Didactical Considerations in the Digitalized Classroom

The interest in this doctoral thesis is how information and communication technologies (ICT) impact on classroom interaction and may challenge and transform teaching and learning. The aim here is to explore in what way the use of ICT may affect the interaction between subject content, teachers and learners. The main findings of the study highlight relations between the subject content and the digital tools and challenges notions about what to teach, which affects possibilities for and limitations in how pupils interact with ICT but also the distinguishing features of the pupils' final outcomes. The ambition is to contribute to the field of 'didactics and ICT' and also to the ongoing debate about 'digital competencies' in the twenty-first century.

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Anne Kjellsdotter DIDACTICAL CONSIDERATIONS IN THE DIGITALIZED CLASSOOM

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Abstract

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The interest in this doctoral thesis is how information and communication technologies (ICT) impact on classroom interaction and may challenge and transform teaching and learning. A reason for considering this as a field of investigation is grounded in the fact that in Sweden, digital tools and they are considered a natural part of elementary education. A lot is expected from ICT in education and the ongoing debate is based on the premise that they will be a catalyst to create change.

The aim here is to explore in what way the use of ICT may affect the interaction between subject content, teachers and learners. Two theoretical approaches: the sociocultural perspective on learning (Säljö, 2000; Vygotsky, 1986; Wertch, 1998) and the tradition of *Didaktik* (Hopmann, 1999; 2007; Klafki, 1995; 2000) are used to answer the study's overall aim and the different aspects of the research questions. The ambition is to contribute to the field of 'didactics and ICT' and also to the ongoing debate about 'digital competencies' in the twenty-first century.

The empirical data is derived from a case study in a primary school. Ethnographic techniques were used in order to collect the data during a period of four years. The research questions have been explored through different analytical lenses and the findings are presented in four papers.

The main findings of the study highlight relations between the subject content and the digital tools and challenges notions about *what* to teach, which affects possibilities for and limitations in *how* pupils interact with ICT but also the distinguishing features of the pupils' final outcomes. This opens the way for a discussion about teaching the subject content in relation to the digital affordances, the understanding of pupils' meaning-making in connection with the premises of digital school tasks, and what competencies are important in the digitalized classroom.

Acknowledgements

The sated day is never first.
The best day is a day of thirst.

Yes, there is goal and meaning in our path -
but it's the way that is the labour's worth –

Karin Boye, *In Motion*. Translated into English: David McDuff

The process of writing this thesis could be described as a journey that was from the start to the end filled with thirst, goals and meaning on the way. Looking back, the path became a motion of joy and sorrow, sickness and wealth, times of unclearness of mind and growth of knowledge. Nevertheless, I have no regrets, only a gratefulness for having had the opportunity to explore the way.

However, I could not have managed this on my own so I want to express my gratitude to my supervisors, Eva Reimers and Anna Maria Hipkiss, for their splendid support. Many thanks also to Catherine MacHale Gunnarsson for excellent language revisions and pleasant meetings.

To my love Peter, thank you for being there throughout this journey in 'slow' motion. To my beloved children, Amanda and Eric, I hope this thesis will inspire you in life. Do not forget your grandfather's words: 'Everything is possible'. And to my relatives who no longer are with me; since I was a child I have heard about my famous ancestor, Sven Kjellström, a professor of music at the beginning of the twentieth century. He left an inheritance of academic inspiration to the family. I hope I will too…

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PART ONE

Introduction

The twenty-first century is considered to be an era of digital revolution. Although many developments have taken place in this period, the developments in the field of digitalization are particularly noticeable. This has affected various sectors such as business, science and technology, infrastructural developments as well as education. Digital technology appears to hold a major symbolic function in contemporary society, associated with imagery of positive change and renewal, and of economic revival. (Player-Koro et al., 2016; Selwyn, 2016). The increased availability of digital technology in educational settings during the last decade mirrors the broader societal changes where these technologies have become an important way to interact in everyday life (Säljö, 2010; 2019).

In education, much of the debate about digital technologies is based on the premise that they will be a catalyst to create change (Selwyn, 2016). Thus, the school as an educational institution has particular aims and scopes that include expectations of how digital technology will change education.

The interest in this doctoral thesis is how information and communication technologies (ICT) impact on classroom interaction and may challenge and transform teaching and learning. The aim is to explore in what way the use of ICT may affect the interaction between

subject content, teachers and learners. A reason for considering 'education and digital technology' as a field of investigation is grounded in the fact that in Sweden as well as in other countries, laptops and tablets are considered a natural part of and a tool in elementary education.

Planning the use of ICT to enhance teaching and learning requires an understanding of how ICT might support designs for learning in particular subject content areas as well as in general processes, roles and strategies in teaching and learning (Selwyn, 2016). In conjunction with digital tasks, didactical questions such as: how, why and what should be taught, have been revitalized in the digital age (Livingstone, 2012). Consequently, the present thesis is based on the assumption that didactical perspectives can contribute to the study of teaching and learning processes in the digital classroom.

In the social classroom practice, teachers and pupils are dealing with learning and teaching of content connected to the curriculum in particular ways. Teachers design classroom activities and ICT allow transformations and combinations of communicative modes. In situated learning activities, ICT may be a part of pupils' meaning-making activities.

This thesis has a didactical perspective on classroom interaction with digital technology. The central questions highlight in what way ICT may affect the interaction between subject content, teachers and learners. The empirical base for the study is a primary school

classroom and the conditions for teaching and learning in a Swedish context.

The point of departure is an engagement in the constructive adjustment of digital technologies in order to explore the possibilities and/or the challenges in classroom interaction. One premise for the thesis is that teaching and learning take place in a social context where one must be aware of technology trends, but at the same time not become too technology driven (Player-Koro et.al., 2017). The ambition is to contribute to the field of 'didactics and ICT' and also to the ongoing debate about digital competencies in the twenty-first century.

Digital competencies in the twenty-first century

A tendency in the twenty-first century is that teaching has become increasingly understood as the facilitation of learning rather than as a process of teachers transferring knowledge to students (Biesta, 2013). Haugsbakk and Nordkvelle (2007) state that this radical shift from teaching to learning is influenced by the rhetoric connected to the use of ICT. In the shift from teaching to learning-centred education, in which ICT was a developing factor, the research studies have been more about finding explanations or solutions for integrating ICT in classroom teaching (Pérez-Sanagustín et al., 2017).

The first implementation of ICT in classroom education provoked a certain profile of questions. Due to the changes in practice, many

of the research studies at the beginning of the twenty-first century are more often related to issues of management and organization than to learning and assessment objectives (e.g. Haydn & Barton, 2008; Hennessey et.al., 2005). Research studies between 2002 and 2014 included a high number of studies on learning approaches and learning environments (Baydas et al., 2015). More recent studies, from 2015 onwards, tend to emphasize digital competence needed by teachers and therefore tend to neglect the influence of broader contextual conditions in the wider school setting (Pettersson, 2018).

'Digital competencies' have been stressed since the beginning of the twenty-first century and there is still an ongoing discussion of what digital competencies should involve (Fransson et.al., 2018b.) At the beginning of the twenty-first century, the European Parliament (2007) defined 'Digital Competence' as one of eight key competencies for life-long learning (Immerfall & Therborn, 2010), which involves the confident and critical use of information in society and thus basic skills in ICT. In 2010, the European Commission adopted a new Digital Agenda for Europe with the objective of maximizing the social and economic potential of ICT (Ranguelov et al., 2011).

In one of the reports from the European Commission, *Key Data on Learning and Innovation through ICT at School in Europe* (Ranguelov et al., 2011), statistics from 20 European countries were presented. Sweden was one of the participating countries in the survey that put forward the importance of strategies to provide the necessary ICT skills to

pupils (in particular literacy skills), as well as provide ICT training for teachers. The report highlights possibilities for learning with ICT:

> Information and communication technologies (ICT) provide a variety of tools that can open up new possibilities in the classroom. They can particularly help tailor the educational process to individual students' needs, and they can also provide learners with the crucial digital competences needed in our knowledge-based economy (Ranguelov et al., 2011).

Overall in ICT policies, there is a remarkable optimistic rhetoric about ICT in education focusing on digital technologies and their potential to enhance educational settings (Haugsbakk & Nordkvelle, 2007; Selwyn, 2010). At a policy level, the expectations often seem to be overrated (OECD, 2015) and are also repeatedly questioned by scholars in different parts of the world (e.g. Håkansson Lindqvist, 2015; Player-Koro, 2016; Selwyn, 2016). ICT in these texts is considered a creative experience that in turn has the potential to innovate within education and is thereby regarded as a key enabler for a competitive school system (Player-Koro et.al., 2017).

Today, in contemporary societies, digital technologies are cultural resources and have to be seen in a wider framework of economic, social and technological changes (Selwyn et.al., 2017) that have an impact on education. However, technology has not always been synonymous with the digital (Hillman, 2019). The use of ICT in

education today can be examined in relation to how various technologies have been used for learning in human practices throughout history. The next section will take its point of departure in technologies for teaching and learning, and present a brief historical review followed by a presentation of the digitalization of Swedish classrooms.

Technologies as artefacts for teaching and learning

From a historical perspective, there are a number of technological inventions used in society that have become artefacts for teaching and learning. The World Wide Web created new conditions for teaching and learning, and today in the 'interactive age', in the twenty-first century, we can see a shift in schools in the implementation of a greater number of digital artefacts (Steinkuehler, 2012; Squire, 2011).

Technology is often perceived as a threat before it is incorporated into culture. In cultures based on the spoken word, writing has often been regarded with scepticism and characterized as unnatural and inhuman. Plato feared that writing would be produced outside of consciousness and destroy the memory. Since then, the art of writing has become completely natural to us. Gutenberg's controversial printing press has been implemented in today's schools. The printed book is natural within schools and is no longer viewed as technology.

Book printing also made an impact on many societies in terms of distributing new ideas, which led to both political and social changes. Later on, books were used as artefacts for learning along with paper,

pen and blackboard (Liedman, 1999; Lovlie, 2007; Säljö, 2005). Paper and pens have also mediated people's experience of knowledge as being fixed.

Using the tools of ICT allows us to represent the fluid character of knowledge by means of their ability to revise and represent experiences in various modes such as sound and image. The way in which we handle different modes of representation, e.g. linguistic and visual representation, are historical acts (Wartofsky, 1983).

The ability to read and write texts has long been valued in educational settings. Books and writing are part of a long tradition but with the advent of digital technologies, representations have moved more in the direction of the medium of the screen (Kress, 2005). Other ways of expressing meaning, such as images and sound, have not conventionally had the same status. From an educational perspective, digital technologies challenge traditional teaching because they provide a range of modes for expression and communication, and are not limited to the traditional medium of paper.

Digitalization of Swedish classrooms

Sweden has invested large resources in ICT and made ICT into a natural and important part of school teaching. The advanced use of ICT has been and still is assumed to lead to educational change and hence better teaching (Swedish Government Official Reports, 1994; 2015; Swedish National Agency for Education, 2011; 2017).

Between 2005 and 2010, the Swedish Government set up special funds for the development of ICT in education and since then, there have been large investments in ICT in schools by the Swedish municipalities. Despite these investments, there are still differences in Swedish schools as regards the number of digital technologies and how they are integrated into classroom interaction.

Later, a government initiative (Swedish National Agency for Education, 2016) suggested a strategy for digitalization of the schools. The policies advocate the importance of ICT in education but at the same time there is an understanding that ICT in itself does not change any conditions for learning.

However, in many of today's classrooms in Sweden, students get their own computer or tablet (1:1), share a device with another student (2:1) or have access to a set of digital tools available in the school. Teachers are supposed to take digital resources into account in the classroom practice and despite the innovative use of digital technology outside the classroom, there are no clear roles regarding how ICT should be used in education.

A lot is expected from ICT in education, although according to a large number of research studies and evaluations, ICT has yet to prove its potential to improve education (e.g. Pate, 2016; Player-Koro, 2016; Wastiau et al., 2013). The introduction of digital technology alone does not guarantee improved learning experiences or greater learning outcomes (e.g. Prieto et al., 2011; Selwyn, 2010 ; Säljö, 2010). Overall, there are difficulties with the lack of clarity regarding different types of ICT and how they may mediate or scaffold different stages in learning processes (Livingstone, 2012; Engerness, 2019).

Research findings also indicate the complexity in teaching with ICT (e.g. Hudson, 2007; Lund et al., 2014). There is a complex interplay of influences, pressures and expectations that surround the use of digital technologies, which may reflect pedagogical traditions (Perotta & Evans, 2013; Player-Koro et al., 2017). Teachers are influenced by what happens outside the classroom, from the broad level of educational policies to the school level where accountability mechanisms and assessment regimes influence teaching and learning practices. Thus, understanding the everyday practices in which teachers try to struggle with the practicalities of using ICT for teaching and learning seems to be vital (Lindberg et al., 2017).

Classroom practices

The teacher and pupils work within a local classroom practice that is influenced by both national and global factors. Within this context, pupils bring to the classroom a history of learning experiences that relate to their previous cultures of learning both inside and outside schools.

In today's society, the Internet is part of children's and young people's upbringing in many ways, i.e. many pupils live in a world of computer games and they are consumers of commercial advertisements in the promotion of products (Carvahlo, 2013; Swedish Media Council, 2019).

In Sweden, children have access to digital tools in their leisure time regardless of their socioeconomic backgrounds. However, a distinguishing aspect is how the digital features are used (Swedish Media Council, 2019). The Internet as a resource for information seeking is frequently used by children that come from highly educated homes. Children from low-income families are high-consumers of digital games. In other words, there is a diversity of content in children's digital experiences (Swedish Media Council, 2019). The important message is that media literacy among young people today is of direct relevance to discussions about learning in schools, and this conflicts with earlier conceptions of literacy and learning.

We are, it seems, at a particular juncture in the introduction of ICT into education. Notwithstanding the apparently unlimited capacity of

ICT, especially the Internet, in terms of information and educational potential, its greater pedagogical benefits are far from proven.

Although getting technology into classrooms has been resource-intensive, this fades by comparison with the far greater demands of ensuring its efficient use. Making changes to schools and the way they work with ICT is, in short, a lengthy and demanding process, and as yet, much of the investment in hardware has to show a noticeable benefit in educational practices and outcomes.

With that in mind, it is important to explore questions about the use of ICT in educational settings and teachers' decision-making and action plans in relation to ICT. The use of digital resources can facilitate a wider range of possible interactions but the ability to understand and assess communication through screen-based activities becomes increasingly important, not least during classroom tasks (Hudson, 2007; Loveless, 2011; Engeness, 2019). In order to understand the interaction between the content, teachers, pupils and the digital resources, more than just the tasks pupils face on the screen must be considered.

The overall contribution of the thesis is to highlight didactical questions, in relation to the interaction between the content, teachers and pupils in a digital primary classroom.

Aim of the thesis

A curiosity about exploring the essence of what is really going on in the digitalized classroom has developed the research questions of the thesis. The aim is to explore in what way the use of ICT may affect the interaction between subject content, teachers and learners. The ambition is to contribute to the field of didactics and ICT in education by asking questions relevant to digital tasks in a primary classroom.

The research study emphasizes the interaction between the teachers, the pupils and the content. Five questions have been given specific attention:

I. How do teachers plan and teach the content of the task?

II . In what ways do pupils interact with the given content?

III. What can be distinguished from the results of pupils' final products?

IV. What answers are derived from examining teaching and learning with ICT in a primary school practice from a didactical perspective?

V. What teaching competencies are important in the digital classroom?

The empirical data is derived from a case study in primary school. Ethnographic techniques were used in order to collect the data during a period of four years, between 2011 and 2015. It was grounded within the interaction between teachers, pupils and digital technology in everyday classrooms, with the focus on the interaction between the chosen content and teachers' and pupils' orchestration of ICT learning tasks. The framework for integrating ICT in a primary school practice has also been taken into account in the form of national and local policy material. The research questions have been explored through different analytical lenses and the findings are presented in four papers.

The first paper explores how teachers employ their didactical competence and to which extent they design appropriate learning tasks in relation to the ICT policy documents at different levels. The second paper focuses on the teacher-designed task and the orchestration of the multimodal learning activities in conjunction with pupils' orchestration of the digital resource. The third paper explores pupils' small-group interaction with ICT and the processes of orchestrating the laptop features during a particular task. The topic of the fourth paper is the similarities of representations in the pupils' final products from the same task.

The overall results of the four papers will consolidate didactical questions to interaction with digital technology in the primary school practice.

Description of terms in use

Information and Communication Technology *(ICT*) in this thesis, encompasses software applications (generic software, multimedia resources) and information systems (Intranet, Internet) available in schools at the time of the research study. The term *digital tool* may include the range of hardware (desktop and portable computers, projection technology, and digital recording equipment). A digital tool may be used to create digital outcomes. The concept of *digital resources* is applied more generally and includes the overall digital affordances built into digital tools.

Outline of the thesis

The text presented here includes a summarising chapter together with four papers. In the next section (Swedish digitalization policies in education), I will give a background to the research study. The following sections will present the theoretical assumptions of the thesis; previous research related to the study; methods used for conducting the study, including the educational setting in which the empirical material was generated; a summary of the four papers, and finally a discussion of the results and the didactical implications of the findings

Papers:

I Kjellsdotter, A. What matter(s)? A didactical analysis of teachers' ICT integration [submitted 2019, in review for publication].

II Öman, A., & Sofkova Hashemi, S. (2015). Design and redesign of a multimodal classroom task–Implications for teaching and learning. *Journal of Information Technology Education: Research*, *14*, 139-159.

III Öman, A., & Svensson, L. (2015). Similar products different processes: Exploring the orchestration of digital resources in a primary school project. *Computers & Education*, *81*, 247-258.

IV Kjellsdotter, A. (2017). From earth to space—Advertising films created in a computer-based primary school task. *Cogent Education*, *4*(1), 1419419.

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Didactical Considerations in the Digitalized Classroom

Swedish digitalization policies in education

One of the central issues dealt with within the research field of didactics is the selection of educational goals, content and teaching methods expressed in curricula. The way in which digitalization policies influence teaching and learning with information and communication technologies (ICT) is of relevance for this study.

The policies at different levels emphasize the achievement of curriculum goals that include the importance of using ICT in education. From a teacher perspective, there are national policy documents such as curricula and syllabi goals to take into account in teaching together with teacher commitment and the large digital investments in schools by Swedish municipalities. The policy background presented in this chapter aims to give a picture of the framework for teachers' and pupils' classroom interactions with ICT. The subheadings below concern Swedish digitalization policies at different levels.

Integration of ICT in education

During the period of collecting the ethnographical data and writing the thesis, there have been several new Swedish policies and decisions that have been concerned with the area of ICT in education.

From the beginning of the 1990s, there have been arguments for using ICT for learning. The primary arguments have been that ICT drives globalization and that it is an issue for the whole country. ICT as a part of a global economy should be made use of with efficiency, and ICT should enhance quality. Students should learn to use ICT, and ICT was to become an integrated tool in all school subjects (Swedish Government Official Reports, 1994).

Further documents from the beginning of the twenty-first century point out strategies for developing learning resources and professional competencies for teachers but also supporting local municipalities on technical issues (Swedish Ministry publication, 2002:19). In 2010, the idea was to make Sweden a world leader in the use of ICT and utilizing the opportunities of digitalization (Government Offices of Sweden, 2010).

In teaching with ICT, the Swedish National Agency for Education (2013) emphasized research that points out 'ICT skills' central to teachers' work and underpins planning, coordination and presentation of the curricula, assessment and pupils' achievements. The term is ambiguous in government curriculum policy, reflecting different and developing aims and intentions. Given some of the

ambiguities and changes in definition and focus of ICT skills, it is difficult to predict primary teachers' perceptions of ICT skills and their role in learning.

Adequate digital competencies

The curricula and syllabi from 2011 highlighted teaching with ICT in primary and secondary school together with additional professional development in digital competence for teachers. In 2017, a supplement in which the framework for a strategy for digitalization of the schools was presented in order strengthen Sweden's ICT policy objective to be the best country in the world at utilizing the opportunities of digitalization. (Fransson et al., 2018b; Government decision I:1, 2017).

Previous documents can be seen in relation to a report published in 2016 by the Swedish National Agency for Education. This report advocates that digital resources per se do not change the conditions for learning. The ICT learning outcomes depend on how the digital resources are used in the classroom practice. The report stresses the notion of 'adequate digital competencies' connected to the curricula and syllabi.

This could be seen as depending on the dimension of time, a contextual dimension and an interpretative dimension (Fransson et al., 2018b).

> 'The use of 'adequate digital competence' allows different actors to interpret the meaning of what is to be regarded as 'adequate', dependent on context and circumstances related to all aspects of the educational system and to different aspects of time' (Fransson, et al., 2018b, p.225).

Teachers are one group of actors responsible for integrating ICT in education in a way that generates 'adequate' learning outcomes. The aim for 2020 is that teachers and pupils develop an adequate digital competence and that research is directed towards the possibilities of digitalization for schools (Swedish National Agency for Education, 2016). Consequently, teachers find themselves in need of better ICT competencies (Swedish National Agency for Education, 2016) and are continuously finding operational ways to include ICT in teaching in order to fulfil the overall governmental goals and the specific curriculum goals expressed in the policy documents.

Thus, the policy documents stress the importance of developing an adequate digital competence, which generally refers to using ICT in relation to the subject syllabi in Swedish schools. Every pupil, on completing primary and lower secondary school, must be able to use modern technology as a tool for knowledge-seeking, communication, creation and learning. ICT is one of the school's teaching tools,

needed to attain the school's aims (Swedish National Agency for Education, 2011; 2017).

A recurring idea in the ICT policy documents is that the modernization of Sweden begins in school education. Using the opportunities provided by ICT in schools will improve citizens' ICT competencies in the long run (Government Offices of Sweden, 2010; Swedish National Agency for Education, 2016; Government decision I:1, 2017).

In order to understand in what way Swedish schools handle the policy directives, a focus in this thesis is how teachers and pupils can harness technology to facilitate classroom interaction with ICT. The policy documents do not exemplify how teachers may design, plan and organize teaching with ICT and how they communicate the content, which opens up a space of freedom as well as responsibilities for teachers. In what way ICT is integrated into the Swedish curricula and subject syllabi will be described below but the section will begin with a brief explanation of the construction of the curricula and syllabi.

The Swedish curricula

The curriculum reform worldwide seems to follow common general ideas on how education should prepare the individual and the national state to become part of a world society (Meyer, 2006). Although many nations create their own guidelines, these are changing with global

demands. Formal curriculum documents refer to multiple contexts, from the global to the local (Karseth & Sivesind, 2010).

There is a trend for national authorities to revise their formal curricula in line with international policy discourse (Sivesind et al., 2012). Rather than focusing on general purposes, aims and content of schooling (Hopmann, 2003, Hopmann & Riquarts, 2000).

In most European countries, decisions are made at a political level about the structure and goals of schooling, accompanied by the development of curriculum guidelines. In northern Europe, a curriculum is by tradition associated with formal documents describing purposes, aims and content for what a particular group of students should be taught and learn throughout their study course (Karseth & Sivesind, 2010; Westbury, 2007). In Sweden, such curricula are published by national authorities.

Traditionally, the basic form of curriculum work has been represented by the philanthropic model (Hopmann, 1999) based on a top-down model in which the state has the right to stipulate teaching ideas but also has to provide information on content for lessons. The predominant model for curriculum work goes from a political discourse as a framework for curriculum work via the development of the specific curriculum down to a practical discourse which is responsible for the local development of the lessons (Hopmann, 1999). The teachers do their own planning, more or less within the framework of the guidelines provided by the curriculum and syllabus goals.

Historically, this top-down model has been followed by a loosening of control that reduces the state's directives in the curricula and the rest is left to subsequent levels. In other words, the decisions on curricula remain part of the inner-didactic discourse (Hopmann, 1999; 2003), in which teachers are guided by the curriculum goals in planning and designing adequate learning task for pupils in order to fulfil the expected curriculum goals.

Today, Sweden is moving partially towards a model of pedagogic performance, with a central focus on school subjects. With influences from EU documents, the idea of organizing school knowledge in terms of competencies has become influential in the Swedish curriculum. Furthermore, unlike many European countries, competencies in the Swedish context have a strong orientation towards subject–content–knowledge (Sivesind & Wahlström, 2016).

Subject content in the Swedish curriculum from 2011

The Swedish curriculum from 2011 focuses on aims and detailing content, and the aims are formulated for teaching and not primarily for learning (Sundberg & Wahlström, 2012). There is an increased focus on content, while at the same time it defines minimum requirements and levels of achievement for different grades. This leads to a different orientation to content, where achievement and what is to be learned are of primary significance for what to teach within the subjects (Sivesind, 2013).

There are similarities to the previous curriculum adopted in 1994, (revised in 2000 and 2008). Both curricula set out values, tasks, goals and guidelines, after which the individual syllabi for the various subjects are presented. However, the curriculum from 2011 contains fewer aims compared to the previous curriculum (Lpo94). The descriptions of aims within subjects refer to school subjects as a frame of reference, but also to the application of generalized knowledge in practical contexts as well as across disciplinary areas (Sivesind, 2013).

The questions posed in this thesis relate to didactical issues concerning the possibilities and realizations of ICT in classroom interaction. The teachers in the study have teaching experience in the context of the previous curriculum (Lpo 94), as well as the curriculum from 2011. In what way the curricula and the ICT policy frameworks impact on classroom teaching have to be taken into consideration in relation to the results of the study. The next section will give an overview of how ICT is integrated into the Swedish compulsory school curriculum (Lgr 11) and primary syllabi.

Digital competencies in curriculum and primary syllabi

Digital competencies are defined in the Swedish curriculum (Lgr,11) as: understanding the digitalized society; abilities to use and understand digital tools and media; having a critical and responsible approach; and solving problem and reacting to ideas (Swedish National Agency for Education, 2011; 2017). These digital competencies are based in the key competencies described by the

European parliament (European Parliament, 2007; Ranguelov et al., 2011).

The term ICT is often used in relation to digital learning tools but it is not used in the Swedish curriculum or syllabi (Swedish National Agency for Education, 2017). However, the curriculum from 2011 stresses that pupils should be allowed to use digital tools in a way that encourages knowledge building, which is described in terms of using digital tools and learning platforms.

Sweden is one example of a place where traditional print-based teaching and learning have dominated the curricula for centuries. Even though there have been variations in formulations between different curricula and syllabi, print-based activities, and written and spoken language, still dominate compared to other modes (Swedish National Agency for Education, 2013). Pencil, paper and books have been the technologies that have not only been prevalent in education since its beginning but also the framework for activities in schools (Tyner, 2014), not least in the subject of Swedish.

In addition to the statements in the curriculum, the Swedish subject syllabus has specific guidelines for teachers' planning and realization of the subject content in relation to digital tools in education. Various subject syllabi, such as mathematics, Swedish and social sciences, give overall guidelines for ICT use in relation to the subject content. A revision of the subject syllabuses was made during 2018, in which programming became part of the subject content for

mathematics. The Swedish subject syllabus is another example where the use of ICT was extended.

As mentioned before, the Swedish subject syllabus is still to a large extent based on written and spoken language, but there are aims described in the syllabus that point out the importance of digital communication by integrating other modes such as image and sound, as well as the importance of using digital media. The pupils are also supposed be given opportunities to work with texts that combine different modes, e.g. film, interactive games and web pages (Swedish National Agency for Education, 2011; 2017). The reasons for pointing out these particular modes of expression were grounded in the view of pupils' everyday lives in the digital society, in which films, digital presentation programs and images are natural parts (Swedish National Agency for Education, 2016).

In the ICT classroom, teachers, pupils and the mediating tools become important actors in the creation of digital learning spaces. The teacher is supposed to interact with the pupils to achieve the objectives specified in the curriculum. Teachers and pupils use digital resources during different types of activities in the classroom context, and designed tasks may be set up with different interactional scope, e.g. whole-class, individual and group activities.

With that in mind, the research questions being posed in this thesis concern the interaction in the ICT classroom between content, teachers and learners. The theoretical approaches of the thesis are described in the next chapter.

Theoretical approaches

In this chapter, I will describe and justify the theoretical standpoints of the thesis. There are various theoretical approaches to explore and explain ICT in education and various perspectives offer partial accounts, e.g. in the form of systems, actions of groups or social practices (Oliver, 2011). The primary position, in this instance, is to make sense of the digitalized classroom as a social practice in which teachers and pupils interact with a given content. This has led me to a selection of theories that together build a framework for studying the relationship between the classroom interaction and the conditions for teachers' work.

A sociocultural perspective

To understand the processes of teaching and learning in the ICT classroom, this thesis uses a sociocultural perspective on learning (e.g. Säljö, 2000; Vygotsky, 1978; Wertsch, 1985). The use of different artefacts leads to different ways of thinking and a critical feature of human action is that technological tools mediate actions, a feature they share with psychological tools, i.e. language, writing, schemes, various systems for counting, works of art, diagrams, maps, all sorts of conventional signs (Vygotsky, 1978; 1986).

In Vygotsky's view, mental functioning in the individual can be understood only by examining the social and cultural processes from which it derives (Wertsch, 1985). The analytic strategy is, for the investigator, to go outside the individual in order to understand complex forms of human consciousness. It assumes that those mental processes can be studied by exploring the communicative processes between people, which has been analysed in the study described here. The analytic focus on inter-mental functioning can explain the intra-mental functioning that emerges through mastery and internalization of social processes (Wertsch, 1985). Joint activities can generate new understandings that we internalize as individual knowledge (Vygotsky, 1978; 1986).

One premise for this thesis is that teaching itself does not necessarily imply learning. In stating this, learning is seen as a development that is connected to a specific situation and a specific setting. In this sense, every context produces its own conditions for learning. In the process of learning, we create experiences, and transfer different meanings and patterns of behaviour to other situations later in life. We add new ways of thinking and acting to the ways we are already familiar with. We embrace aspects of the way we express and understand the world and use them for practical purposes (Säljö, 2000).

In other words, learning is not understood simply as an individual social process but also as a process mediated by the use of cultural resources where the notion of artefacts is central (Vygotsky, 1978;

Säljö, 2000; Wertsch, 1998). Artefacts, digital or non-digital, are defined as intellectual or physical resources which we use when we are actively trying to understand our environment. They are constantly developed in various social activities, and they alter the limits of our abilities and influence our actions (Wertsch, 1998).

Together with a sociocultural perspective on learning, the Northern European research field of *Didaktik* (e.g. Hopmann, 2007; Klafki, 1995; 2000), will provide the theoretical foundation for this doctoral thesis.

The tradition of *Didaktik*

Historically, the field of didactics has had a philosophical perspective in comparison to a tradition of institutional, curriculum theory perspectives in English-speaking countries (Hopmann, 2015; Ligozat & Almqvist, 2018). Within the research field, there has been a growing understanding of the conceptual frameworks used in Europe for studying teaching and learning in classrooms from the perspective of the educational content (Ligozat & Almqvist, 2018). Sweden has an inheritance of *Didaktik*, which was revived in the early 1980s after being out of use for some decades (Bengtson, 1997; Nordkvelle, 2004). It was conceptually developed in the context of education but not in terms of a normative system in which all educational questions could be answered (Bengtson, 1997).

In recent years, didactics within the European research field is characterized by studies on the meaning and purposes of teaching and learning, with empirical analyses of classroom practices in relation to the national curriculum requirements in terms of subjects and/or competencies (Ligozat & Almqvist, 2018). A large number of these research studies come from the Nordic countries as well as from Continental Europe (e.g. Gundem, 2011; Klette, 2007; Ligozat et al., 2018; Marty et al., 2018; Schneuwly & Vollmer, 2018). In this field, didactic research is not a scientific method but rather an interest in research in the knowledge area of didactics which is not limited to any specific method of investigation (Lundgren, 1986).

The thesis takes its point of departure in the field of *Didaktik* with a research interest in classroom interaction and the content being taught and learned. The Northern European *Didaktik* research field is devoted to the theorization of the relations between the teacher, the learner and the content, with the aim of investigating the learner's knowledge development. As a research field, it explores the transformation of the learner based on their learning experiences, i.e. *Bildung*. The purpose of schooling is from this perspective neither to transport knowledge from society to a learning curriculum, nor a transpositioning of knowledge from science or other domains to the classroom but rather the use of knowledge as a transformative tool to unfold the learner's individuality and sociability, i.e. the *Bildung* of the learners by teaching.

The German notion of *Bildung* is still crucial in discussions related to education (Friesen, 2018), which is one of the reasons for bringing in the tradition of *Didaktik* as a theoretical foundation in this thesis. But the most important reason that this theory is suitable is that it allows the conceptualization of the relations between the content and the teaching and learning processes, which are explored in the study. Therefore, the tradition of *Didaktik* (Hopmann, 2007; Klafki, 1995; 2000; Künzli, 1998) will serve as a theoretical approach.

Today, Didaktik is primarily and in every day terms a study of teaching and learning and of instruction. But in the tradition of *Didaktik*, instruction is more than simply the interaction of teaching and learning, i.e. it encompasses different factors in complex relationships. Anyone engaged in a learning process interacts with the world of values, with society and with the location where education takes place.

Basic assumptions

The two theoretical approaches share the same basic assumptions. The questions of *Didaktik* are intertwined with the cultural context we live in (Klafki, 1995; 2000). Within this tradition, the social and cultural world is 'subjectified': there are things to be learned, but students are to be encouraged to find their own path. Seel (1999) emphasizes that human beings are born into a culture and a cultural environment, including a social system. The acquisition of and the ability to deal with cultural objects may be conceived of as a major

part of the process of acquiring *Bildung*. This emphasis on the social context and societal goals is a distinctive characteristic of the tradition of *Didaktik*.

This chapter will also explain the theoretical concepts used in the thesis. The following subheadings will include concepts involved in a sociocultural perspective on learning and in the tradition of *Didaktik*. This section concludes with a summary of how the theoretical concepts have governed the analyses of the empirical material.

Sociocultural concepts

In the sociocultural tradition (Vygotsky, 1978), a practice is not seen as static but something that is established by the participants' interaction. Thus, the participants in educational practices are seen as co-creators of their mutual engagement in collective activities in a particular context. In this thesis, the situated practice through the actions of individuals or groups is as a process mediated by the use of cultural tools and it is not understood simply as an individual process (Vygotsky, 1978 ; Wertsch, 1998). The individual, the artefacts and the sociocultural practice interact with each other and there is a focus on the relationship between human action and the cultural, institutional and historical context (Wertsch, 1998).

Informed by this sociocultural view, the term 'affordance' is used in this study to mean the way of thinking about what it is possible to express and represent by modes and digital resources (Jewitt, 2006).

Digital devices hence afford both possibilities and limitations for the users.

In the sociocultural classroom practice, digital technology opens the way for a broader view of literacy, including various modes of expression, taking into account that language in a globalized society is more than reading and writing skills. Therefore, in this study, literacy entails an extended view of texts. Written or spoken language is not the only mode that is used, which enlarges the concept of literacy to become concepts of 'literacies' (Cope & Kalantzis, 2000).

Multimodal representation and communication

A central part of this thesis, where literacy is seen in a broader sense, includes a multimodal approach to language. The concept of multimodality is not per se connected to digital artefacts but they open the way for various modes of expression compared to other technologies for learning, e.g. books and pens. From a multimodal perspective, different modes such as image, sound, writing, speech and gestures are organized sets of semiotic resources for meaning-making (Kress, 2010; Jewitt, 2008). Multimodal perspectives on literacy have the basic assumption that meaning is made through many representational and communicational resources.

The concept of multimodality in the thesis focuses on all the different resources that are displayed on the computer screen and are part of classroom interaction. Meanings are made in a variety of modes and always with more than one mode (Kress, 2010). The

choice of mode is thus a central aspect of the epistemological shaping of knowledge. Voice, gesture, sounds and other modes are all resources for meaning-making. The orchestration of meaning involves selection and configuration of modes.

The focus on classroom interaction with ICT include teachers' and pupils' multimodal representations and communication. From a multimodal perspective, representation focuses on interest and engagement with the world and making meaning of that world. Communication focuses on the desire to make that representation available to others and includes different modes, and pupils interact in relation to the affordances of these modes (Kress, 2010). In the design and production process, the sign-maker seeks to make a representation of some object that arises from the cultural, social and physiological history of the sign-maker in relation to the specific context in which the sign-maker produces the sign (Kress & van Leeuwen, 2001).

This concept includes teachers as designers of tasks and environments in order to achieve learning. The teachers design multimodal learning tasks, and pupils make meaning by selecting and integrating various modes of meaning in relation to the available resources and affordances of different modes and digital resources (New London Group, 2000). In the re-design process, the pupils seek to make a representation of some object that arises from the cultural and social history of them in relation to the specific context in which they produce the sign (Kress & van Leeuwen, 2001). There are

different semiotic resources for meaning-making available within these digital artefacts for learning, and Jewitt (2006) argues that all modes contribute to learning.

Concepts of *Didaktik*

In this thesis, some central concepts are used that belong to the tradition of *Didaktik*, originating in Continental and Northern Europe (e.g. Klafki, 1995; 2000; Künzli, 1998; Hopmann, 2007).

The Didaktik triad

The present thesis treats the *Didaktik* triad of what, how and why, as a whole. It serves as an exploratory and classifying arrangement, and relates the general elements of the teacher, the subject matter and the student to each other (Hopmann, 1999, 2007; Klafki & MacPherson, 2000).

Historically, the interaction between the content, teacher and learner with different emphases has been illustrated with help from a didactical triangle used from ancient Greece until today (Hopmann, 2007). It has served as an explanatory model in understanding and analysing the educational relation between the content, teacher and learner. (Hopmann, 2007). In Western European history, the *Didaktik* triad (content-teacher-student) is the most well-grounded model for education but there are variations in the emphasis within the triad in various traditions. In its original conceptualization,

Didaktik is about how teaching can instigate learning as a content-based student activity (Hopmann, 2007).

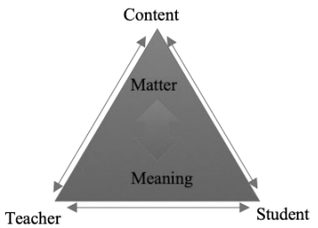

Figure 1: The *Didaktik* triangle

Künzli (1998) has shown that the *Didaktik* triangle can be interpreted in three ways*:* representation (teacher-content), experience (student-content) or intercourse (teacher-student). The arrows on each axis show the emphasis in theory and in practice, depending on the point of reference. During teachers' preparatory work, the mode of representation, between the teacher and the content, could be interpreted in two ways: giving the content priority over the teacher or giving the teacher priority over the content (Künzli, 1998; Künzli & Horton- Kriiger, 2000). This is explained as a dimension of teachers' rhetorical act of re-thinking the intentions of the curriculum guidelines, while at the same time selecting and organizing what is worthy of being taught (Künzli, 1998).

The experience axis between the student and the content could have an objective or subjective interpretation. The objects of experience could be rated highly or it could be preferred to bring the student to the fore. On the teacher-student axis, the emphasis could be on the teacher as a model or a more symmetrical transformation of the teacher-student relationship (Künzli, 1998; Künzli & Horton-Kriiger, 2000).

In teaching, there is first of all a subject to be taught and learned. Second, there is a learner to whom the subject is offered. This thesis explores what this object can or should signify to the student and how the student can experience this significance. In fact, it is a matter of highlighting the importance of building bridges between teachers' understanding and pupils' learning as a process of design, interaction, evaluation and re-design (Schulman, 1986) and the dialectical process by which teaching opens up the world for the pupil, thus opening the pupil for the world (Klafki, 1995).

Matter and meaning

In the classroom practice, the meaning of learning experiences emerges within the learning process based on the meetings of a unique individual with a matter at hand (Hopmann, 2007). *Didaktik* is an important theoretical approach here, in order to analyse and understand the teaching and learning processes. *Didaktik* could also build a bridge between regulations and local teaching. Each element of curricular content has to be transformed into local teaching. How

to interpret this educational transformation is left to the teachers themselves, which has been explored in this study. This includes the specific instructional design as well as the process of performance assessment (Hopmann, 2015).

The common core of *Didaktik* could be characterized as 'restrained teaching' based on a commitment to *Bildung* and the educative difference of matter and meaning, which is how *Didaktik* is positioned within the tradition (Hopmann, 2007). In the *Didaktik* tradition, *Bildung* is what comes out of the unique meeting between pupils and contents, whereas the generalized subject matter of curriculum is only used to instigate the process. Within this perspective, *Bildung* is more than the mastery of contents or development of competencies and abilities, more than knowing something or being able to do it. *Bildung* cannot be achieved by *Didaktik* but *Didaktik* can 'restrain' teaching as a way of opening the way for the individual growth of the pupil (Hopmann, 2007).

This perspective has a strong resonance with the position of Shulman (1986), who emphasizes the way in which a professional is seen to be concerned not only with the how, but also with the what and the why. Klafki (1995) stresses five general didactic questions[1] as the core preparation for instruction. *Didaktik* becomes a tool for

[1] I. What are the individual elements of the content as a meaningful whole?
II. How are these individual elements related?
III. Is the content layered? Does it have different layers of meaning and significance?
IV. What is the wider context of this content? What must have preceded it?
V. What peculiarities of the content will presumably make access to the subject difficult for the children?

teachers to identify and transform curricular matters into local teaching, and from Klafki's perspective, this transformation from matter to meaning is made possible by analysing and answering the basic questions of didactic analysis (Klafki, 1995; 2000). From both Klafki's and Shulman's perspectives, the teacher is seen to be in command, not only of procedure but also of content and rationale, and to be capable of explaining why something has to be done.

This is a way of understanding how the subject matter is enacted and how the teaching intentions, i.e. the educative substance, become part of the teaching process. In the teaching process, there is a question of what to teach, a choice of a certain subject matter. Within the choice of subject matter, there are different concepts of what certain content includes and different aims for what students should acquire by dealing with this or that content (Hopmann, 2007).

Teachers' choices of content and its matter

The thesis highlights the relation between the content, subject matter and the educative substance. The teachers choose to deal with a given content for a given group of pupils. There is a relation between the content and the selection and enactment of its subject matter with the aim of opening up the educative substance for the learner as intended. The intention is to initiate the learner in creating meaning that can open the way for what should be learned in the long run. Learning experiences emerge within the learning process itself based on the meeting of a learner with a matter at hand (Hopmann, 2007).

From the pupils' perspective, meaning is what emerges when the content and its matter are enacted in the classroom based on the methodological decisions of a teacher. The division of labour between the curriculum guidelines developed at the state level and the local lesson planning is shaped by teachers' 'pedagogical freedom' (Hopmann, 2007). The teachers handle the planning of how, where and when to enact which part of the curriculum. The guidelines prescribe general rules about what to deal with, the main topics of instruction, but no specific ways and means for how to achieve it (Hopmann, 2007). A central question is how teachers use their 'pedagogical freedom', which could be described as didactical competencies. In this thesis, 'didactical competencies' are set in relation to teachers' choices of content and its matter and in relation to how the educative substance could be opened up for the pupils as intended.

However, in what way teachers choose the content and its matter in the digital classroom is an empirical question. Teachers have opportunities for re-thinking the curriculum guidelines and considering how the content and its matter could be enacted in the classroom. It is a matter of teachers' choices regarding how the subject matter can be interpreted as meaningful to the pupils (Willbergh, 2015). The study presented here has investigated teachers' choices when dealing with the content and the enactment of the subject matter in relation to ICT tools in their classroom teaching. The relationship between teacher, content and student can give rise

to the traditional didactical questions of what content is chosen, why it is chosen and how it is enacted in the classroom.

Theoretical approaches and analytical concepts

I have used the two theories referred to above to answer the study's overall aim and the different aspects of the research questions. The position I take is that the data analysed in the present thesis has explored in what way teachers and pupils interact with ICT in education, which may involve possibilities and limitations, as well as an increasing understanding of the interaction with digital artefacts.

The two theoretical approaches, the sociocultural perspective on learning (Säljö, 2000; Vygotsky, 1986; Wertch, 1998) and *Didaktik* (Hopmann, 1999;2007; Klafki, 1995; 2000), share the same basic assumptions that knowledge is developed in social practices and that the contents of education are always specific contents and are examples that represents a larger set of cultural contents. Those contents of education that are presented to teachers in the form of curriculum and policy texts must be comprehended as a selection in a historical and contextual situation, i.e. school type, grade or level (Klafki, 2000).

The tradition of *Didaktik* and sociocultural perspectives promote and facilitate systematic reflections on specific ideas that have been around for some time, which involves a dialogue that includes some cultural artefacts in education. In this thesis, the social and cultural

perspective emphasizes language in practice and becomes an important key to realizing the concepts in the tradition of *Didaktik*.

The ICT classroom is explored from a sociocultural perspective on teaching and learning. Within this perspective, various analytical frameworks serve as tools to highlight the relation between the teacher, student and the content. *Didaktik* provides a framework for teachers' enactment of the most basic how, what and why questions of their work. This follows from the emphasis that is placed upon the concepts of *Didaktik* and from the relative professional autonomy of the teacher within this tradition.

The research questions (of this thesis) are used to explore the classroom interaction with different foci on didactical questions in relation to the content, the teachers and the pupils (see Figure 1). These aspects have been analysed with the help of the theoretical concepts based in the theoretical approaches, which have been described in this chapter. The theoretical approaches have been of importance in analysing the data during the ethnographical work but also as a meta-reflective approach in the study.

Figure 2 shows the common base for this case study in analysing interaction in the sociocultural classroom practice and treating the *Didaktik* triad as a whole. The sociocultural perspective (e.g. Vygotsky, 1978; Säljö, 2005) serves as frame for exploring the classroom as a social and cultural practice in which teachers, pupils, content and ICT tools interact with each other. The tradition of *Didaktik (*e.g. Hopmann, 2007; Künzli, 1998*)* represents an educative

perspective from which questions and concepts related to teaching and learning are investigated.

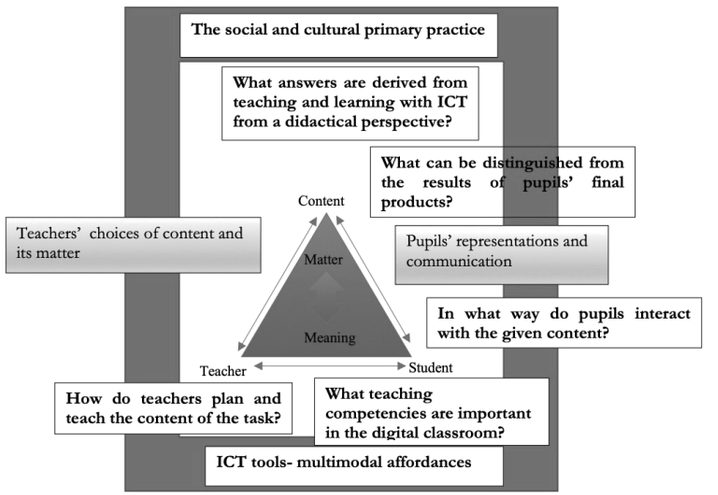

Figure 2: An illustration of the common base for the study

In the four papers of the thesis, there are different aspects explored concerning the content, the teachers and the pupils in relation to each other. The methodological decisions are further described in Chapter 5. In the next chapter, I will present previous research connected to teaching and learning in the digital classroom.

Didactical Considerations in the Digitalized Classroom

Previous research

A range of research studies have served as a base for exploring the research questions. The studies presented in this chapter have different foci but the overall aim of this chapter is to contextualize the research questions and the empirical data of the thesis in relation to relevant research connected to digital classroom practices. The ambition of the research conducted in the thesis, is to make a contribution to the European research tradition of didactical perspectives on meaning-making activities in classroom practices. For that purpose, previous research is divided into two main sections: Didactical questions in the digitalized classroom and Digital competencies in the digitalized classroom.

Didactical questions in the digitalized classroom

The research presented in this section has been selected in relation to the didactical relationship between teachers, learners and the content. With regards to the research questions of the thesis, the selection highlights the changes around ICT in teaching and the impact on teachers' work. Overall, these studies are selected with regard to how ICT tools are used to develop or rehearse meanings between teachers, contents and pupils in a social context (Hopmann, 2007; Vygotsky, 1986).

However, classroom studies in the Swedish primary context seem to be scarce in comparison to studies in pre-school, secondary and upper-secondary education. By contrast, there is a body of international research that concern primary school settings.

This section primarily presents research studies from the primary school context but also studies from other school levels that concern didactical questions, such as content of teaching, methods of instruction and classroom interaction in relation to pupils' learning outcomes.

Content of teaching

Factors that influence ICT integration can be manifold and complex, but a body of research has shown that the key to the effective use of ICT in education relies very heavily on how successfully teachers integrate it into teaching and learning (Bingigmlas, 2009; Nikolopoulou and Gialamas, 2015). In early childhood contexts, Western research has also shown that teachers' perspectives on the role of ICT strongly affect the outcome of ICT integration in the early years (Joshi et al., 2010; Nikolopoulou & Gialamas, 2015). Further research studies also emphasize the complexity of teaching, with screen-based resources opening up new ways of meaning-making that challenge the authority of traditional print-based learning (Merchant, 2007; Kress, 2010).

Haydn and Barton (2008) identify factors that hinder the use of digital technologies in subject teaching, such as lack of time, difficulty in accessing enough computers for the students and the availability of data projectors in ordinary classrooms. Findings also show a perceived conflict concerning whether to use ICT in order to facilitate subject learning, or whether the emphasis should be on demonstrating ways in which ICT can be used and on teaching technical skills. Teachers were found to be generating, and critically reflecting on, some new forms of activity, resources and strategies for mediating ICT-supported subject learning in their classrooms (Hennessey et al., 2005). Based on interviews with teachers from six different subject areas, John (2005) shows how other factors, such as the brief, evolving and incomplete nature of the relationship between a subject and ICT, create problems in teaching.

A study of primary teachers' perceptions of ICT subject knowledge indicate that there are ambiguities held in tension between ICT as a discrete subject domain, as a resource to support curriculum learning objectives and as a capability for higher order thinking and activity (Loveless, 2003).

Further, Loveless (2007) explored in a case study the complexities of preparing to teach with ICT in primary curriculum subjects. The findings shed light on teachers' understandings of the purpose of teaching with ICT, as well as on the consequences of weak didactical relations between content and ICT. The conclusions point in the direction that ICT in primary schools would benefit from teachers

thinking about how the didactical relation between the 'what, how and why' of content and ICT could be articulated clearly (Loveless, 2007). Loveless (2007; 2011) argues that a framework of teacher professional knowledge that highlights the relations between subject domain knowledge, the didactical relation with digital technologies and various teaching situations can support teaching with digital technologies.

Research studies in primary school put forward various findings relating to the use of ICT in classroom teaching. A case study of a primary school which was seen as using ICT effectively to support teaching and learning found that 'fitting ICT in', rather than 'effective use of ICT' provided a more accurate description of the complex decisions and actions that were made regarding ICT use in the school (Cartwright & Hammond, 2007).

In relation to the content of teaching, research studies have explored the transformation of content from the national curriculum into lesson planning and teachers' choices of what specific content should be taught in a particular lesson and why.

Kennewell (2001) argues that recognizing the potential and constraints of ICT as a tool which supports and shapes learning, requires teachers to have knowledge of the subject domain and competence in the appropriate use of the technologies (Kennewell, 2001). The pivotal role of the teacher is also observed in a primary school case study in Singapore (Tay et al., 2012). The study examined pedagogical approaches to the teaching of English and mathematics

with ICT. The findings suggest a difference in the pedagogical approach adopted by English and mathematics teachers.
Teachers' use of pedagogical reasoning and the frequency of ICT use were reported to be significantly higher in English lessons compared with mathematics lessons.

Teachers' pedagogical reasoning, as a process of discovering and taking advantage of the added value of ICT in teaching, seems to be a way of reframing the teaching process and the teaching practice (Holmberg et al., 2017). Other studies also suggest that learning environments which include ICT resources offer new affordances, which requires pedagogical reasoning from teachers which is more complex than before (e.g. Webb and Cox, 2004; Loveless, 2011; Voogt & Roblin, 2012).

The digitalization of schools has changed the practice of teaching and learning and according to Edwards (2015), the changes around the use of ICT have profound impacts on teachers' work, such as methods of instruction, content of teaching and relationship with young children, which have led to new expectations about teachers' work and their roles in facing and dealing with the challenges and changes.

Methods of instruction

Research studies highlight the importance of teachers' instructions in the digitalized classroom. The teachers' close assistance at the beginning of the lesson seems to help the learners to develop their

understanding about how to approach the task and to reveal the potential of the resources useful for solving the task. In doing so, the teacher may enhance the learners' understanding of how to engage with the task (Engeness, 2019).

Similarly, research studies in English primary schools highlight the importance of instruction from the teacher and of teachers guiding the pupils in the use of digital resources in order to fulfil the potential for learning (Hennessy et al., 2007; Kennewell et al., 2007; Warwick et al., 2011). These findings indicate that the teacher is an important person who creates a task in order to support cognitive and meta-cognitive activity. Teachers have opportunities to explore a wide range of digital activities (Beauchamp, 2011) and the choices teachers make in using ICT are affected by their experiences as well as their thinking and pedagogical beliefs (Webb & Cox, 2004).

Warwick et al. (2011) argue that the work of the teacher has to be understood in relation to the features of digital technologies. When pupils are working independently of the teacher, the 'vicarious presence of the teacher' is important in how the teachers use the design of the task to guide pupils (Warwick et al., 2011). Warwick et al. (2011) have also provided good examples of dialogic interaction in conjunction with pupils' orchestration of digital resources in English primary schools. These examples show the importance of the 'vicarious presence of the teacher' regarding how rules and procedures are introduced and how the teachers use the design of the

task to guide pupils' interactions with the digital resources (Warwick et al., 2011).

Further findings also emphasize the crucial importance of teachers' awareness about the type of support ICT and other resources provide in integrating digital resources to enhance pedagogy and student capacity to learn within and across subject domains (Engeness, 2019).

Findings from the Swedish context in digital pre-school settings show pedagogical challenges in teachers' organization of activities and choice of technologies and instructions (Skantz Åberg, 2018).
Challenges in the use of ICT have also been highlighted by Lindberg et al. (2017). The findings indicate that there seem to be similar digital challenges for teachers and upper-secondary students in the use of ICT in education. The students came to the conclusion that they would rather spend time learning the subject than learning how to use a digital tool. On the other hand, the students also gave examples of how YouTube could be supportive in learning (Lindberg et al., 2017).

Other research studies with Swedish data give examples of the students' role in shaping the nature of the technologies they use in their classrooms and the role teachers have in providing space for students to contribute innovative technological practices (Hillman & Säljö, 2016). Fransson et al. (2018a) explored students' views of their teachers' use of ICT. The teachers who use ICT in a 'good way' are digitally skilled, they can demonstrate how to use ICT and they vary their teaching by using different teaching methods and different ICT tools such as software. From a student perspective, teachers who use

ICT in a less 'good way' give insufficient instructions and responses to questions and do not ensure that the students remain on-task.

Classroom interaction

During classroom interaction, research studies have emphasized the importance of conversations in the classroom, as well as the role of ICT in primary schools, in supporting dialogic teaching and learning interactions (Mercer, 2005; 2000; Wells, 1999; Wegerif, 2011; 2016).

Many studies have reported the dominance of teacher talk and the lack of sustained interaction with individuals (e.g. Beauchamp & Kennewell, 2010). According to Beauchamp and Kennewell (2010), most of the orchestration is carried out by the teacher or by rigidly structured software but there is a potential for ICT to support more dialogic and synergistic interaction in both group and individual activities. There is also growing evidence concerning the value of increasing the amount of dialogic and synergistic interactivity for enhancing learning during whole-class, group and individual activity (Kennewell et al., 2007; Mercer & Littleton, 2007; Wegerif, 2010).

Wegerif (2008; 2011), among others (Alexander, 2004; Rojas-Drummond & Mercer, 2003), argues that during classroom activities, dialogic interaction has a particular value as a form of pedagogical practice that helps to develop pupils' understanding. Dialogic interaction is characterized by being reciprocal, supportive, cumulative and purposeful, and dialogic processes are of importance for stimulating and supporting the collaborative development of

knowledge in an educational context (Alexander, 2004; Rojas-Drummond & Mercer, 2003; Wegerif, 2008; 2011).

Wegerif (2010) claims that not only do children learn how to think in the context of interaction but how they interpret the meaning of any utterance depends on the dialogue. The metaphor of 'dialogic space' and the ensuing concepts of opening, closing, widening and deepening a space, prove to be useful in order to recognize what happens in the classroom with respect to the Internet age and new forms of dialogues (Wegerif, 2010; 2016). Not all children have the same language experiences, which might impact on language as a tool for reasoning, understanding and solving problems (Mercer & Littleton, 2007; Wegerif, 2016).

The research of Warwick et al. (2011) has put forward good examples of dialogic interaction in relation to pupils' orchestration of ICT resources during small-group collaboration in English primary schools. But the major importance of these findings is the way that the teachers employ their pedagogical competence and the extent to which teachers design appropriate learning tasks relative to dialogic interaction (Warwick et al., 2011).

Swedish and international studies have pointed in the direction of focusing on pupils' interactions with digital technology, underlining distinctive ways in which the computer software can participate in and support education (e.g. Björkvall, 2014; Edwards-Groves, 2011). Examples from the Swedish context consist of specific primary classroom practices involving the collection of digital images and their

use as semiotic resources in the creation of multimodal texts (Björkvall, 2014). Åberg (2008) shows how different interaction patterns develop between pupils in a Swedish primary school. The pupils interacted by exchanging ideas and experiences and showing peers what they had learned.

Another Swedish example from a primary classroom is a small-scale study that contributes to practice by providing an innovative, theory-based method for literacy development and some empirical evidence for its effectiveness (Genlott & Grönlund, 2013). The key to the success of this method was that it drew on communication and social interaction, using online tools to improve the traditional skills, which were measured by means of the traditional standardized national tests in Sweden. The same study also showed that using ICT without a clear method does not bring about improvement but may rather lead to worse results. There is clear evidence that ICT use does not by itself lead to progress. Findings from the pre-school context also highlight the complex matter of predicting learning outcomes and emphasizes a discussion on how digital tools can mediate and re-mediate activities (Nilsen et al., 2018; Skantz Åberg, 2018).

Another aspect is the positive impact on pupils' performance which has been obtained with particular technologies. The students show habits of fulfilling ICT assignments in schools in an efficient way regardless of whether they know what the learning outcomes will be (Almqvist & Östman, 2006).

Moreover, Swedish classroom studies have highlighted the complexity in digital environments in upper-secondary schools and new dimensions for students to consider (e.g. Lantz-Andersson et al., 2009; Almqvist & Östman, 2006). Interaction with educational software show that utterances and actions were not only about the content of the problems but also about the digital technology (Lantz-Andersson et al., 2009). Additionally, questions of what is learned in this kind of environments were also posed. Bergström and Granberg (2007) highlight the importance of students being aware of the didactical questions of how, what and why in relation to formative assessment and the outcomes in upper-secondary e-learning courses.

Modes of expression

In education, teachers and pupils use software applications that offer different modes of expression. Didactical questions concerning software applications have been explored in research. Wegerif (2004) argues that with the right educational software, computers can interactively work towards curriculum goals but also simultaneously serve as a learning environment in which pupils can explore their ideas.

There are tendencies for ICT to be mechanistic in nature and to be concerned with the development of the tools within the software application. There are also examples which involve accessing pupils' metacognitive skills using strategies such as facilitation and problem solving (Barnes & Kennewell, 2017). Teachers could concentrate on

higher-order issues, such as emphasizing productive discussions (Mercer & Littleton, 2007).

However, many of the software applications used in schools are not designed for educational purposes. The same kind of digital programs used by different teachers and pupils can also generate different interactions both between teachers and pupils and between pupils and the digital resource (Pettersson, 2018).

From 2000 onwards, a range of classroom studies have shown examples of interaction through a variety of modes, where teacher-designed tasks and software programs have provided new opportunities for learning (Cope & Kalantiz, 2000; Jewitt, 2011; 2008; 2006; Kress, 2010; New London group, 2000).

Overall, the results from previous classroom research point out that digital tools challenge traditional teaching because they provide a range of modes of expression and communication, and are not limited to the traditional medium of paper (Kress, 2010; Jewitt, 2008; 2011). During interaction, both pupils and teachers orchestrate digital resources. The increasing number of digital tools and teacher-designed digital activities makes it urgent for both teachers and pupils to develop skills in communication through images and other visual means of communication (Kress, 2005; Jewitt, 2006; 2011).

Mavers (2007), as well as Edwards-Groves (2011), demonstrate creation of dynamic texts in a multimodal writing process with the aim of investigating the principles that guide children's text-making. Likewise, Tomlinson (2013) has elucidated how pupils engage in

multimodal redesign by the orchestration of semiotic modes of music and verbal linguistics as a rich source for communicating meaning and developing higher thinking. In a situated learning context, children communicate their experiences through multimodal redesign, which according to Tomlinson enhances their conceptual understanding.

In the Swedish context, research questions have been posed from a design-oriented perspective on learning (Selander & Kress, 2010). Studies in secondary schools indicate that pupils and teachers use different resources, which consist of a complex weave of modes and are distributed through different media in social practices (Åkerfelt, 2014). Moreover, the role of the teacher also varies, in that the teacher becomes more or less central depending on how the task is designed in relation to pupil-centred activities (Selander & Kress, 2010).

Stenliden et al. (2017) point out students' creative possibilities in the construction of new visual learning tools. Using design-based research, they have explored teachers' development of innovative didactical designs, in order to achieve a better understanding of future outcomes in classrooms where visual learning tools are applied. The results also revealed that teachers were not only aware of the learning processes involved in using the visual tools but also took into consideration how upper secondary students can demonstrate growing knowledge.

Summing up

The classroom research referred to above will be set in relation to the findings of this thesis. In particular, research about the content of teaching in relation to ICT (e.g. Edwards, 2015; Hayden & Barton, 2008; Tay et al., 2012), methods of instruction (e.g. Engeness, 2019; Warwick et al., 2011) and classroom interaction with educational software (e.g Jewitt, 2011; Wegerif, 2010; 2016).

With regard to the research questions, previous research put forward teachers' aim to teach with ICT and teachers' pedagogical reasoning about the appropriate use of the technologies (e.g. Holmberg et al., 2017; Kennewell, 2001; Loveless, 2011).

However, studies from the Swedish and international contexts highlight the complexity in digital environments (e.g. Lantz-Andersson et al., 2007; Nilsen et al., 2018; Voogt & Roblin, 2012), as well as the potential and constraints of ICT as a tool for learning, such as in what way computer software can participate in and support classroom interaction (e.g. Björkvall, 2014; Kress, 2010; Mavers, 2007; Tomlinson, 2013).

Many of the research studies also comment on teachers' digital competencies in relation to the findings of these studies. The major importance of these findings is the way that the teachers employ their digital competence in classroom teaching in different forms (e.g. Genlott & Grönlund, 2013; Mercer, 2005; Warwick et al., 2011). The next section concerns research related to digital competencies in digitalized classrooms.

Competencies in the digitalized classroom

Research literature poses the question of why it is that teachers' digital competence denotes a more complex set of skills and competencies compared to digital competencies needed in other areas of society (From, 2017; Instefjord & Munthe, 2016; Krumsvik, 2008). Moreover, teachers' digital competence appears in complex organizational systems and acts within rich educational traditions, which enhances the complexity when the competence is enacted in educational contexts (Krumsvik, 2008; Lund et al., 2014).

In recent years, a number of attempts have been made to elaborate on the digital competence needed for actors working in schools and education (Blau & Shamir-Inbal, 2017; From, 2017; Hatlevik, 2016; Krumsvik, 2008; Krumsvik et al., 2016; Sipilä, 2014; Wastiau et al., 2013.

Blau and Shamir-Inbal (2017) examined teachers' digital competencies as one important component of ICT integration and pedagogical changes. In their study, they found that ICT integration and digital competence evolve over time and that digital competencies must become an integral part of teachers' core teaching competencies and not as something that is 'an add-on'.

Hatlevik (2016) and From (2017) propose that digital competence can explain variations in teachers' pedagogical use of digital technologies, and that high levels of digital competence can contribute to a more critical and frequent use of digital technologies.

The research of Wastiau et al. (2013) showed that teachers' confidence in their own digital competence influenced students' use of technologies during lessons. Moreover, students taught by teachers with a high digital competence but with limited access to digital technologies in the classroom use digital technologies to a greater extent than those taught by teachers with a low digital competence but with free access to technologies.

A similar result can be found in Sipilä's (2014) work, which showed that students need competent and confident teachers to make use of rich digital learning environments. Sipilä (2014) reports that teachers' sense of control is related to their digital competence. Teachers with high digital competence frequently use ICT in education, but there are differences in relation to gender, different forms of ICT and the use of ICT in different school subjects. Primary teachers are more positive in their perceptions of students' opportunities for and awareness of using ICT compared to secondary teachers (Sipilä, 2014). The analysis also revealed that male teachers considered themselves more likely to master basic ICT competence.

According to Voogt and Roblin (2012), the acquisition of competencies can be best supported by specific pedagogic techniques, such as problem-based learning, co-operative learning, experiential learning and formative assessment. In addition to these innovative teaching approaches, most frameworks also emphasize the need for a comprehensive use of ICT to enhance student learning and

to promote the mastery of twenty-first century competencies (Voogt & Roblin, 2012).

Most research focuses on the specific competence needed by teachers and therefore tends to neglect the influence of broader contextual conditions in the wider school setting (Pettersson, 2018).

However, throughout recent years, attempts have also been made to discuss pedagogical aspects of digital competence from a contextual perspective (e.g. From, 2017; Wastiau et al., 2013). From (2017) focuses on pedagogical aspects as a specific characteristic of the broader term of digital competence. Similarly, Krumsvik (2008; Krumsvik et al., 2016) suggest an inclusion of pedagogical aspects in the concept of digital competence.

From (2017) argues that the pedagogical aspects of digital competence should not only be regarded as a separate set of skills and competencies embedded at the level of teachers but also be seen as embedded within and across the wider school organization.

Following the same line of reasoning, Vanderlinde and van Braak (2010) highlight the importance of supportive organizational infrastructures, formation of policy-related documents and a strategic leadership that can support teachers in transforming policies into realistic goals, where teachers can put these goals into action in the everyday teaching practice. Wastiau et al. (2013) also argue for a comprehensive organization of policies, leadership and supportive organizational infrastructures when trying to achieve

technology integration and development of the digital competencies needed.

The examples above indicate the complexity of digital competence when applied in educational contexts. However, a didactical question is what it might take to develop digital competence and what such competence might look like in today's digitalized schools.

Islam and Grönlund (2016) suggest that much of the research observes the change in the teacher's role and the need for increased focus on "twenty-first century skills". However, there is little research exhibiting proven methods for achieving such change. They argue that twenty-first century skills must be developed not in competition with but alongside and integrated with the 'traditional' skills despite the competition for time with traditional curriculum items.

Pettersson (2018) argues that a critical issue related to this theme concerns policies to be formulated on multiple levels of the educational system. Although policymakers seem to push their ideas on multiple educational levels, policies seem often to become a dilemma to be handled by teachers. A critical question for researchers, policymakers and school leaders appears to be how to steer the responsibility to an organizational level and furthermore, how to close the gap between policy level and the level of teachers when developing digital competence in the wider school organization (Pettersson, 2018).

In relation to digital competencies, *Digital Bildung* is discussed with regards to digital competencies for both teachers and pupils (Gran, 2019). The aim was to uncover teachers' understandings of the *Bildung* processes and how they were affected by ICT use. The results suggest that *Digital Bildung* should be discussed in relation to digital actions in students' social life and in what way ICT changes teachers' classroom management in relation to democracy and teachers' professional competencies.

Another research focus is the relationship between *Bildung* and the teaching and learning of content and its subject matter, which includes 'ways of knowing, ways of acquiring, and ways of reflecting about and of using a piece of knowledge' (Schneuwly & Vollmer, 2018, p.39.) Within this idea, *Bildung* is one driving force behind all educational planning and institutionalized teaching-learning activities.

Summing up

The two main sections in this chapter, *Didactical questions in the digitalized classroom* and *Digital competencies in the digitalized classroom,* have focused on previous research in relation to the research questions and the research study of this thesis. The methodological decisions and the design of the study are presented in the next chapter.

Didactical Considerations in the Digitalized Classroom

Research design and methods

The findings presented in the four papers of this thesis come from a case study based on qualitative methodology with an ethnographic approach, as the research focuses on people's actions on a small-scale and in an everyday school context, which is suited to qualitative ethnographic work (Hammersley & Atkinson, 2007). In line with qualitative research in general, the study is characterized by an interest in analysis of observations rather than experiments, in words and images rather than numbers, and in inductive, hypothesis-generating research rather than hypothesis testing (Hammersley & Atkinson, 2007; Silverman, 2010). Further, the analysis involves an interpretation of human actions and the school practice, as well as implications for a wider context (Hammersley & Atkinson, 2007).

Ethnography is a particularly appropriate method for investigating teaching and learning because there are strong similarities between the way people learn and the activities of conducting educational research. Like teaching and learning, it demands multiple forms of input to be successful (Walford, 2008).

> It cannot answer all educational questions […] but ethnography can answer a range of questions where we are concerned to document and understanding learning and teaching processes (Walford, 2008, p.7)

Ethnography usually involves the researcher participating over an extended period of time, watching, listening, asking questions, collecting documents (Hammersley & Atkinson, 2007), which also means that the researcher must be prepared to consider many different types of data and that the researcher has to be engaged in the material, to invest time and to have a mutually trustful human connection with the participants (Walford, 2008).

The research methods used in the study are the ethnographic techniques of long-term observation of classroom practice, formal and informal interviews with teachers and pupils and the use of written material such as school documentation.

Case study design

The study in the thesis involves the analysis of a single case, a school project, with an emphasis on the examination of the classroom setting. The case study design often includes qualitative methods, e.g. participant observation, which is helpful in generating a detailed examination of a case (Bryman, 2012). The advantage of the case study is that it can "close in" on real-life situations as they unfold in practice. The multiple wealth of details is important for the development of a nuanced view of reality (Flyvbjerg, 2006).

To maximize the utility of information from small samples and single cases, cases are selected on the basis of expectations about their information content (Flyvbjerg, 2006).

The case study presented here has been chosen with reference to the research questions but also because of the fact that it could give detailed information about a single example studied over time. The school was selected because of its intensive work with ICT and the fact that many teachers orchestrated digital resources in daily teaching. This was not a unique case, rather an exemplifying/representative case for a larger category of schools with the same conditions. In a representative/exemplifying case, the aim is to capture the conditions of a common situation, such as a school setting, which represents a broader category of which it is a member (Flyvbjerg, 2006).

A criticism often made of case studies is that findings cannot be generalized on the basis of a single case. However, this does not mean that it cannot enter into the collective process of knowledge accumulation in a given research field or in a society (Bryman, 2012; Flyvbjerg, 2006). The purpose of this research design is not to generalize but that the findings might provide valuable examples and provide a base for discussion.

The empirical material

In selecting a case for research, a researcher must take into account the two levels of choices: the context and the participants. In this study, the participants were chosen in a strategic way, a purposive sampling that is relevant to the research questions. The thesis explores

didactical questions relating to the interaction between the teachers, the students and the content in a digital context, which presupposes the use of ICT in teaching. The representative case chosen for the study exemplifies a dimension of interest, and this particular school was selected because the teachers were working with ICT in daily teaching and it created opportunities to study the way in which the digital resources were used for teaching and learning.

Bezel primary, the Swedish primary public school in focus in this study is situated in the south of Sweden, in a middle-class area. The school children, 298 pupils from 6 to12 years old, come from various cultural and socioeconomic backgrounds. The school has an ICT profile and is engaged in ICT projects, which includes all pupils having access to a digital artefact (a laptop or tablet computer). The school was involved in a project called '2-to-1', which started in February 2009, where two pupils shared one laptop, which was frequently used in learning activities in more or less all subjects.

By 2015, the aims were to:

- increase the number of and the use of laptops and provide a device to all pupils by that time
- involve parents in becoming familiar with these digital tools as a natural part of the pupils' learning processes, and
- develop the teachers' competence in relation to digital tools in order to redefine their perspectives on knowledge building.

During this study, the teachers had regular meetings to discuss how to integrate the laptops into the teaching and they shared their experiences with each other. As mentioned above, this school was chosen because of the interest in integrating digital tools into teaching. However, in order to obtain access to the activities in the classroom, the teachers became 'gate keepers' (Heath et al., 2010), which meant that it was a prerequisite that the teachers were willing to be a part of the study.

The investments in the municipality were made via a private actor in edu-business that described itself as the leading educational consultant in Sweden. This private actor was very active in offering school improvement that included activities such as continuing professional development, consultancy, training, digital equipment and programs (Player-Koro & Beach, 2017). The teachers at Bezel primary were involved in some of the activities provided by the company in order to find operational ways to fulfil the aims of school policy documents and be a part of a technological and professional change with the vision of integrating ICT in education.

The school project

The studied class consisted of 29 pupils, 13 boys and 16 girls. The overall study focused on the work of these nine-year-old children when they were engaged in the school project 'Space'. Over ten weeks, there were different classroom assignments involving individual, group and whole-class work, which was the basis for the

empirical data, more specifically: teachers' preparations and demonstrations in whole-class activities, pupils' group processes and pupils' individual work. The tasks they carried out were: stories in groups, individual research about a scientist, Internet search for facts about a planet where each student did individual research, creation of a planet in *papier-mâché* (a technique using paper and glue) and creation of advertising films, which is the main analytical focus of the thesis. The selection of material from the data presented in the four papers highlights teachers' and pupils' work where the aim was to create films, but also other software activities. The distinguishing feature of this kind of software is that it provides various modes such as image, sound, writing, speech, music and special effects, e.g. colours and backgrounds.

The three teachers included in this study were willing to be a part of the research study. The school project presented here, 'Space', was planned and designed by the teachers at the school, and the task 'Creating an advertising film about the planets in our solar system' was planned by the teachers in one particular class. The subject teachers in the class had about 10 to 13 years of teaching experience in elementary schools in Sweden. They taught different subjects in the class: Swedish, social sciences, mathematics, natural sciences and English. However, the subjects were not always separated, and during the 'Space' project, there was interdisciplinary teaching, i.e. an integration of subject areas, e.g. natural sciences, Swedish, English.

Data overview

The study can be described as explorative in the sense that the data was gathered with the purpose of making visible the interaction between teachers, pupils and content during digital school activities. Exploration is flexible, in the sense that the focus of the study becomes progressively sharpened as the enquiry proceeds (Silverman, 2010).

Data collection

The data was collected thorough classroom observations, formal and informal interviews, representations of pupils' work and local policy documents. These different data collections: descriptive field notes, video/audio recordings, documents and interviews, were later processed and analysed for the purpose of interpreting teachers' and pupils' interaction with ICT in relation to the research questions.

The data collection began with observation of many different features. This resulted in a rich data corpus, and the empirical data gradually became even more detailed and consisted mainly of data from one particular task, the advertising films. Over time, the research questions were developed in line with the findings of the papers. Table 1 illustrates the data from the case study.

Table 1: Overview of the data collection. The data used in the four papers of the study are marked in **bold.**

Type of data	Method of data collection	Type of data collection
Demonstrations given by the teacher	Observations	Video recordings, field notes
Small-group work - advertising films	Observations	Video recordings, field notes
Individual work - searching for facts on the internet	Observations	Video recordings, field notes
Pupils' presentations in whole-class	Observations	Video recordings, field notes
Whole-school activity - starting up the project 'Space'	Observations	Video recordings, field notes
Regular discussions with teachers and pupils	Informal interviews	Field notes
Pupils' evaluations of the project 'Space'	Formal group interviews	Field notes
Teachers' evaluations (3 teachers)	Formal interviews	Audio recordings
Pupils' representations - advertising films	Obtained from web-platform publications	Video materials
Parent evening - presentations of pupils' work	Observations	Video recordings
'ICT pilot group' meetings (5 teachers and the Head)	Observations	Audio recordings, field notes
Policy documents from the municipality and the school	Obtained from on-line publications	Written materials

Altogether, the data corpus of this study involves approximately 28 hours of video material plus audio recordings and field notes consisting of interviews and classroom observations. During the data collection, two video cameras were used, one stationary camera that was placed to capture the whole-class activity and one mobile camera to zoom in on group activities during the classroom work, which was necessary in order to capture the screen activity. The decision to 'zoom in' (Mifsud, 2012) on certain group activities with one of the cameras meant that not all the sequences of the group activities were closely recorded, because the whole-class view did not capture the screen activities. Video recordings of whole-class, group and individual activities were undertaken and to obtain good quality sound, an external microphone was placed in the classroom. During these twelve weeks in the class, field notes of the observations were made during and after every lesson. They were later transcribed digitally.

To enrich the data, formal and informal interviews were conducted with both pupils and teachers. Undertaking fieldwork at the same time as making video recordings provides an opportunity to talk to the participants and discuss anything that might have arisen or aspects of the material environment (Heath et al., 2010), which was a good complement to the video recordings. The informal interviews with the pupils were carried out during their work when it was appropriate to ask questions. My intention was to interrupt as little as possible during their work in order to avoid having an impact on the process.

The formal interviews with the pupils were carried out through group interviews and the initial questions for each group were:

- What did you think about the task?
- What was particularly good, bad, easy, difficult?
- What did you think about working with the film software?

Each group answered these questions over half an hour, but they also talked about other issues that they had reflected on during the work. The ethnographic approach emphasizes the importance of having a curiosity about people's views, a good relationship between the interviewer and the interviewee, and also the importance of witnessing relevant events in order to understand what is in the mind of the interviewees (Cohen et al., 2011).

From my perspective, there was more of a collegial relationship between me as a researcher and the teachers in the study, and the relationships with the pupils became more and more open as the research study continued. I also became a member of the school's 'ICT pilot group' and participated in meetings together with five teachers and the head of the school. The five meetings were approximately one and a half to two hours, every second week. There was also a lot of informal talk with the teachers between lessons and many questions concerning the activities in the classroom. The formal in-depth interviews with the three teachers working in the class were carried out individually. Each interview lasted approximately an hour.

The opening questions for the teachers were:

- Reflections on the project 'Space'?
- The aim of the project 'Space'?
- In what way have the digital resources been used by the pupils?
- What would you like to improve if doing this kind of project again?
- What was particularly good/bad in this project? Explain!
  - during the process? -the learning outcomes?

The field notes, together with the formal and informal interviews, the video recordings and the local policy documents made up different complementary parts of the data collection and contributed to the findings of this study.

Being a participant researcher

During the data collection, I gradually became a member of the class community. In the beginning I was more of a 'guest' but during the process of exploring the classroom activity, I became more and more integrated into the classroom work, and after a couple of weeks, the pupils started to ask about my presence (or absence). My role could be described as an adult in the classroom without a teacher's responsibilities. Over time, I developed a mutually trustful human connection with the participants (Walford, 2008). But becoming a participant in an attempt to understand social processes has its complications. By contributing to the already existing community, the researcher gradually acquires an inside knowledge which might

modify his or her previous knowledge (Hammersley & Atkinson, 2007). However, even if researchers are studying a familiar group, they are required to make an effort to make their presuppositions explicit (Hammersley & Atkinson, 2007).

Flyvbjerg (2006) argues that the researcher who conducts a case study often ends up casting off preconceived notions and theories in the achievement of new insights. During the in depth-data collection, I would say that my own point of departure went from a more favourable view of ICT in education to asking crucial questions. According to Flyvbjerg (2006), case studies are called into questioned:

> [One of the] misunderstandings about case-study research is that the method maintains a bias toward verification, understood as a tendency to confirm the researcher's preconceived notions, so that the study therefore becomes of doubtful scientific value (Flyvbjerg, 2006, p.17).

As a former elementary school teacher, there is a risk of taking normative positions in relation to teaching and learning, which could be seen as a disadvantage. But the increasing number of digital tools in schools and the object of this study, teachers' and pupils' interactions with ICT, was not a learning object during my career as an elementary school teacher. During the ten years of my teaching career in Sweden, from 1990 to 2000, there were few moments of integrating digital tools into teaching because of the lack of devices in schools.

To get a greater understanding of the context and to become familiar with the participants, I started out by being in the classroom without video recording the activities. Once one becomes more familiar with the setting and the participants, one gets a clearer idea of the aims of the research and it is also easier to introduce a camera for recording (Heath et al., 2010), which was suitable for the data collection in this study. Altogether I visited the class over twelve weeks, with two weeks initially when I was only observing the class and the teachers, getting to know the participants in order to help them to get used to me and to the camera. In the beginning, the pupils got very excited and performed in front of the camera. Some of the pupils stopped working when they were video recorded but after some time, they were not particularly concerned about either the camera or about me. The video recordings include footage from two cameras with two different angles: one capturing the whole-class view (stationary) and the other one capturing the group work (hand camera).

Video recordings were used in order to have the opportunity to transcribe and analyse film segments several times (Heath et al., 2010), which also provided opportunities to record aspects of classroom activities in real time. It was possible to record talk, gestures and the use of digital resources. There were opportunities to play back, and refocus and re-evaluate the 'analytic gaze', in contrast to other forms of social scientific data (Heath et al., 2010).

What must be taken into account is that a video recording of an event represents how the researcher has chosen to focus the camera (Baker et al., 2008). The video represents a selected event available for analysis and from an ethnographic perspective, videos and other field notes are ways of representing the social context. But digital video recordings also allow data to be shared with colleagues and with national and international researchers, both at the university and in conferences, which makes the data more 'transparent', and allows others to discuss the findings (Heath et al., 2010).

Analytical process

During the data collection I studied the field notes and watched the video recordings as I gathered them, to be sure that it was possible to answer my research questions with the methods used, which is a key point during the data analysis (Silverman, 2010). The initial analysis consisted of reflections written by hand together with the field notes. After finishing the data collection, the first step of the analysis was to obtain a preliminary review of the data corpus. Video recordings, field notes and audio recordings were digitally organized and summarized, divided into different parts and then put together to get an overview. Categorizing data should not involve more than a simple description and classification of the material (Heath et al., 2010).

The second step was a review of the data and, after repeated analysis of the data corpus, the material was categorized as follows:

- differences in pupils' meaning-making group processes
- differences between teachers and pupils in ways of handling and designing the digital task
- similarities in pupils' final products and
- teachers' planning and demonstrations of tasks

The material in these categories became the initial data during the analysis and enabled me as a researcher in the analytical process to compare and contrast aspects of the data (Heath et al., 2010). The categories emerged by means of an open coding that was closely connected to the overall research questions, and these categories were defined using cultural themes, e.g. features closely connected to the practice. The analysis continued by narrowing down the common features of each category and various samples of the data corpus were compared (Silverman, 2010).

The analyses from the long-term study of teachers' and pupils' interaction with ICT in a primary school practice, which were published in Papers II, III and IV, pointed in the direction of theorizing the findings in terms of didactical questions. Additionally, by going back and forth and analysing the data by using concepts in the tradition of *Didaktik*, the first article presented in the thesis brought together my research project as a unit.

Analytical lenses

Hammersley and Atkinson (2007) have suggested that the analytical process is iterative and that there should be a movement back and forth between theories and data.

> So the analysis is not just a matter of managing and manipulating data. We must be prepared to go beyond the data to develop ideas that will illuminate them, and this will allow us to link our ideas with those of others; and we must then bring those ideas back to test their fit with further data, and so on (Hammersley & Atkinson, 2007, p.159)

During the data analysis of this study, interesting features appeared that had to be taken into account and further analysed. These features were related to ideas from previous research findings, which were then applied to the data in this study. The four papers presented in the thesis consist of the same empirical data, but during the data analysis, various analytical frameworks have been used in order to capture the research questions raised during the analytical process. The analytical focus of each paper is presented in figure 3.

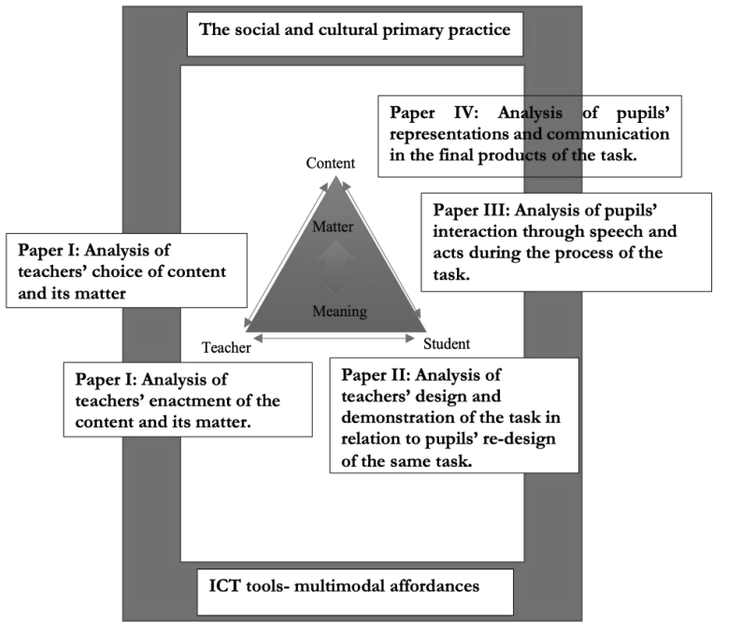

Figure 3: An illustration of the analytical focus of the four papers

Paper I consists of an analysis of teachers' preparations in a 'ICT pilot group' and teachers' demonstrations in the ICT classroom. The paper investigates teachers' choices when dealing with the content and its subject matter but also the enactment of the subject matter in relation to ICT software in their classroom teaching. In this paper, *Didaktik* provides a framework for exploring teachers' enactment of the most fundamental how, what and why questions in relation to the content and the subject matter being taught (Hopmann, 2007). The analysis

focuses on the relationship between teachers and the content in order to give rise to the traditional didactical questions of what content, why and how. In this paper, the analytical concepts of matter and meaning and teachers' choices of content and its matter were applied to the empirical data. Applying these concepts made it possible to discern in what way the content and its subject matter emerged in the teachers' preparatory discussions and how the chosen content and its matter were enacted in the ICT classroom.

Paper II focuses on how the teacher orchestrated the laptop-mediated task and how the pupils made meaning by orchestrating the available resources during small-group processes. In order to conceptualize these initial phenomena from the empirical material, the New London Group's (NLG) (2000) concepts of Design, Available designs and the Redesigned were applied to the empirical data, making both consistencies and discrepancies visible. Applying the concept of design (NLG, 2000) to the empirical data made it possible to explain the distinction between the teaching and learning processes and make it visible. This analytical tool allowed me to capture the dissimilarity of the design task and the redesign process with regard to the teachers' and pupils' focus on the available resources.

Paper III consists of an analysis of interaction, in this study the interaction between pupils and laptops. The Interaction Analysis Framework (IAF) (Beauchamp & Kennewell, 2010) was chosen in order to analyse pupils' group work with the aim of discerning

elements that could accomplish dialogic and synergistic interaction with ICT. The categories initially observed in the data could be explained by using the IAF, and pupils' meaning-making processes could be exemplified and explained by the categories of the framework. The analysis of the empirical data demanded analytical frameworks that could conceptualize the findings and make them explicit. The IAF focuses on mediated interaction and the features that might accomplish dialogic and synergistic interaction with ICT, which was observed in the empirical data but needed further explanation. The observations of the different groups in the study indicated differences during the meaning-making processes in the mediated actions the pupils performed in the groups. The differences did not relate to a practical technological issue but to how they created space for learning by means of the interaction with each other and the laptops.

Paper IV consists of an analysis of pupils' final products in which they made multimodal meanings in a film-editing software application. The empirical data demanded an analytical framework that could capture pupils' representations and communication. Therefore, the analysis of the advertising films was conducted using the visual grammar framework involving three metafunctions: the representational, interactive and compositional (Kress & van Leeuwen, 2006). The framework was used as an analysis of multimodal texts. The pupils' final products indicated similarities in modes of communication. By the use of the visual grammar

framework (Kress & van Leeuwen, 2006), it was possible to conceptualize pupils' representations and the choices of modes of communication.

Reflections on the trustworthiness of the study

It can be problematic to transfer the quantitative concepts of validity and reliability into qualitative research, where these terms may be understood in a different way (Mason, 2002). This can also be discussed using other terms: the concepts of external and internal (Goetz & Le Compte, 1984; Miller, 1986).

The external validity of this study refers to the degree to which the findings may be generalized and the degree to which a study can be replicated, which could be a problem for qualitative researchers because of the tendency towards small samples and case studies.

On the other hand, the concept of internal validity could be a strength of the qualitative research presented here because of the participation in a social group over a long period of time, allowing the researcher to ensure a high level of congruence between concepts and observations (Goetz & Le Compte, 1984).

However, Guba and Lincoln (1994) argue that it is necessary to establish and assess the quality of qualitative research using an alternative to reliability and validity, and they propose two primary criteria: trustworthiness and authenticity.

I have chosen to primarily describe the process of the data collection and analysis by using the concept of *trustworthiness* (Guba & Lincoln, 1994). Trustworthiness is made up of four criteria: credibility, transferability, dependability and confirmability. *Credibility*, which has parallels with internal validity, means that there are several possible accounts of social reality but it is the credibility of the account that a researcher presents that will determine its acceptability to others. To increase the credibility of the research in the thesis, the goal has been to make the data records systematic as well as making a systematic analysis. By comparing different data (video/audio recordings with observations, interviews and written documents), the aim was to ensure consistency between concepts developed and observations.

The data presented here has been collected with a focus on depth rather than breadth and is oriented towards social practice. The aim has been to richly describe the practice in order to improve the *transferability* and increase the degree to which findings can be generalized in other social settings. The transferability of the findings in qualitative research is often a subject of discussion, and replication of a case study may be difficult, but there could also be difficulties for researchers in natural sciences, depending on variation in laboratory conditions and procedures (Silverman, 2006). The audio and video recordings have been transcribed, which gives readers and viewers access to both the video clips and the transcriptions of talk and other actions, and provides the opportunity to discuss whether the conclusions are reasonable. In the papers, there are examples of

transcripts to illustrate the results of the study and in my opinion, there is a possibility of transferring some of the research results to other contexts that also involve digital tasks.

Guba and Lincoln (1994) argue that researchers should adopt an 'auditing' approach, which means that records are kept of all phases in the research process to increase the *dependability*. Peers could then act as auditors and assessors. Using the analysed data, I have given talks at conferences and presentations for research colleagues where brief fragments from the original recordings have been shown in order to get feedback from the audience and to provide evidence for my conclusions, which is a function of audio and video fragments (Heath et al., 2010). This shows some sort of dependability, with another observer observing the same phenomena in the same way and from the same theoretical perspective (Denzin & Lincoln Eds., 1994; Silverman, 2006). However, there are certain features that have to be taken into account, for example that with field notes, the information has been filtered through the researcher. Also, when people's actions are video recorded, the researcher has to decide where to place the camera(s) and when to stop filming, which is a reliability issue (Silverman, 2010).

In addition, there are also issues that have to be discussed in relation to audio- and video-based data, which largely relies on presenting transcripts of the original data. This means that one has to present events from audio-visual recordings in journals where is it not possible to accompany the written text with a display of moving

images (e.g. CDs, DVDs) (Heath et al., 2010). The events are often presented in a written text, which transfers the analysis from talk and the moving image to writing. The methodological ambition of the four papers presented in the thesis has been to give as many illustrations as possible from the collected data by visualizing the data through still images, and in particular in Paper II describing gestural, visual, spatial and auditory modes in order to increase the credibility of the study. However, I am conscious that it is difficult to mirror the video recordings and guide the audience through the analysis in order to help them to understand the findings that have been chosen from the large data collection.

Ethical considerations

This study has followed the ethical principles (Honesty; Openness; Orderliness; Consideration; Impartiality) of the Swedish Research Council (2011). In order to conduct the study, permission from the participants was necessary (Cohen et al., 2011). The participants and their guardians were informed orally about the content of the study, in class and at a parent evening before the data collection. The guardians also received an information sheet about the aim of the research, the purpose of the video recordings and how the data would be managed. They were asked to sign a form, confirming their permission for the child to participate in the research study and to be video recorded during the lessons. Gaining written permission to

undertake video recordings is in many circumstances unproblematic but can be difficult if the children are very young. In these cases, a researcher is not only dependent on permission from the teachers and parents but must also follow the UN Convention on the Rights of the Child (Heath et al., 2010). In this study, it was necessary to explain the purpose of my presence in the class and to obtain approval from the pupils as well from the guardians. All guardians approved except for one, which had to be taken into account. The teacher arranged this by placing the child in question away from the camera and the child has not been a part of the data collection. However, there are more factors than informed consent from pupils and guardians to take into consideration during the data collection.

My role as a participatory observer could be described as another adult in the classroom without a teacher's responsibilities. The research study was overt and the pupils were informed of the intentions of the study and my role as a researcher in the room. However, as a responsible adult there could have been situations in which I had to consider how to act, for example in overhearing insulting comments between the pupils. In such cases, the ethical principles of whether there is *harm to participants* could be discussed, not in relations to the data collection itself rather how to react as an adult in the classroom (Bryman, 2012).

During the participatory observations, there was always at least one teacher in the class and no situations occurred in which I had to (re)act as a responsible adult. However, there were situations where

I was alone together with pupils working in small-groups in a study room connected to the classroom. In those situations, the pupils worked in a very disciplined way, which might be explained by my presence as an adult, in the room. During the data collection, they never asked me questions about the tasks they were working on, which I interpret as meaning that they saw me as a researcher and not a teacher. However, the pupils asked me practical questions concerning general matters that did not concern instructions and content for the tasks.

Another aspect is whether there is *invasion of privacy* linked to informed consent, in that the participants must have a detailed understanding of what participation in the research is likely to entail. This is included in the ethics as confidentiality: that the identities and records of individuals should be maintained as confidential. During my presence in the class, I obtained information concerning pupils that was not of interest in relation to the research study but the information was shared between teachers in different situations in which I was present. Such information has been treated as confidential material.

Didactical Considerations in the Digitalized Classroom

Summary of the papers

Paper I: Kjellsdotter, A. What matter(s) A didactical analysis of primary school teachers' ICT integration. [submitted 2019, in review for publication]

Paper II: Öman, A., & Sofkova Hashemi, S. (2015). Design and redesign of a multimodal classroom task–Implications for teaching and learning. *Journal of Information Technology Education: Research*, *14*, 139-159.

Paper III: Öman, A., & Svensson, L. (2015). Similar products different processes: Exploring the orchestration of digital resources in a primary school project. *Computers & Education*, *81*, 247-258.

Paper IV Kjellsdotter, A. (2017). From earth to space—Advertising films created in a computer-based primary school task. *Cogent Education*, *4*(1), 1419419.

The order of presentation of the four papers of the thesis differs from how they were written chronologically. The purpose of presenting the papers in the following order is to create a didactical chain beginning with the teacher perspective of preparations and demonstrations of ICT tasks. The introductory phase of the teaching is regarded as the premises for pupils' redesign of the task, which is the study object of the second article. This in turn contributes to the analysis of pupils' small-group interaction with the ICT task, which is studied in the third article. Finally, this results in outcomes in the form of pupils' products, studied in the fourth article. In order to understand the research process of the thesis, a brief introduction to the writing process is presented below.

The writing process for the four papers

The thesis consists of empirical material from a primary school setting. The analysis in the papers focuses on digital school tasks, in particular the activity of creating advertising films in a film-editing software application. In Paper III, in the first draft, the interactivity analysis framework (IAF) (Beauchamp & Kennewell, 2010) was used, together with the analytical framework of New London Group (NLG), (2000), which made it difficult to present and discuss the different findings. Consequently, this first draft was separated into two papers, with different research questions, and each paper is based

in one of the frameworks described above (Beauchamp & Kennewell, 2010; New London Group, 2000).

The primary focus in Paper III is how pupils orchestrate digital resources in small-group processes and in what way digital resources can support learning processes. Paper II goes into the small-group orchestration of digital resources in relation to the laptop-mediated learning tasks and the teacher's design and orchestration of the task. Shared findings of these two papers indicate that the laptop features open up possibilities for learning depending on how the pupils orchestrate the digital resources during small-group work. The findings also reveal similarities between the small-group processes in handling the modes of expression, which allowed a further analysis of pupils' film products (Paper IV).

Paper IV consists of a detailed analysis of the advertising films by the use of a visual grammar framework (Kress and Van Leeuwen, 2006). The similarities between the representations concerning things, places and ideas in all of the six advertising films and the composition of the films were interesting because of the classroom context in which the films have been produced. Didactical questions related to what should be taught, how and why, could be discussed in relation to these findings but also in relation to previous papers (II, III).

The use of different analytical framework in Papers II, II and IV resulted in various different findings but also a common indication of a lack of the subject content in the ICT classroom. This led to the

data corpus being further analysed in order to explore teachers' integration of ICT in the classroom. Analytical tools based in the tradition of *Didaktik* (Hopmann, 2007) were used in order to capture teachers' choices of subject content and in what way it was enacted in the classroom (Paper I). The four papers are complementary parts with the aim of exploring the core issues in classroom interaction: the teachers, the pupils and the content. Each paper will be further presented below.

Paper I Kjellsdotter, A. What matter(s)? A didactical analysis of primary school teachers' ICT integration.

The purpose of this paper is to explore teachers' choices of subject content in the integration of ICT in classroom interaction. More precisely, the aim is to explore the use of ICT, in particular the relation between the content and its matter in the teacher's selection of the subject matter in relation to the content and the student.

The research questions are: How do the content and its subject matter emerge in teachers' preparatory discussions in teachers' integration of ICT in a primary-school practice? and How are the content and its subject matter enacted in the classroom?

The theoretical foundation of this paper is the tradition of *Didaktik* (e.g. Hopmann, 2007; Klafki, 1995; 2000), and provides a framework for exploring teachers' enactment of the most fundamental how, what and why questions in relation to the content and the subject matter being taught. In this paper, the focus is on the relationship between

the teacher and the content, and the enactment of teaching and learning. One assumption of this paper is that *Didaktik* provides ways of thinking that highlight educational ICT questions (Hudson, 2007) that could contribute to pedagogical perspectives in Sweden and in other countries. In the *Didaktik* triad (content-teacher-student), meaning is what emerges when the content and its matter are enacted in a classroom based on the methodological decisions of a teacher, which are a part of what constitutes the teacher's pedagogical freedom.

The *Didaktik* concept of 'pedagogical freedom' stresses teachers' choices and responsibilities when conducting lessons (Hopmann, 1999). The main issue is how the subject matter could be enacted in the classroom with the aim of creating meaning that can open the way for the educative substance in education (Hopmann, 2007), meaning that can be learned in the long run.

In teachers' integration of ICT, the formal curriculum serves as a frame for teacher's planning but teachers have opportunities to re-think what the curriculum makers have intended and consider how the content and its matter could be enacted in the classroom. This paper investigates teachers' choices when dealing with the content and the enactment of the subject matter in relation to ICT tools in their classroom teaching. It is an empirical question about what ways the teachers use their pedagogical freedom in regard to the curriculum guidelines and the expectations that surround the use of digital technologies.

The study presented in this paper focuses on a school context in which the school was to make a development plan for the implementation of ICT and, together with seven other schools, provide a good example of ICT teaching for the rest of the schools in the municipality.

The empirical material is part of a long-term study of practices within a particular primary school focusing on the interaction between teachers and pupils in everyday classrooms (Hammersley & Atkinson, 2007). The data was produced through written policy documents, field notes, and audio- and videotapes. Three months of participant observation from the total body of fieldwork has informed this paper in order to consider the context in which knowledge about teaching and learning operates.

The field notes taken during the observations presented in this paper were written down during the five meetings of the pilot group and also during classroom activities. During classroom observations, protocols were used with the purpose of capturing teachers' and pupils' interaction with ICT. Discussions from pilot-group meetings, which consisted of teachers with good insights into and willingness to use ICT technology, were audio recorded and classroom observations were video recorded. Both audio and video recordings were transcribed digitally. Formal interviews with teachers in the pilot group were audio recorded and transcribed in the same way. ICT policy documents from the municipality and the school were also a part of the data corpus.

The fieldwork was concentrated on lessons where teachers and pupils worked with digital technologies in a third-grade classroom. The observations included a variety of ICT tasks, including the 'Space' project and the task of advertising films analysed in Papers II, III and IV.

The different data collections have been processed and analysed in relation to the research question regarding how the content and the subject matter is developed during pilot-group meetings and by the teacher in the classroom integration of ICT, which is a part of the ethnographic work (Hammersley & Atkinson, 2007).

The analytical process followed the theoretical foundation of this paper in the tradition of *Didaktik*. In analysing the data, the focus has been on identifying the transformation of curricular content into the local teaching in relation to the ICT integration in the primary school. The analytical lenses have been concentrated on teachers' choices of *what* content and subject matter in relation to curricular subject domains and *how* they have been enacted in the classroom in relation to the digital technologies available to teachers (Hopmann, 2007; Hudson, 2007).

The analytical tools capture how the content and its subject matter emerged in teachers' preparatory discussions and how they are enacted in the classroom. More precisely, the analysis focuses upon teachers' choices of subject matter in relation to a given content and how it is enacted in the classroom to open up the educative substance for the pupils in the creation of meaning.

The findings indicate that ICT became the content in focus because the aim of teaching was developed in the direction of demonstrating software options to the pupils. The software emerged as the content, and the possibilities and/or limitations of opening up the subject matter and the educative substance were placed in the interaction between the pupils and the knowledge built into the software.

The findings indicate a lack of discussion of the subject matter and of the aims for how the educative substance could be opened up for the pupils. Further, the teachers' choices to demonstrate various software applications resulted in enacting the software as the content. Consequently, the way the teachers demonstrated the software in classroom teaching could be seen as a shift to direct ICT use, i.e. a didactical interaction relation between the pupils and the software. The teachers in this study gave whole-class demonstrations of software rather than demonstrating the design and knowledge built into the software in relation to the subject matter. The interactions were mainly between the pupils and the software (see Paper III).

The findings suggest that the teachers have been influenced to use their pedagogical freedom in the direction of ICT as a catalyst for a change in education. The findings also indicate teachers' expectations for ICT to be a catalyst for change in their professional roles. In this, the teachers tried to find operational ways of teaching from the vague curriculum guidelines of how ICT should be integrated in relation to the subject domains (Swedish National Agency for Education, 2011; 2017).

In understanding the findings here, the question of how the subject matter and the educative substance could be opened up for the pupils in their individual meeting with the content in the given teaching process (Hopmann, 2007) has to be taken into consideration. The way in which the teachers in the study chose to use their pedagogical freedom, in relation to the integration of ICT in the classroom, raises important issues regarding the didactical relation between the teachers, the learners and the content in classroom interaction.

Paper II. Design and redesign of a multimodal classroom task: Implications for teaching and learning

The aim of this paper is to explore the laptop-mediated task at primary school level by deepening the analysis of the designed task and of how the teacher orchestrated the digital resources during three introductory classes, as well as to explore the pupils' redesigning of the task based on the teacher's instructions and available digital resources.

In this study, teachers and pupils have access to ICT, and new forms of representation and communication have to be taken into account in teaching and learning. Written or spoken language is no longer the only means of communication, and there is thus a need to understand the complex ways in which speech and writing interact with other modes (Jewitt, 2011). Developing a classroom environment that includes multimodal resources requires a review of

the existing provision of texts for multimodal teaching (e.g. Kress, 2010; Jewitt, 2008).

This paper explores how pupils mediate the relationship between the teacher's instructions, the digital resources, and the learning goals. The research questions were: How was the multimodal task designed and introduced during a trajectory of teaching sequences? and How did the pupils redesign the task using the available designs provided by the teacher and the digital resources?

The focus is on the teacher's orchestrating of digital resources in contrast to the pupils' selection and integration of modes of meaning, based on the available designs provided in the teacher's instructions and the digital resources.

The theoretical foundation is a sociocultural perspective on pupils' learning (e.g Vygosky, 1986) in a multimodal composing practice. A multimodal approach focuses on the ways in which modes are combined and designed to make meaning (Jewitt, 2006, 2008). The basic assumption is that meaning is made through many representational and communicational resources, of which language is one (Kress & van Leeuwen, 2001). Different modes, such as image, sound, text, speech and gestures, are viewed as organized sets of semiotic resources for meaning-making (Jewitt, 2008; Kress, 2010). The orchestration of meaning involves selection and configuration of modes. Multimodality focuses on all the different resources that are displayed on the computer screen and are part of classroom interaction.

The study as a whole focused on the work of nine-year-old children, grade three, and the school project, 'Space'. The aim of the project was that the pupils should learn about the planets in our solar system by using various forms of digital technology in the learning processes.

The empirical material presented in this paper was collected from group work where the aim was to create advertising films about the planets using the film-software, *iMovie*. A characteristic of this kind of software is that it affords various modes such as image, sound, text, speech, music and special effects, e.g. colours and backgrounds.

The main teacher had designed a task and the aim of this task was to "make presentations on the planets in the solar system." The children were divided into six groups of three to four children where each group was responsible for one planet. None of the pupils had worked with the *iMovie* software prior to this project. During this task, the pupils were given one computer per group.

The data presented in this paper is based mainly on video recordings, but in order to analyse the data it has also been necessary to use other sources of data, particularly the field notes and formal and informal interviews with both pupils and teachers, which were carried out over a period of three months. Field notes of the observations were made during and after every lesson and later transformed into digital text.

These different data collections were utilized in order to describe and analyse the teaching and learning processes in the classroom, e.g. teachers' introductory lessons and how pupils made meaning during

this specific task of creating advertising films. By 'only' analysing the video recordings, this wider context would have been missed.

The unit of analysis in this paper is pupils' meaning-making in groups in relation to a teacher-designed ICT task. Sequences of a learning trajectory were analysed from a multimodal perspective with a focus on the designed task and the processes of how pupils orchestrate meaning through their selection and configuration of available designs. The analysis is based on a multimodal theory and the framework developed by the New London Group (2000). This theoretical framework has focused on the ways in which modes are combined and designed to make meaning (Jewitt, 2006; 2008).

The concept of Design (New London Group, 2000) forms the basis for analysing the classroom communication as digital resources open up for multimodal composing and communication of different modes of expression. This concept of Design includes teachers as designing learning processes and environments in order to achieve learning. Designs of meaning include available designs, which are resources for meaning in relation to the discourse in a given social space. Available designs are defined as resources for Design and include various semiotic systems such as language, film, photography and gestures (New London Group, 2000).

The findings show a distinction between the selection of design elements in the teacher's orchestration of the laptop resources during instruction and the pupils' redesigning of the task. The findings also indicate a distinction between how the teacher and the pupils

communicate regarding the multimodal modes of expression. Pupils' orchestration developed from the linguistic design provided by the teacher towards visual design and the use of images as the central mode of expression in the process of creating advertising films.

During the introductory lessons, the different modes of expression in the software were introduced separately from each other. During the composing process, all six groups orchestrated a multimodal mixture of different modes afforded in the software and combined images with sound, music, text and special effects, even though in the introductory mini-lessons, the teacher focused on the modes separately. The available designs provided by the digital resources became more important to the pupils than the available designs provided by the teacher.

The findings presented here confirm the linguistic tradition in schools also in the context of introducing digital tools for learning. The analysis of design elements shows a development on the part of the pupils from a more traditional print-based school task, engaging the pupils in linguistic composing, towards screen-based activities where the pupils engage in creative and explorative multimodal design.

Further, the findings also indicate a lack of orientation towards subject content due to the teacher's primary focus on introducing the software to the pupils. During this task, the semiotic resources of different modes opened up a space for the pupils' communication of meaning and learning.

The communication among pupils during the group work related mainly to the affordances of modes and how to compose the modes to convey the intended meaning. However, there were no discussions about how to convey their meaning using an advertising film. The teacher had not introduced the significant features of this specific genre; there were no discussions during the introductory mini-lessons concerning the content.

The findings opened the way for a discussion about the teaching of modal affordances and multimodal design in digital composing in relation to the outcomes and subject content knowledge.

From an educative perspective, the teacher is an important factor in the designing of the classroom task as well as in providing a platform that enables collaborative dialogic learning, where both teachers and pupils contribute to common knowledge building (Warwick et al., 2010).

To achieve a more coherent classroom communication, a pedagogical discussion should include how to emphasize the development of pupils' communicative skills in relation to the subject content and the digital resources for learning without necessarily teaching practical aspects of using the software.

Paper III. Similar products different processes: Exploring the orchestration of digital resources in a primary school project

The aim of this paper is to explore primary school pupils' interaction within group activity and how they make use of the features of the laptops, but also in what ways digital resources support dialogic and synergistic interaction.

The interest in exploring in what ways ICT resources in a classroom context could open up possibilities and/or limitations for learning is grounded in the increasing number of computers and other digital devices in Swedish primary schools, as well as in other countries. In particular, this paper has explored how laptops can support dialogic and synergistic interaction in a primary school task. The theoretical base is a sociocultural perspective, in which learning depends on the interaction between the individuals, the social practice and the opportunities afforded (Vygotsky, 1986). Dialogic interaction is here viewed as a cultural tool that has the role of mediating thinking. Dialogic interaction is characterized by being reciprocal, supportive, cumulative and purposeful, and dialogic processes are of importance for stimulating and supporting the collaborative development of knowledge in an educational context (e.g. Bruner, 1978; Rojas-Drummond & Mercer, 2003; Wegerif, 2010).

The empirical material presented in this paper (the same task presented in Paper II) was collected from group work where the aim was to create advertising films about the planets using the film-

software, *iMovie*. The material was collected through a microethnographic approach by the use of video recordings (Baker, Green, Skukauskaite, 2008) together with formal and informal interviews with both pupils and teachers. Video recordings were used in order to have the opportunity to transcribe and analyse tape segments several times (Heath et al., 2010). Conducting fieldwork at the same time as video recording provides an opportunity to talk to the participants and discuss any issues that might have arisen or aspects of the material environment (Heath et al., 2010). These different data collections were utilized for the purpose of describing and analysing the pupils' interaction when ICT was integrated in the classroom context.

The data was further analysed with the interactivity analysis framework (IAF) developed by Beauchamp and Kennewell (2010). The IAF model made it possible to describe the diversity in detail. IAF is based on a sociocultural perspective on activity. In the classroom setting, there are interrelated resources that include people and objects in a particular context. IAF provides a tool for analysing the interaction with ICT and, in addition to whole-class teaching, includes modes of classroom organization such as group interaction and individual interaction. The analysis framework contains categories of interaction from none to synergistic but there is no qualitative or quantitative hierarchy in the categories because a combination of categories is likely to be found during learning activities (Beauchamp & Kennewell, 2010).

According to the observations and the teacher interviews, both formal and informal, the final products were similar in the sense that the pupils used similar modes of expression. However, the findings also point out a variety in patterns of interaction during the small-group interaction with ICT. The variations in pupils' interactions with ICT during this task indicated the ways in which the digital resources were used in different groups.

Using the IAF as an analytic lens highlights how the pupils orchestrated ICT resources during the group task, and the variety between the groups. The variations in the processes were of interest because these findings could contribute to a richer understanding of the role of ICT, thereby addressing the main research question: In what ways do ICT resources support dialogic and synergistic interaction in a classroom context?

Two out of six groups used the digital resource as an 'object of interaction', where the tool had a more passive role during the group collaboration. Even though these pupils tried to use the Internet as a resource, they never really interacted through this medium.

The other four groups used the ICT resource as a 'tool for interaction', where the resource became more of an interaction partner during the meaning-making processes, which opened up opportunities for learning. In these groups, the pupils interacted through the digital media in order to find images and facts about the planets by exploring, analysing and discussing the information obtained by searching on the Internet. The pupils took control and

explored the features of different modes by posing challenging questions and sharing relevant information through responsive actions. The groups therefore had a richer pattern of interaction.

The findings also indicate that the interaction in these four groups between the group members and the laptop features seems to have developed the pupils' understanding of ICT resources as well as their understanding of the subject content during the group work. Synergistic interaction with ICT was rather rare but was observed in one of the groups.

These findings illustrate that a key factor in achieving dialogic interaction was that at least two members in each of the four groups started out the discussion by using the features of the laptop while communicating with each other. Clearly, the members of these groups were engaged in the creative process and the interactions concerning the laptop features, as well as the 'Space' content.

The classroom task reported in this study was open in that sense that the pupils had a space of opportunities to play a greater role in orchestrating the ICT resources. This kind of designed school task allows for pupils' orchestration of digital resources, which leads to the development of dual educational goals. The pupils in the four groups with the richer interaction pattern explored the laptop features in a creative way, which led them to question the Internet sources.

The analysis of the processes revealed a lot of important information about the group interactions with ICT, which is of significance from a teaching perspective. But the teacher did not use

the task structure to guide and mediate pupils' interaction with the ICT tool during the introductory lessons. The rules and procedures for group talk and actions were not introduced, which led to the capabilities of the members in the groups becoming very important in how they interacted with the available resources.

The film products themselves did not reveal which opportunities for learning may have arisen during the group processes. The results of this study indicate that, by emphasizing the group processes with ICT in the introduction of the task as well as during the classroom work, teachers could open up further possibilities for learning.

Paper IV From earth to space—Advertising films created in a computer-based primary school task.

This paper is primarily connected to Paper III but with the analytical focus on pupils' film products. In Paper III, the processes were analysed but the findings (as well as the title of that paper) indicate that the products were similar in the way the pupils used the modes of expression in the process of creating the advertising films.

The empirical material presented in this paper (the same task presented in Papers II and III) was collected from small-group work where the aim was to design advertising films about the planets, using the editing software *iMovie*. The distinguishing feature of this kind of software is that it provides various modes such as image, sound, text and speech, where the image is the primary mode for production.

The pupils in the study had not been explicitly instructed about how to construct or understand the genre of advertising. In the social and cultural classroom context, this kind of rather open task gives the pupils opportunities to explore the software and use its resources to design advertising films. Advertising is influenced by the social context and reveals social values. Advertisements are frequently used in Western society magazines and on marketing-oriented websites, and children are consumers (Carvalho, 2013).

The aim of this paper is to make a detailed analysis of the film products in order to distinguish the ways in which the pupils made multimodal meanings. The study in this paper has explored the question: What multimodal meanings are created in the products made by pupils using film-editing software?

The theoretical foundation of this study presumes that pupils' meaning-making is dependent on the available resources but also upon the social and cultural contexts. The premise for the classroom task is the teacher's and pupils' orchestration of the task and the unit of analysis is the product (the advertising film) created by the pupils in small groups. From a sociocultural perspective, learning is seen as a development that is connected to the situation and the setting. In this sense, every context has its own conditions for learning, and communication is closely connected to the context.

From a multimodal perspective, different modes such as: image, sound, text, speech and gestures are organized sets of semiotic

resources for meaning-making and communication (Jewitt, 2008; 2011; Kress, 2010).

In this study, digital media offer ways to re-design elements already designed in a previous process. Meaning is made through various modes, and multimodal perspectives on literacy have the basic assumption that meaning is made through many representational and communicational resources, of which language is one (Kress & van Leeuwen, 2001).

In order to distinguish pupils' multimodal meanings, the analysis of the advertising films has been conducted using the visual grammar framework involving three metafunctions: the representational, interactive and compositional (Kress & Van Leeuwen, 2006), which allows a systematic description of the analysed data presented in this paper.

The analysis of the three metafunctions: (representational, interactive and compositional (Kress & Van Leeuwen, 2006) shows similarities in the design between the six advertising films, i.e. similarities in represented participants: people, things, places, interpersonal relationships and composition. During the process of composition, the pupils interpreted and selected messages according to their communicative needs and interests, and the findings indicated similarities not only between the six groups but also similarities between the pupils and the advertisements of Western culture in various ways, e.g. colours, clothing, status and lifestyle. The pupils had designed the advertising films with representations of objects that

arise from their cultural, social and physiological history in relation to the specific context in which the sign-maker produces the sign (Kress & van Leeuwen, 2001).

The findings here are connected to the social and cultural context, which must be set in relation to the specific context in which the sign-maker produces the sign (Kress & van Leeuwen, 2001). The representations in the six advertising films also indicate close connections to the children's world, both in terms of societal expectations about vacations and in terms of what is expressed in advertisements about vacations, e.g. luxury hotels, amusements for children, low costs.

The visual design became the central point of departure for the multimodal project since the teacher had instructed the pupils to design a film in the film-editing software by creating film clips based on image, text and music. From a multimodal perspective, the images were central, as the visual mode was the primary mode for film-making in the software. The digital features made it possible to compose film clips with a variety of modes of expression, close to the advertising films that children are exposed to. The representations were made in order to communicate, and communication is not only dependent on the available semiotic resources but also upon the social and cultural contexts in which we communicate (e.g. Hodge & Kress, 1988; Vygotsky, 1978).

The teacher's demonstrations concerned the film software rather than the subject content of advertising, which most likely resulted in the pupils representing ideas that were inspired by the advertising genre of Western society. Overall, the film clips were composed using representations similar to the advertising genre, where the aim is to suggest that the viewer buys or does something (Kress & Van Leeuwen, 2006).

From an educational perspective, the similarities between the representations concerning things, places and ideas in all of the six advertising films and the composition of the films are interesting because of the classroom context in which the films have been produced. The advertising films were designed on the basis of certain social and cultural premises and the instructions of the teacher.

The findings presented in this paper open the way for a further discussion about teaching subject content in relation to the digital affordances and the understanding of pupils' meaning-making in relation to the premises of the school task. In this case, the relation between the "what, how and why" of the content of subject domains in relation to the digital technologies (Hudson, 2007) was not taken into account. The teacher's instructions concerned the digital media rather than the subject content of advertising and 'Space'.

Didactical Considerations in the Digitalized Classroom

Concluding discussion

In this chapter, I will discuss how the use of ICT may affect the interaction between learners, teachers and content, viewed from the situated and contextual conditions in which the study was carried out. I will also problematize the research findings in relation to ICT policies and previous research studies in the context of digital classrooms.

The growing use of digital tools in education provides an opportunity to discuss what teachers and pupils do in the classroom. The main findings of the thesis point out the subject content as an important issue in meaning-making processes with ICT. The discussion addresses didactical questions in which general elements of the teacher's work, the subject matter and the pupils are related to each other. The first section in this chapter opens up a discussion about teaching subject content by using digital affordances and about the understanding of pupils' meaning-making in relation to the premises of the school task. Further, from the findings in the thesis, there is a discussion of teaching competencies of importance in the digital classroom. The chapter is rounded off with a discussion of didactical implications derived from examining teaching and learning within a digital primary school practice.

Emergence and enactment of the content

From the findings of this thesis, the relationship between the teacher and the content are discussed in the tradition of *Didaktik* (Hopmann, 2007; Künzli, 1998). The findings here indicate that ICT became the content during teachers' preparatory work as well during classroom demonstrations.

Consequently, the policies on different levels had influences on the teachers that resulted in the content (in terms of ICT) being given priority over the teachers and not the other way around (cf. Künzli, 1998). The teachers in this study were finding operational ways to include ICT in education. They also found themselves in need of better ICT competencies, which is reported as a common opinion among Swedish teachers (Swedish Ministry of Education, 2016).

In teachers' rhetorical act of transforming the curriculum guidelines into the local practice, the findings show that the teachers found ways to plan and design adequate learning tasks for the pupils in order to fulfil the expected goals. The policies stress that pupils should be allowed to use digital learning platforms and that pupils are supposed to be given opportunities to work with texts that combine different modes (Swedish National Agency for Education, 2011; 2017).

An interesting finding relating to the task as whole is that because the teacher primarily took time to demonstrate the software, not to elucidate the subject matter, it was the former that emerged as the

content. This could be traced to a lack of discussion between the teachers of the subject content and its matter but also a lack of discussion of the aims for how the educative substance could be opened up for the pupils. Teachers' instructional planning seems to be a critical aspect both in this study as well as in previous research studies that stress the content of teaching in relation to ICT (e.g. Edwards, 2015; Hayden & Barton, 2012; Tay et al., 2012) and teachers' knowledge of the subject domain and competence in the appropriate use of the technologies (Holmberg et al., 2017; Kennewell, 2001; Loveless, 2007).

The importance of instruction, particularly in the initial phase of the ICT task (e.g. Engerness, 2019; Warwick et al., 2011), could be set in relation to the findings from this study that show how the teachers demonstrated the software in classroom teaching and the orchestration of pupil-centred learning. This kind of open task, with few demonstrations of the subject content, could be seen as a shift to direct ICT use, i.e. an interaction between the pupils and the technology at hand. In other words, the possibilities of opening up the content matter relied on the interaction between the pupils and the knowledge built in to the software and information on the Internet.

The intended matter itself was not explicit in the teachers' planning and demonstrations of the task. If the teachers' purpose was to achieve a shift from the traditional linguistic mode of teaching to communicating meaning through various digital modes of meaning,

this would demand teaching in meta-cognitive terms, using a language addressing the digital affordances (Warwick et al., 2011; Vygotsky, 1978). This could be explained as an ambiguity held in tension between ICT as a discrete subject domain, as a resource to support curriculum learning objectives, and as a capability for higher order thinking and activity (Loveless, 2003).

In this social and cultural setting, the notion of ICT is central, and this study stresses the interaction processes between the subject content, the teachers and the pupils. The results here suggest that the challenge is *what* to teach in regard to the technological features. A critical aspect seems to be the consideration of how the educative substance can be opened up for the pupils in their individual meeting with the content matter in the given teaching process (Hopmann, 2007).

Meaning-making processes

The findings underline the importance of pupils' experiences and learning opportunities during their small-group processes. This involves teaching of the subject content and its matter. In what way the content matter might be opened up for the pupils could be distinguished in pupils' small-group interaction with ICT. One critical difference seems to be in the way the pupils interacted with the knowledge built into the digital resources.

The analysis revealed various ways of orchestrating the software and other laptop features, as well as certain abilities to accomplish a richer interaction pattern. The findings illustrate the ways that the pupils could experience possible objects of learning. An important factor was the interaction between the laptops and the group members, which was developed during the process between at least two group members, who initiated the group interaction and were very engaged in the discussion.

The film software and other laptop features became important mediating resources but as the findings also indicated, as well as previous research (e.g Wegerif, 2010), they alone could not trigger a richer interaction pattern for all pupils, which gave rise to diverse opportunities for learning. The basic interaction pattern in the groups who used the laptops as 'an object of interaction' was rather poor, with few explorations and analyses of the digital affordances by speech and gestures. These groups tried to use the internet as a resource but they never really interacted through this medium. The internet can enable the widespread sharing of valuable resources, affording the means of collaborative learning and new forms of dialogues (Jewitt, 2011; Wegerif, 2016). In the other four groups, there were examples of richer dialogic or synergistic interaction patterns, with reciprocal responses and joint learning that became important in the meaning-making processes. Synergistic interaction, which included skills such as reflecting and asking critical questions, was rare.

The application of the two theoretical approaches in the thesis (Hopmann, 2007; Vygotsky, 1978) indicate that the pupils with a richer interaction pattern explored the laptop features as well as the subject content of 'Space', which opened up possibilities for learning. The available designs of the software and the laptop features, such as the internet, became the primary resource in pupils' small-group interaction, which introduced the issue of the interaction between the pupils, the content and the digital resources at hand.

Further, there are indications that the richer interaction pattern drove work forward in the small-group processes, which suggests that how to interact in small-group discussions is a competence (topic) in itself that needs to be developed and should be explicitly taught. Raising awareness about the learning potential of group work generates new understandings that we internalize as individual knowledge (Vygotsky, 1978; 1986).

The findings from this study suggest that interaction with ICT could lead to the accomplishment of dialogic interaction with the digital resources, where pupils analyse and reflect in terms of meta-cognitive activities such as hypotheses and critical questions. On the other hand, the results also show rather poor examples of pupils' small-group interactions. From that point of view, teachers' choices of subject content and its matter in relation to the mediating tools becomes important in creating opportunities for learning (Hopmann, 2007; Klafki, 1995).

The outcomes, in the form of digital products, were the result of the teachers' demonstrations and the mediating features of the ICT tool. In the task of making advertising films, the teacher's demonstrations concerned primarily the film software and not the subject content of 'Space' or this specific genre, advertising films. Consequently, the final products revealed findings of social and cultural influences, i.e. the products were created in the social school practice with its premises, which included both possibilities and limitations. The findings here as well as previous research stress that teachers' perspectives on the role of ICT affect the outcome of ICT integration in primary education (Joshi et al., 2010; Nikolopoulou & Gialamas 2015).

Teaching competencies of importance

When it comes to pupils ICT competencies, the findings indicate that the products produced by the different groups of pupils were similar in a technological way (i.e. the pupils used the same modes of expression), and there were no difficulties in using the software program, even though no one in the class had previous experiences of using the film- software, *iMovie*. During the small-group interaction, the pupils explored a range of modes provided in the available design of the software, indicating a curiosity about exploring the digital affordances. In other words, the pupils seem to relish their expertise and status in the digital world.

An interesting point here, is pupils' competencies in handling digital affordances but also the cultural influences from contemporary society in the advertising films. After the teacher's demonstration, the pupils moved in the direction of primarily orchestrating the different modes afforded in the software, combining images with sound, music, writing and special effects. The images became a central mode of expression in the meaning-making processes (Kress, 2010; Jewitt, 2011) of creating advertising films. This resulted in pupils' compositions of film clips with a variety of modes of expression with influences of social and cultural influences. But also, representations of ideas that were inspired and by the advertising genre of Western society.

As a result, the final products consisted of the pupils' cultural experiences from advertising in contemporary society, which the analysis revealed. The software itself became the content in focus, nor the subject content of 'Space' or the advertising genre. This may be discussed by thinking about the relationship between the content and its matter in teaching and/or demonstrating ICT resources such as: software?

The pupils in this study come from different cultural and socioeconomic backgrounds and there might be a diversity of contents in children's digital experiences (Swedish Media Council, 2019). Not all children have the same experiences at home which might impact on language as a tool for reasoning, understanding and solving problems in the construction of knowledge (Mercer, 2000;

Wegerif, 2016). From that point of view, language is central as a mediating tool in developing competencies concerning how to think in the context of interaction (e.g. Mercer & Littleton, 2007; Vygotsky, 1978; Wegerif, 2016) and also an important commitment for schools.

The conclusions go in the direction of that the pupils would benefit from teachers' preparations of how the didactical relation between the 'what, how and why' of content and ICT could be articulated clearly in the classroom. A suggestion is to find a balance in teaching between the subject content and its matter in relation to the mediating digital tools. However, this suggests a didactical perspective on digital tools in education and policies. Teachers have to be trusted in using their didactical competencies and determine how to use ICT in relation to the chosen content.

Blau and Shamir-Inbal (2017) put forth that ICT integration and digital competence evolves over time and that digital competencies must become an integral part of teachers' core teaching competencies. On the one hand, the teacher's focus on technology might be a natural part of a process where ICT is implemented in teaching. On the other hand, the teachers in the study have teaching experiences from the former curriculum (Lpo 94) as well as the latter from 2011, which could include questions such as: what ICT is good for or what can ICT do in better ways?

However, national and international studies since the beginning of the twenty-first century highlight the complexity in digital environments (e.g. Lantz-Andersson et.al, 2007; Nilsen et al, 2018; Voogt & Roblin, 2012).

Each element of curricular content has to be transformed into local teaching and how to interpret this educational transformation is left to the teachers themselves. This implicate a complex interplay of influences, pressures and expectations that affects the preparation of teaching with ICT (e.g.; Loveless, 2007; Lund et al., 2014; Kervin et al., 2019; Perotta & Evans, 2013; ; Wegerif, 2010).

Even though teachers may have didactical competencies to re-think the intentions of the curriculum guidelines and select and organize what is worthy of being taught (Künzli, 1998), the policies in the twenty-first century stress teachers' digital competencies rather than didactical competencies. Digital technology is supposed to change education and the teacher's role (e.g. Ranguelov et al., 2011; Swedish Government Official Reports, 2015). The findings here revealed that the teachers expressed an optimistic rhetoric about ICT in education and their potential to enhance educational settings, which is also described in ICT policies (Swedish National Agency for Education, 2016).

Moreover, the shift from teaching- to learning-centred activities in the twenty-first century, which can be best supported by specific pedagogic techniques, such as co-operative learning, fits in well with

the digitalization in schools (Biesta, 2012; Haugsbakk & Nordkvelle, 2007; Voogt & Roblin, 2012).

Current policies in Sweden propose that teachers are actors responsible for integrating ICT in education in a way that generates 'adequate' learning outcomes (Swedish National Agency for Education, 2016). There are arguments that twenty-first century skills must be developed alongside and integrated with 'traditional' skills, despite the competition for time with traditional curriculum items (Islam & Grönlund, 2016).

There also seems to be a complexity in the discussion of teachers' digital competencies and what 'digital competence' should include (From, 2017; Instefjord & Munthe, 2016; Krumsvik et al., 2016; Lindberg et al., 2017b). With regard to the content of this thesis, I suggest, in line with Krumsvik et al. (2016), a broader use of the term digital competencies which includes pedagogical aspects. This entails devising didactical strategies which maintain the focus of attention on content matter and learning objectives. Specifically, these strategies may include structuring activities and beliefs about the chosen content and its matter. Thus, I suggest that using ICT to assist learning can be located within a didactical and sociocultural agenda where reflections on content matter, interaction and learning processes are of importance.

Didactical implications

In contemporary society, the debate about technology and education is based on the premise that technology will be the catalyst to create change (Selwyn, 2016). In what way ICT may affect classroom interaction has been explored in this doctoral thesis. The findings here have shown that the subject content is a crucial issue in the sense of *what* to teach, which affects possibilities for and limitations in *how* pupils interact with ICT but also the distinguishing features of the pupils' final outcomes.

From a historical perspective, there is no doubt that new skills are required and no doubt that ICT needs to be an integral part of education. Digital tools provide a range of modalities that are natural in the literacy practices of today's society. However, with the rapid changes in the capabilities and directions of the technology, too much attention is focused on the actuality of ICT rather than their function and implications.

Based on the present study, I suggest that the pedagogical discussion should focus on teachers' didactical competencies instead of the ongoing discussion of how to develop teachers' digital competencies. Teachers must be trusted in the choices of subject content and teaching methods in relation to how the digital resources can be orchestrated in relation to the subject matter.

During classroom instruction, the teacher orchestrates the settings but it does not necessarily require teachers' involvement in the process (Beauchamp, 2011). The 'vicarious presence of the teacher' regarding how rules and procedures are taught in relation to group talk is of importance during the processes of meaning-making (Warwick et al., 2011). The findings here indicate that the following are highly relevant in relation to the content and its matter: how to find reliable and adequate sources in different media, and how to accomplish dialogic communication by asking critical questions and listening to and learning from each other. One suggestion is that teaching could include a focus on communicative skills in relation to the content matter and the laptop features without necessarily teaching the details of the software.

Previous research has shown a perceived conflict concerning teachers' relations to ICT in teaching: whether to use ICT in order to facilitate subject learning, or whether the emphasis should be on demonstrating ways in which ICT can be used and on teaching technical skills. One key to the effective use of ICT in education relies very heavily on how successfully teachers integrate it into teaching and learning (Bingigmlas, 2009; Haydn & Barton, 2008; Nikolopoulou and Gialamas, 2015).

Nevertheless, with a continuing emphasis on professionally developed software that is not necessarily designed for education, it is not surprising that there is little clarity in 'what' the teaching objectives will be or 'what' content matter will be presented to the

pupils. Instead, if ICT is a quality of *Bildung* in education, how do teachers develop their teaching to enhance learning? The challenges for teachers will be to analyse and understand the orchestration of classroom activities in real time from both the teacher's and pupils' perspectives in order to open the way for pupils' learning in the long run.

Based on the present study, I argue that teachers' relation to the *Didaktik* triad (Hopmann, 1999) of *what*, *how, why* could be emphasized in relation to ICT integration in classroom interaction. The use of ICT by teachers and learners provides a catalyst for identifying both new teaching strategies and those qualities of teaching which will not change, but will need to be honed and refined. The effect of ICT on the factors that influence education is considered, and I highlight the central importance of an understanding of ICT across and within subject domains. To provide assistance for teachers, I argue for additional resources on a governmental level in order to extend teachers' professional development in relation to didactical competences. I agree with Loveless (2007; 2011), who argues that a framework of teacher professional knowledge that highlights the relations between subject domain knowledge, the didactical relation with digital technologies and various teaching situations can support teaching with digital technologies.

If practice in the use of ICT in school changes, it will be because educators are being deliberate about shifting to a new pedagogy by changing the norms and routines that shape the daily work of learning environments. Teachers themselves must contribute to this debate, one for which they are both well suited and informed.

Teachers are experts in pedagogy in contrast to most designers of digital resources (Kervin et al., 2019). Many teachers certainly have didactical competencies in creating digital learning activities and assessing communicative presentations but I suggest that the curriculum and the content syllabi as well as other ICT policies ought to be extended in order to achieve equality between Swedish schools in Sweden based on research studies, primarily from the Northern European tradition of *Didaktik* (e.g. Klafki, 1995; 2000; Hopmann, 2007).

Further research

The results presented in this study have opened up further research questions, relating to increasing and exploring new empirical material on classroom interaction with ICT, for example exploring critical features of knowledge construction in digitalized classrooms. There are still knowledge gaps within the research field of ICT and education, primarily research that concerns primary education in Sweden. From that point of view, it would be fulfilling to further explore the primary practice.

With regard to the ongoing discussion of digital competencies in the twenty-first century, it would be interesting to further investigate the relationship between different patterns of interaction and different learning outcomes in relation to the notion of *Bildung*.

There is a tendency in the ongoing debate today to stress *Bildung* in relation to the digitalized classroom and put forward the concept of *Digital Bildung* (Gran, 2019). In contemporary societies, digital technologies are cultural resources but there is a question of how the resources should be used in schools. Research about teaching and learning with ICT and a discussion of the content of teaching in schools could contribute to the debate. With regard to the content and its subject matter, it would be worthwhile to further investigate the notion of *Bildung* by following the idea of Schneuwly and Vollmer (2018), in which *Bildung* is seen as ways of knowing, acquiring and reflecting on a piece of knowledge, in relation to ICT use in education.

From my point of view, didactical perspectives on digitalization in schools can contribute to questions of subject content in relation to teachers' and pupils' work, in contrast to the discussion of developing ICT competencies expressed in policies. For that reason, my ambition is to continue with research that concerns didactical questions and contributes to the European research field of didactics.

Swedish Summary

Här nedan följer en svensk sammanfattning av avhandlingen.

Introduktion

Den här avhandlingens fokus är riktat mot hur information och kommunikationsteknologier (IKT) används i klassrumsundervisningen, samt hur digitala verktyg kan utmana och omskapa undervisning och lärande. Målet är att undersöka lärare och elevers användning av digitala verktyg och på vilket sätt dessa redskap utmanar interaktionen mellan lärare, elever och ämnesinnehållet.

Det som motiverar den här studien är den ökade digitaliseringen av svensk skola. Från förskola upp till gymnasiet har elever tillgång till exempelvis surfplattor och bärbara datorer, som förväntas utveckla den pedagogiska verksamheten både för lärare och elever.

Förhoppningar om att datorer och andra digitala verktyg skulle fungera som ett pedagogiskt verktyg har förekommit sedan slutet av 1980-talet. Dessa förhoppningar har stärkts i takt med att informationsteknologin blivit alltmer lättillgänglig. Sedan 1990-talet står digitaliseringen på agendan och under de senaste tjugo åren har stora resurser investerats i svensk skola (SOU1994:118; SOU2015:28).

Men utbildningssektorn har även varit lovligt byte för politisk påverkan under lång tid i Sverige (Player Koro, 2016). Satsningar har ofta introducerats som ett sätt att lösa problem, ofta av organisatoriskt slag, snarare än att de har varit inriktade mot att utveckla den pedagogiska verksamheten (Selwyn et al., 2017).

Under lång tid har läraryrket dessutom varit hårt utsatt för press från politiskt håll vad gäller implementering av digitala verktyg som undervisningsredskap. Trots försiktiga forskningsresultat gällande ett positivt samband mellan digitalisering och elevers kunskapsutveckling har investeringarna fortsatt. Parallellt med denna utveckling har privata aktörer utövat påtryckningar på skolor gällande inköp av digital teknologi.

I takt med skolans digitalisering har också styrdokument, läroplaner och kursplaner revideras och förstärks med skrivningar om såväl användning av digitala verktyg som förväntad utveckling av digitala kompetenser. Senare revideringar har lyft fram digitala kompetenser som ett centralt innehåll där digitala resurser ska användas på ett adekvat sätt och uttrycks som ’adekvat digital kompetens’.

Avhandlingens syfte och frågeställningar

Avhandlingsstudien som helhet behandlar interaktionen mellan lärare, elever och ämnesinnehåll i ett digitalt klassrum. Syftet är att studera hur integrering av digitala verktyg påverkar en lågstadiepraktik.

Utifrån avhandlingens syfte har fem frågeställningar formulerats som direkt relaterar till studien som genomförts. Den första frågan undersöker lärares planering och undervisning av en digital skoluppgift. Den andra frågan riktas mot eleverna och hur de interagerar med ämnesinnehållet. Den tredje frågan rör elevernas slutprodukter och vad som kan utläsas av dessa. Därefter följer frågan om vilka svar studien kan ge utifrån ett didaktiskt perspektiv vad gäller digital klassrumsinteraktion på lågstadiet. Avslutningsvis ställs en femte fråga om vilka kompetenser som blir viktiga i ett digitalt klassrum?

Teoretiska ansatser

Studien tar sin utgångspunkt i två teoretiska ansatser: ett sociokulturellt perspektiv på lärande (Säljö, 2000; Vygotsky, 1978; Wertsch, 1985) och den nordeuropeiska *Didaktik*traditionen (Hopmann, 1999; 2007; Klafki, 1995; 2000). Dessa båda ansatser utgår från sociala och kulturella förutsättningar som grund för att förstå lärandeprocesser i en specifik kontext.

En utgångspunkt i avhandlingen är en social och kulturell klassrumspraktik där digitala artefakter ingår som en del i undervisningen. Det sociokulturella perspektivet möjliggör analyser av handlingar som synliggörs mellan olika aktörer och artefakter i en situerad praktik. I samspel med dessa artefakter öppnas möjligheter till kommunikation via modaliteter som bild, ljud och text. Centrala begrepp som används i avhandlingen är multimodal kommunikation och representation.

Den nordeuropeiska *Didaktik*traditionen, å sin sida, bidrar med frågor som rör relationen mellan innehåll, lärare och elever i en institutionell skolpraktik. Denna tradition grundar sig i tankar om individens utveckling. Centrala begrepp i avhandlingen är 'matter' och 'meaning'. Det handlar om hur ett specifikt utvalt stoff [*eng*: matter] kan öppna upp möjligheter för individens meningsskapande [*eng*: meaning]. Viktigt blir därmed lärarens val av innehåll och dess specifika stoff i förhållande till elevens meningsskapande, i syfte att stödja individens utveckling.

Den nordeuropeiska *Didaktik*traditionen och ett sociokulturellt synsätt på lärande används både teoretiskt och analytiskt för att kunna besvara avhandlingens fem forskningsfrågor.

Tidigare forskning

Urvalet av forskningsresultat som presenteras här ligger i linje med avhandlingens forskningsfrågor och visar på möjligheter och begränsningar i digitala klassrum. Forskningsstudierna fokuserar på innehållet i undervisningen; val av metoder; klassrumsundervisning och kompetenser i digitala klassrum.

Flertalet forskningsstudier har undersökt digitala klassrum och pekar på en ökad komplexitet i undervisningen vid införande av digitala verktyg. Flertalet studier lyfter fram läraren som en viktig aktör för det digitala klassrummets möjligheter. Resultaten visar att när lärare resonerar med varandra om hur hur dessa verktyg ska användas i olika ämnen, utvecklar de förståelse för dessa verktygs undervisningspotential (Holmberg et.al., 2017; Loveless, 2011; Tay et.al., 2012). Det argumenteras även för att de innehållsliga effekter införandet av digitala verktyg får, är beroende av hur väl lärare lyckas integrera verktygen i undervisningen (Bingimlas, 2009; Nikolopoulou & Gialamas, 2015, Voogt & Roblin, 2012). Lärares instruktioner, främst i början av lektionen, har visat sig leda till att elever i större utsträckning utvecklar förståelse för hur de kan använda digitala erbjudanden för att lösa klassrumsuppgifter (Engeness, 2019).

I linje med detta visar flera studier från engelska lågstadieklasser att läraren har en betydande roll i digitala klassrum för att öppna upp möjlighet till utveckling av kognitiva och metakognitiva förmågor (Kennewell et.al, 2007; Warwick et.al., 2011).

Vad gäller digitala möjligheter, visar forskningsresultat att digitala erbjudanden kan fungera som stöd för dialogiska processer i syfte att utveckla elevers innehållsliga förståelse (Beauchamp & Kennewell, 2010; Mercer & Littleton, 2007; Wegerif, 2010). Det har också rest anspråk på att mjukvaruprogram – genom att de ger möjligheten att kommunicera via modaliteter som bild och ljud – leder till elever utvecklas i mer kreativ riktning (Coop & Kalantiiz, 2000; Jewitt, 2011; Kress, 2010). Andra forskningsresultat visar att utfallet i förhållande till elevers interaktioner med mjukvaruprogram är nära sammankopplat med val av metod och syfte med uppgifterna (Genlott & Grönlund, 2013; Nilsen et.al., 2018; Skantz Åberg, 2018).

I flertalet forskningsstudier diskuteras också vilka digitala kompetenser som är nödvändiga i en samtida utbildningspraktik (Blau & Shamir-Inbal, 2017; Hatlekvik, 2016; Krumsvik et.al., 2016). Dessa diskussioner om lärares digitala kompetenser kan föras tillbaks till den ökade komplexitet i klassrumsundervisningen som införande av digitala verktyg leder till (Krumsvik, 2008; Lund et.al., 2014). Flera försök har gjorts att definiera vad lärares digitala kompetenser bör infatta (Hatlevik, 2016; From, 2017). Dessutom fokuserar flertalet studier på specifika digitala kompetenser som de menar att lärare behöver, såsom kritiskt förhållningssätt och ökat självförtroende, och tenderar bortse från skolpraktikens kontextuella förutsättningar (Pettersson, 2018).

Det finns emellertid studier som försökt inbegripa såväl kontextuella som pedagogiska aspekter vad gäller lärares digitala

kompetenser (From, 2017; Krumsvik et.al., 2016; Wastiau et al., 2013). Slutsatser som dras i dess studier är att digitala kompetenser utvecklas över tid och måste bli en integrerad del av lärares undervisning (Blau & Shamir-Inbal, 2017). En annan aspekt som lyfts fram är att strategiskt skolledarskap och policydokument bör stödja lärares arbete med digital integrering och de kompetenser som krävs (Wastiau et.al., 2013). Det har även konstaterats att även om policydokument är riktade till flera olika samhälls- och skolnivåer, tenderar dessa skrivningar att bli ett dilemma för lärare (Pettersson, 2018).

Studiens design och metod

Avhandlingsstudien grundar sig i en kvalitativ metod och är en etnografiskt inspirerad fallstudie (Flyvberg, 2006). Studies design öppnar för möjligheten till en tät och informationsrik datainsamling (Hammersley & Atkinson, 2007; Silverman, 2006). En längre tids deltagande observationer i en undervisningspraktik har genomförts och det datamaterial studien grundar sig på är omfångsrikt och varierat.

Datainsamlingen genomfördes under tre månader i en tredjeklass med 29 elever på en skola med ambition att satsa på digitala verktyg. Det selekterade urvalet, en skola som på daglig bas arbetar med digitala verktyg, kan i det här fallet utgöra ett

representativt exempel utan att göra anspråk på generaliseringar av de resultat som framkommer i studien (Flyvberg, 2006).

Den insamlade empirin består av klassrumsobservationer, formella och informella intervjuer, elevarbeten, lärargruppsmöten och lokala policydokument.

Klassrumsobservationerna dokumenterades med hjälp av videokamera och fältanteckningar. Informella intervjuer med lärare och elever som genomfördes under skoldagen antecknades i en fältdagbok. Formella lärarintervjuer och observationer under lärargruppsmöten i 'IKT pilotgruppen' audioinspelades och antecknades.

I enlighet med Vetenskapsrådets etiska koder blev deltagarna informerade om studiens syfte och var villiga att medverka. Elevernas medverkan godkändes även med vårdnadshavares underskrifter.

Under datainsamlingsperioden genomfördes ett skolprojekt om rymden som utgör den största delen av den insamlade empirin. Eleverna arbetade med diverse uppgifter i olika undervisningsformer, i helklass, grupp och individuellt.

Den uppgift som främst analyserats är en reklamfilm om rymden. Olika analytiska linser har använts för att fånga lärares planering, instruktioner och iscensättning av uppgiften; elevernas grupprocesser samt de färdiga produkterna.

Under datainsamlingen började den initiala analytiska processen, därefter transkriberades video/ audioinspelningar och fördes samman med fältanteckningarna till en helhet. Nästa steg

var att kategorisera materialet utifrån studiens forskningsfrågor. Det analytiska arbetet började med en analys av elevers meningsskapande i grupp med hjälp av det analytiska ramverket *Interactional analytical framework* (IAF) (Beauchamp & Kennewell, 2010).

Därefter analyserades lärare och elevers användning av multimodala uttrycksformer under introduktion och genomförande av en digital uppgift. Analysen utgår från New London Groups (2000) begrepp om skapande [*design*], omskapande [*redesign*] och det färdigskapade [*the designed*]. I nästa steg användes *The grammar of visual design* (Kress & van Leeuwen, 2006) för att analysera de färdiga elevprodukterna, reklamfilmerna om rymden.

Den avslutande analysen inkluderar såväl uppgiften om reklamfilmerna som en stor del av annan klassrumsdata för att kunna analysera lärares iscensättning av en digital uppgift. För att förstå bakomliggande orsaker inkluderar analysen även lärares planering i 'IKT pilotgruppen'. Med grund i den nordeuropeiska *Didaktik*traditionen (Hopmann, 2007) har lärare, elev och innehåll initialt stått i centrum för dataanalysen. Därifrån har analysen fokuserat på relationen mellan lärares val av innehåll och det specifika stoff som lärare valt att instruera för att kunna synliggöra vilka möjligheter som öppnas upp för meningsskapande i ett digitalt klassrum.

Sammanfattning av artiklarna

I den första artikeln undersöks hur lärarna använder sin didaktiska kompetens och i vilken utsträckning de utformar lämpliga uppgifter i relation till kunskapsmål. Resultatet visar att lärarnas fokus under planering och genomförande låg på digitala programvaror. Detta resulterade i att programvaran blev det reella innehållet, vilket skapade en didaktisk relation mellan eleverna och programvaran snarare än mellan eleverna och ämnesinnehållet.

Den andra artikeln undersöker hur läraren utformar och introducerar en digital uppgift och hur eleverna därefter använder möjliga meningserbjudanden. Resultatet visar en tydlig skillnad mellan hur läraren introducerar uppgiften uppdelad i olika uttrycksformer, såväl analoga som digitala, och hur eleverna omskapar denna uppgift till en digital multimodal produkt som kombinerar flera uttrycksformer.

I den tredje artikeln studeras en specifik gruppuppgift med fokus på processen mellan eleverna och digitala erbjudanden. Resultatet tyder på att kvaliteten på samspelet mellan gruppmedlemmarna och programvaran verkar vara avgörande för utvecklingen av elevernas förståelse för digitala resurser och deras förståelse av ämnesinnehållet.

Den fjärde artikeln ar kopplad till den tredje, men med analytiskt fokus på elevernas slutprodukter av samma uppgift. Resultatet visar att lärarna fokuserar sina instruktioner på

programvaran snarare än på ämnesinnehållet, vilket resulterar i att de idéer som representeras i slutprodukterna tenderar att spegla elevernas tidigare erfarenheter och etablerade kulturella normer.

Avhandlingens samlade resultat belyser en didaktisk relation mellan innehåll, lärare och elev och ger perspektiv på ämnesinnehållet, i form av *vad* som ska undervisas, i ett digitalt klassrum.

Slutsatser

Utifrån avhandlingens samlade resultat framträder betydelsen av lärares val av innehåll och genomförande i relation till de digitala verktygens möjligheter och begränsningar. Resultatet visar på att den digitala mjukvaran framträdde som det huvudsakliga undervisningsinnehållet i de digitala klassrumsuppgifter som studerats.

Det medförde att elevernas möjligheter till meningsskapande varierade beroende på interaktionen mellan gruppmedlemmarna och möjliga digitala erbjudanden. Resultatet leder fram till kritiska frågor om val av innehåll, och vilket specifikt stoff som står i fokus, och bör stå i fokus, i ett digitalt klassrum.

De resultat som här presenteras bör förstås i relation till skolans digitalisering under de senaste tjugo åren. Skolans styrdokument har stegvis reviderats i syfte att stärka lärare och elevers digitala kompetens.

Baserat på avhandlingsresultatet, blir min slutsats att frågor som rör ämnesinnehållets betydelse och de kompetenser som är viktiga i ett digitalt klassrum behöver diskuteras, och undersökas ytterligare. Lärare har möjlighet att använda sin didaktiska kompetens för att ta ställning till hur valet av ett specifikt stoff kan instrueras på bästa sätt i klassrummet, med eller utan digital teknologi.

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PART TWO