforts will be made to cause minimal disruption to the teaching and treatment of all data falls under the laws of privacy and they will not be personally identifiable in any way.

With the hope of positive answers.

Ásrún Matthíasdóttir

Assistant professor and project manager for distance education at Reykjavik University