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Necessities and complexities regarding teachers' assessment practices in technology education

EVA HARTELL

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Doctoral Thesis
in
Education and Communication in the Technological Sciences

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This doctoral thesis consists of three parts: (I) an introduction, (II) a summary in Swedish, and (III) the following four papers:

1. Hartell, E. (2014). Exploring the (un-) usefulness of mandatory assessment documents in primary technology. *International Journal of Technology and Design Education. 24*(2), 141–161. doi: 10.1007/s10798-013-9250-z (Published here with kind permission from Springer)

2. Hartell, E. (2013). Looking for a glimpse in the eye. In I. B. Skogh & M. J. de Vries (Eds.), *Technology teachers as researchers: Philosophical and empirical technology education studies in the Swedish TUFF research school* (255-283). Rotterdam, The Netherlands: Sense Publishers. (Published here with kind permission from Sense Publishers)

3. Hartell, E., Gumaelius, L., & Svärdh, J. (2014). Investigating technology teachers' self-efficacy on assessment. *International Journal of Technology and Design Education*. DOI 10.1007/s10798-014-9285-9 (Published here with kind permission from Springer)

4. Hartell, E., & Skogh, I.B. (submitted manuscript). Criteria for success: A study of primary teachers' assessment of e-portfolios.

The papers are not included in the electronic (PDF) version of the thesis.

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Abstract

This thesis focuses on teachers' assessment practices in primary and lower secondary schools for technology education (Sv. Teknik). It is grounded in my prior experience as a teacher but also addresses the national and international research fields of technology education and assessment.

The thesis is based on four papers covering different aspects of teachers' assessment practices in technology. Its aim is to contribute to knowledge regarding how teachers use assessments in primary and lower secondary school. The thesis explores: teachers' formal documenting practices; primary teachers' minute-by-minute classroom assessment; teachers' views on assessment and finally teachers' statements and motives relating to criteria for success while assessing students' e-portfolios.

The choice of methods varies, depending on the focus of each sub-study, including quantitative data, collected from official governmental databases, software-generated statistical data and questionnaires as well as qualitative methods such as observations and interviews.

Formal documents proved to be unsupportive for teachers' assessment practices. Lack of instruction and deficiencies in design templates made these documents practically useless. The classroom study shows that the studied teachers have great ambitions for their pupils to succeed but lack collegial support concerning their assessment practices. Findings also show that teachers who are specifically trained in technology show higher self-efficacy regarding their assessment practices. Based on the results from the teachers' assessments of e-portfolios, it is concluded that there is consensus among the teachers to focus on the whole rather than on particular details in student's work. The overall results strengthen the importance of designing activities and that students should be taught and not left to unreflective doing in technology.

Teachers' assessment practices are complex. This thesis shows that teachers work with assessment in different ways. It is also shown that the educational environment is not supportive enough. Assessment is a necessity in the endeavour of bridging teaching and learning in technology, thus affordance for teachers' assessment practices must be increased.

Keywords: *technology education, primary education, assessment, classroom assessment, formative assessment, assessment for learning, self-efficacy, e-portfolio, e-assessment, engineering education, STEM*

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This journey was undertaken in two parts. During the first part, I had the privilege of participating in the program *Lärarlyftet* (Boost for Teachers) initiated by the Swedish government with the purpose of allowing established teachers to undertake graduate studies. I do not know who came up with this bright idea, but thank you, whoever you are.

I began the first part of this thesis during my work in the graduate school of Technology Education for the Future (TUFF)– *Teknikutbildning för framtiden*. My participation was funded by the Swedish government and by the municipality of Haninge. The second part was kindly funded by the municipality of Haninge, KTH Royal Institute of Technology and the European Social Fund. This support is gratefully acknowledged.

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During these years, I have been privileged to present at national and international conferences on several occasions. Attending these conferences has contributed to my growth and self-efficacy as a researcher by giving me valuable opportunities to test hypotheses and ideas and to take part in the valuable and most current work of other scholars. These conferences have also given me the opportunity to meet new friends from all over the world. I am very thankful for all of these experiences, and I would like to take the opportunity to send my thanks to all of you.

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Eva Hartell, Nynäshamn 6 February 2015

Contents

Chapter 1 INTRODUCTION

1 Background

Every child knows many things. When a child knows something, she has learned it somewhere, in school or elsewhere. However, when the child does not know, she has not learned it in school either. – Unknown

This thesis begins with a quote that highlights the importance of recognising that children know many things, are able to do many things and are competent in different areas. The quote also put forward that society is responsible for giving them opportunities for further development. Compulsory schooling and teachers are important here. When orchestrating learning opportunities, teachers must begin instruction from where her students are and proceed by inviting students to participate as active, engaged and entangled agents. As most teachers have experienced, a one-to-one relationship between teaching and student learning does not exist and receiving instruction in a subject is no guarantee that students will reach specific learning goals. Therefore, some sort of follow-up and assurance is necessary to infer from if instruction is contributing to student progress, or not. This processes of follow-up is here referred to as *assessment*.

This thesis is about teachers' assessment practices in technology, thus addressing two relevant fields: classroom assessment and technology education. Little is known regarding teachers' assessment practices in general and even less about assessment within particular subjects (Black & Wiliam, 2009; Forsberg & Lindberg, 2010; McMillan, 2013). The field of technology education requires more research related to assessment, both internationally (Jones, Buntting, & Vries, 2013; J. M. Ritz & Martin, 2012; Wiliam, 2013), and nationally in Sweden (Bjurulf, 2011; Skolinspektionen, 2014).

1.1 Assessment

Assessment is a major issue in public debate. Use of assessments by teachers has been both a controversial and forgotten topic of discussion in Swedish schools. As a colleague of mine once told me, 'I can understand your interest in assessment since you have awarded grades to your students. I do not include assessments since I do not award grades.' This comment reveals an unfortunate misconception that assessments are closely connected to grading, and by that excluding the greater part of assessment, undertaken during teaching and learning. Not every teacher award grades to students, but all teachers must include assessment as part of their work. They must do so to draw inferences and conclusion to identify if their teaching is contributing to or impeding progress. Lindström (2006) argues that refusing to assess is a concession to those people who debate whether any learning takes place in the classroom at all.

A few years ago, the silence surrounding teachers' assessments suddenly ceased, with discussions emerging about the different types of assessment. These types primarily differ in terms of procedure names and how evidence for learning is collected but not in the purpose of the assessments and the actual use of the evidence. When the concept of formative assessment entered the conversation, it soon became a buzzword among teachers and educators. There is substantial evidence that formative assessment may have a significant impact on student achievement (Black & Wiliam, 1998a; Hattie, 2009). Difficulties relating to this form of assessment such as superficial adaptation and understanding, the term's lack of definition and the difficulties of embedding formative assessment practices into classrooms have often been disregarded in the discussions (Bennett, 2011; Levinsson, 2013; Moss & Brookhart, 2009; Torrance & Pryor, 2002; Wiliam, 2009; Wiliam, 2011).

Within an educational context, assessment is often associated with grading and evokes strong emotions. Most people remember one or two occasions when they felt that they were the subject of unfair grading or a teacher's judgemental comments. However, grading is only a small part of educational assessment practices. Assessment involves various stakeholders with different agendas, with most arguing that they are seeking to increase the level of student achievement. Assessments range from large-scale forms, like PISA and TIMSS, to classroom assessments undertaken by teachers and students. These assessments occur using different timescales, from a fraction of a second to a number of years. Thus, assessments are undertaken in different ways, with different purposes and the meaning of each change for different groups of people, as contexts differ over time.

1.2 Labeling assessments

Formative assessment is sometimes referred to as assessment *for* learning, whereas assessment *of* learning is labelled as a summative assessment. At times, the differences between these two types are clearly distinguished and emphasised, depending on the collection method for data or the use of the information itself, as in summative tests or formative diagnoses (Harlen, 2010).

In educational forums, summative assessment is often described as being negative, while formative assessment is considered positive. This simplistic view is unfortunate. As Newton (2007) suggests, the discussion needs to shift focus away from competitive opinions regarding summative versus formative. He emphasises that the focus should be on the purpose of assessment and on interpreting the results. He objects to simple classification because this might become misleading, when multiple purposes are attributed to either summative or formative assessments. Wiliam (2009) emphasises the need to reconsider the previous distinction between summative and formative or of how to gather evidence about learning, arguing that

the focus should be not only on the purpose but also on the use of the evidence gathered to enhance learning. A great deal of evidence can be gathered with a formative intention but never put into practice, thus the intent itself is not enough. Therefore, Wiliam (2009) suggests a distinction between the terms and explains assessment for learning as being the overarching concept. The purpose of assessment is to move the learner forward and assessment functions formatively when this purpose is served. As such, formative assessment refers to the function and assessment for learning to the intention.

When discussing the significant impact of formative assessment might have on student achievement, there is a crucial time factor to consider (Wiliam, 2009). A formative assessment is more likely to positively influence a student's achievement when it falls into what Wiliam (2009) calls a short cycle formative assessment. In such assessments, inferences are drawn and adjustments made to better meet learners' needs within minute-by-minute or day-by-day classroom practices (Wiliam, 2009). Such assessments are very difficult to accomplish and embed in classroom practices (Black & Wiliam, 1998b; Moss & Brookhart, 2009). These difficulties are often forgotten in discussions surrounding assessments.

2 Aims, purposes and research questions

This thesis aims to deepen and generate knowledge regarding how teachers use and perform assessments in primary school technology education. The primary focus is on teachers' multifaceted use of assessments in teaching practices but also touches on the surrounding environment in which the teachers act. Four sub-studies were conducted in combination with a literature review [in English and Swedish], for the purpose of investigating, illustrating, describing and exemplifying compulsory schoolteachers' assessment practices. It is also investigated how assessment is undertaken and how results can be incorporated into technology education.

2.1 The emergence of sub-studies

Research takes time. During the years 2009–2015, when this thesis was being written, much has happened in the field of education. There have been new curricula and education laws introduced, which include changes to regulations regarding teachers' formal assessment practices and how they relate to grading and documenting.

The first sub-study (1) originates from my prior experience as a teachers in compulsory school and difficulties working with the mandatory assessment document Individual Development Plan with written assessments (IDP) (NAE –The Swedish National Agency for Education), 2009a). I had to produce IDPs for my 100+ students every semester in each of the following subjects: technology education, physics, biology, chemistry and mathematics. The first research question (RQ1) was as follows: how is the IDP document used by primary school teachers in their follow-up and future planning of their student's knowledge development in technology? This first study aimed to gain knowledge for how written assessments in technology were designed and how they were enacted, by exploring the usability of this assessment tool.

The preliminary results from sub-study (1), my prior experience as a teacher and the existing literature (mainly the works of Black, Kimbell and Wiliam) all highlight the importance of short cycle assessment being undertaken and subsequently incorporated into classroom instruction practices. Based on this insight, other teachers' classroom practices and experiences were investigated in sub-study (2) using the RQ2: how is teachers' minute-by-minute follow-up enacted in classroom? This study was undertaken by observing two teachers—Karen and Karl—while they taught a sequence of technology lessons during school years four and five.

In sub-study (3), RQ3 considers factors regarding teachers' views on assessment in technology. Teachers' self-efficacy beliefs regarding their own views on assessment practices were considered, and possible differences between teachers, depending on prior subject-related training, were investigated. This study emerged because of a lack of teachers specifically trained in technology education and the recent (2011–2015) regulation changes related to who is permitted to teach and assess for grading in Swedish schools.

The preliminary results of the first three sub-studies revealed two interesting topics: the classroom environment and the actual act of assessment. In sub-study (2), the teachers interpreted signs of understanding from students' body language, including nods and winks. The aim of sub-study (4) was to investigate thoroughly what factors influenced teachers' decision-making during the act of assessment, using the following RQ4: what criteria for success do primary teachers emphasise during the act of assessment?

These four sub-studies are presented in four papers: (I) Exploring the (un-)usefulness of mandatory assessment documents in primary technology, (II) Looking for a glimpse in the eye: A descriptive study of teachers' work with assessment in technology education, (III) Investigating technology teachers' self-efficacy on assessment and (IV) Criteria for success. From this point forward, these numbers will be used to refer to the papers.

3 The background environment and context of the study

3.1 Technology education in Sweden from an assessment point of view

The Swedish school subject technology both differs from and resembles technology education in other countries, which is sometimes called engineering education or design and technology. In this thesis, these similarities and differences are not discussed. The following section provides a brief summary of technology education in Swedish schools.

3.1.1 The Swedish technology subject: A brief summary

The goal to enhance Swedish children's knowledge in technology has existed for some time, and since the beginning of the 1980s, Technology is a mandatory subject in the nine-year Swedish compulsory school system (Hallström, 2009; Hultén, 2013; Riis, 1989). Technology was first consolidated with the science subjects, which include physics, chemistry and biology. However, technology received a syllabus of its own in the mid-90s with the introduction of the LpO-94 curricula (NAE, 2009b). This particular technology syllabus covered a range of different fields of interest, and it included aims to strive for and goals to achieve in school years five and nine (NAE, 2009). According to Hagberg and Hultén (2005), this syllabus was ambitious, yet Norström (2014) argues that it was quite vague and difficult to interpret.

In 2011, Sweden adopted a new national curriculum—Curriculum for the compulsory school, preschool class and leisure-time centre 2011 (LGR11), with syllabuses for all subjects, including technology

(NAE, 2011).[1] These syllabuses have stricter designs, stipulating not only knowledge requirements in school years six and nine but also the abilities that students will have the opportunity to develop based on the lessons in each subject. In 2011, technology education was also introduced as a mandatory subject in special schools. Therefore, beginning in fall 2011, all students in Swedish compulsory schools became entitled to education in technology. Both technology syllabuses from 2011 stipulate a core content to which instruction shall connect to, something the former syllabuses from 1994 did not do. The core content includes a wide-range of interests and topics. Both syllabuses still provide leeway for teachers to interpret and enact technology in their own individual instructions.

3.1.2 Technology teaching and technology teachers in Sweden

The Swedish regulations governing compulsory school state that 'every pupil has the right to develop in school, feel the joy of growth and experience the satisfaction that comes from making progress and overcoming difficulties' (NAE, 2011, p. 13). The national regulations also state that every pupil has the right to exceed the level of knowledge stipulated in technology syllabus.

Even though more than three decades have elapsed since the subject of technology was introduced; the field remains surrounded by problems. A consensus has not been reached regarding the subject's content, and sufficient guidelines for instruction have not been set, particularly not in the lower years of schooling. Several reports have been published over the years (ASEI, 2012; Fabricius, Malm, & Pisilä, 2002; Swedish School Inspectorate, 2009; Swedish School Inspectorate, 2014), which all highlight limited access to learning opportunities in technology for students. Teachers report

[1] There is an official translation of the Swedish syllabus in English at http://www.skolverket.se/publikationer?id=2687 . Unfortunately, there is no officially translated syllabus for special schools available in English.

low self-efficacy for teaching technology (ASEI, 2005; Nordlander, 2011), and all parts of the curriculum are not included during instruction (Klasander, 2010).

During the fall semester of 2013, the Swedish School Inspectorate (SSI) undertook a quality review of the technology subject. The resulting report (Skolinspektionen, 2014) revealed that instruction within the subject did not align to the current (LGR11) curricula and was at a too low level. For example, in school years 7–9, instruction focused on core content that was supposed to be provided in years 4–6. This report highlighted a lack of access to teaching materials, including books and equipment, and indicated a lack of collegial learning and planning with others, among teacher. When the teachers were faced with a new class, they had to start from the beginning, which was a consequence of such lack of progression. This report also confirmed the common knowledge that there were not enough hours of instruction allocated to the subject.

3.1.2.1 Teachers in technology

Black and Wiliam (2009) found that even if general principles apply across subjects, the ways in which formative assessment manifest would vary in different subjects. To provide high standards for assessment in technology, teachers must also have content knowledge, understand learning within the subject matter and be aware of common misconceptions among learners (Harrison, 2009; Kimbell, 2007; Moreland, Jones, & Barlex, 2008). Norström (2014) points out that this is uncharted territory in Sweden.

Various stakeholders have launched interventions involving technology education, which target Swedish compulsory schools (Teknikdelegationen, 2010). Not many of these interventions are firmly followed up on (Svärdh, 2013). According to Darling-Hammond (1997), teachers' competence is the single most important educational variable related to student achievement, and working in a supportive environment remains particularly crucial.

She argued that it is important to invest in teachers and teacher education. Some interventions for in-service teacher training have been undertaken to increase the number of certified teachers for technology in Sweden (Hartell & Svärdh, 2012; Skogh, 2001). Even so, the majority of the teachers teaching technology lack training in the subject (Skolverket, 2013).

Even though a lack of trained teachers has long been a problem, it became more explicit in 2011, when a teacher certification reform was launched in Sweden. In the Swedish context, school principals can hire teachers with or without an education degree, as long as they do not have a criminal record. However, if there is competition for a teaching position, the applicant who has a certificate issued by the National Agency for Education (NAE) should be given the position. Sweden recently changed the regulations regarding who is allowed to teach and assign grades in compulsory school (Skollagen Svensk författningssamling 2010:800, 2013). Since 1 December 2013, only individuals with a teacher education degree and a teacher certificate authorized by the NAE is permitted to be hired. Beginning 1 July 2015, only certified teachers will be allowed to award grades to students, which is already the case in countries such as Australia. However, unlike in these other countries, non-certified persons, with or without a teacher's education, will still be permitted not only to teach but also to assess students for grading. As a consequence of this new regulation, certified teachers must supervise uncertified teachers, and the certified teacher must be the one who signs the grading documents.

Due to a shortage of teachers with subject-specific training, this regulation change is particularly problematic for mandatory technology education, since there are not enough teachers with subject-specific training to fill all the positions available for mandatory school subjects (Skolverket, 2013). The issue is further complicated by the fact that few people are training to become technology teachers (Jällhage, 2011). Consequently, principals might

face difficulties following the regulations concerning certified teachers.

3.1.3 Teachers' views on the subject from an assessment point of view

Teachers' views of the subject influence both their teaching and their assessment practices (Gipps, 2004). Moreland, Jones, and Barlex (2008) believe that assessment becomes problematic when the teacher holds a limited view of technology and does not embrace the entire curriculum. Teachers place varying emphasis on different areas or topics of school subjects. They tend to choose topics they believe they are able to teach and that are more familiar to them. This belief, concerning one's ability to succeed, is sometimes called self-efficacy (Bandura, 1997). When teachers' self-efficacy, both individual and within a team, is strong, students' achievements and successes increase (Hattie, 2009). However, there are difficulties in defining and measuring self-efficacy because it varies and depends on individual contexts (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). Within the realm of teacher self-efficacy, there are also teachers' beliefs regarding their own content knowledge and ability to teach the school subject. These two beliefs do not always match; therefore, Nilsson (2008) emphasises the importance of strengthening teachers' self-efficacy regarding both their understanding of the content and their ability to teach the school subject, and especially the intersection of these two. According to Nordlander (2011), Swedish teachers have expressed insecurity in teaching technology.

According to Bjurulf (2008), the teachers in her study valued theoretical knowledge more than practical knowledge among their students, while assessing for grading. From an assessment perspective, there is tension in curriculum alignment. This tension between the enacted and intended curriculum occurs when more instruction time is allocated for practical work. It is strengthened by the notion that students aiming for higher grades are not supposed

to ask questions, which is a perspective, Bjurulf (2008) claims, that exists in teachers as well as students. This situation contradicts not only the alignment between teaching and learning opportunities but also the emphasis on creating learning opportunities in technology. The importance of a permissive social climate in the technology classroom cannot be overstated. Students need to be able to ask questions and learn from mistakes (Benson, 2012; Black, 2008; Moreland, Jones, & Barlex, 2008).

3.2 Assessment from a technology point of view

3.2.1 Teachers' assessment practices

Teachers use assessments for a range of purposes (Harlen, 2010; Newton, 2007), from reporting achievements to authorities and establishing where learners currently are to informing future instruction. They also use assessments to advance their pupils or for grading. These purposes are not always possible to separate, and teachers often include several of these purposes within their practices.

Teachers base their assessments on classroom interactions (Cowie, 2013; Kimbell, 2007; Klapp Lekholm, 2010). Sometimes, they simply assess based on whether or not they have taught the topic to their students (Kimbell, 2007). It is unfortunate to base the assumption of student learning on this context alone because students learn in other contexts as well, and they do not always learn everything they are taught (Kimbell, 2007; Wiliam, 2011). Teachers use a mixture of information from different sources for different purposes when using assessments, including grading (Cowie, 2013; Kimbell, 2013; McMillan, Myran, & Workman, 2002). As a result, they sometimes blend achievement with student characteristics, such as effort and participation (Lekholm & Cliffordson, 2009).

There are different ways to conduct assessments. For example, teachers might ask questions and interpret student questions and

answers with various agents involved (Wiliam, 2011). These different methods for assessment may also serve different purposes (Bonner, 2013; Wiliam, 2011). Teachers adjust their assessments to the individual contexts to advance students both cognitively and socially. Teachers must therefore embrace the focus on achievement and student motivation. However, opinions regarding the validity of assessments differ depending on the purpose. Assessments are procedures for making inferences, and these inferences may, and sometimes must, be informed by a host of factors, both inside and outside of the classroom and in different ways (Bonner, 2013; Gipps, 2004; Wiliam, 2011). This blend of purposes and sources for information is necessary but sometimes confusing and consequently overshadows the necessary transparency of assessment (McMillan, 2005).

3.2.2 Providing time and encouraging risk-taking

Fragmented instruction and a lack of progression undoubtedly hinder students' ability to learn technology. According to Skogh (2001), students require opportunities for engaging in technology to gain the courage to try, thus, multiple opportunities to experiment are important factors in the learning process. Skogh (2001) argues that this entangled relationship between opportunities and the courage to try technology is important in the early years of schooling and not just occasionally in the later years.

Moreland, Jones and Barlex (2008) emphasise that the structure of lessons including the embedding of assessment for learning, strongly influence how students undertake their assignments. Benson (2012) and Dakers (2007) both stress the importance of students being given sufficient time to explore and consolidate their thoughts and work based on possible feedback. When working with younger students, Benson (2012) added that it is especially important for teachers to ensure sufficient time for individual reflection and peer work, allowing students to finish their tasks to their own satisfaction.

Working with formative assessment is an integral part of technology education (Black, 2008). Wiliam (2011) stresses the importance of a permissive classroom environment, which includes the notion of learning from one's experience and mistakes and openness for discussion and frequent questions from students. This format draws on learners' interests by inviting them into discussions regarding their own interests and concerns. Researchers note that this feature is of particular importance in the technology classroom (Black, 2008; Moreland, Jones, & Barlex, 2008; Skogh, 2001). Black (2008) emphasises the importance of an appropriate wait time, both before and after a student replies or asks questions, before moving on to the next topic. This necessity for a wait time puts demands on the pace of learning in the classroom and, even more so, on the quality of questions posed.

Kimbell (2013) and Wiliam (2011) emphasise the importance of planning assessments ahead of time. This planning should include qualitative questions that provide information on what comes next and leads to student thinking, inviting them into discussions and promoting risk-taking. In such contexts, mistakes are seen as learning opportunities.

To formulate questions and interpret student responses and questions, teachers need content knowledge and an understanding of the difficulties students may have to encounter. They also require creativity to formulate questions that promote thinking and provide information for progression (Black & Wiliam, 2009; Hattie, 2009; Leahy, Lyon, Thompson, & Wiliam, 2005; Moreland, Jones, & Barlex, 2008; Wiliam, 2009). To make inferences based on students' responses and put them into practice, adapting activities in the classroom to better meet students' needs also demands thorough planning, both individually and with colleagues (Harrison, 2009). Hence, teachers must plan their questions in advance, prepare for possible student responses and consider different options for the next steps, while providing sufficient wait time for students to respond (Black, Harrison, Lee, Marshall, & Wiliam, 2004; Kimbell,

2007; Leahy et al., 2005). This planning must be developed individually and in groups within a permissive environment (Harrison, 2009). In this context, it should be noted that, according to Blomdahl (2007), this planning for teaching and learning is secondary in primary technology education. Instead of focusing on teaching and learning, primary technology teachers spend their time covering up for a lack of material and other frame factors, such as equipment and time.

3.2.3 Assessments in technology in Sweden

Sweden has a strong tradition for classroom assessment, relying on a belief in the teacher's ability to independently assess the pupil's knowledge and decide on a grade (Lekholm & Cliffordson, 2009). Teachers are expected to assess their pupil's knowledge in relation to the national curriculum and keep track of the pupil's development (cognitive and other) to make it possible for him or her to develop as far as possible within the syllabus (Skollagen Svensk författningssamling 2010:800, 3kap §3, 2013). Meanwhile, the school principal should provide support for teachers to meet this expectation properly, by providing allowances for teachers to develop their assessment abilities alongside their students and their peers (Statens Skolverk (NAE), 2011). Several researchers have questioned teachers' alignment with previous and current steering documents, as well as teachers' opportunities and abilities to teach technology (Bjurulf, 2008; Blomdahl, 2007; Klasander, 2010; Skolinspektionen, 2014; Teknikdelegationen, 2009; Teknikföretagen & Cetis, 2012). Information regarding Swedish students' educational positions in technology is limited and difficult to interpret (Teknikdelegationen, 2010).

National grading statistics assembled by the NAE give contradictory information compared to the previously reported neglect of technology instruction. Results from grading in year 9, with a pass grade or higher reveal that the pass rate in technology is among the

highest of all the mandatory school subjects on a national level (Hartell, 2011).

As with other school subjects (Jönsson, 2010), alignment and transparency in assessment is important in the technology classroom too. Another concern involves the environment of the technology classroom, which needs to be safe enough for students to reveal their concerns and ideas (Black, 2008; Moreland, Jones, & Barlex, 2008; Wiliam, 2011). Within the Swedish context, these factors are problematic. Even though assessment was not the focus of the review undertaken by the SSI (Skolinspektionen, 2014), they still put forth concerns about how students' knowledge is assessed and graded with regards to technology. They stated that the students did not know on what grounds they were assessed, and they were not provided with adequate information on where to go next to make progress. According to Bjurulf (2008), discussions about grading only occur occasionally towards the end of a theme. Otherwise, grading discussions between teachers and students are unusual. Bjurulf (2008) even suggests that there might be a hidden agenda among technology teachers where teachers often emphasise criteria connected with the self as a person, such as working individually or being thorough. According to Bjurulf (2008), this notion of working individually is not made explicit by teachers; even so students aiming for higher grades understand this. These students subsequently work on their own and avoid asking questions of teachers and peers.

3.2.4 External assessment resources or support for teachers' assessment practices

In 2003, the NAE initiated an evaluation (the NU03 Report)(NAE, 2004) of all mandatory school subjects in compulsory school, with the exception of technology. The NU03 report concluded that teachers need support in interpreting the curricula (LpO94) and in formulating subject content and assessment criteria for the syllabuses. As a consequence of this report, the NAE provided some supporting materials for the former LpO94 curricula, such as the guidelines "Samtalsguider" (NAE, 2008) and national tests (NAE, 2010). However, technology was not included in this support initiative (Hartell, 2011).

This thesis was undertaken during a busy period (2009–2015) in the Swedish school system. Many things have happened, and it seems that assessment has gained more attention. After the introduction of the current curricula (Lgr11) during the fall semester of 2011, the NAE began providing an increased amount of support material for teachers. These materials include general guidelines regarding how to plan and teach (Statens Skolverk (NAE), 2011) and subject-specific support material. Fortunately, technology is included in this initiative (Skolverket, 2011a; Skolverket, 2011b).

To calibrate and align the grading with Lgr11, national tests are available in some subjects, such as mathematics, Swedish, physics and history, which was the same in the former curricula. Even though the number of national tests has increased and the tests include more subjects and school years than before, technology is not included.

3.2.5 Supporting lifelong learning for teachers

Kimbell (2013) and Wiliam (2013) argue that teachers require a fundamental understanding of assessment, to be aware of the difficulties of assessment to handle teaching and learning properly. Teachers need to be able to conclude whether or not instruction is contributing to or impeding student processes linked to teaching and learning. This delicate task to make inference aims to guide students on their learning journey. Keeping every student on board is a challenge worthy of a world sailor and needs to be handled with care to release the power of assessment.

Training in assessment is important. However, several researchers, including Lundahl (2009) and Torrance and Pryor (2002) argue that teachers lack training in assessment in general and classroom follow-up in particular. Within the Swedish context, some interventions regarding assessment have been undertaken by the NAE to support teachers; unfortunately, these interventions do not include the primary years of schooling in their target groups (Fagerlund & Högberg, 2010).

Teacher education can provide some knowledge and strategies regarding assessment for different purposes; however, since teacher education can never prepare for all situations in the classroom, experience remains an important factor (Wiliam, 2011). As Wiliam (2011) also noted experience does not come automatically from teaching because it is such a difficult task. Therefore, he points out that the teaching profession demands a life-long learning perspective, which includes continuous in-service training and time to reflect upon one's practice in discussion with other professionals. Klenowski (2009), who also emphasises the importance of teachers understanding assessment, believes that teachers must have opportunities to practice assessment in order to become assessment literate. They should be given opportunities to discuss, share, negotiate and take part in students' work, together with other teachers, to develop a shared understanding of quality and

capability. These notions of developing a shared understanding through discussion are concurrent with Pettersson (2009), who also stresses the importance of discussion among teachers, concluding that teachers are at risk of not aligning with current steering documents without such discussion. Against a backdrop of increased demands for external assessments, Klenowski (2009) believes that teachers must be able to see beyond scores on external exams and continue to develop their classroom assessment practices because this directly assists student learning.

Technology teachers lack access to opportunities to share, build and develop assessment with other professionals (Hartell, 2012). Klenowski and Andre (2009) and Pitman, O'Brien and McCollow (2002) assert that this lifelong learning perspective can be built into the system of education. They exemplify this perspective through the example of moderation in Queensland, Australia. They argue that these discussions, in which teachers draw on their own individual and explicit knowledge of standards, assist in keeping the role of teachers' judgement at centre stage while enhancing the comparability of teacher assessment. Others have also suggested the importance of strengthening teacher assessments by creating a culture of practice (Bergman & Schoultz, 2014; Leahy et al., 2005; Leahy & Wiliam, 2010). Such research emphasises the importance of regular and structured meetings to help all teachers develop their classroom assessment practices and adjust their teaching to better meet student needs, which shifts the role of assessment from quality control to quality assurance. This notion of quality assurance should be embedded in the follow-up to the minute-by-minute and day-by-day life of classroom teaching (Black & Wiliam, 1998a; Wiliam, 2009). This has proven difficult, especially when teachers are alone and unsupported by their environment (Wiliam, 2011).

4 Methodological framework and research design

This chapter presents an overview of the methods, decision-making and analysis undertaken in this study. For more detailed descriptions of analyses, readers are referred to each paper (I-IV), respectively.

4.1 Overview

Both qualitative and quantitative methods have been used to investigate, illustrate, describe and exemplify the use of assessment by teachers in technology education.

Table 1 provides an overview of the research plan, including methods, empirical data and the context of collection.

Theoretical information and previous research both in printed and digital form has been continuously gathered. This information was taken from different literature searches in various databases, journals and conference proceedings, as well as from social media and colleagues.

Table 1

Overview of the Research Plan and Empirical Data in the Four Sub-Studies

Paper	Method	Data	Scope	Analysis tool	Main informants	Other informants	School year	Time for data collection
I	Collecting documents	Documents	351 documents, 14 different templates of (IDP)	Content analysis	Five municipalities		1-6	Spring/fall 2009
	Databases	Grade statistics						
		Municipality-descriptors	SALSA/SIRIS SALAR					
II	Classroom observations	Field notes in observations scheme	Observations from six lessons (approximately 6.5 hours), including, photos, annotations in observational schemes, supplemented with recordings and transcripts of teacher's voice supplemented with interviews w teachers.	Triangulation of data.	Two teachers	Pupils	Four and five	Fall/ Winter 2010/2011
	Interviews	Voice recording and transcripts, interview		Five key strategies for formative assessment				
		Lesson plans						
III	Questionnaire	Replies to questionnaires	Replies from 88 teachers.	Optical analysis of diagrams. Mann-Whitney T-test	88 teachers	School	1-9	Fall 2011
	Databases	Official data bases (SALSA and SIRIS)						
IV	Recordings of teachers' voice	Voice recording	135 judgements recorded and transcribed.	Content analysis	Five teachers	21 year five students and their teacher.	Five	Spring 2014
	Multimodal student portfolios	Think aloud protocols	Approximately 6 hours.	Statistical measures				
	ACJ	Stats from soft-ware						

4.2 Quantitative and qualitative research—The use of multiple methods

In this thesis, it has been necessary to involve different methods, appropriate for the purposes of each study. The following section will provide an overview of the theory and decision-making process for the methods chosen.

Table 2

Overview of the Use of Quantitative or Qualitative Approaches in the Sub-Studies. Bolding Indicates the Main Approach

Sub-study	Qualitative	Quantitative
1	√	√
2	√	
3		√
4	√	√

4.2.1 Qualitative and quantitative methods

When aiming to provide information on a larger scale, quantitative methods such as questionnaires or data registration may be preferred, but these methods are more appropriate for smaller samples as well. Quantitative methods can be used to investigate or measure a phenomenon with the purpose of answering or searching for questions for further research using qualitative methods. Generalised inferences are possible with quantitative methods, but it is easy to make prejudiced assumptions as well. Quantitative data can be analysed by using various software programmes or traditional hand counts (Cohen, Manion, & Morrison, 2008). This research has

used both traditional counting (in papers I, III and IV) and software programmes (in paper II and IV).

Qualitative methods are another way of making sense of the data. Though these methods do not aim to generalise, qualitative techniques can still be used for analysing, organising, accounting for, interpreting, explaining and presenting data. In other words, qualitative methods are about making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities (Cohen et al., 2008). According to Bogdan, and Knopp-Bilken (2007), qualitative research is descriptive with data consisting of words rather than numbers. The researcher decides which data to select and investigate to answer the research questions. These research questions can change during the investigation or during data analyses. The researcher must remain open to deducing new meaning from the data. Consequently, data collection and analyses become reflective interactions with the information encountered (Bogdan et al., 2007; Cohen et al., 2008). Eisner (2007) emphasises expressive writing and highlights the importance of inviting the reader into the researcher's experience.

According to Cohen, Marion and Morrison (2008), another major feature of qualitative research is the early onset of analysis because it is possible to probe, test and gather data before assembling it to make a coherent whole. Once the whole is compiled, the data is then taken apart to compare and match, with the intention of moving from description to explanation to generate a theory. There are so many stories to be told, and, as Eisner so eloquently puts it, "What we see is frequently influenced by what we know" (2007, p. 67), and the way of seeing is also a way of not seeing. Thus, subjectivity is a part of the interpretation because the researcher is part of the research process (Kvale, 1997). The qualitative researcher uses him or herself as an instrument when undertaking qualitative research (Bogdan & Knopp Bilken, 2007; Bresler, 2006; Cohen, Manion, & Morrison, 2008). The researcher contributes to the data by bringing her own experiences, background, interests, agendas,

biases and preconceptions into the study. A significant amount of self-awareness and reflection is necessary and researchers must use caution during the process (Bogdan et al., 2007; Bresler, 2006; Cohen et al., 2008).

4.3 Empirical data

The empirical data forming the basis of this research are taken from four different studies. All four studies were performed in compulsory schooling, and they focused on assessing technology from a teacher's perspective. The empirical data underpinning this thesis consists of IDPs, classroom observations, interviews with teachers, recordings of teachers' voices while assessing, think-aloud-protocols, questionnaire responses, a collection of different documents regarding teaching and assessing students' knowledge and official data records and literature (see Table 1). The following section will provide a theoretical overview of the different methods used.

4.3.1 Classroom observations

To investigate the complexity of classroom assessment, the researcher must be present. Observation is one method used in paper II. Based on direct observations, instead of second-hand information, observational data provide strong validity for research on classroom assessments (Randel & Clark, 2013). Observations are also methodologically beneficial because they can provide multifaceted information and investigate different aspects of assessment, simultaneously. However, observations in the classroom also have several disadvantages. Cohen et al. (2008) and Randel and Clark (2013) note that an observer affects the environment whether actively participating, as in participatory observations, or taking a more salient role in non-participant observation. It is important to be aware of such effects because the observed subject can feel uncomfortable for various reasons. Even with careful planning, the

observer must adjust to the environment, and he or she cannot capture everything. Observers are bound to miss certain things and be focus on others.

The collection of data, called sampling, is another problem of classroom observation. While investigating classroom assessment practices, planning is essential according to Randel and Clark (2013). The sampling must be undertaken while the issue under investigation is likely to occur; otherwise the observer may miss an opportunity for data collection. For example, if students are watching a video or doing mathematics during the observed lesson, this information will not provide valid inferences about the teacher's assessment practices in technology. Therefore, planning for observation must include sampling during appropriate situations. These problems are overridden by the benefits of collecting data through classroom observation. According to Randel and Clark (2013), the main disadvantage of classroom assessment is not the above-mentioned problem instead the time consuming nature of classroom observations.

In paper II of this thesis, it was required that observations be undertaken while teachers were giving technology lessons. It was time consuming to find teachers conducting these lessons. However, since the purpose was to investigate what happened in the classroom, observation was the preferred method. In order to build trust, the teachers and students were visited in advance to discuss the study. Trust was also built by acknowledging the professionalism of the teachers and by allowing them to choose the topic of the technology lesson.

4.3.2 Interviews

The qualitative interview can be used as a method for data collection in various types of research. According to Bogdan, Knopp and Bilken (2007), qualitative interviews are commonly used for gathering descriptive data in the subject's own words and to gain insight about the subjects' interpretation in some parts of the world, without aiming for quantification or generalisation. Instead, the purpose of an interview is to seek an understanding at both the factual and meaning level (Kvale, 1997). According to Kvale (1997), capturing the meaning level is more difficult due to implicit messages sent back from the interviewer to the interviewee. These individuals give immediate confirmations or rejections, while both giving and receiving information. This process is done deliberately and unconsciously. Data from interviews can be used in two ways: as the dominant collection of data or as a supplement for other data collection techniques. Interviews can be conducted in various ways, such as semi-structured, standardised, open-ended or informal conversations. They can also occur within different groupings of people. Data from interviews depend on the questions, which can be decreased in number through careful planning and by focusing on the purpose of the interview. However, Kvale (1997) also stresses the importance of careful listening while interviewing and being open to other interview forms as opportunities appear. Careful listening also establishes trust between the interviewer and interviewee.

Interviews can follow a variety of structures, strictly follow an interview guide or use open-ended informal conversations. Semi-structured interviews fall between informal conversations and the closed, more quantitative approach that uses strict interview guidelines (Kvale, 2008). Semi-structured interviews have some questions prepared in advance, which are supplemented with new questions that emerge during the conversation. This style opens up two-way communication, allowing the researcher to both give and receive information (Kvale, 2008). Qualitative interviews are more

often used for clarifying questions that have arisen during observation.

According to Cohen et al. (2008), interviews are informal when conversations occur and questions emerge about the immediate context or situation. These questions are asked as a natural consequence of issues that have emerged. The strength of interviews undertaken as informal conversations is that the questions have emerged from observations and interpretations of the world, making it possible to match individuals with their contexts. The main weaknesses of informal interviews are that different questions provide different answers, making it more difficult to interpret the data systematically.

In paper II, interviews were primarily used as a complementary method to bring clarity to issues and concerns, which arose during the observation process. These interviews were undertaken as informal conversation.

4.3.3 Content analysis

According to Cohen et al. (2008), content analysis is often used to analyse large amounts of text. It is a method for examining any form of communicative material, and it can be successfully applied to written material. Content analysis is performed by breaking down text into separate units for analysis, such as counting concepts, words and coding. Alternatively, it may seek patterns or clusters of similarities and differences by comparing, drawing connections and forming categories. Categories are the main groups of themes that represent links between units of analysis. Researchers often present data in an economical way, such as in a table to organize the data and draw conclusions from it, and content analysis involves statistical elements, such as counting and making tables. Cohen et al. (2008) states that units must fit into the appropriate categories and these units can occasionally be placed into more than one category that is under discussion.

In this thesis, content analysis has been used in paper I for the IDP documents, in paper II for the transcripts of recordings of teachers' voices and in paper IV for think aloud-protocols. A more quantitative approach was taken when analysing the IDP documents in paper I, and the think-aloud protocols in paper IV to decipher meaning from the text data.

4.3.4 Documents and text

Different types of documents have been collected for this study, and they are considered valuable sources of information. These are listed and described below.

Individual development plans with written assessments
In order to investigate IDPs with written assessments, the relevant documents had to be retrieved. These are public documents but were not easy to come by. Documents from five municipalities were examined for the purpose of the first sub-study. They are described in detail in paper I.

Transcripts of voice recordings and think-aloud protocols
Transcripts of teachers' voices constitute the data used in papers II and IV. The teachers' voices were recorded and transcribed word-by-word by repeated listening and comparing the transcript with the original recordings. Transcribing itself can be a valuable form of analysis, and in sub-study II, transcribed recordings of teachers' teaching lessons in the classroom were made, verbatim, before being compared with a separate transcription to check accuracy. This process was very valuable for understanding the data, but was also time-consuming.

In paper IV, a professional transcriber transcribed the recordings in order to save time. These transcripts were checked researchers for clarity and accuracy by comparing transcripts and recordings. These transcripts of teachers assessing student portfolios also included detailed timescales for the teachers' judgments. These transcripts are called think-aloud protocols because they are recordings from when

the informants had a discussion with themselves regarding their motives, while conducting assessments. The timescale was included in the think-aloud protocols to make it possible to go back and add a time elapsed factor between the assessment and the decisions made. These time annotations can be used as track records of silence and provide valuable information on decision-making.

There are different ways to transcribe spoken voice into written text. Even though careful and accurate wordings are included, there are always sighs, pauses, emphases and intonations that may be included. There may be lost information (Nikander, 2008). The data analyses for this thesis have therefore included iterative listening of the recording together with reading the transcripts in Swedish. Some would say that presenting data in another language is risky, since the wordings are not easy to translate without omitting some meaning. Transcript analysis, and analyses of the other data collected, has been undertaken in Swedish. To present this information in English, it has been carefully translated back and forth between the two languages. To invite the reader into the context in which the data was collected, illustrative examples are presented in the papers.

4.3.5 Questionnaires

A written questionnaire was used in sub-study 3. Questionnaires can be designed in different ways, depending on purpose and usability (Cohen et al., 2008; Djurfeldt, Larsson, & Stjärnhagen, 2010). Questionnaires take into account not only the researcher's perspective but also include the respondents' point of view (Cohen et al., 2008). Individuals interpret questionnaire items differently, and these items may range from open-ended essay questions to short yes or no answers. Regardless of the design, the items must be tested, along with the questionnaire as a whole to validate possible inferences (Cohen et al., 2008). The questionnaire items in sub-study 3 were selected from a pool of questions gathered from other technology education studies (Nordlander, 2011; Cetis, unpublished; Skogh, 2004). These items were complemented with original

questions to fit the purpose of this particular study. Before the launch of the questionnaire in sub-study 3, it was tested several times among other researchers, statisticians, relatives and friends. The guidelines for the design of the questionnaire were provided by Statistics Sweden (http://www.scb.se; Cohen, 2007; Djurfeldt, 2003).

4.3.5.1 Likert scale

According to Cohen et al. (2008), Likert scales are often used when investigating opinions because they are considered easy to understand and time-efficient for the respondent. There is also the possibility of using different scales on the Likert scale, often; these are 5- or 7-point scales. In sub-study 3, a five-point scale (1 = disagree totally, 2 = disagree to some extent, 3 = neither disagree nor agree, 4 = agree to some extent and 5 = agree totally), was chosen based on the assumption that it would be the most time efficient for the informant. Likert scales are also beneficial because they provide more nuanced answers than yes or no or short answer questions. However, when investigating opinions through questionnaires, data are difficult to analyse because of personal interpretations of the questions and value-added wording in the rating. To some extent, agreement can mean different things to different people. Therefore, it is important to design questions that equally account for different kinds of respondents. Items in a questionnaire need to be tested thoroughly before it is launched (L Cohen et al., 2008; Djurfeldt et al., 2010).

According to Cohen et al. (2008), the Mann-Whitney U-test is the preferred method for analysing ordinal scales. However, when the population is too small, a T-test can be used as a supplementary method of analysis (Moore & McCabe, 2006).

4.3.6 Register data

This thesis uses data from two official records in paper I and paper III. These records were compiled by the state agency Statistics Sweden (SCB) and presented by the NAE in the SALSA[2] and SIRIS[3] databases. These two databases are used in various settings when describing the outcomes of Swedish schools.

SALSA is used to present grading results on the municipal and school levels with respect to student composition. Merit points are compared with the following background factors: (1) the parents' education levels, (2) the percentage of students born in Sweden with foreign backgrounds, (3) the proportion of students born abroad and (4) the distribution of boys and girls. The parents' level of education has been identified as having the greatest impact on students' achievement results on this model.

SIRIS is a tool providing statistical information on various levels, such as municipal, educational and national, about school results, quality reports, students, costs and various documents. It is used to observe changes over time and determine how different interventions affect various factors in schools. This database provides information on awarded grades in year nine and year six as a consequence of the implementation of the LGR11 curriculum.

[2] http://salsa.artisan.se
[3] http://siris.skolverket.se/

4.4 Ethical considerations

All participants have been informed about the studies and the possibility to withdraw their participation.

All participants' names, including individuals, schools, and municipalities, have been changed, and all data have been kept in a safe place to preserve the ethical principal of confidentiality (Vetenskapsrådet, 2005).

4.4.1 Selection of informants and the informant's agreement

This study considers assessments in technology education in compulsory schools, with a primary focus on teachers. However, different informants have kindly participated and contributed, including pupils, teachers, school-leaders and other people working at local school authorities. They were all informed of the study and kindly agreed to participate. They were also informed and reminded of the possibility of withdrawing from the study.

In order to investigate IDP documents, it was necessary to access these documents. Even though the IDPs are public documents, they were not easy to find. In paper I, authentic samples of IDPs were collected from primary schools in five different municipalities through personal contacts. Illustrative examples of IDPs were first collected from three municipalities, and to increase the scope of this study, the first collection was supplemented with samples from two other municipalities, collected by Hirsh (2011). All collectors were informed of the study, and they agreed to participate. The collectors were asked to hand in anonymised copies, though some names remained, requiring that information to be disregarded during analysis.

A top-down approach was used to select teachers for paper II. First, municipalities were chosen from Swedish Association of Local Authorities and Regions (SALAR) and their grouping of municipalities that are similar to the one in which the researcher

worked as a teacher. From this sample, three municipalities were chosen. Each local school board was asked to appoint schools to the study, and principals were requested to appoint teachers to participate in the study at each of the schools. The intention was to find teachers who were willing to participate in the study without using personal contacts, which could have been an option to save time. Finally, two teachers from two municipalities were willing to participate. Ultimately, this way of selecting informants was time-consuming, but it fulfilled the goal of not selecting particular teachers through personal contacts and instead allowed an unbiased individual to select participants. This path was not as straightforward as it might seem. Some school heads were surprised when asked to provide a participant who taught technology in year five. One teacher first agreed to participate but had to resign due to a heavy workload, due to renovation of the school buildings. Similar to the majority of teachers in Sweden, the two teachers participating in sub-study II were not trained in the subject of technology. One possible consequence of this selection would be that it provides a somewhat accurate picture of current practices. The results might have been different if the participating teachers would have had subject-specific training in technology, but such a sampling would have been less likely to represent current circumstances. During the study, these appointed teachers were regarded as competent representatives for their respective schools. The extent to which they are representative of their schools has not been questioned. The intention was not to find a representative teacher, whatever a representative teacher might be.

Learning from this experience, the informants in paper IV were chosen out of convenience by personal contacts; in groups of network participants, former students and other acquaintances were asked to participate. Finally five informants both willing and able to participate were found. These teachers were not in positions that could be considered dependent on the researchers.

The teachers were the main informants in papers II and IV, which were both conducted in a classroom setting. Students were also involved. In accordance with the general guidelines of the Swedish Research Council (Vetenskapsrådet, 2005), the guardians of these under-aged students were informed, with an understanding of the purpose of the studies, and they agreed in writing to let their children participate. One consequence of the necessity of informed consent from guardians was that it was decided not to use video recordings as first planned in paper II. Less than a handful of students failed to return their signed parent agreements by the first day of observation. The teacher decided to put them in the corner of the classroom, so that they would not be within the scope of the video camera. Based on the researcher's prior experience as a teacher, and not wanting to exclude these students, it was decided to shut off the camera instead.

The participants in paper III were informed and they agreed to participate in the research by joining the Boost of Technology[4] (BoT) project. Still, they had the opportunity to return the questionnaire and revoke their participation in this particular study. Due to the size of the project, it might be possible to ascertain which schools participated. However, paper III focused on the group level, making it impossible to identify individual teachers' responses.

[4] www.tekniklyftet.se

4.4.2 Acknowledging the participating teachers' professionalism

It was impossible to avoid disturbing the classrooms that were visited. However, to diminish these disturbances, the participating teachers' professionalism was acknowledged by allowing them to choose and validate what to teach during observational visits. This decision acknowledged these teachers, their professional judgement and privilege to design learning opportunities for their pupils. These teachers are responsible for their students' progress and have limited amounts of time, and they have generously contributed to this thesis by allowing the study to take place in their classrooms. In paper II, the teachers were permitted to decide on the theme and area of interest in technology to be taught during the lessons observed, and in paper IV, the teacher validated the tasks as appropriate for her pupils.

Due to the importance of testing and evaluating tasks in authentic settings, a ready-made task was chosen for the project described in paper IV. This choice provided validity for possible inferences based on the elicited evidence, as highlighted by Professor Emeritus Richard Kimbell in May 2012. The task was designed and evaluated by the software provider to give evidence of primary school student learning in a structured, multi-mode and active way. Because regulations concerning Swedish compulsory schooling acknowledge that each teacher can choose how to interpret the syllabus and how the subject shall be enacted in the classroom, the participating teacher validated the task as an adequate task for her pupils and as aligning with the Swedish national curricula connected to working methods for developing technical solutions. The task was translated into Swedish to limit potential misunderstandings due to use of the English language.

4.4.3 Presenting data in another language

In order to provide illustrative examples to an international audience the data had to be translated. The process of translating data, which has been collected and analysed in Swedish, into English can be problematic. Nikander (2008) has the following to say:

> Translating data extracts is not merely a question of 'adopting' or 'following' a 'transcription technique' but rather includes a range of practical and ideological questions concerning the level of detail chosen in the transcription and of the way in which the translations are physically presented in print. (p. 226)

The translation into English has been kept as accurate as possible, word-by-word. However, some linguistic adjustments and minor modifications have been made in order to preserve the statements' tenor and style.

4.4.4 Comments regarding methodological considerations

Personal experiences as a teacher in compulsory school provide certain prerequisites and preconceptions, including bias. These experiences influence what the researcher is able to see, interpret and explicitly choose to highlight. Eisner (2007) and Stenhouse (1981) propose that it is beneficial to have teaching experience while examining these issues. Meanwhile, Van Driel, Verloop and de Vos (1998) emphasised the importance of classroom experience to develop an understanding of teaching and learning within a specific subject. Therefore, the researcher's prior experience as a technology teacher has contributed to an understanding of the complexity of the situation.

As mentioned at the beginning of this chapter, many events have occurred while this thesis was underway. It has been intriguing to take part in these changes, though these reforms have created challenges for fully understanding everything within the scope of this thesis. Some issues with these reforms were included within the four papers and some were excluded as well.

Teachers' assessment practices are complex. The four papers stand for themselves and can be read separately. However, they are closely related as investigations of different perspectives of teachers' multifaceted work with assessments and are relevant to both the fields of assessment and technology education. By nature, methods are dependent on their fitness for the purpose of a study, and the aims and purposes of this thesis required the use of multiple methods. These opportunities have contributed to a more personal aim for the researcher; being a PhD student is a journey with the purpose of learning to conduct high-quality research. With this in mind, having had the opportunity to experience various methods during this research has been extremely beneficial.

5 Summary of papers

This chapter provides a summary of the four papers, focusing on the complementary methodological considerations and results for each. For more detailed information the reader is referred to the respective articles.

5.1 Paper I Exploring the (un-) usefulness of mandatory assessment documents in primary technology

Hartell, E. (2014). Exploring the (un-) usefulness of mandatory assessment documents in primary technology. *International Journal of Technology and Design Education. 24*(2): 141-161. doi:10.1007/s10798-013-9250-z

This paper investigates the possibility of navigating student learning in primary technology education by using the mandatory assessment tool, the IDP. Every student in the Swedish compulsory school system is entitled to information regarding their progress in all subjects. One purpose of introducing the IDP was to provide teachers with a formative assessment tool for evaluating student progress and to clarify the information for guardians. However, the document falls into the long cycle of formative assessment, according to Hirsh (2011). The regulations concerning IDP state that each pupil is entitled to written assessment in every subject. In addition, every school can decide on the IDP design template, which creates design differences.

The results presented here are based on an analysis of 351 authentic documents from five different municipalities. Supplementary registered data from SIRIS was used to find quantitative data, such as the number of schools, pupils, inhabitants and awarded grades. These data provided a background against which the research data could be matched.

Anonymous examples of authentic IDPs were analysed by repeated readings and by exploring the IDP documents for patterns of similarities and differences, such as school name, teacher name, design, goal formulations, subject and layout boxes that record progress (see Table 1 on page 149 of paper I). Fourteen different IDP templates in the collected data were found. The documents were examined again for information regarding student progress in technology. This second examination resulted from a lack of information, and the word *teknik* (Swedish for *technology education*) was searched for, along with any other information regarding students' knowledge of technology. While interpreting the data, this qualitative analysis to find information regarding technology was undertaken using the researcher's prior experience as a technology teacher.

The first two groups of templates in the IDP samples exhibited the following: (1) IDP templates that included *teknik* and (2) IDP templates that did not include *teknik*. The five templates that included *teknik* were examined more deeply for explicit and implicit information regarding the student's current level of progress and the next step of their learning. Finally, the results were compared to previous findings about technology education, formative assessment and IDP documents to generate conclusions.

The results show that information regarding technology in these IDP documents is very limited and how they are used must be questioned. The study shows that, the situation is worse in technology education because information regarding this specific subject is not present in the majority, or nine of fourteen templates used. Some of the templates include goal formulations of what the students are expected to achieve. The number of goals varies between three and fourteen. In technology, these goals vary between three and four, when they happen to occur.

When *teknik* is present, all students receive the same information in each IDP. There are no suggestions for next steps in technology

education. The long-cycle time span, which is included in the IDP process, impedes the general impact and usability of the documents and could have a possible impact on the strategic level as well.

This study further contributes to current knowledge by providing unique results regarding reported goal fulfilment prior to year nine. The reported goal fulfilment shows a remarkably high level of achievement among the students. Unfortunately, it is not possible to compare these to prior results because information regarding written assessments specific to technology are absent. However, in relation to the known situation in this subject, these results require further investigation and deserve special attention since the validity, reliability and comparability of these assessments should be questioned on every level in the school system.

The analysis concluded that the mandatory documents are not useful tools for identifying student progress in technology, and that the documents might possibly be used, in theory, for formative purposes in technology, but this is not a likely reality.

Complementary information to paper I

Since this paper was written, regulations regarding the IDP have changed. Since December 2013, the IDP is introduced in school years 1–5, instead of 1–9), and excluded in school years 6–9 when grades are given (Skolverket-National Agency for Education, 2013). Similar to practices prior to December 2013, progress must still be stipulated in writing during development dialogues in teacher-guardian meetings and is only given once a year, instead of once every semester. On behalf of the government, the NAE has also published a template for IDPs, which is available for voluntary use. In this template, it is possible to indicate whether a student is progressing in each of the subjects by ticking a box on a three-point scale, which indicates unacceptable knowledge, acceptable knowledge and more than acceptable knowledge levels.[5] An

[5] Icke godtagbara, godtagbara och mer än godtagbara.

allocated space is provided to write subject-specific comments, and technology is included in this template.

5.2 Paper II: Looking for a glimpse in the eye

Hartell, E. (2013). Looking for a glimpse in the eye. In I. B. Skogh & M. J. de Vries (Eds.), *Technology teachers as researchers: Philosophical and empirical technology education studies in the Swedish TUFF research school* (255-283). Rotterdam, The Netherlands: Sense Publishers.

Paper II investigates and describes the short cycle of formative assessments undertaken in two primary technology classrooms. Two teachers—Karen and Karl—were observed teaching a lesson with a technology theme of their choice.

The classroom is a busy environment, and as an observer qualitative research demands flexibility (Cohen et al., 2008). Inspired by Kimbell and Stables (2008) an observation chart to organize data collection was developed for this study (see Appendix 1). Annotations were made periodically and iteratively every tenth minute in the observation scheme and photos were taken of the teacher at that same moment. Occasionally, additional annotations or photos were taken. The lessons were also recorded using an MP3 recorder. Both the researcher and an additional assistant carefully transcribed these recordings for accuracy control. To sort out questions that had arisen during observations, semi-structured interviews—informal talks—were undertaken as a supplementary method.

The aggregated data were analysed using the following four steps.

1. The recordings of each lesson were listened to repeatedly, and annotations were made.
2. Annotations from the observations and repeated listening sessions were matched. Subsequently, they were compared

with both the photos and the transcripts of the recordings, for every lesson.

3. The data were reviewed again using the five key strategies for formative assessment (Black & Wiliam, 2009) as a checklist. This checklist was used to identify the five key strategies for formative assessment and possible patterns in classroom procedures. As Wiliam (2009) puts it, if you are working with formative assessment, you are connecting to at least one of these strategies. The effect of assessment was not investigated in this study. Therefore, formative assessment and assessment for learning were distinguished in this study, as suggested by Wiliam (2009). When formative assessment improves or is more likely to improve student achievement, then it is appropriate to say that assessment for learning was investigated here.
4. The interpretation was controlled again using lesson transcriptions. Research colleagues were met with to interpret and discuss findings. The findings were then compared with the literature review.

Throughout this study, it was the privilege of the researcher to witness how two teachers express love, trust and expectations, through small gestures and glimpses[6]. This is hard to capture and describe in a text; therefore, to share this experience with the reader, the word pupil is consistently used. This can be translated, through a play on word, into the apple of the eye or sweethearts, instead of student, when presenting the results of paper II.

Results reveal the teachers' desire to advance their pupils. Traces of all five key strategies for formative assessment are present in their practices to differing extents. As the title of this paper suggests, these teachers appear to base their assumptions regarding their

[6] There seems to be different wordings for when teachers catch "the look" of understanding in pupils' eyes, which many teachers are familiar with. Glimpses, sparks or glints in the eye seem to be used differently and sometimes interchangeably, depending on whom you ask. I have decided to use glimpse here.

pupils' understanding on evidence of learning gathered during interactions in the classroom. This notion was made explicit by Karl's reply to a direct question asking him how he knew if his pupils understood during his lessons or not; his reply—he could see understanding in his pupils' eyes. This notion was confirmed from analyses of classroom interactions, where these teachers gathered evidence of understanding from the nods, gestures and glimpses in the eyes of their pupils. In addition, they listened to their students and asked probing questions, encouraging interaction with peers. These finding are concurrent with Kimbell (2007). This notion of drawing inferences from classroom interaction aligns with the practice of not documenting on paper, which was also a result of the study.

The literature regarding assessment for learning shows that planning for assessment, for example formulating questions, is needed (Black, 2008; Wiliam, 2009). Posing and interpreting questions and answers can be a successful way of eliciting evidence of pupils' understanding. While questioning, Black (2008) suggests careful listening and an appropriate wait time, which was present in Karen's classroom. She waited for her pupils' responses before continuing the lesson, after either she herself or the students had posed questions and before and after they responded. In her experience, this wait time was something she had found helpful for learning. She expressed the lack of opportunities for discussion of classroom practices with fellow teachers and welcomed more support by colleagues.

Results included evidence of all five strategies, indicating that these teachers are using assessments for learning for the purpose of moving their pupils forward on their learning journeys. Here, the term assessment for learning is used instead of formative assessment, since the actual function of the intention of the assessment was not investigated in this study. Results also show that access to discussions with colleagues, teacher training, professional development and equipment were not provided, with the

consequence that these teachers spend a great deal of their individual time planning and gathering information, knowledge and materials to prepare for lessons, by themselves.

In conclusion, it is evident that these teachers are working with assessment for learning, and they expend a great deal of effort to fulfil their ambitions. Results also show that these teachers are alone when planning, executing and following up on pupils' progress in technology education. As such, support is both requested and needed.

5.3 Paper III: Investigating technology teachers' self-efficacy on assessment

Hartell, E., Gumaelius, L., Svärdh, J. (2014). Investigating technology teachers' self-efficacy on assessment. Published online in *International Journal of Technology and Design Education*. DOI 10.1007/s10798-014-9285-9

A quantitative approach was used in paper III to explore possible variances in technology teachers' self-efficacy in assessment. Aggregated data comes from a substantial questionnaire launched among all participants of the project *Tekniklyftet*.[7] In total, 651 completed questionnaires were received, which corresponds to a response rate of 95.5%. In this particular study, teachers who claimed that they taught technology (n=88) constituted the group of informants. This group was then divided into two groups, according to their claims regarding their academic credits in technology:

- TC: School staff working as technology teachers with academic credits in technology (TC) (n=60)
- NTC: School staff working as technology teachers with no academic credits in technology (n=28).

[7] www.tekniklyftet.se

Replies to six questions regarding teaching and assessment in technology constitute the data used for the results presented here. The six questions were presented on a five-point Likert scale, with 1 = disagree totally, 2 = disagree to some extent, 3 = neither disagree nor agree, 4 = agree to some extent and 5 = agree totally. This five-point Likert scale was chosen as the most appropriate method because of the ease of clarity and time needed for completion.

The aggregated data from replies to the questionnaire were transformed into a web file. The resulting data file was organised in Excel and analysed in Statistical Package for Social Sciences (SPSS). Final diagrams were processed in Excel. The diagrams were first analysed by ocular observation. Mann-Whitney U-tests were used as a preferred method for analysing ordinal scales (Cohen et al., 2008); these tests established if differences were statistically different between the groups of technology teachers in these data.

Supplementary registered data from SIRIS and SALSA were used to establish groups and comparable information by region and country, and to gather information regarding grading. These findings indicate a questionable variety in awarded grades, which did not result from student composition.

In summary, the results of this study show statistically significant differences in self-efficacy for assessment in different groups of teachers who teach technology:

1. Teachers who are trained in the subject express greater self-efficacy in assessing their students.
2. Trained teachers emphasised a significantly greater use of the technology curriculum as the basis for their teaching.
3. The subject-specific trained teachers expressed greater self-efficacy in describing what is expected of their students when compared to their non-trained peers.

The findings also indicate that, when awarding grades, all informants express generally low self-efficacy. However, teachers who lack

teacher education but have subject-specific training in technology express greater self-efficacy, when it comes to awarding grades to their students. Teachers who lack teacher training but have subject-specific training also use curriculum documents (both national and local) significantly less than teachers who have a teacher education degree. Combined, these findings indicate challenges for curriculum alignment in the awarding of grades.

The concluding results indicate a significant difference between teachers with training and those without training in technology education, particularly regarding their perceptions of their ability to teach and assess technology.

5.4 Paper IV: Criteria for success. A study of primary teachers' assessment of e-portfolios

Hartell, E., & Skogh, I-B. (Submitted manuscript) *Criteria for success. A study of primary teachers' assessment of e-portfolios.* Publisher.

Paper IV investigates what teachers emphasise as criteria for success in primary technology education. The research was undertaken during the assessment of multimodal student portfolios, examining five teachers' decision-making during the assessment of 21 authentic multimodal portfolios collected from year five classes. They undertook 135 Adaptive Comparative Judgements (ACJs) (Pollitt, 2011, 2012). The teachers' decision-making was recorded using an MP3 device. These recordings—totalling approximately six hours—were transcribed word by word, and the time elapsing between each judgement was noted. The recordings were transformed into think-aloud protocols, one for each informant.

Each judgement was numbered and constituted the first units of the analysis. Thirteen judgements were omitted from further analysis

because of software failure during the judgement, leaving 122 judgements for analysis. These judgements were listened to and read repeatedly and 159 motives for these judgements were found. These 159 motives constituted the data for further analyses. The analysis focused on the motives supplied by the teachers, using these as units without any predefined categories.

When dividing and sorting the data into categories, there is always an issue of subjectivity, and categories result from personal interpretations based on prior experience. Three main categories were found; *Particular* –where focus was laid on a particular detail of function, *Whole*– where focus is on the read thread or similar holistically and *Other*– focusing on other things. The statements were grouped within each main category or a subcategory, when necessary. These subcategories evolved from content analysis while looking for patterns of similarities and differences and various areas of concern. The amount of entries for each category has been accounted for, but the study aims to clarify areas of concern as thoroughly as possible rather than provide quantitative information on frequency.

The number of teachers mentioning certain motives is given more importance than the number of statements included in each category. To minimise interpretative errors, the think-aloud protocols were both individually and group read as part of the process for forming subcategories. This qualitative analysis was complemented with quantitative measures using the LiveAssess software to support the argument that these teachers had agreed to these processes and had taken their task seriously.

The results reveal that these teachers show consistency as a group and as individuals. Teachers primarily focus on the whole, emphasising the importance of being able to see entire the story of portfolio evolution. They also emphasised the importance of the students completing the tasks. This notion of completing tasks is interpreted in two ways: (1) more evidence of learning is provided in

a portfolio where all sub-tasks is fulfilled, making it easier for the teacher to see a pattern for coherence and (2) fulfilment itself is important. Both of these interpretations put high demands on the design of the task and the circumstances under which it is undertaken concurrent with Belgrad (2013). The quantitative results show a significant inter-reliability among the teachers of the pair judgements (.932). This high reliability confirms the consistency found in qualitative analysis on what they assessed. When given the opportunity, teachers' assessments agree in relation to pupils' work—because they focus on the whole rather than the particular.

6 Summary of results and discussion

The overarching aim of this thesis is to deepen and generate new knowledge regarding the use of assessments by teachers in primary and lower secondary technology education. This goal was pursued through four sub-studies, as previously described.

The outcome of teachers' documenting practices was investigated in the first study, providing findings regarding the feasibility of the IDP document for teachers in technology. The straightforward answer to this query would simply be that it is not useful. The results show that this type of document is currently unsuitable for use as a formative assessment in technology education. The analyses conclude that this mandatory document fails to provide information regarding students' current or future progress in the subject of technology. There are two reasons for this failure. First, theoretical use is impeded due to the long cycle nature of the formative assessment. There is a long time span present in the process between the gathering of the evidence for learning and putting it into practice (Hirsh, 2011). Second, this study provides new knowledge about the lack of information regarding technology in these documents. Even though it is an illustrative sample, not covering the entire country, this study provides a strong indication

that technology is not even present in all schools' templates. This omission impedes teachers' ability to use the document realistically, and it mirrors the current teaching situation for this subject.

As an aside, this study provides interesting results regarding the reported goal fulfilment in technology education prior to year nine. The study reveals a remarkably high level of achievement among primary students, as only a handful of the students are reported not to have achieved formulated goals. In relation to the well-known lack of instruction in the subject, especially in primary school, these results require further investigation. This finding also deserves special attention because the validity, reliability and comparability of these assessments need to be questioned on every level in the school system.

Short cycle formative assessments, undertaken minute-by-minute in the classroom setting, have great potential to provide opportunities for student learning (Wiliam, 2009). Paper II therefore studies how teachers' minute-by-minute follow-up is enacted in the primary technology classroom. The results indicate that these teachers are working with assessment for learning with the ambition to advance their pupils. In this study, traces of all five strategies were found to various extents. Teachers used several strategies, including probing questions, listening, interpreting responses, waiting, interacting, looking for body language cues, such as glimpses, and encouraging pupils. Both Kimbell (2007) and Black and Wiliam (2009) confirm that these are ways for teachers to make inferences from evidence to advance their pupils. Paper II shows that teachers put a great deal of enthusiasm and effort into their practices. However, even though the bearing of forward is not evident; these teachers are intending to advance their pupils and demonstrating great beliefs in pupils' abilities to learn.

Student progression is not investigated in this study. The results show that access to discussions with colleagues, teacher training, professional development and equipment are not provided for,

despite the fact that teachers often seek these resources. The consequence of this lack of support is that these teachers are alone in planning, executing and following up on student progress in technology education. They are also spending a great deal of time gathering materials for their lessons, which confirms Blomdahl's assertions (2007). This time could be spent more wisely if teachers were able to support each other in planning procedures designed to support and draw inferences from pupils' learning to inform instruction and school policy.

The results presented in the third sub-study indicate that training in technology affects teachers' self-efficacy for assessment. There are significant differences between teachers who have training in the subject compared to those who do not. Teachers who have subject-specific training express greater confidence in informing students of their expectations and in describing students' level of knowledge in IDP documents. They also report using the curriculum documents to a greater extent than non-trained teachers.

Both groups indicate that they are insecure while grading, and within the schools where these informants work; there is a questionably large variance in awarded grades. Results show that subject-specific training seems to affect teachers' self-efficacy on assessment in a positive way. However, at the same time it is well known that the majority of teachers who teach technology in Sweden lack subject-specific training. The consequences of this trend are unknown, and the answer elusive. The certification process now taking place in Sweden may be a step in the right direction, but it is not enough. The subject-specific content in technology changes quickly, and there is a lack of knowledge regarding what constitutes learning in technology. A perspective of life-long learning must be embedded into teachers' assessment practices, involving subject-specific training and focusing on both content and pedagogy. Such an approach would go far in developing understanding of the subject and helping instructors teach the subject.

In classrooms, teachers make inferences based on nods, winks and glimpses in the eyes. It is not known if there is a consensus regarding these nods, winks and glimpses. The fourth study considers the criteria for success that primary teachers emphasise while assessing. In the study, it seems that the teachers agreed upon the importance of focusing on the whole. This study investigated circumstances where teachers were assessing student e-portfolios. There was a relatively small sample made up of 21 portfolios and 5 teachers. In interviews that were not included in the paper, these teachers also claim to focus more on the whole than on the particular. This claim is confirmed by analysis of the think-aloud protocols and quantitative data provided in this study. The notion that students must complete their tasks is also present. The meaning of this finding can be interpreted in different ways. One interpretation holds that completed tasks provide more evidence for learning. Another interpretation holds that completing the task is a virtue in and of itself. Regardless, it puts high demands on the design of the task and on the circumstances in which pupils' portfolios are collected.

Assessment often focuses on the teachers' perspective of assessing student achievement. It is even more important to see assessment as a process from which to make inferences on the alignment of teaching and learning. This highlights the process of planning instruction. Therefore, it is necessary to emphasise the necessity of pupils having sufficient time to finish their tasks. They require opportunities to learn in an environment where teachers encourage risk-taking and learning from mistakes. These results also indicate that pupils should be taught, not just left to unreflective doing, as reported in Skolinspektionen (2014).

7 Conclusions

The results show that teachers' assessment practices are complex and undertaken in different ways. The overarching results show an undoubted desire, willingness and engagement among teachers to provide learning opportunities that advance their pupils.

This ambition to move pupils forward and provide learning opportunities in schools is present in the surrounding society as well. Society's ambition is made explicit in documents that govern compulsory school, including syllabuses and educational reforms. This ambition is also made explicit by several educational interventions to increase interest in technology among youngsters supported by different stakeholders such as the Association of Swedish Engineering Industries (*Teknikföretagen*), Snilleblixtarna, and The Royal Swedish Academy of Sciences for example. Teachers and their use of assessment bridging teaching and learning play an important role in making this ambition a reality.

The results presented here shows limited affordances for teachers to accomplish this ambition. Affordance is here considered as the quality of the environment that allows the teacher to perform actions. The quality of the environment includes both material and non-material prerequisites. Unavailable to teachers are the prerequisites needed to increase the power of assessment, as identified by researchers and practitioners and including open environments for discussions and lifelong learning with peers. There is a lack of teacher education, in-service training, professional development, documenting templates, teaching materials and resources. Instead, teachers are left alone to compensate for this lack by relying on their own prior experience. The results presented here show that teachers in technology are currently not supported in the environment in which they are set to perform.

It is pleasing to see that technology education is receiving increasing attention. For example, the NAE has produced supporting material

for teaching and assessment in technology (Skolverket, 2011a), which can be used as navigational tools for education. In fact, according to the official Twitter channel for NAE's conferences (Skolkonf, 2014), there has never been so much supporting material available as there currently is. Though promising, the material must be put into practice to be useful and teachers need affordances to do so. School principals and local school authorities must design an environment for teachers where they are able to plan instruction, develop forms of collaboration and share knowledge, taking responsibility for the regulations (NAE, 2011).

Learning requires active participation by the learner. Different stakeholders may have varying suggestions on how to make sure every pupil prospers in the area of technology. Teachers are best suited to both navigate and hold the helm in designing teaching and learning opportunities suited to their pupils. For this to happen, teachers need to know when to push and when to hold back, using evidence of learning to adapt what happens in the classroom to best meet the needs of their pupils in each individual context. They need to make sure that their pupils' progress according to the regulations that govern compulsory schooling; in doing so, teachers invite pupils to become owners of their own learning in technology. However, teachers cannot do this alone. There is a necessity for inviting school leaders at every level to participate and provide affordances for the use of assessments, to bridge teaching and learning, and to sit beside their pupils and to lift them up.

It is well known that assessment can benefit student learning, but it needs to be handled gently and embedded firmly into practices. Research regarding assessment is a growing field, identified as an uncharted area in technology. This thesis has provided findings that assessment in technology education is a minefield. Students' opportunities for learning technology in school are a lottery, solely depending on the teacher. This circumstance must be changed.

8 Implications and future research

This thesis has generated and deepened knowledge of teachers' use of assessments in primary and lower secondary technology education, concluding that affordances must be increased for teachers to use assessments as a bridge between teaching and learning in technology to answer national and international needs regarding technology and assessment. There is, however, more research to be done.

This thesis uses a teacher perspective; however, it is important to remember the persons for which schooling is most important, the pupils. *Elev*, is the Swedish word for pupils in school. I am told that it originates from the French verb *élever*, which means to raise, lift up or even elevate. When translating the English word *pupil* into Swedish, it can be translated in two different ways: first *elev*, which would be translated back as *student/pupil*, or more importantly, *ögonsten*. *Ögonsten* signifies the apple of one's eye or sweetheart. The word assessment is derived from the Latin word *assidere*, meaning sitting beside or sitting by (Nyström, 2014). Playing with these words clarified the true meaning of teachers' work with assessment as spiritually (and sometimes physically) sitting beside their sweethearts with the purpose of lifting them up together. This is, of course, difficult to accomplish, however that notion of assessment and to walk that extra mile to orchestra learning opportunities together is a step in that direction.

The findings from this thesis encourage further research based on several questions: How can affordances for teachers' work with assessment be increased? How can environments be provided where teachers develop and share while gaining tacit and explicit knowledge that will strengthen their self-efficacy? How can documenting be enforced in a cost-efficient and useful way to encourage progression? How can we build a tradition that teaching and learning in technology can rely on? Can assessment be

embedded into the everyday work of teachers and pupils to make the most difference, namely in the instruction environment? It is of great importance to strengthen teachers' competence and self-efficacy regarding both their own understanding and content knowledge, ability to teach the school subject and, especially, the intersection of the two.

Even though there are many general aspects of assessment, there are even more context-dependent aspects that are often forgotten: the context in which the learner is situated and the context of the particular school subjects. An area of special interest to the researcher is technology in special schools, where technology has only recently been introduced. When it comes to technology, the context of the subject involves different meanings in Sweden compared to different parts of the world. It is particularly interesting to investigate assessment in different contexts and with different purposes in Sweden and other countries. What are the important factors of technology education? How do these factors relate to other subjects? Technology is often combined with science, engineering and mathematics in the growing Science Technology Engineering and Mathematics (STEM) movement. What is subject-specific and what is general within the realm of STEM? What is specific and what can be synergetic to increase student capabilities and interest within these areas, in all forms of education? This is an international need, and international collaboration is necessary.

It is easy to embrace the almost mythical success of formative assessment by forgetting the difficulties included. Current regulations governing education emphasise the importance of embedding formative assessment (NAE, 2011). However, this emphasis regarding the importance of adjusting instruction to better meet the learners' needs is nothing new. Even in the 17th century, the teacher John Amos Comenius emphasised the importance of teachers starting from where their pupils are and adjusting their teaching to the pupil's needs to enhance learning (Skogh, 2008).

My findings also call for further studies to increase understanding of how to provide affordances for teachers. What can be done to make it easier for teachers to work formatively or to sit beside their pupils in technology education, starting today? There are examples of how to embed formative assessment into practices (e.g. Leahy & Wiliam, 2010). However, questions remain: How should institutions go about supporting assessment for different purposes and involving the student's perspective in technology education? How can assessments be organized? Can digital tools be used to minimise the necessary time and space to bring teachers together? These questions deserve more attention, and there may be different ways to accomplish these goals, which cannot be met without the involvement and suggestions of teachers to increase such affordances.

The title of this doctoral thesis, *ASSIDERE NECESSE EST* should be seen in light of this discussion. The title plays on my interpretation of the classic saying among sailors, *Navigare necesse est*, which emphasises the quality of life that sailing provides. It is crucial that change starts from the current position and uses different sources to make inferences to actively navigate, make better-founded decisions about the next step to avoid dangers and arrive safely at these goals. Even more so, this expression emphasises the challenge, joy and excitement of shared adventures. The same is needed to embed assessment into everyday practices. Within the educational context, assessment can be a powerful tool for navigating cognitive and social development. However, like any other navigational tool, it needs to be handled carefully to be useful in an educational environment.

9 References

ASEI. (2005). *Alla barns rätt till teknikundervisning*. Stockholm.

ASEI. (2012). *Teknikämnet i träda*. Retrieved from http://www.teknikforetagen.se/documents/utbildning/teknikamnet_i_trada.pdf

Bandura, A. (1997). *Self-efficacy. The exercise of control* (13th ed.). New York: W. H. Freeman and Company.

Belgrad, S. F. (2013). Portfolios and e-portfolios. Student reflection, self-assessment, and goal setting in the learning process. In J. H. McMillan (Ed.), *SAGE Handbook of research on classroom assessment* (pp. 331–346). SAGE Publishers.

Bennett, R. E. (2011). Formative assessment: a critical review. *Assessment in Education: Principles, Policy & Practice*, *18*(1), 5–25. doi:10.1080/0969594X.2010.513678

Benson, C. (2012). Conformity or diversity: Developing creativity in design and technology in the early years. In H. Middleton (Ed.), *Explorations of best practice in Technology, Design & Engineering education. Volume one* (pp. 42–51). Brisbane: Griffith Institute for Educational Research.

Bergman, G., & Schoultz, J. (2014). *NTA och kollegialt lärande*. Stockholm: NTA Skolutveckling.

Bjurulf, V. (2008). *Teknikämnets gestaltningar : en studie av lärares arbete med skolämnet teknik*. Doctoral thesis. Karlstad. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:kau:diva-2729

Bjurulf, V. (2011). *Teknikdidaktik*. Riga, Latvia: Norstedts.

Black, P. (2008). Formative assessment in the learning and teaching of design and technology education: Methods and techniques. *Design and Technology Education: An International Journal*, *13*(3), 19–26.

Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2004). Working inside the black box: Assessment for learning in the classroom. *Phi Delta Kappan*, *86*(1), 8–21.

Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. doi:10.1080/0969595980050102

Black, P., & Wiliam, D. (1998b). Inside the Black Box: Raising standards through classroom assessment. *Phi Delta Kappan*, *80*(2), 139–148.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, *21*(1), 5–31. doi:10.1007/s11092-008-9068-5

Blomdahl, E. (2007). Teknik i skolan : en studie av teknikundervisning för yngre skolbarn. Doctoral thesis. Stockholm, Sweden: HLS Förlag. Retrieved from http://su.diva-portal.org/smash/record.jsf?pid=diva2:197227

Bogdan, R. C., & Knopp Bilken, S. (2007). *Qualitative research for education. An introduction to theories and methods* (Fifth.). Boston, MA: Pearson International.

Bonner, S. M. (2013). Validity in classroom assessment: Purposes, properties, and principles. In J. H. McMillan (Ed.), *SAGE Handbook of research on classroom assessment* (pp. 87–106). Thousand Oaks, USA: SAGE Publishers.

Bresler, L. (2006). Embodied narrative inquiry: A methodology of connection. *Research Studies in Music Education*, *27*, 21–43.

Cohen, L., Manion, L., & Morrison, K. (2008). *Research methods in education* (6th ed.). Great Britain: Routledge.

Cowie, B. (2013). Assessment in the science classroom. Priorities, practice, and prospects. In J. H. McMillan (Ed.), *SAGE Handbook of research on classroom assessment* (pp. 473–488). Thousand Oaks, USA: SAGE Publishers.

Dakers, J. R. (2007). Incorporating technological literacy into classroom practice. In M. de Vries, R. Custer, J. Dakers, & G. Martin (Eds.), *Analyzing best practices in technology education* (pp. 125–137). Rotterdam, Netherlands: Sense Publisher.

Darling-Hammond, L. (1997). *Doing what matters most. Investing in teacher in quality teaching* (pp. 1–66). New York.

Djurfeldt, G., Larsson, R., & Stjärnhagen, O. (2010). *Statistisk verktygslåda 1: samhällsvetenskapliga orsaksanalys med kvantiavia metoder*. Lund: Studentlitteratur.

Eisner, E. W. (2007). *The enlightened eye: Qualitative inquiry and the enhancement of practice*. New York: Macmillan Publishing Company.

Fabricius, T., Malm, I., & Pisilä, S. (2002). *Skolinspektörernas årsrapport 2001/2002: Grundskolan*. Stockholm, Sweden.

Forsberg, E., & Lindberg, V. (2010). *Svensk forskning om bedömning - en kartläggning. Rapportnummer 2:2010*. Stockholm, Sweden: Vetenskapsrådet.

Gipps, C. (2004). *Beyond testing. Towards a theory of educational assessment*. London/ New York: The Falmer Press.

Hagberg, J.E., & Hultén, M. (2005). *Skolans undervisning och elevers lärande i teknik: svensk forskning i internationell kontext*. Stockholm, Sweden: Vetenskapsrådet.

Hallström, J. (2009). Technical knowledge in a technical society: elementary school technology education in Sweden, 1919–1928. *History of Education*, *38*(4), 455–474. doi:10.1080/00467600801995427

Harlen, W. (2010). On the relationship between assessment for formative and summative purposes. In J. Gardner (Ed.), *Assessment and learning* (pp. 103–117). Chippenham: SAGE.

Harrison, C. (2009). Assessment for learning. A formative approach to classroom practice. In A. Jones & M. deVries (Eds.), *International handbook of research and development in technology education* (pp. 449–459). Rotterdam, Netherlands: Sense Publishers.

Hartell, E. (2012). *The inefficient loneliness. A descriptive study about the complexity of assessment for learning in primary technology education.* Licentiate thesis. KTH Royal Institute of Technology. Stockholm, Sweden.

Hartell, E. (2013). Looking for a glimpse in the eye: A descriptive study of teachers' work with assessment in technology education. In I.-B. Skogh & M. J. De Vries (Eds.), *Technology teachers as researchers:: Philosophical and empirical technology education studies in the Swedish TUFF research school* (pp. 255–283). Rotterdam, Netherlands: Sense Publishers.

Hartell, E. (2014). Exploring the (un-) usefulness of mandatory assessment documents in primary technology. *International Journal of Technology and Design Education*, *24*(2), 141–161. doi:10.1007/s10798-013-9250-z

Hartell, E., Gumaelius, L., & Svärdh, J. (2014). Investigating technology teachers' self-efficacy on assessment. *International Journal of Technology and Design Education*. doi:10.1007/s10798-014-9285-9

Hartell, E., & Svärdh, J. (2012). Unboxing technology education part I – Starting point. In *Technology Education in the 21st Century* (pp. 211–222). Stockholm: Linköping University Electronic Press. Retrieved from http://www.ep.liu.se/ecp_article/index.en.aspx?issue=073;article=025

Hattie, J. (2009). Visible Learning: A synthesis of over 800 meta-analyses relating to achievement. Chippenham, UK: Routledge.

Hirsh, Å. (2011). A tool for learning? An analysis of targets and strategies in Swedish Individual Educational Plans. *Nordic Studies in Education*, (1), 14–30.

Hultén, M. (2013). Technology for all: turning a keyword into a school subject in post-war Sweden. *History of Education*, *42*(5), 622–637. doi:10.1080/0046760X.2013.832410

Jones, A., Buntting, C., & Vries, M. J. (2013). The developing field of technology education: a review to look forward. *International Journal of Technology and Design Education*, *23*(2), 191–212. doi:10.1007/s10798-011-9174-4

Jällhage, L. (2011). Elever utan betyg om inte fler tekniklärare utbildas. *Dagens Nyheter*, 3 June 2011, p. 10. Stockholm.

Jönsson, A. (2010). *Lärande bedömning*. Malmö: Gleerups.

Kimbell, R. (2007). Assessment. In M. de Vries, R. Custer, J. Dakers, & G. Martin (Eds.), *Analyzing best practices in technology education* (pp. 247–258). Rotterdam, Netherlands: Sense Publishers.

Kimbell, R. (2013). Understanding assessment, its importance; its dangers; its potential. In J. P. Williams (Ed.), *Technology education for teachers* (1st ed., Vol. 7, pp. 137–166). Rotterdam, NLD: Sense Publishers.

Kimbell, R., & Stables, K. (2008). *Researching design learning. Issues and findings from two decades of research and development*. United Kingdom: Springer.

Klapp Lekholm, A. (2010). Lärares betygssättningspraktik . (S. Eklund, Ed.) *Bedömning för lärande- En grund för ökat lärande. Forskning för undervisning och lärande*, (3), 20–29.

Klasander, C. (2010). Talet om tekniska system: förväntningar, traditioner och skolverkligheter. Doctoral thesis. Linköping University.

Klenowski, V. (2009). Raising the stakes: The challenges for teacher assessment. In *AARE International Education Research Conference - 2009, 29th November - 3rd December 2009, National Convention Centre, Canberra, A.C.T.* Canberra. Retrieved from http://eprints.qut.edu.au/43916/

Klenowski, V., & Adie, L. (2009). Moderation as judgement practice: Reconciling system level accountability and local level practice. *Curriculum Perspectives*, *29*(1), 10–28.

Kvale, S. (1997). *Den kvalitativa forsksningsintervjun* (1:17 ed.). Lund: Studentlitteratur.

Kvale, S. (2008). *Doing interviews*. Wiltshire, UK: SAGE Publications.

Leahy, S., Lyon, C., Thompson, M., & Wiliam, D. (2005). *Quality Assurance*, *63*(November), 1–7. Retrieved from http://nj.gov/education/njpep/classroom/arts_assessment/worddocs/ClassroomAssessment.pdf

Leahy, S., & Wiliam, D. (2010). *Embedding formative assessment-a professional development pack for schools*. London, UK: Specialist Schools and Academies Trust.

Lekholm, A. K., & Cliffordson, C. (2009). Effects of student characteristics on grades in compulsory school. *Educational Research and Evaluation*, *15*(1), 1–23. doi:10.1080/13803610802470425

Levinsson, M. (2013). *Evidens och existens Evidensbaserad undervisning i ljuset av lärares erfarenheter*. Doctoral thesis. Göteborgs universitet. Retrieved from http://hdl.handle.net/2077/32807

Lindström, L. (2006). Creativity: What is it? Can you assess it? Can it be taught? *The International Journal of Art & Design Education*, *25*(1), 53–66.

McMillan, J. H. (2005). Understanding and improving teachers' classroom assessment decision making: Implications for theory and practice. *Educational Measurement: Issues and Practice*, *22*(4), 34–43. doi:10.1111/j.1745-3992.2003.tb00142.x

McMillan, J. H. (2013). Why we need research on classroom assessment. In J. H. McMillan (Ed.), *SAGE Handbook of research on classroom assessment* (pp. 3–16). Thousand Oaks, USA: SAGE Publishers.

McMillan, J. H., Myran, S., & Workman, D. (2002). Elementary teachers' classroom assessment and grading practices. *The Journal of Educational Research*, *95*(4), 203–213. doi:10.1080/00220670209596593

Moore, D. S., & McCabe, G. P. (2006). *Introduction to the practice of statistics*. W.H. Freeman & Company. Retrieved from http://www.amazon.com/Introduction-Practice-Statistics-David-Moore/dp/071676654X

Moreland, J., Jones, A., & Barlex, D. (2008). *Design and technology inside the black box. Assessment for learning in the design and technology classroom*. London, UK: GL Assessment.

Moss, C. M., & Brookhart, S. M. (2009). *Advancing formative assessment in every classroom: A guide for instructional leaders*. Alexandria, VA, USA : Association for Supervision & Curriculum Development (ASCD).

NAE. (2004). *Nationella utvärderingen av grundskolan 2003. (NU03) Sammanfattande huvudrapport. Rapport 250*. Retrieved from http://www.skolverket.se/publikationer?id=1369

NAE. (2008). *Matematik. En samtalsguide om kunskap, arbetssätt och bedömning*. Retrieved from http://www.skolverket.se/2.3894/publicerat/2.5006?_xurl_=http://www4.skolverket.se:8080/wtpub/ws/skolbok/wpubext/trycksak/Record?k=1952

NAE. (2009a). *Allmänna råd och kommentarer Individuella utvecklingsplanen med skriftliga omdömen 2008 reviderad 2009*. Stockholm: Statens skolverk (NAE). Retrieved from http://www.skolverket.se/publikationer?id=2114

NAE. (2009b). *Syllabuses for the compulsory school, (LpO94) 2nd edition, Originally published 1994. Revised 2000 and 2008*. .

NAE. (2010). *Ämnesproven 2010 i grundskolans årkurs 9 och specialskolans årkurs 10*. Retrieved from http://www.skolverket.se/prov-och-bedomning/nationella-prov/2.1101/2.1181/2.1182/amnesprov_i_arskurs_9

Newton, P. E. (2007). Clarifying the purposes of educational assessment. *Assessment in Education: Principles, Policy & Practice*, *14*(2), 149–170. doi:10.1080/09695940701478321

Nikander, P. (2008). Working with transcripts and translated data. *Qualitative Research in Psychology*, *5*(3), 225–231. doi:10.1080/14780880802314346

Nilsson, P. (2008). *Learning to teach and teaching to learn primary science student teachers´ complex journey from learners to teachers*. Doctoral thesis. Linköping university, Norrköping.

Nordlander, E. (2011). Vad tycker tekniklärarna? In S.-O. Hansson, E. Nordlander, & I.-B. Skogh (Eds.), *Teknikutbildning för framtiden - perspektiv på teknikundervisning i grundskolan och gymnasium*. (pp. 90–102). Stockholm: Liber AB.

Norström, P. (2014). How technology teachers understand technological knowledge. *International Journal of Technology and Design Education*, 24(1):19–38. doi:10.1007/s10798-013-9243-y

Norström, P. (2014). *Technological knowledge and technology education*. Doctoral thesis. KTH Royal Institute of Technology. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-144875; urn:isbn:978-91-7595-078-5

Nyström, P. (2004). *Rätt matt på prov. Om valideringar av bedömningar i skolan.* Doctoral thesis. Pedagogiska institutionen, Umeå universitet. Retrieved from http://www.diva-portal.org/smash/get/diva2:142615/FULLTEXT01.pdf

Pettersson, A. (2009). Bedömning- varför, vad och varthän? In L. Lindström & V. Lindberg (Eds.), *Pedagogisk bedömning* (2nd ed., pp. 31–42). Stockholm: Stockholm universitets förlag.

Pitman, J., O'Brien, J., & McCollow, J. (2002). A system combining school-based assessment and cross-curriculum testing considered in the context of some key debates in the educational assessment literature. Level 5 Appendices. In J. Pitman (Ed.), *The senior certificate: A new deal* (pp. 317–360). Brisbane, QLD Australia: Queensland Department of Education.

Pollitt, A. (2011). Comparative judgement for assessment. *International Journal of Technology and Design Education*, *22*(2), 157–170. doi:10.1007/s10798-011-9189-x

Pollitt, A. (2012). The method of Adaptive comparative judgement. *Assessment in Education: Principles, Policy & Practice*, *19*(3), 281–300. doi:10.1080/0969594X.2012.665354

Randel, B., & Clark, T. (2013). Measuring classroom assessment practices. In J. H. McMillan (Ed.), *SAGE Handbook of research on classroom assessment* (pp. 145–163). Thousand Oaks, USA: SAGE Publishers.

Riis, U. (1989). *Teknik- för alla? Tema T rapport 19*.

Ritz, J. M., & Martin, G. (2012). Research needs for technology education: an international perspective. *International Journal of Technology and Design Education*, *23*(3), 767–783. doi:10.1007/s10798-012-9215-7

Ritz, J., & Martin, G. (2013). Research needs of technology education: Highlights of a preliminary analysis. In P John Williams (Ed.), *PATT27 Technology education for the future: A play on sustainability* (pp. 387–392). Christchurch, New Zealand: Technology Environmental Science and Mathematics Education Research Center, University of Waikato.

Skogh, I.B. (2001). *Teknikens värld - flickors värld : en studie av yngre flickors möte med teknik i hem och skola*. Retrieved from http://libris.kb.se/bib/8375742?vw=full

Skogh, I.B. (2008). Teknikdidaktisk forskning i Comenius spår. In K. Borg & V. Lindberg (Eds.), *Kunskapande, kommunikation och bedömning i gestaltande utbildning*. (pp. 65–78). Stockholm: Stockholms universitets förlag.

Skolinspektionen. (2014). *Teknik – gör det osynliga synligt. Om kvaliteten i grundskolans teknikundervisning*. Stockholm. Retrieved from http://www.skolinspektionen.se/Documents/publikationssok/granskningsrapporter/kvalitetsgranskningar/2014/teknik/kvalgr-teknik-slutrapport.pdf

Skollagen Svensk författningssamling 2010:800 (2013). Retrieved from http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Skollag-2010800_sfs-2010-800/?bet=2010:800

Skolverket. (2011a). *Diskussionunderlag för grundskolan. Diskutera kursplanen i ämnet teknik*. Retrieved from http://www.skolverket.se/publikationer?id=2547

Skolverket. (2011b). *Kommentarmaterial tillkursplanen i teknik*. Retrieved from http://www.skolverket.se/publikationer?id=2568

Skolverket. (2013). *Beskrivande data 2012. Förskola, skola och vuxenutbildning*. Retrieved from http://www.skolverket.se/publikationer?id=2994

Skolverket- National Agency for Education. (2013). *Allmänna råd med kommentarer om utvecklingssamtalet och den skriftliga individuella utvecklingsplanen*. Stockholm, Sweden: Retrieved from http://www.skolverket.se/publikationer?id=3133

Statens Skolverk (NAE). (2011). *Skolverkets allmänna råd Planering och genomförande av undervisning för grundskolan, grundsärskolan, specialskolan och sameskolan.* . Stockholm: Elanders.

Stenhouse, L. (1981). What counts as research? *British Journal of Educational Studies*, *29*(2), 103–114. doi:10.2307/3120018

Svärdh, J. (2013). *Measuring long-term effects of a school improvement initiative*. Licentiate thesis. KTH Kungliga Tekniska högskolan, Stockholm.

Swedish School Inspectorate. (2009). *Skolinspektionsmyndigheten (Swedish School Inspectorate)*. Retrieved from http://www.skolinspektionen.se/Documents/Rapporter/Mora_Inspektionsrapport.pdf?epslanguage=sv

Teknikdelegationen. (2009). *Finns teknik och är matte svårt? Rapport 2009;2*.

Teknikdelegationen. (2010). *Vändpunkt Sverige – ett ökat intresse för matematik, naturvetenskap, teknik och IKT, SOU 2010:28*. Stockholm.

Teknikföretagen, & Cetis. (2012). *Teknikämnet i träda: teknikföretagens och CETIS rapport om teknikundervisningen i grundskolan*. Stockholm: Teknikföretagen.

Torrance, H., & Pryor, J. (2002). *Investigating formative assessment.* Maidenhead, USA. Open University Press.

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, *68*(2), 202–248.

Van Driel, J. H., Verloop, N., & de Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching*, *35*(6), 673–695.

Wiliam, D. (2009). *Assessment for learning: why, what and how? An inaugural professorial lecture by Dylan Wiliam*. Institute of Education University of London.

Wiliam, D. (2011). *Embedded formative assessment*. Bloomington, IN: Solution Tree Press.

Wiliam, D. (2013). *Principled curriculum design, Redesigning Schooling-3*. London, UK: SSAT (The School Network) Ltd.

Williams, P. J. (2011). Research in technology education: looking back to move forward. *International Journal of Technology and Design Education*, *23*(1), 1–9. doi:10.1007/s10798-011-9170-8

Chapter 2 SUMMARY IN SWEDISH SAMMANFATTNING

1 Inledning

Den här avhandlingen handlar om lärares arbete med bedömning i skolämnet teknik. Den är sprungen ur min egen erfarenhet som lärare i grundskolan och belyser det som jag som lärare brottats med länge – nämligen förhållandet mellan utlärt och inlärt. Som de flesta lärare har erfarit så kan man inte förutsätta att allt utlärt också är inlärt. Någon form av uppföljning är sålunda på sin plats. Denna uppföljning kallas här bedömning.

Kunskapen om lärares bedömningspraktik är föga känd generellt. Än mindre hur det tar sig uttryck i olika ämnen (Bennett, 2011; Black & Wiliam, 1998a; Forsberg & Lindberg, 2010; McMillan, 2013). Det teknikdidaktiska fältet efterlyser också mer forskning kring bedömning, såväl internationellt (Jones et al., 2013; J. Ritz & Martin, 2013; Williams, 2011) som nationellt i Sverige (Bjurulf, 2011; Skolinspektionen, 2014).

2 Metod

Avhandlingen fokuserar på lärarnas dagliga arbete med bedömning och kopplar samman bedömningsforskning med lärarnas undervisning i teknikämnet. Huvudfokus ligger i lärares mångfacetterade arbete med bedömning och berör även miljön som läraren befinner sig i. Avhandlingen bygger på fyra delstudier som alla berör olika aspekter av lärarnas bedömningspraktiker i teknik. I syfte att generera och bidra till kunskap om hur lärare kan arbeta med bedömning i grundskolan undersöker avhandlingen (1) lärares formella dokumentationspraktik [Individuella utvecklingsplaner med

skriftliga omdömen], (2) hur två mellanstadielärares minut-för-minut uppföljning tar sig uttryck i teknikklassrummet, (3) två grupper av lärare som undervisar i teknik och deras uppfattning om teknikundervisning och sin förmåga att bedöma elevernas kunskaper samt (4) vad lärare fokuserar på och värderar när de bedömer digitala elevarbeten i teknik.

För att kunna genomföra dessa delstudier krävdes olika metoder. Tabell 2 i avhandlingens kappatext ger en överblick över de metoder, empiriskt data och information samt i vilken kontext de samlades in. Det empiriska materialet, på vilken denna avhandling bygger på, består av IUP-dokument med skriftliga omdömen, klassrumsobservationer, transskript från klassrumsobservationer, intervjuer, registerdata, autentiska e-portföljer, transskript från när lärare bedömer autentiska multimodala elev-e-portföljer och enkätsvar. Materialet har analyserats främst kvalitativt men även kvantitativa metoder har använts. Teori och tidigare forskning har samlats under tiden som gått. Litteratur i tryckt och digital form som har använts har samlats genom litteratursökningar i olika databaser och sökmotorer, tidskrifter, konferenspublikationer samt genom sociala media [t.ex. Twitter och Facebook] samt genom kollegor.

Informanterna är informerade kring respektive studie. Informanterna har främst utgjorts av lärare men elever har också deltagit. Eftersom dessa elever är minderåriga har även deras vårdnadshavare informerats och godkänt att eleven deltagit. Alla namn är fingerade.

För mer detaljerad information vad gäller metod hänvisar jag läsaren till metodavsnittet i kappan samt respektive artikel.

1. Hartell, E. (2014). Exploring the (un-) usefulness of mandatory assessment documents in primary technology. *International Journal of Technology and Design Education*. 24(2): 141–161. doi:10.1007/s10798-013-9250-z

2. Hartell, E. (2013). Looking for a glimpse in the eye. In I.B. Skogh & M. J. de Vries (eds.) *Technology teachers as researchers: philosophical and empirical technology education studies in the Swedish TUFF research school*. pp. 255–283. Rotterdam, The Netherlands: Sense Publishers.

3. Hartell, E., Gumaelius, L., Svärdh, J. (2014). Investigating technology teachers' self-efficacy on assessment, Published online in *International Journal of Technology and Design Education*. DOI 10.1007/s10798-014-9285-9

4. Hartell, E. and Skogh, I.B. (insänd för publicering). Criteria for success: A study of primary technology teachers' assessment of digital portfolios.

3 Resultat och diskussion

Resultaten visar att lärares bedömningspraktik är komplex och involverar många olika aktörer, syften och sätt. De övergripande resultaten visar en tveklös önskan, vilja och engagemang bland lärare att ge elever möjlighet att utvecklas. Denna ambition att föra elever framåt och att i skolan ge möjlighet till att lära återfinns också i det omgivande samhället. Denna ambition görs explicit i nationella styrdokument som t.ex. kursplaner och skollagen. Även andra intressenter så som t.ex. Teknikföretagen, Snilleblixtarna och Kungliga Vetenskapsakademien visar det genom sitt engagemang i teknikämnet. Utifrån tidigare forskning (t.ex. Black & Wiliam, 1998b; Hattie, 2009; Wiliam, 2009; Wiliam, 2011) vet vi att lärare och lärares bedömning i syfte att överbrygga utlärt och inlärt spelar en viktig roll för att realisera denna ambition.

Resultaten utifrån denna studie lyfter dock fram att förutsättningarna för lärare att fylla denna ambition är begränsad av miljön som de verkar i. Miljön, såväl materiella som immateriella

förutsättningar håller för låg kvalitet. Förutsättningar, som forskning och erfarenhet har identifierats som nödvändiga, så som diskussionsforum och livslångt lärande tillsammans i kollegiet är inte tillgängliga.

Den första delstudien utgår från en kvalitativ ansats och ett begränsat antal IUP-dokument har studerats. I ljuset av detta pekar resultatet av denna studie, sammanvägt med resultat från tidigare studier, på allvarliga brister när det gäller uppföljningen av elevers kunskapsutveckling i teknik. Resultaten visar att syftet med dokumentet inte uppfylls då (1) teknik saknas i majoriteten av det insamlade underlaget och (2) ingen individuell information förekommer. Sammanfattningsvis kan man säga att resultaten från denna studie visar att de tillgängliga mallarna för dokumentation i form av IUP inte är användbara i teknikundervisningen. Denna studie ger också en unik inblick i hur kunskapsläget ser ut bland svenska elever som visar en förvånansvärt hög inrapporterad måluppfyllelse. Det är inte utan att man frågar sig på vilka grunder som dessa bedömningar gjorts. Dessa resultat måste ifrågasättas på samtliga nivåer i skolsystemet. Slutsatsen blir sålunda att dessa dokument inte fyller någon funktion i teknikämnet samt att fler studier behövs både vad gäller elevers kunskaper i teknik och lärares bedömningspraktik men även nyttan med dokumentet generellt.

Klassrumsstudien visar att de studerade lärarna har höga förväntningar på att eleverna ska lyckas och har ambitiösa ambitioner att förverkliga detta. Resultaten visar dock att det saknas kollegialt stöd för detta arbete då dessa lärare är ensamma vad gäller planering, utförande och uppföljning av elevernas kunskapsutveckling vilket ger slutsatsen att stöd både behövs och efterfrågas. Många lärare som undervisar i teknik saknar utbildning i ämnet (Skolverket, 2013). Resultaten från den tredje delstudien pekar på att ämnesspecifik utbildning i kombination med lärarutbildning verkar stärka uppfattningen av ens egen förmåga att arbeta med bedömning i teknik. Samtliga informanter uttrycker en osäkerhet kring sin förmåga att betygssätta elevernas kunskaper och

analysen av betygsstatistik indikerar en synnerligen märklig distribution bland inrapporterade betyg mellan de olika skolorna där dessa informanter arbetar.

Studien kring e-portföljer visar att det råder en hög samstämmighet bland lärarna om vad de fokuserar på när de bedömer elevernas arbeten. Resultaten visar att lärarna främst fokuserar på helhetsbilden av portföljen. Den röda tråden lyfts fram som viktig, det vill säga det att går att se och följa berättelsen från start till slut. De lyfter också fram vikten av att eleven har gjort färdigt alla deluppgifter. Detta tolkar vi på två sätt. Det första att det ses som en dygd i sig själv att göra färdigt och det andra sättet är att en mer färdig portfölj innehåller mer belägg som en lärare kan ta beslut ifrån. Sammantaget verkar det som det senare överväger.

Denna fjärde delstudie, tillsammans med de övriga lyfter också fram hur viktigt det är att eleverna faktiskt undervisas i teknikämnet och inte lämnas ensamma i vad Skolinspektionen (2014) kallar ett ”oreflekterat görande”, som så mycket att den tid, när eleverna får chansen att möta teknik i skolan, ägnas åt (i onödan) samt att läraren är öppen i förväg med vad som ska bedömas.

4 Slutsats

Det är väl känt att bedömning kan fungera som ett skarpt verktyg för elevernas lärande, men det krävs också att det hanteras varsamt som en integrerad del i verksamheten. Forskning kring bedömning är ett växande forskningsfält och är identifierad som i det närmaste okänd mark i teknikämnet. Denna studie har bidragit till att området bedömning i teknik nästan kan betraktas som ett minfält eftersom elevernas tillgång lärsituationer i skolan, är i det närmaste att betrakta som ett lotteri avhängt på vilken lärare de råkar få. Detta måste ändras.

Lärares bedömningspraktiker är komplexa och nödvändiga. Den här avhandlingen visar att lärare arbetar med bedömning på olika sätt. Resultaten utifrån denna studie lyfter dock fram att förutsättningarna för lärare att fylla sin ambition om elevernas lärande inte stöds av den miljö de verkar i. Miljön, såväl materiella som immateriella förutsättningar håller för låg kvalitet och måste sålunda utvecklas.

Utifrån detta vill jag avslutningsvis lyfta fram att det finns ett stort behov att utveckla förståelsen kring bedömning i olika syften och involvera olika agenter i olika kontexter (inklusive olika ämnen). Frågan är hur detta ska gå till. Men en sak vet jag och det är att lärarna måste involveras i detta arbete.

Den här avhandlingen har växt fram under en tidsperiod (2009–2015) då mycket har hänt inom utbildningsväsendet. Det är glädjande att se att bedömning och teknikämnet får allt mer uppmärksamhet. Till exempel så har Skolverket tagit fram och håller på att ta fram ännu mer stödmaterial till teknikämnet enligt Lgr11 (Skolverket, 2011a), som kan tjäna som navigeringsstöd i undervisningen. Enligt Skolverkets konferensers Twitterkonto så har det aldrig funnits så mycket undervisningsstöd som nu (Skolkonf, 2014). Det är som sagt mycket glädjande och verkligen ett steg i rätt riktning. Problemet är bara att detta stöd måste

användas i praktiken också och lärare måste få möjlighet att göra det. Utan att på något sätt frånta lärarna sitt eget ansvar vill jag skicka en uppmaning till rektorer och huvudmän runt om i landet att bereda en miljö i vilken lärare kan få möjlighet att planera undervisning, där bedömning är integrerad, tillsammans med andra. Bygga upp och dela en gemensam kunskapsbas samt ansvar i enlighet med förordningen (Statens Skolverk, 2011).

Avhandlingen utgör ett viktigt bidrag till forskningsfälten teknikdidaktik och bedömning och är utförd i den viktiga men komplexa grundskolan. Slutsatsen är att förutsättningarna för lärarna att arbeta med bedömning– på ett för lärande fruktsamt sätt– måste förbättras.

5 Referenser

Bennett, R. E. (2011). Formative assessment: A critical review. *Assessment in Education: Principles, Policy & Practice*, *18*(1), 5–25. doi:10.1080/0969594X.2010.513678

Bjurulf, V. (2011). *Teknikdidaktik*. Riga, Latvia: Norstedts.

Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. doi:10.1080/0969595980050102

Black, P., & Wiliam, D. (1998b). Inside the Black Box : Raising standards through classroom assessment. *Phi Delta Kappan*, *80*(2), 139–148.

Forsberg, E., & Lindberg, V. (2010). *Svensk forskning om bedömning - en kartläggning. Rapportnummer 2:2010*. Stockholm: Vetenskapsrådet.

Hartell, E. (2013). Looking for a glimpse in the eye: A descriptive study of teachers' work with assessment in technology education. In I.-B. Skogh & M. J. De Vries (Eds.), *Technology teachers as researchers: Philosophical and empirical technology education studies in the Swedish TUFF research school* (pp. 255–283). Rotterdam, Netherlands: Sense Publishers.

Hartell, E. (2014). Exploring the (un-) usefulness of mandatory assessment documents in primary technology. *International Journal of Technology and Design Education*, *24*(2), 141–161. doi:10.1007/s10798-013-9250-z

Hartell, E., Gumaelius, L., & Svärdh, J. (2014). Investigating technology teachers' self-efficacy on assessment. *International Journal of Technology and Design Education*. doi:10.1007/s10798-014-9285-9

Hattie, J. (2009). Visible Learning: A synthesis of over 800 meta-analyses relating to achievement. Chippenham, UK: Routledge.

Jones, A., Buntting, C., & Vries, M. J. (2013). The developing field of technology education: a review to look forward. *International Journal of Technology and Design Education*, *23*(2), 191–212. doi:10.1007/s10798-011-9174-4

McMillan, J. H. (2013). Why we need research on classroom assessment. In J. H. McMillan (Ed.), *SAGE Handbook of research on classroom assessment* (pp. 3–16). Thousand Oaks, USA: SAGE Publishers.

Ritz, J., & Martin, G. (2013). Research needs of technology education: highlights of a preliminary analysis. In P John Williams (Ed.), *PATT27 Technology education for the future: A play on sustainability* (pp. 387–392). Christchurch, New Zealand: Technology Environmental Science and Mathematics Education Research Center, University of Waikato.

Skolinspektionen. (2014). *Teknik – gör det osynliga synligt. Om kvaliteten i grundskolans teknikundervisning*. Stockholm. Retrieved from http://www.skolinspektionen.se/Documents/Kvalitetsgranskning/teknik/kvalgr-teknik-slutrapport.pdf

Skolverket. (2011). *Diskussionunderlag för grundskolan. Diskutera kursplanen i ämnet teknik*. Retrieved from http://www.skolverket.se/publikationer?id=2547

Skolverket. (2013). *Beskrivande data 2012. Förskola, skola och vuxenutbildning*. Retrieved from http://www.skolverket.se/publikationer?id=2994

Statens Skolverk (NAE). (2011). *Skolverkets allmänna råd. Planering och genomförande av undervisning för grundskolan, grundsärskolan, specialskolan och sameskolan*. Stockholm: Elanders.

Wiliam, D. (2009). *Assessment for learning: why, what and how? An inaugural professorial lecture by Dylan Wiliam*. Institute of Education University of London.

Wiliam, D. (2011). *Embedded formative assessment*. Bloomington, IN: Solution Tree Press.

Williams, P. J. (2011). Research in technology education: looking back to move forward. *International Journal of Technology and Design Education*, *23*(1), 1–9. doi:10.1007/s10798-011-9170-8

Chapter 3 PAPERS

The author's contribution to the papers

Paper I Hartell full authorship.

Paper II Hartell full authorship.

Paper III Hartell first authorship, and by that taken responsibility for produce the full paper (draft, outline & final) in continuous discussion with the co-authors. Gumaelius has contributed by taken the holistic view of the paper by processing the text and particular theoretical input (self-efficacy) for the final paper. Svärdh has contributed by main responsibility for the statistical analysis. Data underpinning this study comes from a larger data collection undertaken by Hartell, Svärdh and Norström, financed by European Social Fund.

Paper IV Hartell first authorship, and by that taken full responsibility for research design, data collection and production of the paper in discussion and close collaboration with Skogh, who has also contributed by theoretical aspects from philosophy.