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Towards a Deeper Understanding of the Impact of Technology Enhanced Learning in Swedish Primary Schools

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ABSTRACT (MAX. 200 WORDS):
Technology Enhanced Learning (TEL) impacts primary schools in Sweden in terms of teaching and learning practices as well as analysing how the school is affected as an organisation and social environment to the technologies. The benefits and challenges following the implementation of TEL in a learning environment is often subject to various theories and factors when it is implemented into practice. This thesis bases its theoretical framework on digitalisation, blended learning, TEL & collaborative tools, Organizational Learning Theory and Social Learning Theory. The empirical research takes a qualitative approach based on interviews of scholars who have conducted research in the field of digitalisation in education. The study identifies that digital competence, teacher freedom, interoperability and attitude towards digital tools in education are key factors affecting the outcome of digitalisation in the Swedish primary school educational system.

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Samrachna Adhikari & Oscar Andersson

1 Introduction

1.1 Background

The evolution of technologies has enabled enhancements in various aspects of everyday life, and Information and Communications Technology (ICT) platforms have become a major proponent in excelling how people work, learn and collaborate (Salavati, 2016). With a continuous expansion of participation in education globally for the past few decades, the opportunities of widening the reach of education through different mediums has grown (Dohmen, 2018). Advancing them are various digital platforms, the internet, mobile devices and tools that aid in different forms of learning and provide the necessary environments for learners and educational institutions (Díaz & Ioannou, 2019). The development in learning or educating through the means of digital tools can be tailored by Technology Enhanced Learning (TEL). TEL comprises the learners, the organizational setting, and the technology in terms of different tools, resources, and the social environment (Kurti, 2009). The characteristics influencing the learning environment either directly or indirectly have an impact on one another in a digital environment. The application of digital tools provide a structural system to plan, create, manage and allocate information in conveying learning processes among educational institutions and students(González-Sancho & Vincent-Lancrin, 2016). Interactive tools enabled by digital technologies, have the potential to be beneficial for learning in primary school education (Burnett, 2016).

Collaboration enabled by TEL is no longer a voluntary ordeal as the Covid-19 pandemic has forced distance learning upon primary schools worldwide (Daniel, 2020). Distance learning nowadays, means the use of digital technologies for both teachers and students to connect and to conduct learning and teaching practices (Burnett, 2016). As primary schools can make use of remote teaching practices, the collaborative aspects of the tools and the enhancements in learning are of great importance to be able to understand what digital learning tools have to offer from a learning and social perspective. Children in the Swedish primary school ages of 7-15 face challenges which are unique to the age group compared to higher education (Burnett, 2016; Saykili, 2019).

Learning in collaboration for pupils in primary schools prioritizes the learning of the pupils themselves, where knowledge is formulated through peer interaction and assessments of results (Austin, Smyth, Rickard, Quirk-Bolt & Metcalfe, 2010) Austin et al. (2010), also elaborate on how collaborative learning through the integration of ICT assists in a more pronounced analytical thinking, learning process among pupils and participating in classes more actively among pupils. The authors argue that the benefits and success of TEL lie in various aspects such as retaining learned information for the long-run, a deeper understanding and a shared understanding among peers and teachers. However, there have been complicated aspects outlined when integrating digital collaborative tools and technology assisted learning materials for schools (Burnett, 2016). These aspects involve issues with tool integration, not implementing the tools that would suit the school or pupil's learning needs and learning practices sufficiently and obstacles in ease of accessibility (Austin et al. 2010; Blundell, Lee & Nykvist, 2016; Wegerif, 1998). Additionally, the attitudes towards accepting to adapt to the technologies or not in schools, shifts more towards the attitudes of the teacher (Hsu & Kuan, 2013).

With changing learning approaches due to digital learning, the educational researchers have over the years attentively defined the terms used through mediums of technology such as blended learning, mobile learning, collaborative learning, distance learning and several others (Hodges, Moore, Lockee, Trust & Bond, 2020). According to Díaz and Ioannou (2019), there needs to be more studies done concerning technology-enhanced learning mediums in educational curricula. There is an emphasis by researchers (Cerratto-Pargman, Järvelä & Milrad, 2012; Kurti, 2009; Pargman & Jahnke, 2019; Salavati, 2016) that digital environments that assist in building knowledge along with digital learning tools are crucial for the ability to decipher and implement understandings from sources such as graphics, video or text contribute to knowledge-building (Scardamalia, Bransford, Kozma & Quellmalz, 2012). Inan & Lowther (2010) elaborate on how there are several underlying factors affecting the implementation of technology in primary school classrooms. Through the former authors and the interpretation from Scardamalia et al. (2012), technologies can be implemented through three categories, namely for instructional purposes through preparation, delivery and using technologies as a learning tool. With these underlying studies, and different learning modes studied through researchers in primary school education, there lies a need to look into and understand the factors of influence for learning through technology and collaborative learning tools.

1.2 Problem Area

The impact of digital learning and digital tools in education is crucial and research done towards digitalisation of education has gained prominence in teaching and knowledge acquisition in primary schools (Salavati, 2013; Burnett, 2016). Researchers and technologists have built applications and tools for facilitating digital education and have grounded years of their studies as well as research on the implications and applications of existing or novel uses of technology in learning (Salavati, 2013). According to Alvesson and Sandberg (2011), instead of going through associated literature and spotting gaps in the existing knowledge, we can rather opt for problematizing the existing literature and theories that would result in answering the research question at hand. While taking this into consideration we have adopted the arguments presented by Alvesson and Sandberg (2011), and worked towards structuring our research through problematizing the existing literature. The studies and literature present in digital education look into how existing digital learning tools have made a difference in primary school education systems (Milrad, Wong, Sharples, Hwang & Looi, 2013). The respective studies conducted by the researchers on digital platforms in learning and educating have yielded corresponding results to a great extent. The enhancements in learning through technology are put forth on teaching curriculum without initial considerations of whether the applied system matches the education purposes and fulfil its potential by being beneficial to both teaching and learning alike (Laurillard, Oliver, Wasson & Hoppe, 2009). Additionally the studies conducted by Cerratto-Pargman, Järvelä and Milrad (2012) on designing TEL in the context of Nordic learning draws conclusions regarding the various challenges that arise when simply designing learning materials based on technology. With designing such tools themselves being challenging, we are keen on drawing results on how the designed and developed TEL tools influence the learning that stems from it. Also, ICT is implemented in a limited manner for teaching and educating in primary schools and while the access to technology has been readily improved, the extent to which it has been applied in practicality is comparatively narrow (Salavati, 2013).

1.3 Purpose

Digital tools in terms of TEL, are getting more prevalent in Swedish primary school education (Utbildningsdepartementet, 2017). To underline the importance of the conducted research and the topic of digitalisation of education in Sweden, we wish to refer to the Swedish national digitalisation strategy. The strategy highlights that the possibilities of digitalisation is to be able to contribute to increased goal fulfillment, equality and gender equality in the school system and that it is important to have research as a basis for being able to develop both activities and initiatives (Utbildningsdepartementet, 2017). The strategy further states that the research done in the area of digital tools in schools is modestly researched which strengthens the relevance of researching the topic of using digital tools in Swedish primary schools.

Despite the fact that there is grounded research on how the technologies should be implemented in practice, schools are still adapting to how they can approach their digital integration for learning (Cerratto-Pargman, Järvelä, & Milrad, 2012; Salavati, 2016). Analysing the previous research done in the field of digital education in Swedish primary schools, there is a need for understanding the impacts and challenges from researchers and educational technologist's perspective (Cerratto-Pargman, Järvelä, & Milrad, 2012). This is of interest because researchers have not only been involved in designing and adapting digital tools, they have been studying their design, implementation and use in learning environments from early on (Pinkwart, Hoppe, Milrad & Perez, 2003). Furthermore, we intend to gain a holistic view of how the technology at hand works with students, teachers and the organisation. As a result, this study's purpose is to better understand how TEL makes an impact in learning among pupils in primary schools, both from a social and organizational perspective.

1.4 Research Focus & Research Question

As mentioned, impacting practice through research has shown to be challenging. In this thesis, the aim is to gain an understanding of how education at primary schools in Sweden is influenced by TEL, correlating to the impact of the scholarly works that have studied digital learning. In regards to observing how it has influenced education in primary schools, there are numerous scholars that have conducted studies to analyze, recommend and influence digitalisation processes in education. The thesis focuses on how the use of technology impacts learning and the school environment, with the means of showing that learning is affected by technology, both in terms of benefits and challenges. Therefore, in the context of understanding how learning in Swedish primary schools is influenced by TEL, we focus on answering the following research question:

What impact does the application of Technology Enhanced Learning (TEL) have on Swedish primary schools?

1.5 Delimitation

With the conducted study and its respective outcomes there are certainly some delimitations. As this research focuses on the Nordic education system in the Swedish primary school context and the studies done solely through the perspective of researchers and educational scientists

and their corresponding outcomes when they conducted their studies. Additionally, through this thesis the outcomes and evaluations done would only focus on the digital tools, technology enhanced learning, systems and strategies implemented by these scholars and researchers when they were studying the use of technologies in teaching and learning scenarios in primary school education in Sweden. As our research time is limited, we are not able to garner a clear understanding of how the applications of TEL are being implemented in a global context through this current study.

2 Theoretical Background

In this chapter, the literature governing digitalisation in primary school education, blended learning, Technology Enhanced Learning and the theories that relate to education are presented. The information derived from these aforementioned topics will be used as the foundational structure to guide us for the collection of the empirical data and its respective analysis.

2.1 The Definition of Learning

To fully understand education and the learning process, it is important to define what learning means. There isn't a single set definition of what learning signifies and there may never be, however, there are different ways to approach the definition based on perspective. The form of learning that this thesis is focusing on is the form of learning which educational institutions create their business from.

To start off the mapping of what *learning* is, this is a definition provided by the Oxford Dictionary: "To gain or acquire knowledge of or skill in (something) by study, experience, or being taught." (Lexico Dictionaries, 2021). This definition tells us that learning is about the acquisition of knowledge and that this knowledge is acquired through study, experience or most importantly for us in the context of schools *being taught.* An important aspect of learning in the context of education in primary schools is that individuals have different ways of learning and processing information (Bullock & Muschamp, 2006). Thus, the challenge for educational institutions, teachers and students in terms of learning is the strive for creating something that works for every individual.

Another definition of learning is the following provided by Richard Gross (2015) from his book *The Science of Mind and Behaviour*: "Learning is the process of acquiring knowledge, new understandings, behaviours, skills, values, attitudes and preferences." (p.34). Beyond the acquisition of knowledge, you can go as far as stating that learning is vital for our existence as human beings. As Gärdenfors (2010) puts it: "Learning is both an essential characteristic of human kind and also a basic requirement for human life." (Gärdenfors, 2010, p.20).

For this theis, we will not go further into the definition of learning, although the authors see it as a necessity to highlight some aspects of the term to clarify what learning refers to in the coming chapters. The definition provided by the Lexico Dictionaries (2021) and Gross (2015) is practical in the sense that it paints a picture of what is meant by learning from cognitive and behavioral perspective. Gärdenfors (2010) defines what learning means from a societal perspective and thus what motivates us as humans to acquire knowledge. We argue that these definitions are valuable to keep in mind to fully grasp the notion of learning used in this thesis.

2.2 Digitalisation in the context of Education

The transformation which digitalisation offers reaches beyond what traditional educational tools make possible (Díaz & Ioannou, 2019). Digitalisation introduces virtual, augmented and mixed reality, social and mobile computing, interactive surfaces, robotics and Internet of Things

(IoT) tools and gamification which can lead to learning opportunities and a way of dealing with educational challenges and possibilities of twenty-first-century society. Although the rise of increasingly sophisticated technologies and the possibilities that come with it, there are challenges to consider when it comes to digitalisation specifically in the context of education. ICT goes beyond simply being technological tools and digital society now shapes how we interact with others and our environmental setting as well as how we perceive ourselves and our faced reality (Díaz & Ioannou, 2019).

The changes in lifestyle that the modern digital society transforms is important to address to fully understand how digital education could and should influence the process of learning (Griffin, Murray, Care, Thomas & Perri, 2010). The oftentimes called twenty-first-century educational challenges include how to support hyper connected people to develop skills in critical thinking, problem solving, creativity, collaboration and communication. Many of these challenges are not novel yet the way we acquire and apply these skills has changed dramatically due to the extent of the relationship with ICT (Díaz & Ioannou, 2019). Digitalisation has changed the dynamic of the world to be more global and immediate. To exemplify this, take collaboration as an example, collaboration has always been regarded as a highly valued interpersonal skill (Díaz & Ioannou, 2019). *Collaborative problem-solving* is something that highlights the challenges of collaboration in a group and consists of five broad strands, the capacity of individuals to recognise the perspective of other people in a group, participate as a member of the group by contributing their knowledge, experience and expertise in a constructive way, recognise the need for contributions and how to manage them, identify structure and procedure involved in resolving a problem; as well as a member of the collaborative group, build and develop knowledge and understanding (Care, Griffin & McGaw, 2012).

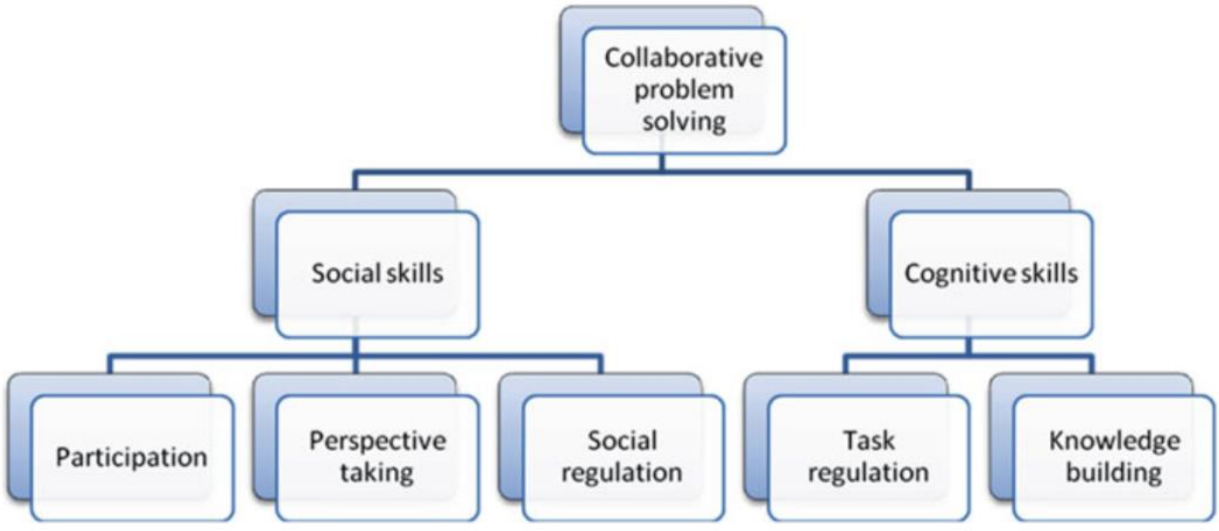

Figure 2.1. Conceptual framework for collaborative problem-solving (Griffin et al. 2010, p.8)

To collaborate in the digitalisation era, you need the knowledge of how to navigate in a complex technology-mediated environment which requires learning in the digital systems to navigate with ease (Díaz & Ioannou, 2019). What a complex technology-mediated environment refers to is that the nature of collaboration is shifting to a more sophisticated skillset (Dede, 2010).

Beyond collaborating face-to-face with colleagues across a conference table, 21st century workers are increasingly required to accomplish tasks through mediated interactions with peers across the world whom they may never meet face-to-face. Thus, even though collaboration is always occurring naturally regardless of technology, collaboration is worthy of inclusion as a 21st century skill because the importance of cooperative interpersonal capabilities is higher as the skills involved are more sophisticated than in the prior industrial era (Díaz & Ioannou, 2019).

These new digital environments require people to learn new skills and adapt new attitudes to be able to cope with challenges provoked by distance as well as multidisciplinary and multicultural relationships (Díaz & Ioannou, 2019). Another important skill is learning to learn, with digitalisation the learning expectations look different to the pre-digital era. Education needs to prepare people for lifelong learning through active engagement with information society, collaborative learning environments, or multi-user critical thinking and social creativity tools. ICTs have the possibility to enable simulations of these active ways of engaging (Díaz & Ioannou, 2019; Dede, 2010).

2.2.1 Digitalisation in Swedish Primary School Education

The Swedish National Agency for Education has as of 2017 constructed a plan for digitizing the Swedish primary school system on a national level (Utbildningsdepartementet, 2017). The idea of the *Nationell digitaliseringsstrategi för skolväsendet (the national digitalisation strategy for the school system)* is to combat this problem of unequal conditions across Sweden. As stated in the National Digitalisation Strategy of the School System (2017), the government adopted a national strategy for the digitalisation of the school system. The Government wants the Swedish school system to be a leader in using the opportunities of digitalisation in the best way to achieve a high level of digital competence and to promote the development of knowledge and equality. (Utbildningsdepartementet, 2017). Thus, Sweden has set a high goal for the role of digitalisation of the education system. The strategy for achieving this goal is based on three focus points: firstly *digital competency for everyone in the school system*; secondly *equal use and access*; thirdly *research and follow-up on the possibilities of digitalisation* (Utbildningsdepartementet, 2017).

The overall goal with this initiative is described in terms of Swedish school systems being a leader in digitalisation using the best possibilities in the best manner for achieving *a high level of digital competence* among students so the knowledge can be equally promoted and fostered (Utbildningsdepartementet, 2017). The keywords used to describe the gains of digitalisation in education are surrounding the promotion of *development and equality*. Creating an increased equal opportunity has been a major expressed goal from the municipalities of the Swedish school system. The Swedish Education Act states that all children and young people shall, regardless of gender, geographical residence, and social or economic situation, have equal access to education in the public school system for children and young people.(Wildt-Persson & Rosengren, 2002). As Sweden has a decentralized educational system where it is up to the municipalities and regions to make decisions regarding the schools, monitoring and follow-ups are of central importance in monitoring equity. The question becomes how digitalisation can contribute to promoting development and equality for Swedish children in primary schools. An important distinction to be made is between the difference of equal outcome and equal opportunity. The goal of the Swedish school system is to create equal opportunity while equal outcome cannot be guaranteed (Wildt-Persson & Rosengren, 2002).

Furthermore, in the digitization plan for the Swedish education system it is stated that interoperability is of importance for the successful implementation of digitalisation in the education system (Utbildningsdepartementet, 2017). The digitalisation plan argues that the focus on interoperability between the digital tools can help principals with limited development resources to take part in existing solutions. Thus, reaching a quality of outcome achievable without prior knowledge from the school leadership. This can be interpreted as the recognition of the limitations of digital competency around the education system in Sweden and strategising around sharing knowledge in the education system and not mainly conducting education on an individual level.

But what is an adequate level of digital competence for the teachers in Swedish primary schools is important to address what the digitalisation strategy for Swedish primary school education aims at in concern to digital competency. In their paper, Olofsson, Fransson & Lindberg (2020) conclude that the term digital competency is flexible in its meaning for the Swedish primary schools. The study highlights that there is a connection between local contextual conditions and that the digital competence is related to teachers' own framework of values (Olofsson, Fransson & Lindberg, 2020). The study further concludes that there is a risk of unequal possibilities for students to develop an *active citizenship* in the digitalised Swedish society of today and tomorrow that the policy seems to expect. Thus, the goal for the Swedish digitalisation plan is to strive for equality but in reality there can be no guarantee as it still comes down to local contextual conditions.

2.3 Blended Learning

Blended learning in primary school education is increasing in scope and is no longer solely a distance learning phenomenon (Horn & Staker, 2011). Blended learning, sometimes called hybrid learning model, means that education is set in both a digital as well as a physical environment. Digital learning is evolving both in terms of the sophistication of tools as well as strategies to enable the learning efficiency. The term blended learning is frequently used, although there is an ambiguity in what is meant with the expression (Hrastinski, 2019). Driscoll (2002) argues that blended learning has taken on several means, such as combining different modes of web-based technology, instructional technologies, pedagogical approaches, and actual job tasks.

Blended learning has thus become an umbrella term used in education which beyond describing an educational approach, includes descriptions for different blends of instructional methods and pedagogical approaches (Hrastinski, 2019). The result is an unclear idea of what is meant when referring to blended learning methods. The problem with having an ambiguous term is that it can mean different things to different people with the result of the term being vague when addressed. This validates the need to clarify what is meant by blended learning in the context of this thesis. There are three definitions of what blended learning is according to the literature:

1. "Blended learning systems combine face-to-face instruction with computer-mediated instruction" (Graham, 2006, p.5)
2. "The thoughtful integration of classroom face-to-face learning experiences with online learning experiences" (Garrison & Kanuka, 2004, p.96)

3. "Course that blends online and face-to-face delivery. Substantial proportion of the content is delivered online, typically uses online discussions, and typically has a reduced number of face-to-face meetings" (Allen & Seaman, 2010, p.5)

These definitions emphasize the importance of the key components *face-to-face learning* and *online instruction* or *learning*. Graham (2006) argues that blended learning should be viewed in an inclusive way to describe the combination of face-to-face and online learning (Graham, 2006). The reason for this is that it would be too difficult to limit the definition beyond this since most education in modern times combines this type of learning. The definition provided by Garrison and Kanuka (2004) acknowledges the complexity of blended learning and recognizes that no two blended learning methods are identical and suggests that the term blended learning should instead be used when face-to-face learning and online learning is used in a *thoughtful manner* (Garrison & Kanuka, 2004).

The difference between Graham (2006) and Garrison and Kanuka (2004) is that they both recognize the difficulty in limiting the concept but Garrison and Kanuka argues that it is beneficial to set a limit to when the definition is used with thoughtfulness, in contrast to Graham's inclusive definition were *everything goes* as long as it touches upon face-to-face and online learning. Furthermore, the third definition provided by Allen and Seaman (2010) argues that blended learning has to be limited in terms of how much face-to-face and online learning the education needs to contain. To set a limit Allen and Seaman (2010) put the criteria of having 30 to 79 percent of learning online in an attempt to limit and create frames for what the term means. In conclusion, there could be potential in limiting the definition of blended learning, although since there is so much different research and references to the term there could also be a more realistic approach to accept that the term will be used as an umbrella term to describe where face-to-face and online learning meet (Allen & Seaman, 2010). Since most education nowadays combines both face-to-face and online learning the term blended learning will continue to be relevant in the context of digitalisation and education.

The potential for the blended learning model for primary school education surrounds personalized learning and boosting productivity (Horn & Staker, 2011). In practice, this means that blended learning can enable a more consistent and personalized pedagogy where students can use a learning style that fits them better on a personal level and where the blended learning environment can provide students with more control over time, place, path for the instructions (Smith & Suzuki, 2015). Blended learning also enables education to be tailored to match a student's cognitive abilities and through tools leveraged by technology, students can learn at their own pace, use preferred processes and get feedback at a more frequent pace. Online programs can also capture the students' achievement data in real-time which can help the teacher personalize the learning experience for the students as well as track their progress (Horn & Staker, 2011).

Beyond positive results for the students, the blended learning model has the potential to reinvent the teachers' role (Horn & Staker, 2011). One study suggests that teachers that are using the blended learning model have more time to focus on high-value activities such as critical thinking, writing and project-based learning as a consequence of spending less amount of time on low-value manual tasks. The blended learning model can also lower the amount of teachers needed by having more specialized teachers and also lower the requirements for physical space needed for teaching. Through technology, the staffing structures can be radically reformed in comparison to traditional models where labor accounted for 70 to 85 percent of the costs and where only a fraction of the students have access to great teachers. With the blended learning

model, it is suggested that the cost of labor can be reduced and teachers have more time to spend on increasing the quality of the teaching (Horn & Staker, 2011).

Studies on blended learning for students in K-12 schools showed that on average students in online learning conditions performed modestly better than those that received face-to-face instructions (Means, Toyama, Murphy & Baki, 2013). The advantages over face-to-face classes was significant in the studies which contrasted blended learning to traditional face-to-face instructions, although not in the studies contrasting purely online with face-to-face conditions (Horn & Staker, 2011). One factor to consider with the studies on blended learning is that studies researching blended learning tend to involve additional learning time, instructional resources and elements that encourages and enables increased interaction among learners. Another potential benefit of blended learning environments is to provide a way to deliver standardized curriculum and tests to students and instructors in large-scale implementations (Çakır & Bichelmeyer, 2016). According to literature, the correlation between a teacher's educational and professional attributes does not impact the learning outcomes of the students, the examined teacher's characteristics and teaching practices did not have an impact on student achievement.

2.4 Technology Enhanced Learning

Technology Enhanced Learning (TEL) is defined as the application of technologies which enhances the learning and teaching capacities among educators and learners (Dunn & Kennedy, 2019). TEL works as an enabler at the fore-front of both technology and education and facilitates in providing respective solutions to existing problems. The educational mediums based on the field of technology enhanced learning research emphasize on having a collaborative and holistic environment when it comes to learning and teaching (Kurti, 2009). This field is constantly evolving as it is directly or indirectly influenced by its reliance on technology, related fields, or depending on the nature of the subject adapting to TEL (Laurillard et al. 2009).

With the advancements in mobile technologies and the rise in online learning mediums, TEL assists in e-learning models where the implemented technology aids in the impact of knowledge through educators (Cerratto-Pargman, Järvelä & Milrad, 2012; Laurillard et al. 2009). Studies and research through TEL simultaneously encourages new methods to be applied in the digital tools involved and also benefits the individuals through a blended medium of learning. With the implementations of TEL educators and practitioners encounter several interdisciplinary and radical changes in teaching and learning practices (FitzGerald, Jones, Kucirkova & Scanlon, 2018). TEL utilizes the formats of blended learning and does not limit learning to just textbooks but with the implementations of audio, video and other interactive engaging technological mediums that complements focus of both learning and teaching (Kurti, 2009). The social aspects involved in TEL offers learning in a human-centered way where the current practices followed by the educational institutions are adapted to the use of novel technologies that will assist learning (Laurillard et al. 2009). The authors argue regarding the effectiveness of TEL that when designing the relative tools there requires additional focus on the thought towards what the learners need, the relative outcomes and what challenges TEL adoption can solve.

Additionally, TEL encourages students to be more active in adapting learning techniques, seamless interaction between respective students and educators, and a diverse form of learning and

comprehensive reciprocation among students (Casanova, Moreira & Costa, 2011). The proliferation of TEL has also been primarily influenced by mobile devices that encourage seamless collaboration among individuals in different learning environments. The inclusion of various mobile technologies and digital tools gives room for educators to restructure their teaching techniques in a classroom (Heflin, Shewmaker & Nguyen, 2017). Through these implementations TEL leverages advancements in academics among the respective researchers, students or educators in terms of the efficiency and productivity (Fonseca, Martí, Redondo, Navarro and Sánchez, 2014). Cerratto-Pargman, Järvelä and Milrad (2012) view implementation of TEL with the perspective of designing and developing tools in an interdisciplinary approach for the emerging technologies to be implemented in a learning environment. If TEL is to be implemented with the goal of it being productive and checking every goal for learning outcomes, it is essential to have it designed with the critical end user in mind, which is, the learner or primary school pupils (Mor & Winters, 2007). The design initiated for the TEL related system needs to constitute the main factors that will enable the pupils to gain insights on the domain they are seeking knowledge in. With TEL designed through the respective context, it can tackle the techniques that are challenging in the system and design the tools through adaptable design and foster innovative learning environments (Laurillard et al. 2009; Mor & Winters, 2007). The former authors also illustrate that collaboration among stakeholders who would be involved in implementing and designing the technologies such as teachers, school board managers, designers, developers or practitioners would help provide the essential groundwork in innovating the tools to be used. The motivation of active engagement through TEL falls primarily through the experience of deploying the digital tools, students and how it is implemented in the classroom or learning environment. For instance, Sung, Chang and Liu (2016) emphasize that technology adopted deliver their efficiencies when they have been adapted by the teacher to have a holistic experience that favors the course, digital tools used and expected outcomes for their respective course. For example, partnering with online curriculum providers that provide technical resources for a broad range of learners and topics to be covered with the assistance of blended learning through interactive mobile devices which enable learning anywhere according to the goals and potential of learners (FitzGerald et al. 2018).

Moreover, TEL also pushes teachers to be engaging and creative towards the relevant content they deliver to the students. Also, it can be interpreted that technology does not merely support the learning approach of pupils in primary schools, it moreover transforms how we learn and decipher learning. However, in a study conducted by Mozelius, Eriksson Bergström and Jaldemark (2017), where they used location based games to observe learners and how they learn through mobile devices in an outdoors setting. Through their analysed results it was outlined that teachers do lack some levels of competency with teachers having to level up their skills and be adept in using the included technologies. The use of updated technologies in schools puts up teachers to deal with the new development and design challenges that it comes with. Thus, in relation with the insights provided by Laurillard et al. (2009), the engagement of prospective users of the technology is to be prioritised from the beginning when creating them for learning to be successful both among teachers and pupils. In accordance with the skills and digital literacy they have, teaching practices and implementations of required tools in the learning environments need to be re-thought critically before implementing in practice.

2.4.1 Digital Collaborative Learning

Computer Supported Collaborative Learning (CSCL) environments are regarded significantly in facilitating engagement among students and teachers as it provides an insight towards how

new ideas can be implemented in an innovative manner in a learning environment (Janssen & Bodemer, 2013). Also, the implementation of ICT with collaborative learning aids in the process being innovative, engaging and motivating towards students (Janssen & Bodemer, 2013). Collaborative learning tools posit a significance for both students and educators when encouraging interaction among one another in learning (Hernández-Sellés, Pablo-César Muñoz-Carril & González-Sanmamed, 2019). Additionally, with access to effective collaborative tools, it assists teaching and collaborating in a seamless manner with enhanced communications and collaboration. This provides students with tools that give real-time focus on interactions with the right context and assist in problem-solving, effective learning and influencing support in their respective learning environment (Ornellas & Muñoz Carril, 2014). Also, these tools along with collaboration provide an outlet for instructors to select whether the chosen tools are appropriate or foster engagement or learning among students (Kajamaa & Kumpulainen, 2020).

In their paper, Kajamaa & Kumpulainen (2020) present the study on how digital makerspaces have been affiliated in creating a rich teaching and learning environment through accompanying different forms of integrated learning in the fields of science, technology etc. and also increasing the digital knowledge among students at the same time. In general, makerspaces work as a collaborative space in educational or private facilities which give room for creating, making, learning collaboratively utilizing either technical or non-technical tools (Makerspaces, 2021). Through digital makerspaces, learning in a technology-rich environment assists in better student-to-student or student-to-teacher interactions which works beyond the traditional in-person learning and makes knowledge accessible even remotely and adds more value in knowledge creation (Kajamaa & Kumpulainen, 2020). With the use of ICT enabled collaborative learning, collaboration among students and teachers is made convenient from any mobile device, or a device with an internet connection (Gallant, 2020). In addition, with applications such as Moodle, G suite for education which consists of a varied number of applications suitable for seamless collaboration and fusion of technologies as a medium to support learning activities (Education, 2021; Gallant, 2020). The application of collaborative learning can be seen through how students can teach each other valuable information and they can learn by learning by exchanging ideas and information through different platforms (Austin et al. 2010).

2.5 The School as an Organisation

Through this chapter we will address how the school as an organisation learns and maintains the information. When integrating technology into the school and its classrooms it is important to highlight what this means from an organisational perspective. Thus this chapter will briefly delve into how individual learning can contribute to learning of the organisation as a whole.

2.5.1 Organizational Learning Theory

The Organizational Learning Theory (OLT) model evolved from the questioning of the rational perspective that organizations were simply factories which could be effectively managed through manipulation of processes and procedures leading to increased efficiency (Fauske & Raybould, 2005). Scholars argued that this idea of mapping out an organization's processes and workflows and optimizing them as you would optimize an assembly line simply wasn’t enough to paint the whole picture.

Organizational Learning Theory parallels models of individual learning grounded in cognitive and social psychology and defines the learning process as organizational change (Fauske & Raybould, 2005). The relevance of organizational learning theory in the context of digital technologies in education can be argued (by the authors) as Whyte (1997) puts it "A change in the technical system necessarily impacts on the functioning of the social system, and a change in the social system has impacts on the technical system" (p.57). What this means for the use of digital technologies in the context of education in primary schools is that it highlights the interconnection of a social system to a technological system as organizational learning theory encompasses both structural technical as well as social cognitive systems (Fauske & Raybould, 2005). As research suggests, an organization learns through the individual learning of its members (Huber, 1991). The initial phase of organizational learning takes place at the individual level and does not become organizational learning until the information is shared and stored in organizational memory so that it may be transmitted and accessed, and used for organizational objectives (Zahller, 2011). In organizational learning theory, there are three stages of learning in an organization: *Data acquisition, interpretation, adaptation/action*.

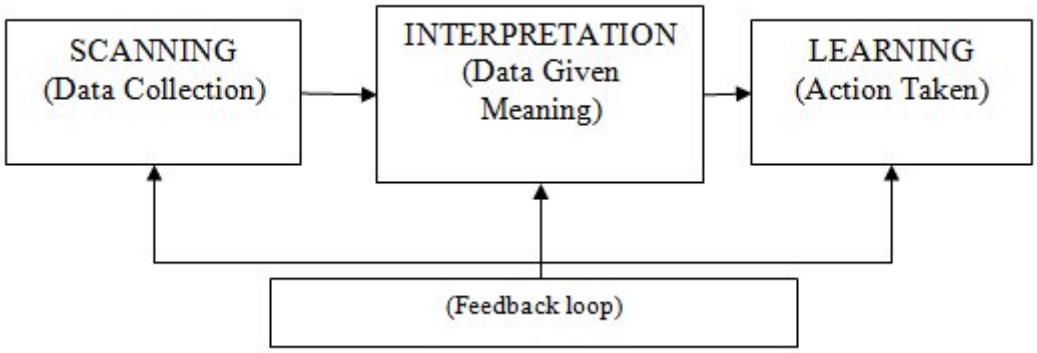

Figure 1.2. Organisational Learning Theory stages (Zahller, 2011)

Data acquisition refers to the process of acquiring a *memory* of action-outcomes, environmental conditions where those outcomes are valid, the probability of the outcomes as well as the uncertainty around that probability (Zahller, 2011). There are a number of ways to acquire these *memories* through different benchmarking processes, although they all require a conscious effort to discover, confirm or utilize a cause and effect relationship. Otherwise, the risk is that the efforts are just a shot in the dark relying on chance of success without understanding how one ended up there. One critical factor in achieving a successful organization is that an organization's actions need to change in synchronization with changes in the environment as the links between action and outcomes must be specified in terms of applicable conditions (Zahller, 2011).

Interpretation is the second stage in the organizational learning process and refers to the process of interpreting the acquired information and adding it to the organizational *memory*. This is done through the comparison of the actual results to expected and thus gaining insight into causation of outcomes which in turn increases organizational learning (Zahller, 2011).

The last stage is *adaptation or action* which is when an organization takes the interpreted information and uses it to select new action-outcomes which fit the current environmental conditions (Zahller, 2011). This is a process of continual adaptation to the environmental conditions

which include internal, external, competitors, state of technology and so forth. These environmental conditions will be based on the complexity and the experience of the organisation (Zahller, 2011). Once adapted, the organization's knowledge base is updated to have these new action-outcome links, probabilities, uncertainties, and applicable conditions and the process continues.

What learning refers to in organizational learning from a cognitive perspective is the individual learning which involves retrieving, transforming, storing and applying information which is stored in the memories of the individuals involved (Fauske & Raybould, 2005). These memories are shared with other individuals in an organization and these collections of memories shared between members of an organization are referred to as *mental models* in organizational learning theory.

Mental models refer to the function of activating memories and responses that have been previously developed to solve earlier problems or to address previous incidents (Fauske & Raybould, 2005). They include knowledge, assumptions, values, beliefs, emotions, and norms which guides behaviours and actions. Mental models provide a mapping of the preconceived context in which to view and interpret new material, and they determine how stored information is relevant to a certain situation (Garvin, 1993).

Furthermore, mental models in the context of OLT have two dimensions to them which are routines and *frameworks* (Fauske & Raybould, 2005). The routines dimensions describe the "doing" components of memories while the framework dimensions describe *thinking* components of memories. Routines are enacted from frameworks that reflect reasons for actions based on existing patterns. Thus, mental models include both cognitive and behavioural components. Mental models can be used to map how an organisation learns and how sharing of information between individuals occurs (Fauske & Raybould, 2005).

2.5.2 Organizational Learning in Schools

Organizational learning is in its essence, when individuals learn and contribute with that knowledge to a collective mind (Leithwood, Leonard & Sharratt, 1998). The individual mind can be conceptualized as a set of internalized processes controlled by a brain but the collective mind is something that can not be conceptualized in the same way. The literature identifies the need for schools to become more efficient "learning organizations" (Leithwood, Leonard & Sharratt, 1998; Collinson, Cook & Conley, 2006). The term learning organizations refers to how an organization learns and adapts through being skilled at acquiring, transferring, and creating knowledge, and also through reflecting new insights, values and knowledge accordingly (Garvin, 1993).

Schools as other organizations are in need to evolve and store their knowledge to be able to share and grow as organizations (Leithwood, Leonard & Sharratt, 1998). There exists multiple processes for this and the literature identifies and argues the presence of five sets of variables which covers the causes and consequences for organizational learning processes in schools:

Stimulus for learning. The need for there to be a drive toward finding a solution to a certain problem. Organizational learning (OL) needs some collective search for a solution. One example suggested by Watkins & Marsick (1993) exemplifies that even a labor strike would lead to

organizational learning since it identifies a problem and calls for a collective search for a solution(Watkins & Marsick, 1993).

Out-of-School conditions. Out-of-School conditions refers to external factors that affect organizational learning in schools (Leithwood, Leonard & Sharratt, 1998). The external factors are something which has an effect and influences conditions and initiatives inside the school. Examples include economic health of the community and state regulation from educational municipalities.

School conditions. Here the question is: What activities exist in the school environment which fosters or inhibits organizational learning? The conditions referred to are the school's mission and vision, culture, decision-making structures, structures used for change, and the nature of policies along with the availability and distribution of resources (Leithwood, Leonard & Sharratt, 1998).

School leadership. The definition of school leadership in this context are the practices of the people in formal administrative roles, oftentimes principals, who determine the vision and goal of the school as an organization (Leithwood, Leonard & Sharratt, 1998). Through the enactment of the formal leadership role (not in the context of schools) enables the structuring of organizations through which individuals are able to expand their capabilities for understanding complexities, vision and improve their shared mental models (Leithwood, Leonard & Sharratt, 1998).

Outcomes. To be worth the attention and strive for organizational learning, OL must result in something consequential for the schools (Leithwood, Leonard & Sharratt, 1998). Such outcomes of organizational learning are individual and collective understanding, skills, commitments, and overt practices as a result from organizational learning in schools.

As stated in the research, sustainability of educational reform depends highly on educator's willingness and capacity to change their behaviour, understandings and action repertoire (Rikkerink, Verbeeten, Simons and Ritzen, 2016). The characteristic which the digital era reinforces for schools is to be innovative and that teachers need to have access to stimulating learning environments. Schools have the potential to exploit and examine what they have already learned, as well as solving problems, innovating, and learning strategies and knowledge to meet new challenges (Collinson, Cook & Conley, 2006). Schools can instead of taking a reactive approach to the challenges take a proactive stance where organizational learning can occur.

2.5.3 Social Learning Theory

In contrast to OLT, we argue that for this research the aspects that influence use of digital tools in primary school is also a social learning process where the individuals involved in the organisations, here schools, possess behaviours that shape the respective outcomes for the schools which will be elaborated further in this sub-chapter. Social Learning Theory (SLT) *implies that norms, attitudes, expectations, and beliefs arise from an interaction an individual has with their respective environment* (Hammer, 2011). The term coined by psychologist (Bandura, 1977) described social learning being an aspect of how people learn from their daily interactions with the environment they predominantly interact with. According to him, the learning behaviours in children or young people are stimulated by observing other people or systems in their environment and if the systems receive positive reinforcements from said systems they are more

likely to imitate the same and achieve the same actions (Bandura, 1977). The author emphasizes on effective learning to be successful on the basis of motivation, information retention and provided attention by an individual.

The *social* aspect in SLT primarily refers to the conditions individuals are subjected to when learning techniques or mechanisms are applied. Within this theory the paradigm of *reciprocal determinism* is influenced and influences both personal factors and their environment, which makes it interconnected with an individual, their environment, cognitive abilities and behavior that assists learning to be an evolving experience (Bandura, 1978; Crittenden, 2005; Lorenzo, Kawalek & Ramdani, 2008). Below, *Figure 3* (Crittenden, 2005) is illustrated to depict the relationship among these connected aspects that have an impact on the learning process for an individual. This theory and the perceived relationship can be applied to group behaviour among individuals as each individual characterises different behaviour or nuances in different groups or environments. According to Harrison & Mclntosh (1992), individual behaviour in certain groups and environments is determined by their efficacy and related outcomes in the group situation and these outcomes in turn influence the individual's personal expectations and outcomes.

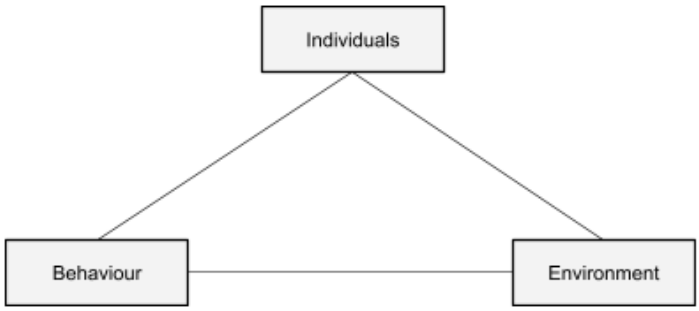

Figure 2.3. Connection of core aspects in SLT adopted from Crittenden (2005, p.961)

On the other hand SLT and its implications work in tandem to the OLT elaborated in the previous section and several of their practices are merged to study both the individual and organisational characteristics. In terms of education and learning, SLT governs the learning materials provided to the students and their corresponding actions and feedback to the learning that they can derive productive results from (Hammer, 2011). In reference to the aforementioned figure, the individuals here refer to the students, environment co-relates to their classrooms and behaviour entails the experience in terms of knowledge or skills derived through the classroom environment by the students (Crittenden, 2005). Crittenden (2005) also elaborates on how viewing SLT in education through a cross-functional learning approach results in a holistic approach of the knowledge, skills or behavioral traits the student brings to the study environment created in the respective organisational environment, which is, school or the respective classroom. The author emphasizes how such teaching strategy aids in adapting to a student's respective learning ability to the environment they are taught in which is illustrated in *Figure 4*. Additionally, similar aspects that influence learning falls on the learner's paid attention and previous reinforcements which we argue is co-relative to the basis of our study.

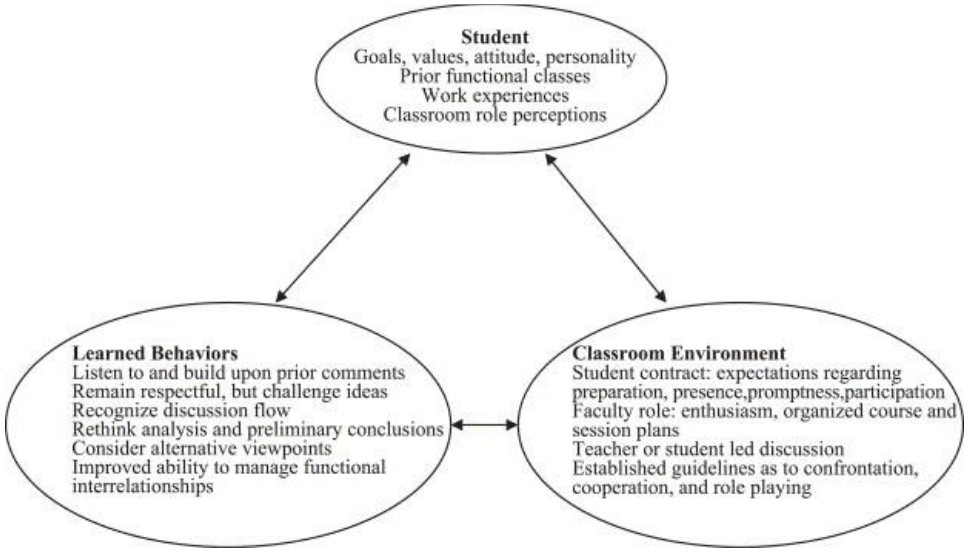

Figure 2.4 Social learning theory in cross-functional case education (Crittenden, 2005, p.962)

As mentioned in the previous chapters, the implementation of digital tools in learning have received appreciable attention. With ample resources being a pertinent characteristic in technology based learning it creates sufficient opportunities for learning (Hill & Hannafin, 2001). The resources represent various mediums such as audio, video or textual-content, and through the usage of different resources it gives access to students to identify the right resources that complement their objectives and learning styles (Hill & Hannafin, 2001). Furthermore, in our study the use of SLT provides a considerable grounds to the theoretical background of understanding the implementations of aforementioned tools and techniques for use of collaborative digital tools and technology enhanced learning in primary schools.

2.6 Research Summary

Regarding the presented theoretical background, the findings and knowledge provided through the presented literature assisted in having a better understanding regarding the several underlying aspects involved in digital education in primary schools. The approach with implementing blended learning, digital collaborative learning materials and technology enhanced learning and their benefits and challenges were grounded through this approach. Additionally, it assisted in coming up with essential questions to frame the interview guide which would respectively help in making the analysis to answer our research question. Each of the presented chapters above also aided in creating themes and sub-groups to section our interview guide where the questions compliment and build up on one another and to create a coherent flow. The table below illustrates the highlights of each chapter with the themes and sub-groups stemming from them to support the results in this research.

Table 2.1. Summary and highlights of theoretical background

Themes	**Sub-group**	**Source**
Definition of Learning	Learning in the context of the Research	Bullock & Muschamp (2006); Gross (2015); Gärdenfors, (2010); Lexico Dictionaries, (2021).
Digitalisation in the Context of Education	Digitalisation in Swedish Primary School Education	Care, Griffin & McGaw (2012); Dede (2010); Díaz & Ioannou, (2019); Griffin et al. (2010); Olofsson, Fransson & Lindberg (2020); Utbildningsdepartementet, (2017); Wildt-Persson & Rosengren (2002).
Learning Methods	Blended Learning	Allen & Seaman (2010); Çakır & Bichelmeyer (2016); Driscoll (2002); Garrison & Kanuka, (2004); Graham (2006); Horn & Staker (2011); Hrastinski, (2019); Means et al.(2013); Smith & Suzuki (2015).
TEL & Collaborative Learning	Collaborative Learning Environments	Cerratto-Pargman, Järvelä & Milrad (2012); Fonseca et al.(2014); Hernández-Sellés, Pablo-César Muñoz-Carril & González-Sanmamed (2019); Kurti (2009); Laurillard et al. (2009); Mor & Winters (2007); Salavati (2013)
Organizational Learning Theory (OLT)	Learning Perspectives & Relevance of tools	Collinson, Cook & Conley, (2006); Fauske & Raybould (2005); Huber, (1991); Leithwood, Leonard & Sharratt (1998); Rikkerink et al. (2016); Watkins & Marsick (1993); Whyte (1997); Zahller, (2011)
Social Learning Theory (SLT)	Learning Environment	Bandura (1977); Bandura (1978); Crittenden (2005) Harrison and McIntosh (1992); Hammer (2011); Hill & Hannafin (2001);

The information regarding the prominent factors have a direct or indirect influence on the digital tools used in primary school education. Thus, to outline those factors the figure below illustrates the conceptual model to be used for analysing the results that come forth from the empirical studies. The model below is an abstract interpretation of our theoretical background

which gives a context to how the elements essential for this thesis are interconnected to each other. As we summarise this chapter and draw connections between the themes we have analysed, each of the components shown in *Figure 5* have a connection with one another. The themes identified are all encompassed within the use of digital tools in primary schools, in layers, which can be elaborated as: use of digital tools with blended learning addresses the traditional learning and digital learning practices in primary schools; with OLT it addresses the relevance of tools in organisations and how organisations learn; with SLT it addresses the environment the pupils learn in and how they interact with the technology and tools in their learning environment; and finally with TEL and collaborative tools it focuses on the tools that are adapted to the pupils needs, interactive learning and promoting equal learning opportunities

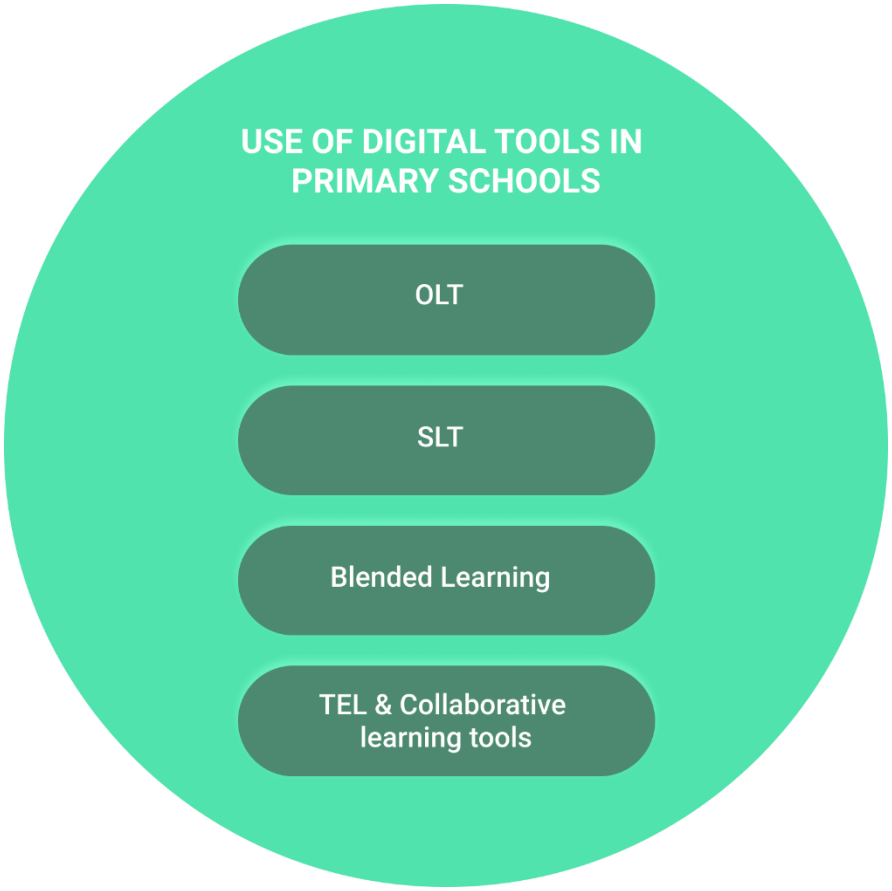

Figure 2.5. Conceptual Model based on theoretical background (developed for this study)

3 Research Methodology

This chapter outlines the methodologies that have been chosen for conducting the study. The section includes the explanations of why and how the research was conducted. It discusses the adopted research strategy, data collection and analysis techniques, respondents and interview guide, and research quality and ethics.

3.1 Research Strategy

In order to address the current research question, to find out the influences on applications of TEL in primary school education, it has provided us a focus on what approach to be taken to go more in-depth in this domain. With this study, we will look into the views and perspectives of researchers and educational scientists towards their work, outcomes and observations, and contribution to the above mentioned domain of TEL, a qualitative research methodology will be adapted as a primary basis for this research. According to Kaplan and Maxwell (2005), this research methodology focuses on comprehending the interpretations, analyses and perspectives of people subjected to a certain environment. As the perspectives of the aforementioned group of people will be thoroughly studied to provide answers to our research questions, this approach will allow the participants to clearly express their thoughts and interpretations. In addition, the data gathered from this research will focus on analysing non-numerical data such as values, perspectives, experiences through the observations of conducting in-depth interviews with the respective interviewees and through different data analysis techniques (Patton, 2015). Through this research we will be interviewing our selected participants and along with a qualitative research approach they will be able to fully express their experiences and interpretations during their own research and implementations regarding TEL. Through the respective context and with a qualitative study will assist in providing rich insights in terms of their individual experiences. Furthermore, with a qualitative analysis for our research domain, it will not only lead to collecting respective data regarding TEL in primary schools but also documenting essential findings and formulate introspective ideas that add value to new findings that come from the research (Patton, 2015).

In addition, the research philosophy considered most suitable for the research context through this paper is interpretivism, due to its comprehension and in-depth analysis of the subjects at hand (Goldkuhl, 2012). As it assists in understanding perceptions and evaluations from different perspectives this approach in tandem with the qualitative research aids in building up new analysis and perspectives from various individuals working in the same field of research (Saunders, Lewis & Thornhill, 2009). With working through these approaches, the study will deliver a unique and subjective understanding of our research and the perspectives, and results analysed from experts in this field aids in the focus needed to provide tangible results towards our study. Furthermore, the results to be obtained through this research will be grounded in first-hand empirical research conducted with the experts in this field and a thorough literature review for the research question presented. As mentioned above the data collected through the interviews put forth the personal opinions and perspectives of our participants in terms of TEL implementations. Through working with interpretivism philosophy, we will be able to gain a clearer assessment of what the interviewees think and perceive. In contrast to the analysed literature,

which provided a broad knowledge of existing practices of digitalisation in education, an interpretive view will provide reflections on existing perceptions and a thorough subjective knowledge in this domain can be derived. These aforementioned steps would serve as a primary basis for proceeding with our research and deriving formidable analysis and results.

3.2 Literature Study

For this research, as the secondary source of data collection, the literature available regarding TEL and usage of digital tools in primary schools in Swedish schools was examined to generate the research question at hand. The literature review was conducted according to the steps outlined by Bhattacherjee (2012), who argues that the purpose of conducting a literature review is three fold. Firstly, it is to survey the current state of knowledge in the area of inquiry. And secondly, to identify key authors, articles, theories, and findings in the specific area, and finally to identify gaps in knowledge in that research area (Bhattacherjee, 2012). The author further highlights the importance of using a range of journal articles with different years of publication and methodologies. In the approach to the literature review, the authors of this research paper explored the vast width of topics and beliefs surrounding digital education with the aim to get broad insight into the field.

Furthermore, theories needed to be carefully selected based on how well they fit with the target problem and to which extent their assumptions were consistent with that of the target problem which Bhattarcherjee (2012) identifies as critical. After acquiring insight into the field, a limitation of what to focus on had to be set to match the research question. When finding relevant literature, the authors mainly used LUBSearch and Google Scholar with the keywords of: *Digitalisation in Education, Blended Learning, Organizational Learning Theory, Social Learning Theory, Technology Enhanced Learning, Collaborative Learning, Computer Supported Collaborative Learning (CSCL), Digital Tools, Primary School Education and K-12 Education.*

3.3 Empirical Data Collection

For the research to proceed forward and to be backed up by first-hand information and perspectives, a semi-structured interview will be the primary method of data collection in this paper. Recker (2013) suggests in qualitative research interviews are the most common forms of data collection. Through the interview procedure there is a given advantage of emphasizing the focus on answering the research question directly and having an insightful approach to retrieving information from the interviewee (Recker, 2013). The types of interviews to be conducted can be face-to-face, via one-to-many or through telephone/conferencing (Recker, 2013), for this research, due to the ongoing pandemic situation, all the interviews were conducted through the video conferencing tool Zoom. The interviews conducted in our study were semi-structured which was followed throughout the beginning and end with an interview guide, which is explained in detail in *Chapter 3.5*.

In addition to the outlined benefits, there are a few challenges that come with conducting interviews for the research settings. Recker (2013) elaborates on how observation is one of the key elements when conducting an interview as it assists in looking into how the interviewee reacts to the directed questions and also analysing how the respondent's environment affects their

responses. As we had to resort to having a video conferencing interview, it was challenging to observe the interviewees in their environment in-person, but conducting the interview through video conferencing did allow us to monitor and read the respondent's body language while they answered the questions. The interviewees could answer the questions according to what the researcher wants to hear, moreover while recalling the answers provided, the researchers could miss out on certain information (Recker, 2013). In order to minimize the inaccuracies in the information recall and have all the data derived from the participants laid out precisely, our entire interview procedures were recorded with the provided consent from the participants.

Additionally, with the inclusion of semi-structured interviews the interviews can be carried out with added flexibility as follow-up questions can be asked to the interviewees according to the answers they provide through the predefined questions (Recker, 2013). This approach provided the research a conversational flow which aided in additional insights to the questions asked and gave a richer and detailed responses for the questions. Adopting this procedure allowed the interviewees to provide rich and thorough answers with diverse data as per their perspectives which enabled us to develop a deeper understanding and inputs for the presented research.

3.4 Respondent Selection

The intention of this study was to gain an understanding relative to the research question from the perspectives and experiences of an expert in the field of digital education. Thus, the number of respondents that the authors aimed for was at least up to seven people, but due to some participants not being able to do the interview we had a total of six participants for this study. As Bhattacherjee (2012) argues, the level of generalisability increases as the number of respondents increases due to the fact that respondents are likely to have various opinions and experiences on different topics. As we are conducting a qualitative study, there is a need to limit the amount as well. The authors aimed to reach out to researchers and educational scientists who were familiar with digital education, involved in building tools for assisting collaborative digital education and its literature with even some specifically knowledgeable in primary school education. The aim for having these sets of participants was to have a holistic and wide range of perspectives from individuals involved in contributing to studying the factors that influence the use of digital tools in primary school education. The criteria we set when selecting the participants for our empirical study were:

- Experience with research in primary school education
- Experience with using digital tools, technology enhanced learning or digital collaborative tools to have conducted their study on a research level

Additionally, the criteria for taking part in this study was hence that you had done some research on a university level, specifically researching digital education and digital tools used in education as a primary focus in their studies. With this limitation of participant selection, the authors would be able to ensure that the interviews could go more in depth on certain topics and issues laid out in the prepared interview guide which will be discussed in the following chapters. Therefore, with the set criteria we reached out to potential participants via email where we explained to them our research area, purpose and question, and what we aim to do with the study. Most of the participants responded to our request expressing interest in contributing to

our research. A few requested to read our study beforehand to get a general overview of what it entailed and then agreed to participate in the study. However, due to the current situation of having limitations of meeting the participant's in-person, we conducted all the interviews via Zoom where they lasted approximately around one hour. Furthermore, all participants opted to be anonymous in the research when the ethics forms were provided to them when requesting for the interviews. Henceforth, the respondents are named and identified through Rsp*(n)*, where *n* is the number denoting when they were interviewed, for example, Rsp1 is the first respondent interviewed in this study.

The descriptions of the respondents selected for the study are described below, and a brief overview of the conducted interviews are tabulated in *Table 2*.

Rsp1, Anonymous - Associate Senior Lecturer

Rsp1, the anonymous respondent is an Associate Senior Lecturer at Linnaeus University who primarily works with Soft Systems Thinking. In addition, the respondent has been involved in several research projects that look into use of digital technologies in everyday life in primary schools, innovative technologies in education, and novel use of mobile technologies in everyday learning practices etc.

Rsp2, Anonymous - Senior Lecturer

The second respondent is a Senior lecturer in Malmö University, whose research area of focus lies on Mobile and web engineering, and web architectures. The participant builds and develops an open architecture for flexible systems that are applicable in various different domains. These systems include open architectures where the participant's research promotes openness which includes open source components, data standards, and innovation in technical artefacts.

Rsp3, Anonymous - Associate Professor

The third respondent is an Associate professor of computer science whose primary expertise lies in TEL, designing and developing different types of mobile and ubiquitous environments that foster learning. The participant is also a creative educational technologist who is keen on investigating the intersection between how people learn and play. Additionally, the interviewee is also passionate about designing and developing experiences that nudge people's curiosity regarding exploring the physical and digital world around them through innovative technologies.

Rsp4, Anonymous - Associate Professor

The fourth respondent is an associate professor for Computer Science and Media Technologies where their primary area of studies lies among integrating mobile, web and sensory technologies to support inquiry-based science learning. In addition the interviewee's research interests are within the areas of mobile systems and pervasive and ubiquitous computing, especially in exploring the use of contextual information for designing and developing innovative services and applications in specific application domains.

Rsp5, Anonymous - Professor

The fifth respondent is a professor of Media technologies and Computer Science and has done extensive research on their ongoing research interest in designing learning environments which support learning on complex domains of technology. Additionally, the participant's work includes development of mobile systems and applications that support collaborative learning.

Rsp6, Anonymous - Associate Professor

The sixth respondent is another anonymous interviewee who is an associate professor of human computer interaction at the Department of Computer and Systems Sciences at Stockholm University. And also a guest researcher in the Department of Communication, and education, or the School of Communication and education. The respondent has been working for several years with digitalisation, and working on trying to understand the changes that novel technologies, emerging technologies bring to educational practices, and more specifically to teaching and to teaching professionals.

Table 3.1. Overview of the research's respondents

ID	**Respondent's Position**	**Affiliated Organization**	**Interview date**	**Duration** (minutes)
Rsp1	Associate Senior Lecturer	Linnaeus University	6th April, 2021	39:05
Rsp2	Senior Lecturer	Malmö University	15th April, 2021	46:02
Rsp3	Associate Professor	University of Copenhagen	16th April, 2021	43:51
Rsp4	Associate Professor	Linnaeus University	22nd April, 2021	40:37
Rsp5	Professor	Linnaeus University	26th April, 2021	61:02
Rsp6	Associate Professor	Stockholm University	30th April, 2021	44:56

3.5 Interview Guide Design

As outlined in the previous chapters, to garner results from the research, working through an interview guide to conduct the empirical study was the chosen approach to gather data. The interview guide was developed in reference to the identified key aspects in the literature through the theoretical background that was covered in *Chapter 2*, which grounded our questions and information we seek from the respective interviewees. As Bryman & Bell (2015), elaborate

while formulating an interview guide while approaching qualitative research, a prime aspect is for the questions to be grounded in presented literature and structure the interview guide around the research question and theoretical background.

In order for the research question to be answered, the interview guide consists of questions separated into each category covered in the theoretical background and further segregated into themes governing those backgrounds. This resulted in having a cohesive set of questions which were grounded in the literature. The interview guide design was also influenced according to the preliminary steps outlined by Bryman and Bell (2015) required for developing the guide, such as, creating and order in the interview questions so questions can flow in tandem to one another in a reasonable manner; creating the questions that aid in answering the research question; and use of language that is relevant and comprehensible to the respondents (Bryman and Bell, 2015).

Through following these steps, each interview was followed with a general introduction from the interviewers' end to familiarise them regarding the individuals interviewing them and the related questions they were to answer. Even though the purpose of the interview was explained to them when contacting them via email, we proceeded this way to create a familiarised environment as it was being conducted digitally. Also, before proceeding with the predefined questions, we also began with asking the interviewees their current background and the experiences they have had with use of digital tools and technologies in primary school education. The questions during the interview were directly asked from the interview guide with some deviations in a few parts when we required more contextual information regarding what the respondents were talking about, but the guide was thoroughly followed to stay in context.

3.5.1 Stages of Development

For developing the guide, we followed the aforementioned recommendations from Bryman and Bell (2015), and started developing the questions by basing them on the topics and sub-topics of our research summary table which is outlined in Table 1, and the details of the entire interview guide can be found in *Appendix I.*

The first question under Topic A was formulated to gain the overall, open-ended and general understanding of the interviewees regarding the topic of digitalisation in education, especially in primary school education. As mentioned before regarding our interview guide design and the summary outlined in Chapter 2.6, the interview guide is grounded through the literature selected for this research (see Bullock & Muschamp, 2006; Gross 2015; Gärdenfors, 2010; Lexico Dictionaries, 2021; Care, Griffin & McGaw 2012; Dede 2010; Díaz & Ioannou, 2019; Griffin et al. 2010); Olofsson, Fransson & Lindberg, 2020; Utbildningsdepartementet, 2017); Wildt-Persson & Rosengren, 2002). Questions formulated under Topic C are related to TEL and collaborative learning which emphasize around collaborative learning environments through TEL to gain a technological context on the tools used in primary education (Cerratto-Pargman, Järvelä & Milrad, 2012); Fonseca et al. 2014; Hernández-Sellés, Pablo-César Muñoz-Carril & González-Sanmamed, 2019; Kurti, 2009; Laurillard et al. 2009; Mor & Winters, 2007; Salavati, 2013). The questions under Topic D focuses on the organizational context and their learning perspectives and how relevant the tools used in such organizations remain and the aspects to consider when developing a learning environment with digital tools (see Collinson, Cook & Conley, 2006; Fauske & Raybould, 2005; Huber, 1991; Leithwood, Leonard & Sharratt, 1998; Rikkerink et al. 2016; Watkins & Marsick, 1993; Whyte, 1997; Zahller, 2011). Whereas, Topic

E focuses on the social aspects of learning and how learning and the implementation of digital tools can be influenced by the environments they are integrated and applied to (Bandura, 1977; Bandura, 1978; Crittenden, 2005; Harrison and McIntosh, 1992; Hammer, 2011; Hill & Hannafin, 2001). Finally, with Topic F, the interview guide comes to a conclusion with questions to the interviewees that seek additional inputs on their views when implementing digital learning and the respective tools which were not covered through the theoretical background.

3.6 Data Analysis

When conducting qualitative research, there are no rigid rules that need to be followed when conducting the respective data analysis (Bryman & Bell, 2015). The author mentions the general approaches for analysing qualitative data that vary from deductive to inductive approaches, such as using grounded theory, analytic induction, text analysis, etc. In our study, the coding technique has been taken as a tool to do our text analyses of the interviews after their transcription process, as it makes it convenient for analysing and interpreting our empirical data. With the entire empirical data gathered through interviews, coding is considered to be a well-known technique when analysing such qualitative data so it can be derived to meaningful and interpretive data (Bryman & Bell, 2015; Recker, 2013). The interviews were transcribed soon after they took place, and as they were recorded it was easier to go through them time and again to check for consistent data so the right data could be coded. In addition, when the transcribing and coding of our data took place, we referred to the recommendations outlined by Bryman and Bell (2015), such as:

- Transcribing data as soon as you finish the interviews,
- Read and go through the initial transcribed data and notes,
- Repeating the process to proofread and have consistent data,
- Have coding the transcribed data in perspective

Taking the aforementioned steps into consideration, the transcription of our recorded interviews were done through the web tool Otter.ai, which assists in transcribing English conversations with ease. Once the transcriptions were completed through the tool we listened through the conversation again so we could tabulate them in a more structured way, so the respective coding can be done. Also, to check the interviews with the transcribed text and correct if there were any mistakes manually so we would have a verbatim copy of what answers the respondents provided. The parts said by the respondents which contained private information have been denoted with "******" and the parts which contained a lot of pauses have been denoted with ".....".

Furthermore, we decided to code the data in accordance with our themes in conceptual model, where we coded our data according to the presented themes in the model. The coding scheme created for categorising our data is tabulated in *Table 3*. This scheme is only used for identifying the patterns in our interviews and not used prominently in comparison to the thorough text-

analysis of the interviews. Therefore, the scheme will only assist in checking the relevant context in the transcribed interviews which is primarily used for their text analysis for our empirical findings, which will be further elaborated and analysed in *Chapter 4 and 5*.

Table 1.2. Representation of the coding scheme

Theme code	**Description of code**
Di-Ed	Digitalisation in Primary Education
Te-Le	Technology Enhanced Learning
Di-To	Digital Tools
Co-To	Collaborative Tools
Di-Co-Le	Digital Collaborative Learning
Di-Co-To	Digital Collaborative Tools
So-Le	Social Learning
Le-En	Learning Environments
Or-Le	Organisational Learning
Le-Pr	Learning Perspectives
Bl-Le	Blended Learning
Rel-To	Relevance of Tools

3.7 Research Quality and Ethics

3.7.1 Research Quality

For the purposes of this research and selected research approaches, to adhere to its respective scientific quality various aspects were taken into consideration as according to Patton (2015), it is of utmost importance to maintain a good quality of research whilst conducting qualitative

research. The provided findings from the research need to be reliable and trustworthy so the empirical data obtained through their respective findings do not contradict the research problem, question or approach and the analysis of data (Bhattacharjee, 2012). When working with a qualitative research approach, Bryman (2006) elaborates on how a research needs to have two forms of reliability complementing the research at hand, external reliability and internal reliability. External reliability refers to the replication of the exact same study in the same situation or scenario, but as a qualitative research is being conducted for this study conducting the interviews and having them consistent throughout the data collection process can prove to be quite tricky to obtain the same data in every interview scenario (Bryman, 2006). Whereas, internal reliability refers to interpreting the data through a set of pre-defined criteria, such as interview questions or guide, and observing the study each time it is conducted and validating the obtained findings (Bryman, 2006).

In addition to reliability, a conducted study should also be reliable to retain its respective quality. According to Patton (2015) it is important to analyse the collected data from the informants to ensure it is accurate, reliable and useful for the researcher and their study. Along with considering the anonymity and ethical requirements from the interviewees, they will also have the access to confirming the data that has been interpreted and used for the progression of the research. Therefore this would aid in the confirmability of the study and ensure its quality even further (Bhattacharjee, 2012).

3.7.2 Research Ethics

As implied in the previous chapter, a qualitative study approach will be taken with interviewing the participants as the primary source of data collection. Interviews would entail asking questions depending on the personal perspective of the participants which would require substantial ethical considerations when collecting data for research purposes (Patton, 2015). Thus the recommendations provided by the author were followed for ensuring the research's ethical considerations were followed through. When proceeding with the interviews, the participants were provided with an informed consent regarding what the study entails, what data would be collected through them and how that collected data would be interpreted and used in the study. This would be ensured by providing a detailed consent form to the participants before beginning with the interview procedures (Patton, 2015).

In addition, during the collection of data on the interviews, we had asked and received permission on whether the interview can be recorded or not both when we contacted them via email initially and before we started the interviews. The participants should have the right to stay anonymous or use a pseudonym if they do not wish to have their names and their respective organisations specified in the research (Wiles, 2013). Along with the participant's anonymity, the confidentiality of how their perspectives and views will be shared also needs to be assured among the participants (Wiles, 2013; Patton, 2015). Furthermore, the participants were also made fully aware of their rights, such as the right to withdraw from the study or to retract any information they do not want to be published in the future (Wiles, 2013). Including these aforementioned steps, regarding the ethical concerns as the participants were reached out to for the study made sure that they were fully aware of what their data will be used for and how.

3.8 Limitations

With the outlined methodology and the steps that were taken to ensure the research had a good flow, there have certainly been some limitations for our research. In order to gather the empirical data we were limited to only six interviewees as several of the interviewees we reached out to were unable to give time to our research. Also, the respondents we interviewed could only provide limited time during the interviews, and having to conduct the interviews online sometimes created minor issues due to some technical difficulties. Moreover, we could only find out of the descriptions of the tools and their implications used in the studies of our respondents, but we were not able to know of the technological aspects of the tools by using them in person through practice.

4 Empirical findings & analysis

This chapter elaborates on the findings through the conducted semi-structured interviews for this research and categorises the findings according to the research sections outlined and summarised in chapter 2.6. The transcriptions of the interviews referred here in this section can be found from Appendix III -VIII.

4.1 Digitalisation in the context of education

In all of the interviews the discussion was central to the digitalisation in primary school education in the Nordic context. The majority of our interviewees put forth their opinions of digitalisation being more and more prominent in the Swedish educational context throughout the years (Rsp3:L2; Rsp2:L4; Rsp6:L2). One of the respondents pointed out that schools are the facilitators when it comes to influencing children in how digital tools such as mobile devices can be used for productive purposes instead of just for entertainment (Rsp3:L2). Also, from all of our interviews, the respondents, when providing a general perspective on this topic through their experiences focused on topics related to interoperability (Rsp4), having a structured challenge and decentralised systems (Rsp6), educating teachers on the use of digital tools in primary schools (Rsp2) and how organisations (schools) should view having digital tools in their classrooms (Rsp3). Rsp4:L2 talks about the challenge of interoperability from a systemic perspective. The respondent provides insights regarding how the choices of technology in regards to tools and providers mean for the learning process, and how certain regions in Sweden adapt to one form of systems whereas another region adapts to another system that is more suitable to them.

"Nevertheless, I still feel that a more comprehensive systemic perspective of the impact of the integration of the digital tools within the overall learning process needs to be made. Secondly, I think there are other issues more technically related to interoperability of the different tools and the providers because the regions in Sweden, as far as I know, have their own autonomy to decide about the service providers. (Rsp4:L2)

Regarding the benefits surrounding this domain, Rsp2 provided insights on how through their observations, use of digital learning environments and tools provided them with a convenient infrastructure to manage information and distribute them simultaneously among students. With their perspective digitalisation has assisted them in managing learning content and enhanced collaboration among students and teachers when it comes to learning (Rsp2:L62). Rsp6 highlights the goal of equal opportunities and digital competence among schools and the teachers in Sweden. Although the structure of the Swedish school system which gives power to the municipalities leads to difficulties. Rsp6 argues that the structural challenges that are faced in Sweden are due to the 'enormous' power that municipalities have. Following up with the opinions of the different municipalities imposing different challenges when it comes to digitalisation the respondent also focused on having specific objectives and having a clear goal when implementing the digital tools in primary schools. Because, without a clear structure they have observed several schools get trapped in a loop not being able to figure out what actions need to be taken to implement the right methods and tools (Rsp6:L8).

"We are dealing with a structural challenge in Sweden that has to do with this enormous power that municipalities have, that means that it is quite decentralized. When it comes to digitalisation, because depending on the money that the municipality wants to put on the on the technology, then there will be some schools, which will have more access to certain types of technologies and competence and, and others, which perhaps, design other municipalities decided to put the money in other areas."(Rsp6:L8).

Similar to Rsp6, when outlining the challenges in terms of digitalisation in primary schools, Rsp3 mentioned that with the pupils using several technologies from home to school there is a dissonance among the young children regarding their school experiences and the provided learning materials (Rsp3:L2). When it comes to digital tools used in schools, Rsp3 highlights that Sweden and Scandinavia are faced with a more unique problem of having more up to date technology at home than what they have at their disposal at school. Having up-to-date tools can therefore be seen as something of importance for the schools in order to stay relevant for the students. In addition, the respondent viewed digital tools complementing the learning among students to create other materials that could be used for learning, such as exploration of new environments. The respondent believes that through teaching children to work through both digital tools but also focus on traditional forms of learning where they can learn numerous personal skills is also of equal importance. Additionally, with addressing challenges, Rsp5 focused on how there are good efforts being made to utilise digitalisation in schools but there still requires a substantial amount of work that needs to be done when making the teachers aware of the existing tools and technologies. Furthermore, Rsp2 addresses how different backgrounds and interests affect how digitalisation is adopted in schools. Rsp2 argues that having a background in computer science could generally mean a greater openness to digital transformation. Rsp2 lands in the idea that an educational program would be beneficial for teachers to keep up with digitalisation of education.

" [...]And I have no doubt that also k-12 schools and teachers there, they had some issues. So that's why I'm saying there is a need for because the tools are there. The technology is here. It's just what we need is the proper, let's say educational program that will keep up with the digitization processes that are happening globally." (Rsp2:L4)

" tools used for creating other digital materials, they can be used for exploring the world so I think it is an important part of primary school education" (Rsp3:L2)

"there are good efforts underway, but there is a lot of work still needed to make teachers aware of what the technology could be used to improve on which new problems are generated." (Rsp5:L2)

"I mean, it was very helpful to, to work with specific applications, that helped children who have, who were developing the Swedish language competence"(Rsp6:L8)

Relating to the current scenario, Rsp1 talks about the Covid-19 pandemic's impact on digitalisation in schools. There has been a need for change when it comes to the digitalisation of schools. It has also become clear that it isn't just as simple as handing out the technology, with the handed out technologies there need to be a strategy in line as mentioned by Rsp6 previously. With other means of introducing digitalisation in a structured way, Rsp5 pointed out how now it is obligatory for Swedish school children to learn programming according to the new curriculum. According to their words, even with curriculums introducing these tools that have direct

relation to IS or the field of computer science which aids in pushing digitalisation directly into the curriculum there is still lack of awareness among teachers regarding this (Rsp5:L2).

"Taking into account what has happened the last year with the pandemic, as far as I know, the school education has had to open up their eyes on how it has been previously and that they need to focus on certain things and certain things that are more important than just telling teachers or students" (Rsp1:L2)

"...You have textbooks that are interactive books, or your teaching now, kids from age from grade six to nine programming, because now it is in the curriculum is obligatory in the math curriculum in Sweden for children, grades six to nine to learn programming. But teachers are not aware of that" (Rsp5:L2)

Rsp5 problematizes how Swedish culture communicates a sense of superiority to other countries and that the political system visualizes a false picture of Sweden as something monolithic.

"...So my message is, try to be very critical in not presenting a monolithic view about what Sweden is because this is part of the Swedish. Very good marketing of showing a view about what reality it is not [...]" (Rsp5:L10).

What the schools can provide is a place where students can develop digital competency and have access to role models that can show the students how to use digital tools for other things than entertainment. As Rsp3 mentions, if you come from a lower socio-economic background you are more likely to only be familiar with using the digital technologies for entertainment purposes. As the school is a place envisioned to promote digital literacy, the future role of the school is to educate the student in this. According to the respondent, the technology does not make it easier, it makes it more efficient and effective (Rsp3:L34).

"You're not using it to get knowledge to make informed decisions because you don't have any role models and this is what's most important about the technology in school because they can provide that" (Rsp3:L22).

4.2 Learning Methods

This chapter presents the findings of the empirical studies regarding the point of view of the interviewees around the topic of blended learning and learning methods. Only a few of the respondents have had full experience in working with blended learning or are still in some way involved in the study of the use of blended learning in an educational setting.

Rsp6 addresses what situations the blended learning method can be viable to use in primary school education. There is a possibility to support student learning which isn't otherwise possible without the digital tools. Rsp6 adds that in order for this to work, you need to have a concrete objective and a strategy to get the benefits of the blended learning method. For example, when working with non-native children who were developing their Swedish language competence, it was very helpful for them to use these digital tools. They could through these tools translate to their own language, visualise terms that were otherwise difficult to understand. The benefits are linked to having a specific goal with using the digital tools as the teachers could

divide children into groups and allow each student group to focus on which application features works best for the students (Rsp6:L8).

"...What I understood is that if you don't have a really concrete objective, and a strategy, you get trapped, because you don't really know what you do. " (Rsp6:L8).

Rsp3 addresses the possibilities with blended learning in terms of students being able to learn at their own pace. The possibility to interact with the learning material in a personal way is something that could be further enabled through digital tools. However, Rsp3 argues that the possibilities with the learning material is secondary to relationship with the teacher. This argument highlights that the material or the way that students take part in information is only a factor when the pedagogical needs are satisfied.

"...So I think there are a lot of positive things about blended learning in terms of pacing and how you as a student interact with the learning material in your own way. But at the end of the day the relationship between the teacher and the student is the best way and much more important than the good material because if you have a child that is struggling does not really matter how good or bad the material is, they're still not going to understand it." (Rsp3:L4)

Similarly, with the insights received from Rsp2(L8), a blended learning approach provides both students and teachers a level of flexibility in conducting classes and providing independence to both the individuals in regards to learning. The schools need to have the technology ready and at hand and be able to accept in terms of providing education in a both digital and physical environment (Rsp2:L6). In the studies done through Rsp4, they had more of an exception on having a blended learning environment rather than having a strict rule on following the blended approach (Rsp4:L4). It was similar to the studies where students had to collect data from outdoors during their biology classes through the mobile devices given to them and analyse the results in their labs or classrooms. Besides these outlooks the respondent did not have much to provide regarding blended learning or different learning methods in primary schools. The same responses were received when questions regarding a blended approach were asked to Rsp1, as even this respondent had quite limited experience in this domain. But the respondent did believe that for primary schools they cannot fully replace traditional education with digital but the latter needs to complement the former (Rsp1:L8). But, according to Rsp5, schools have now been forced to learn with blended learning. The respondent who is currently working with STEM and information technology in the study of social sciences of Swedish languages says that IT tools are promoting innovation and theories such as discovery learning or problem based learning or challenge based learning. According to them, adopting tools with such learning approaches which encourage students to explore things in their subject areas sticks to them for a long time (Rsp5:L18), which was also one of the sentiments shared by Rsp6 as mentioned before.

" ... In problem based learning, you give a problem that needs to be solved in challenge based learning, you give a challenge an area that needs to be identified, and one of the goals is to find what the problem is.(Rsp5:L18)"

Overall in terms of blended learning, there has been a push to adapt to a blended approach when implementing both traditional and digital learning methods even though there are some levels of skepticism from the researchers of this field. According to one of the respondents, technology itself changes constantly so it is up to the students and teachers to decide upon what works best for them (Rsp3:L24). And although some teachers might not want to adapt to new technologies

in teaching (Rsp1:L26), there are also teachers who are open to adapting new and updated learning methods and are quite open minded and engage in introducing new technologies to the students (Rsp6:L10).

4.3 TEL & Collaborative Learning

When approaching technology enhanced learning and the use of collaborative learning for primary schools, each of the respondents had their own perspectives and point of view that delved into either fully being in support of it or being skeptical regarding its implementation.

Rsp6(L12) mentioned how the use of TEL and collaborative technologies had assisted the students they had worked with where students would treat learning subjects such as physics and mathematics as a game where one would roleplay as a teacher and teach it to the students while recording the entire interaction. The video later would be put up online for other students to see and provide feedback on. At the same time, they also added that students would work with film and filming their work and also use tools to construct and make presentations. The students would use not only visual mediums but also audio and other multimodal techniques where they would create interactive presentations. The respondent also elaborated on how a certain application (which was unnamed) had helped students with dyslexia to cope and perform better as a whole compared to how they were performing previously.

"So I have seen that children with dyslexia, they get a lot of help from specific apps, and, and children, you know, talking with the children during the breaks, you know, some of the ones having dyslexia, they confess to me, Well, you know, now I can cope. Because I can, you know, I have this app, and I can do, you know, I can go through and everything is very well structured for me. So I think that in that respect ..., has been very, very helpful."(Rsp6:L12)

In addition, for the research done by Rsp6 they worked with schools that were using fun and engaging tools for collaboration such as Kahoot or Gleerups where the students could learn in a more interactive way that would stick to them for a long time. Similarly, on creating interactive experiences through TEL, Rsp3(L12), explained how they were involved in creating physical computational devices where students were able to create and build upon an interactive experience/s. According to them the development of this project involved students where they did not require to write down the code through text, but with a flow based language and helped students engage in exploring different topics with a new approach. It also assisted them more in regards to computational thinking and making sense of logic in a program. With having a focus on making learning more engaging for pupils, the feedback received is oftentimes positive regarding involving students with various interactive approaches.

"Collaborative tools, yeah. Oh that the school was using, oh, I don't know, collaborative tools. There were so many. I mean, Kahoot, they were using Kahoot, a lot. They were using Gleerups they were using[...]."(Rsp6:L17)

"These projects were about sort of engaging you know school children or older primary school children to sort of explore you know different topics you know like that related to computational thinking so that was like you know understanding how to sort of do the logic to do

a color sort or to build something that's responsive to light or sound ... or to make device drive around."(Rsp3:L12)

Whereas Rsp2 was quite skeptical about how the use and influence of tools completely depends on the type of collaboration the tool facilitates. The respondent argues that in his studies the technology on its own had made the students collaborate better as it was more interesting for them to be using those tools and learning. In their studies, the tools they had developed, it provided students with immediate feedback and results and when students analysed their works among one another, they would continue collaborating and have a discussion among one another. The tools Rsp2 developed for their studies included data analysis, visualization and integration systems where students could update and upload their data in a centralised system and have access to different other visualisations included in their courses. Through discussing this aspect with Rsp2, we can assess how having access to such tools helps in enhancing collaboration among the students and also increase their skills with having reflections on their work and peer discussions. Additionally, through a more practical approach on students to implement their knowledge with the combination of a real world environment, digital tools and discussion among one another stimulates learning (Rsp2:L66).

"The tool that we have developed was mainly a, let's say, a platform, which kind of had different systems in it. Like data collection systems, data analytics systems, data visualization systems, and data integration, where students in K-12 schools, they were just using the phones, attaching different sensors, uploading the data into the cloud somewhere, and then they were having access to different visualizations. [...]".(Rsp2:L66).

On the other hand, with the point of view of integrating TEL in primary schools, Rsp5(L30) recommends having a multiple stakeholder point of view and keeping all the stakeholders and actors involved such as teachers, students and policy owners. We believe this delves more into organizational learning whilst drawing the relations towards using collaborative learning tools as well as TEL in schools. Rsp5 mentioned that TEL integration needs to follow through with more of an information ecosystems notion and a systems thinking approach. This would be able to guide what kind of learning technologies should be used to enable such procedures which would be supported by technology. He also argues that an approach to collaboration should be guiding the technological decisions to be implemented.

"The agreement between the three of them is the collaboration part, guiding the technological decision, and not the other way around. So do you see how collaboration can be used to design technology"(Rsp5:L30).

With the point of view of Rsp5 into consideration, the TEL based systems do require adopting systems that combine a pedagogical method which is supported by technology where systems should implement the ideas inspired by events happening in real life. This would thus assist to think in the direction of creating systems that are designed for collaborations keeping the real life perspectives in mind. In contrast to Rsp5 and their view on TEL, Rsp1 implied that implementing TEL is more often based on how the teacher chooses to implement the technology and materials into the classroom. And the learning environment has more control through the teachers. In addition to that, the tools to be used in the learning environment were also influenced by the school leaders and municipalities.

"How the teacher chooses or doesn't choose to use technology and material. It goes down to the teachers and when it goes to the teachers, it's either their own worldview or their own

perspective or their own way of learning/teaching and also the support that they get from school leaders. So the learning environment is a lot run by the teachers, regardless of how the teaching is done". (Rsp1:L18)

This relation was also mentioned by Rsp6 where they mentioned how the schools are able to implement digitalisation majorly varies on how the municipality decides to invest on technological tools and competence. While Rsp4:L14 emphasized on not having done research in a fully digital environment in terms of collaboration through digital tools, but only done research with TEL tools where they observed technology as a facilitator and use of the technology needs to be seen in a perspective of learning most importantly, which also comes in line with the statements made through Rsp5 which were pointed out before.

"Talking about technology enhanced learning, I would say that it's important to see it from the perspective that learning is not the technology that is the driving force. Technology is the facilitator of the learning activity. So basically, you design the learning activity with the teacher. And then you can see which parts of those activities or the total activities can be facilitated by the means of the technology" (Rsp4:L14)

Although Rsp4 talked about the importance of using technological means to facilitate learning, they also pointed out that use of various digital tools could sometimes be distracting. This also relates to a factor pointed out by *Rsp6* where they said before the Stockholm Stad provided devices without certain applications, it was quite distracting to students as they were deviating their attention from the classroom. This goes to show that just including certain technologies to facilitate the learning environment is not enough, it needs to be thought through in regards to what aspects would make students more productive and implement their knowledge better. Both of the respondents asserted how there must be the technology that can help achieve the particular goals and adding more than necessary technology can lead to distraction and deter the pupils from learning and focusing on their academics. In terms of the other challenges that come with implementing TEL or collaborative learning, Rsp3 discussed how relative digital tools are great for collaboration and providing feedback among students, there could also be disadvantages such as cyber bullying. The students when doing peer reviews through these tools could be harsh or provide extremely negative feedback or bully one another, that could pose a demotivation in their learning, challenges like these should be considered as well when implementing some tools (Rsp3:L26). To ensure the tools work best for the benefit of the students or the respective users, Rsp4 mentioned how when designing and developing such technologies, there should always be a human factor in mind so it supports the learning to its potential.

"Where it's really interesting that you can't escape the human factor. You have no but I think the the what we do whatever we do with regard to technology, we should always have human in the loop."(Rsp4:L19)

4.4 Learning Perspectives & Relevance of Tools

In regards to the organizational perspective, most of the interviewees claimed that the organizational factor was not part of their expertise. However, the interviewees agreed that the challenges of using digital tools could be linked to organizational factors of the Swedish education system. When asked about how organizations learn, Rsp3 responds with the challenge being

the gap between the technologists and people coming from education. Technologists generally have a limited idea of how education should be conducted while the people coming from education have a limited idea of what technology can offer.

"-Sometimes it's driven by universities as well in teacher training so I think it's a very complex problem because we need to innovate schools but for good or for worse, the innovation is slow because i think if you listen to a lot of technologists you know they have a lot of ideas that have to innovate education the thing is they don't know anything about the theories of it, and on the flipside if you listen to a lot of the people coming from education, they have a lot of ideas of education and very little ideas about technology so it's a very hard thing to create innovations." (Rsp3:L18).

Rsp1 talks from a general perspective of how the role of school leaders and how their approach affects organizational learning. While teachers' role in adopting digital tools in the classroom plays a big part, Rsp1 highlights the importance of the school leadership and how the whole organisation should approach this.

"But, out of general, looking from an informatics perspective. I would say that it is what the school environment broadly looks like. Do you have support from the school leader? What is their approach? And then go down to the single teachers again [...]." (Rsp1:L24).

Rsp4 argues for the need to work with the users of the technology. Simply enforcing any piece of technology without consulting the users will result in a higher chance of failure. This idea is also supported by Rsp1.

"Well, I think the most important aspect is to work with the actual users of that particular technology. If you try to enforce any piece of technology without consulting and working with the users, the chances for failure will be much harder."(Rsp4:L17)

As Rsp1 states, it comes down to the teachers' own perspective on teaching and using technology in the classroom. As the teachers are free to set their own limits based on their own views, there are structural challenges in having a freedom in choosing, which can affect the way that the teachers conduct their work.

"It goes down to the teachers and when it goes to the teachers, it's either their own worldview or their own perspective or their own way of learning/teaching and also the support that they get from school leaders. So the learning environment is a lot run by the teachers, regardless of how the teaching is done." (Rsp1:L18).

The notion of teachers deciding on how they conduct their teaching (Rsp1) is in union terms *teacher freedom*. Teacher freedom refers to how teachers are free in their role to decide on how they dispose of their time:

"They have this so-called "teacher freedom." (Rsp1:L20).

While highlighting the critical factors that affect the organisations in terms of learning perspectives and implementing the required digital tools to enable better learning, one of the important aspects is for the applied technologies to have a human factor among them (Rsp4:17). The respondent emphasised that technology first needs to be in a user testing phase with the actual users of the technology because simply enforcing the tools without having a firsthand consultation with the primary users would have a higher margin of failure. For instance, if the users

are not capable enough to utilize it, there will be more issues rather than benefits of the system at hand. With the application of educational systems that facilitate technology enhanced learning, there needs to be a systemic perspective in relation to the design choices that go into the technology (Rsp4:17). In their words, organisations need to be critical regarding the effects the wrong design choices have on the interaction among the technology and the users.

"Because if the users do not have the capabilities, they might have troubles actually using and with improper use that may cause more trouble than actually the benefits."(Rsp4:L17)

Regarding the discussion on learning perspectives, Rsp4 tells about when individuals learn in an organisation, the foremost requirement in the implemented digital tools would be an engagement factor and the second to be of presence. Use of such technology peaks the interest of the students and makes them more present in learning and gaining knowledge, also maintaining the balance among these two requirements is also crucial as it acts as a key factor in providing a great learning experience for students (Rsp4:L19). According to the respondent, going overboard with technology is not always the best approach, and technology must be adapted to the needs and circumstances of the school and students.

One of the things organisations see as a challenge is applying technology and adopting it is how the teachers come to terms with it and adapt to it. There is a level of ease among students when introducing new technology as it keeps them excited to try on the new tools to learn and engage more. According to Rsp4, to keep up with the engagement levels, there is an added challenge to the organisations to keep upgrading their tools and technology. These challenges come with the resistance of some teachers to using them and also an economic cost to the organisation itself (Rsp4:23)

"So in order to keep the engagement level, you might need to consider upgrades. But these upgrades will be costly, both in terms of technology, but also in terms of the resistance from the teachers to use them." (Rsp4:23)

The digital acceptability of the organisation can vary and that can create problems. In the interview with Rsp1 it is highlighted that the differences in digital acceptance and knowledge and that the school as an organisation needs to recognize this. Rsp1 builds upon their previous idea of having a strategy of integrating digital tools with the regard to individual differences among teachers.

"When it comes to educating them and teaching them you have to split them in different categories. Because, you have some that are technically interested and skilled and those who're interested but not as skilled and you have those who are skeptical and then you have those who are "I will not touch that thing". (Rsp1:L26)

The organisational factors affecting the school are mainly concerned with the schools not recognising the discrepancy between teacher knowledge and attitude toward digital tools in teaching practices. The empirical findings suggest that it also could not be simplified to a age-related generational issue which a Swedish study suggested. Rsp5 argues that it had to do with how comfortable the teachers were in their role as teachers and that was the first and foremost important aspect before the teachers could make use of the digital tools.

"Also there were more positive and smarter and the use of technologies were those between 45 and 55. Because they are very well, experts in what they are teaching. And they know how to handle the classroom so they know where the problems are, and how technologies could be used to do things that are impossible with technology." (Rsp5:L52)

4.5 Social Learning & Learning Environments

Through this chapter the empirical findings analysed through the SLT and learning environments perspectives for the use of digital tools will be reflected upon.

With the factor of creating a social learning environment through digital mediums most of our respondents leaned towards having the same perspectives on what aspects need to be thought of thoroughly. Rsp4 highlighted that a complete purpose of the digital environment needs to be put forth to increase the efficiency and which can help the pupils to collaborate and construct knowledge effectively (Rsp4:L31). On the other hand, Rsp1 provided insights on how creating such an environment would aid some students and perhaps aid less to other students, but according to their research as society is leaning towards more digital it is quite important to have it but questioned on how exactly can you make to adapt to each individual's needs (Rsp1:L45).

"a society that is going more towards the digital, so it's important and you need to have it. Then the big question is, how do you make it?" (Rsp1:L45)

Whereas, Rsp4 suggests that when creating a digital environment we should learn from the mainstream social media, where they have used persuasive techniques through the use of great technologists, interactions, ability to the language of different concerns. Their outlook is that through this approach, this could assist students to be more creative and engage in a digital learning environment setting as well (Rsp4:L31). Having this approach could be favorable as it would be creating an environment familiar and relatable to the students themselves. Adding to the previous remarks, Rsp3 points out that the pupils should experience the benefits of both the digital and also the social, as the tools are great since they can connect students from different parts of the world. In their projects he pointed out how there have been students who were able to conduct scientific experiments by remotely controlling the equipment to successfully conduct the experiments (Rsp3:L29). In addition, Rsp3 mentioned that there are added disadvantages to this such as having to work through the wrong information, but also adds that even if it is dangerous it is alright as children need to understand the potential of dangers out there from a young age. This was also a concern identified by Rsp4, regarding the information that pupils could find when using the internet to do their works, which could have compromised information that is not always true, but this also provides room for them to be self-critical when they analyse the information thoroughly (Rsp4:L35)

"But there are also the disadvantages of learning how to decipher what is misinformation and propaganda. So I think that it's okay that its dangerous, you know we need sort of risk in the world, children have to understand that there is the potential of danger out there and that it could be a good way to do it whether it's like virtual reality or using these materials to discuss them in the class or investigating them." (Rsp3:L30)

Also, Rsp6 reflects on how creating such an environment is important but it does impose some constraints given the type of medium used in learning compared to traditional learning. Similar

to what was pointed out by Rsp4, Rsp6 also emphasizes that when creating the digital learning environments you need to think about the task one would be doing through the tool and have a certain margin of maneuver so it can be adapted accordingly (Rsp6:L43). Rsp6 also mentions that they are still in the process of experimenting with and recreating such tools as it would take some time to reconstruct what it takes to include the indicators which would facilitate the traditional learning interactions through a digital medium (Rsp6:L44). As with the use of TEL reflected on the previous chapter, Rsp5 mentioned the creation of a learning environment that needs to be taken through the point of view of the stakeholders in schools. And reflects on taking the initial steps on what the major learning goals are that can be supported with the different digital tools that can be used (Rsp5).

"First is, which are the learning goals and what you'd like to achieve learning outcomes. Then the second, I mean, assuming that you want to, I'm talking from the point of view of a designer or a teacher or principal, from all these different stakeholders in schools, we assume that you want to use digital tools to support digital learning, okay, that's a point of departure. Then the first step is, which are the learning goals and the learning activities that you have that the second is, which are the methods you want to use, which are the strategies and based on that, you can start thinking about, which are the different tools, digital tools that you could use to support those activities." (Rsp5:L62)

With the outlined insights from the respondents that highlight their perspectives and skeptical views on creating a learning environment with digital tools, they do outline some primary benefits experienced through their research. Rsp4 highlights how such an environment creates an ease of communication among their peers and teachers, which was also a point highlighted by Rsp1 regarding a wider audience in terms of learning styles. Both agree on reusing the content that can be adapted to the learning and teaching imposed through the learning environment and provide an engaging, interactive learning experience for the students (Rsp4:L33). Other benefits outlined by Rsp4 was how pupils can have access to their work anywhere as they would have the opportunity to save their work digitally and have easy access to it conveniently anywhere and continue working on them without any hindrances. When providing more insights on this domain, and relating it to Chapter 4.3, Rsp3 believes that the benefit of creating a learning environment provides a better way to collaborate with different people and also work in a way that is suitable for you (Rsp3:L26). This supports the pupil more on a social side as well, since it makes them feel like they belong and are being understood in terms of their academic capabilities. And when an individual feels that way and they get more value from the education and are more likely to perform better (Rsp3:L34).

"Benefit is the ability to have their work saved constantly, because it will be stored on the clouds. [With] The technological tools, we provide them with a gateway to new knowledge and so on."(Rsp4:L35)

Additionally, Rsp3 believes that building the systems that provide the analytics can assist the students and teachers to self-regulate their usage, and the analytics provided by such collaborative tools would have the potential to have the respective information to organise and support better learning experiences (Rsp3:L32). The respondent also pointed out that learning in a primary school setting along with technologies teach students how to navigate the respective tools and solve or approach problems with different means (Rsp3:L24). For instance, they provided a scenario where schools act as a role model apart from their family or environment, as there is no digital divide in the classrooms and everyone gets a device to work on. Through this they

imply that students coming from a low socioeconomic background will be assisted to use the devices for more than entertainment, they could have the devices but may not be using it to make an informed decision. Thus the use of technology in schools can influence students to use technology more effectively in terms of learning (Rsp3:L22).

"Support or offer support or to like identify patterns that might be disruptive then figure out how to make the correct intervention" (Rsp3:L32)

"We do not have a digital divide, everybody has devices but we have a divide on how people use these devices (Rsp3:L22)"

Through the insights provided above, Rsp3 talks about how the teachers and technologies create a ripple effect on how a child can perceive and utilize technology. Pupils that have received the guidance to understand technology would be able to decide for themselves regarding what they want to learn and use technology as a mediator to achieve that goal (Rsp3:L22). Rsp2 did not have much experience in creating or working with creating learning environments but provided some insights on how they could be carried out. According to the respondent, the Covid-19 pandemic has nudged schools to be more digital and carry out their daily procedures digitally. The students can engage with one another digitally when working on their assignments or when playing games on their devices like they would at their schools (Rsp2:L54).

4.6 Additional Findings

In addition to reflecting on the findings we obtained through the themes outlined in our interview guide, the interviewees also provided additional insights on the areas that were not included in our research. One of the topics that came up while talking with the respondents was related to the ethics and privacy of the matters that relate to the teaching materials and environment. In the words of Rsp3 on collaborative learning and TEL, they outlined how young children or teachers can be explorative and find the knowledge that works for them to get the respective support but it could have complications due to data, ethics and privacy concerns (Rsp3:L32).

"I can organise things in a way that can work for me, so I think there is a lot of advantages, even for younger children to get support or offer support or to like identify patterns that might be disruptive then figure out how to make the correct intervention but it's complicated due to the ethics and the privacy and the ownership of the data and the risks of that" (Rsp3:L32)

The similar concern was outlined by Rsp6 who was currently working on the ethical and legal concerns of using machine learning enabled tools in learning. In their words, schools should be a place of experimentation and exploration, and not performance. Additionally, Rsp2 also mentioned that the security and privacy of digital tools needs to be taken into account and one needs to be careful regarding that when incorporating these tools in a learning environment. According to their words, the environment is changing with how the new mediums are being introduced to children and teachers and aspects such as privacy and security will be faced and people need to be more aware regarding those factors. Also, Rsp2 emphasizes on how there should be better regulations that need to be updated accordingly which should comply with the organisations (Rsp2:L66 - L70).

Furthermore, Rsp2 also complemented to what was said by Rsp5 regarding having a stakeholder point of view in a different way where they elaborated on how there needs to be good strategies and specialists in schools or school boards that implement the technologies to adapt to the growing and changing times (Rsp2:L72 - L73; Rsp4:L29). Addressing their point of view in relation to organisations, Rsp4 recommends that to make use of technologies to enhance educational institutions and their outcomes they need to have a thought process of including solutions that bring forth activities with the strategies from a pedagogical instruction. The respondent also addresses that moving forward to digitalisation without proper training of the teachers might be prone to failure and the innovative solutions need to be more systemic rather than individualistic for smooth implementation in primary schools (Rsp4:L37).

5 Discussion

This chapter will discuss our empirical findings and analysis in relation to the presented theoretical background in Chapter 2.

5.1 Implications to Research

Collaboration in the 21st century looks different to what it has (Díaz & Ioannou, 2019). Modern day schools expect students to collaborate between peers through digital tools and the use of these tools is a necessity in the Swedish school system as of today (Utbildningsdepartementet, 2017). This means that digitalisation in education is something that primary schools need to strategize around for them to meet the criteria set out for the Swedish primary schools. As of 2017 the Swedish government adopted a national strategy for the digitalisation of the Swedish school system (Utbildningsdepartementet, 2017). The strategy highlighted that the goal for the Swedish educational system is to achieve a high level of digital competence and to promote the development of knowledge and equality among Swedish students. As the empirical findings suggest, there is difficulty in achieving equal opportunities in the context of digitalisation in Swedish primary schools, since there is no way to ensure that the teachers are educated in using the digital tools. This leaves the schools at the mercy of the teacher's personal interest and knowledge in these technologies which cannot be ensured to hold a certain standard. Beyond the educational factor for the teachers, another challenge for the Swedish school system is the fact that it is decentralized in governance (Wildt-Persson & Rosengren, 2002). Our findings show that the challenges that this poses is the risk of unequal opportunities as the empirical findings suggest, meaning that the possibilities that you have in a certain area in Sweden are not the same as you would in another. As highlighted in the literature findings, in Olofsson, Fransson and Lindberg (2020) the authors conclude that the term digital competency is flexible in its meaning in the Swedish primary school context. Meaning that there is a connection between local contextual conditions and that the digital competence is related to teachers' own framework of values (Olofsson, Fransson & Lindberg, 2020). Thus, this in combination with the empirical findings would suggest the need to revise teachers' own frameworks of values and work with them in combination with training teachers in digital competence.

While one could think that the digital competence of the school as an organisation would be a generational issue, a study done in Sweden suggests that the connection between teacher age and receptibility of using technology is not as linear as in the younger you are the more receivable you are to adopting these technologies (Lundqvist, 2006). This means that it is the teachers as individuals that need to be educated and convinced that the tools are something of importance for their teaching practices which regardless of age need to be adhered to. As Díaz and Ioannou (2019) highlight, the future role of primary schools is to prepare people for lifelong learning through active engagement with information society, collaborative learning environments, multi-user critical thinking and social creativity tools. In reference to this, in our empirical findings we could distinguish two views.

First, the recognition that there is a need to educate educators in digital learning. Handling technology as something of value on its own is not beneficial for the schools since the tools

need to be used efficiently to have value. The empirical findings exemplify this by giving examples of schools buying digital tools to be used in the classroom while a lot of times they are left not integrated into the learning practices. Second, there is a gap between technologists and people coming from education and how this discrepancy results in poor adoption of digital tools. What the empirical findings alongside the literature points to is that there is a need to integrate continuous digital competency training for the teachers if the goal is to achieve digital competence among the students as well.

The technological challenges for the schools lie in the interoperability of the digital tools. A sentiment shared in our findings, particularly the different decisions of service providers for the Swedish regions and the challenges this can cause for the Swedish educational system when there can't as easily be a set standard or quality control (Wildt-Persson & Rosengren, 2002). As highlighted in the Swedish strategy for digitising the educational system, technology must not be an obstacle to good education (Utbildningsdepartementet, 2017). As the empirical study argues that there isn't a one-size fits all approach to the digitalisation of education, the technology should be looked at from an individual perspective of the teachers. The technological challenges thus lie in the balance between interoperability of the digital tools and that these tools can align with the individual preferences of the teaching practices. Additionally, having a concrete objective with what you want to achieve with the digital tools is vital for the successful use. As highlighted in the empirical findings, without a concrete objective you are lost in what you do with the digital tools. The empirical findings also highlighted that use of tools that are interoperable minimize the need for the use of one tool to another and have the required work done in schools. But also one of the other challenges that come with it is that the integration of similar tools is considered to be seamless and solve the underlying problems but when implemented in practice becomes frustrating to some of the users that are not ready for it.

Furthermore, when it comes to blended learning, the blended learning approach has become an umbrella term to describe when learning is conducted both in a physical as well as digital environment (Horn & Staker, 2011). When addressing the topic, the interviewees treated the topic as the umbrella term of traditional (pen & paper) learning done with the help of digital tools. The literature identifies the key benefits of blended learning being that the students are given more control over pacing, as well as place and path for the instructions (Smith & Suzuki, 2015). This in turn can promote more efficient learning among the students. The empirical findings suggested that there were considerable benefits of using the blended learning approach compared to the traditional teaching format but that technology could not solve problems by itself. A big part of the challenge was concerning the integration of technology into learning practices. Simply buying the technology and envisioning it as a problem-solver by itself was a pattern that the interviewees could distinguish. Additionally, the empirical findings suggested the importance of envisioning what Technology Enhanced Learning would provide and anchoring that vision with the teachers. Simply handing out the technology without any set goal has proven to have a negative effect on the outcome. Furthermore, teachers in Sweden have a lot of room to work within their role, this is addressed as "teacher freedom". Teacher freedom can result in governance challenges for the Swedish schools as the teachers have leeway in how they wish to conduct their teaching and thus if and how they make use of TEL. As the empirical findings suggest, the organisational structures of the Swedish school system need to be understood and revised to understand the impact it has on digital adoption in Swedish primary schools and in regards to teacher freedom.

As defined by Dunn and Kennedy (2019), the findings in our study leaned towards the support of having Technology Enhanced Learning among schools to facilitate the development and interactions among students and teachers. Through the gathered perspectives, use of technology was quite beneficial to the researches where students themselves took the initiative in terms of creating new mediums of learning for their peers through the facilitation of existing technology. In addition to that in the researches conducted by the respondents, TEL and collaborative learning tools effectively maximise the use of new methods and technologies to create a more engaging learning environment (FitzGerald et al. 2018). In our findings, the use of an engaging and fun tool such as Kahoot was proven to be an effective source of learning among students to engage among each other and learn effectively. This approach also comes in line with the research presented by Mozelius, Eriksson Bergström and Jaldemark (2017), where a tool that was not made particularly for learning, it can be seen that other forms of technology can also effectively facilitate learning in certain scenarios.

Along with supporting the knowledge from our theoretical background (Mor & Winters, 2007; Laurillard et al. 2009), the level of how thought-out the tools need to be was one of the prominent factors that emerged in our study frequently through the respondents who were more involved in creating, designing and developing tools based on TEL. Creating the tools does remain a challenge but when they are implemented effectively, they promote the critical thinking and interpretations required by pupils in both the technological and traditional learning aspects (Cerratto-Pargman, Järvelä & Milrad, 2012; Laurillard et al. 2009). Pupils when engaged and use the tools get more attentive as they are receiving immediate feedback regarding their tasks. In addition to having several benefits, as observed from the findings, major implications of associating TEL and collaborative learning tools in schools is taking into account all the stakeholders that are involved. This draws contrasts to how organisations learn and integrate technologies as they fit into their curriculum. Also taking into consideration the organisation and the information structures of the applications to be used, the technological tools that are implemented can determine the use of technology to its best potential for collaborative learning.

Moreover, when creating a respective learning environment through the facilitation of digital tools, the tools should aim towards creating a holistic learning environment that suits both the teachers and students in their teaching and learning respectively. As mentioned by Crittenden (2005), the behaviour of the student is shaped through the learning environment that they are exposed to. With the development of digital and a social learning environment connects pupils to perceive information in different ways. They will be able to experiment with what works best and what does not, and learn through various mediums (Sung, Chang & Liu, 2016). Through the empirical findings, pupils were able to conduct remote scientific experiments and discuss their findings and results with their peers conveniently. Along with the positive aspects, the study could identify that creating a digital social learning environment does come up with complications and would be difficult for teachers who have been teaching through a traditional approach. There would certainly be difficulties in adapting to switching to a technology assisted learning environment as creating a medium they are familiar with would certainly require a lot of experimentation to study what would be suitable and what would not.

5.2 Implications to Practice

With the respective findings and analysed literature, our study has confirmed that there are several factors that would have positive influences when applied to practice. As argued by Kurti (2009), the implementations of TEL when executed provide better responses such as more engagement in the course materials, critical thinking through different domains among pupils and teachers. Through our findings we have identified the immersion of pupils through a personalised learning approach aids in them learning at their own pace in a productive manner. Adapting to the needs of students and working towards the aim of accomplishing learning goals were found to be more facilitated through personalised TEL. Leading the teaching and learning environments with this approach provides a more immersive and interactive learning experience for pupils as it helps in them visualizing the given contexts with ease (Hernández-Sellés, Pablo-César Muñoz-Carril & González-Sanmamed, 2019). Apart from this, the empirical findings also pointed towards considering the human factor when designing and implementing the tools, where the teachers, students or the end user always needs to be in the picture. This will lead to the techniques and technology used to be more effective as it is adapted to the design and needs of the learning at hand and result in a productive outcome that does not go to waste (Mor & Winters, 2007).

Through TEL the pupils are able to take their growth of knowledge into their own hands and implement them as suitable to their needs, and the learning assisted through technology has been the medium of learning enhancement. Ornellas and Muñoz Carril (2014) refer to how these tools give a good focus to students with the real-time contexts and perspectives, and we argue that the environments through which the pupils are immersed into gives them a worldlier context of critically thinking and problem solving. Additionally, when the tools provide a good experience among the students it becomes attractive to use and they feel more inclined towards learning through them (Hernández-Sellés, Pablo-César Muñoz-Carril & González-Sanmamed, 2019). The implementation of these technologies provide a clear goal for what is to be achieved for a productive learning environment that caters to both the student and teacher requirements. However, as mentioned in the previous chapter, with the use of interactive or immersive learning technologies, there also lies the possibility of how interoperable they can be. Through the findings, interoperability was addressed as a challenging factor when implementing TEL in primary schools. Instead of having one tool that supports all approaches or only relying on one system to accomplish all the learning goals, the implementation of the digital tools or systems would require to complement one another so it is convenient for pupils or teachers to switch among one another. This interoperability aspect of the tools is a challenge which was prominent in our findings which would require a thorough study in both design and development when adapting to new technologies.

The empirical findings in regards to the school as an organisation highlights the differences in prerequisites and interest among teachers. As the Swedish school system is decentralized in governance, the regions and municipalities have the role of communicating the goals and strategies for the schools to use with the final goal of reaching the teachers. Arguably, this creates a need for strong leadership and follow-up of whether the intended results are met. Addressing the teaching staff as one entity could therefore prove to be counterproductive as there can exist a discrepancy in regards to digital competence and attitude toward TEL.

In addition to the findings and the research in accordance with the theoretical background, there were also new findings that were presented through the perspective of the respondents. Such as

the consideration of privacy matters among the pupils and the involved ethics when it comes to handling their data or the data they are associated with. With the faster changing technological mediums, this aspect of having privacy and security measures in mind when creating, implementing and adopting digital learning environments or tools need to be of utmost importance. As the adoption of various TEL enabled tools come into use in the primary school learning environments, the concern towards the safety of the data of the pupils and teachers alike needs to be addressed accordingly. With the use of well-researched tools that are catered to bridging the gap for enhancing learning and learning practices, the privacy and ethical concerns that circulate this field should not be overlooked.

6 Conclusion

The purpose of this research was to look into the factors affecting the use of digital tools which influence learning in Swedish primary schools, especially collaborative and TEL tools. The findings we came across throughout the duration of this study highlight that there are several factors that come into play when it comes to using digital technologies, tools and collaborative learning among primary schools in the Swedish education context. In reference to the question, we primarily looked into literature that was available in this topic. The substantial information obtained from the literature review aided in creating the themes and sub-groups that would proceed to frame our conceptual model and interview guide. This worked as a primary guide in conducting the research with our participants to gain more comprehensive knowledge and add on to new first-hand findings to answer the research question. With our research and findings we have observed that there is no one-size-fits all perspective when it comes to better understanding the use of technology for learning in Swedish primary schools. Thus, through the identified findings, it led us to address the following research question:

What impact does the application of Technology Enhanced Learning (TEL) have on Swedish primary schools?

There are multiple factors impacting the application of TEL in Swedish primary schools. The factors that could be distinguished in this research surrounded the education of teachers using digital tools. *Firstly*, understanding the individual preferences among the teachers. *Secondly*, creating tools with the users in mind and not just building them for the sake of it. *Thirdly*, interoperability of tools and *lastly* how the schools leadership affect the digitalisation outcomes for the schools.

The authors found that teachers with their ‘teacher freedom’ (meaning that they are largely free to manage how they conduct their work) and the school as an organization have a challenging task in creating the same learning environment for the students regardless of teacher and school since the tools used are oftentimes varied and lack interoperability. Not educating the teachers and the lack of teacher motivation in using the digital tools are other factors which hinders the successful use of digital tools in Swedish primary school education. While these tools create a lot of possibilities with regards to learning, the human-factor is inescapable in terms of personalized prerequisites of understanding and using the tools for the teachers and the students. Also, the tools come as an additional secondary social connection between students and teachers in terms of how both teachers and the pupils interact with the technology to maximize their learning.

Several of the challenges come down to the digital tools being treated as something that can solve problems *on their own* and that human factor of using and integrating them into real-life situations is something that causes digitalisation in a tug-of-war between uselessness and usefulness. This thesis thus implies that digital tools are useful for the students and the teachers as long as they are in line with the digital competency of both the teachers and the students.

6.1 Suggestions for Future Research

Throughout this study there were several factors that pose both benefits and challenges when TEL is applied to learning environments in a primary school setting. As mentioned in the delimitations section, this study is conducted through the perspective of researchers who have conducted research only in Swedish primary schools studying the implications of TEL and collaborative learning technologies. We suggest the research done in the future focuses on a global scale, doing the same studies with countries or educational institutions that have only recently initiated the uses of TEL or digital tools to facilitate learning.

In addition, we suggest there should also be the emphasis of giving a more thorough teacher training while having the human-usability factor of the technologies in mind. Furthermore, with the growing concerns expressed by the researchers there must also be a relative focus on the ethical and privacy concerns which arise from the integration of various tools and technologies among school children and teachers. Moreover, there is also room for researching on creating or implementing the interoperable tools that facilitate the learning and what its respective outcomes could be.

Appendix I: Interview Guide

Topic	Questions	Source	Argument
A. Digitalisation in the context of Education	**Digitalisation in Primary Schools' Education** 1. What do you think of the current process of using digital tools in the context of education at primary schools (particularly Sweden), give a general and a quick perspective?	Bullock & Muschamp (2006); Gross (2015); Gärdenfors, (2010); Lexico Dictionaries, (2021); Care, Griffin & McGaw (2012); Dede (2010); Díaz & Ioannou, (2019); Griffin et al (2010); Olofsson, Fransson & Lindberg (2020); Utbildningsdepartementet, (2017); Wildt-Persson & Rosengren (2002).	1. Introducing the broad topic, commencing the thought process.
B. Learning Methods	**Blended Learning** 1. What's your experience of blended learning methods in primary school education in comparison to strictly digital learning? a. According to your scholarly work, what was proven to be the best approach?	Allen & Seaman (2010); Çakır & Bichelmeyer (2016); Driscoll (2002); Garrison & Kanuka, (2004); Graham (2006); Horn & Staker (2011); Hrastinski, (2019); Means et al.(2013); Smith & Suzuki (2015).	1. Get a perspective on different learning methods. 2. Problematizing digitalisation from a primary school education point of view.

C. TEL & collaborative learning	**Collaborative Learning Environment** 1. What implications do you see (through your empirical studies) TEL having in the learning environment of primary school? 2. Could you provide us with the examples of the collaborative tools for learning used by you in your empirical studies for primary schools? a. Could you elaborate on why this tool was optimal in your studies?	Cerratto-Pargman, Järvelä & Milrad (2012); Fonseca et al.(2014); Hernández-Sellés, Pablo-César Muñoz-Carril & González-Sanmamed (2019); Kurti (2009); Laurillard et al. (2009); Mor & Winters (2007); Salavati (2013)	1. Looking into the perspective of the use of TEL in primary schools 2. Seeking answers regarding the benefits and challenges that come with TEL or collaborative learning tools 3. Regarding how imminent is the use of TEL and collaborative tools is for student's learning
D. Organizational Learning Theory (OLT)	**Learning Perspectives** 1. How do organizations learn, such as when they implement new technology and start adopting and adapting to it? (What is learning from an organizational perspective?) 2. What is learning from an individual perspective? (when kids learn through traditional format versus digital format) 3. What do you see as the main challenge of implementing digital technologies in primary schools from a technological perspective? **Relevance of Tools** 4. For how long do the tools stay relevant? How do major changes in collaborative tools affect the schools from a learning perspective? a. How do primary schools adapt to the changes? 5. What do you think are the (max) five key aspects of creating a learning environment with digital collaborative tools? a. Also technological?	Collinson, Cook & Conley, (2006); Fauske & Raybould (2005); Huber, (1991); Leithwood, Leonard & Sharratt (1998); Rikkerink et al. (2016); Watkins & Marsick (1993); Whyte (1997); Zahller, (2011)	1. Digging into how digital tools affect organizational learning. 2. OLT talks about learning environments, expanding on what it means for digital education. 3. Observation on the lifecycle of the tools in primary schools and what factors affect it

E. Social Learning Theory (SLT)	**Learning Environment** 1. In comparison to traditional learning, what is your view on creating a social learning environment through digital tools? 2. What would you consider to be the primary benefits of using digital collaborative tools/TEL for educators and students?	Bandura (1977); Bandura (1978); Crittenden (2005) Harrison and McIntosh (1992); Hammer (2011); Hill & Hannafin (2001); Kawalek, Lorenzo and Ramdani (2008);	1. Regarding how impactful is the use of creating a learning environment via tech
F. Conclusion & future research	1. To recap what we have discussed so far, do you think then, that digital technologies as you have studied them in the context of primary schools' education influence learning? 2. Finally, what is your suggestion of how primary schools should envision their future of digitalisation?		1. Final question to wrap up the interview. 2. Possible suggestion for future research

Appendix II: Interview email request

This section outlines the draft email written when approaching the interviewees to be a part of our empirical study. When approaching certain respondents, the emails were also modified whilst specifying the particular works they had conducted to give it a personal touch. And to let them know we were aware of their works and why they were suitable for our research.

Hello xxx,

I hope this email finds you well. I am a master's student in Information Systems at Lund University and I and my thesis partner are working on our master's thesis which looks into what aspects influence the use of digital tools in primary school education, especially in the Nordic education context from a researcher, scholar or scientist's point of view.

We went through your works regarding mobile learning, learning facilitated through technology and primary school education where you have worked on/been working on the area of digital technology learning, mobile learning which were quite rich in information. We believe you are an ideal interviewee for our empirical study and would love to have a meeting with you regarding our paper.

I have attached our interview guide along with this email for your reference. Hope you can consider our request and to hear from you soon.

Thank you.

Appendix III: Rsp1 - Interview transcription

Respondent: Rsp1

Position: Associate Senior Lecturer

Date: 6th April, 2021

Interview Duration: 39:05 minutes

Line	Individual	Questions/Responses	Theme
1	Researcher	What do you think of the current process of using digital tools in the context of education at primary schools? Give us a general and quick perspective, particularly from Sweden.	
2	Rsp1	Taking into account what has happened the last year with the pandemic, I think as far as I know, the school education has had to open up their eyes on how it has been previously and that they need to focus on certain aspects and certain things that are more important than just telling teachers or students: "Here you go, here's a phone, here's an iPad, here is something, use it". So I think it has been an eye-opener if you look at last year specifically. In terms of the digitalisation in schools.	
3	Researcher	It isn't enough to just give the hardware or the software, you have to have a plan with implementing it. So just, introducing the broad topic to get some insight. Then we want to get into learning methods. What is your experience of blended learning methods in primary school education in comparison to strictly digital learning?	
4	Rsp1	What would strictly digital learning be?	
5	Researcher	On a distance, everything …. isn't face-to-face. To give an example, if we take the pandemic (Covid-19) for example, if you were just at home on a distance learning, digital setting. Compared to face-to-face, blended learning where you have face-to-face and a digital setting.	
6	Rsp1	Could you please repeat the question?	

7	Researcher	What is your experience of blended learning methods in primary school education, in comparison to strictly digital learning?	
8	Rsp1	I would say that I have limited experience... So to say that I have seen it or myself worked with it. But from my experience in terms of research that I have done, and also been working as a teacher, not in primary school. I would say that blended learning would be more beneficial as you gain certain things by having people face-to-face rather than fully on distance and I think for youngsters and children depending on what age we are looking at, I think, the actual physical contact is needed. Because I strongly believe that you cannot replace traditional education you need to complement it with the digital.	**Bl-Le**
9	Researcher	As a follow-up to that, according to your scholarly work that you have done throughout the years. What has proven to be the best approach?	
10	Rsp1	I haven't continued looking into this further and I have no research done on fully digital education in schools. So, I don't have any experience in terms of neither doing research or working with it myself. So I wouldn't be able to give you an honest reply on that.	
11	Researcher	Ok, on your paper "*****" you studied 3 tools in schools in **** right?	
12	Rsp1	Yes.	
13	Researcher	Could you explain and elaborate more on those if possible?	
14	Rsp1	Oh, that was several years ago. It was Collboard, it was GEM and LETS GO. I think out of these 3 projects, the one that I believe was the easiest to use was the Collboard. Because it was integrated in their everyday standard teaching in a different way than for instance, …. GEM was. LETS GO was also there, they had the sensors and they had the visualisation but it was a bit more advanced. So it would get there eventually and maybe today I don't know if they have continued working with that, and if they have gotten more naturally integrated. Collboard they would use and and worked with mathematics but then they would go up on the board and they would write and you know the technology actually enhanced the teaching in those terms rather than just being a tool. But again, this was quite many years back. So there might have come additional and other tools that are in-line with this and more	**Te-Le**

		integrated. Because the issue is to integrate it into the everyday teaching.	
15	Researcher	So in terms of TEL (Technology Enhanced Learning) and Collaborative Learning, what implications do you see through your empirical studies that you have done, TEL having in the learning environment of primary school?	
16	Rsp1	... What implications?... Can you take the question again?	
17	Researcher	What implication that you saw through your empirical studies with TEL having in the learning environment of primary schools?	
18	Rsp1	I think it was quite different, if I look at my most recent which was the study that I did after school, was quite different depending on the approach that the teachers had. It goes back to how the teacher chooses or don't choose to use technology and material and approach and design. It goes down to the teachers and when it goes to the teachers, it's either their own worldview or their own perspective or their own way of learning/teaching and also the support that they get from school leaders. So the learning environment is a lot run by the teachers, regardless of how the teaching is done. The teachers are also framed from the school leaders and the school leaders are framed by the municipality. So more detailed than that would actually be difficult for me to provide.	**Le-En**
19	Researcher	We have also found literature which supports the claim that it's very much up to the teachers if they use technology and how they should use technology.	
20	Rsp1	Yes, they have this so called "teacher freedom".	
21	Researcher	Could you elaborate on why you chose to use those 3 tools in your study?	
22	Rsp1	It was the projects we had going on at the research center that I was working on. So that's the basic reason, I was a research assistant at that time, working with other colleagues and PhD-students	

		working on this. It wasn't a decision by me so to say, it was the projects we had at hand.	
23	Researcher	Getting into learning perspective, we have a question here: How do organisations learn such as when they implement new technology and start adopting and adapting to it? So, in the implementation, when you "launch" a new system for a primary school how would you say that that period is for the school in the context of learning environment for the organisation?	
24	Rsp1	I can actually not answer that, since I have not seen it up close. I haven't been in that process in my research. But, out of general, looking from an informatics perspective, I would say that it is the ... how the school environment in broad looks like. Do you have support from the school leader? What is their approach? And then go down to the single teachers again, but I can not give you a direct detailed answer on that unfortunately.	**Le-En** **Or-Le**
25	Researcher	That was kind of into the learning perspective of an organisation. What is the learning process from an individual perspective? … How does the learning process of using these technologies look in terms of getting to know the software and such?	
26	Rsp1	Again and as I have also seen in my research and it goes down to individual people, so what I saw in my research and what I strongly believe is that when it comes to these kinds of issues, when it comes to asking and telling teachers to use technology, you need to involve them in the process of the purchase, the choice, which ones to have and the whole implementation phase. When it comes to educating them and teaching them you have to split them in different categories. Because, you have some that are technically interested and skilled and those who're interested but not as skilled and you have those who are skeptical and then you have those who are "I will not touch that thing". Depending on which category, you need to address them differently. I think that you need to do it regardless, for those who understands it and are advanced, you need to give them the education anyhow. But that should be different than the ones that are not interested and the ones that are not interested should be involved earlier ahead. What I could see in my research is that the teachers who were not interested in technology at all was like "okay what am I removing from my duties? You can not also add this. If you want me to do this then I'm going to remove something else, tell	**Le-En** **Or-Le**

		me something to remove". Then they don't want to compromise and use something that they do not have full control over.	
27	Researcher	It's also up to "teacher's freedom" that you have talked about before, that there seems to be a clash between the freedom that they have in using their time to do their different assignments already.	
28	Rsp1	It is very important that those who chooses what to buy, when they implement it, the whole process prior to the actual use has, it has been thought about quite detailed. Where you bring it in it becomes more than a replacement of the book. It becomes more than the replacement of the pencil and the notebook. So that you actually show what value does this give, what can you do and give them the technical support. If something happens, there will be someone who will support and help so that the whole class does not collapse.	
29	Researcher	Our next question is more on the relevance of tools. Our question is: For how long do the tools stay relevant? How do major changes in collaborative tools affect schools from a learning perspective? You don't need to provide the exact time, although discuss the time that tools stay relevant. Because that is something that we in our research have understood as a major challenge.	

30	Rsp1	It's a very tricky question. Because when it comes to our field, technology might be relevant day one and might be un-relevant day two. But when it comes to education you are still building on the same foundation on how you learn and what you need to learn and all this, you have a stable ground in terms of learning education in these parts. So the trick part here is that I'm not sure if you can answer that. Because if you have design and develop a tool that is thorough in terms of added value, and addresses the basics of learning and need that can be the idea of that tool can be relevant then maybe the graphical interface and so forth can be outdated faster. But if you create a tool that is a replacement of a traditional that might have a shorter relevance age, so if you give them a desktop computer, that would be outdated quite fast compared to the actual computer and then the iPad. So if you don't have a pedagogical idea its build on, so I think it depends on	**Rel-To** **So-Le**
31	Researcher	So if I understand it correctly, there's a difference between like the possibilities with like the digital tools, so they build on, they evolve in one way, but then the interface can look different. That there is a distinct difference between the possibilities with digital tools when it comes to its practicalities and when it comes to the the visual interface?	
32	Rsp1	Yeah, the idea, what is the idea and the aim of what the tool is supposed to do? How is it supposed to be integrated and used in teaching. I remember when I did my studies, the smart boards came. The schools invested in them super fast without having an idea of how pedagogically it would work and what foundations it would build upon and very fast it became irrelevant. The same with interactive whiteboards, they were used as regular whiteboards it was just an expensive version. But if there is an idea behind it, if you do something that builds upon software then those things can change, the idea of the tool is fundamental.	**Te-Le**
33	Researcher	I think you describe the whole information system field there, pretty much.	
34	Researcher	We have a follow-up question to the previous question, how do primary schools adapt to the changes?	
35	Rsp1	I think they don't, at least during my time when I was doing more research in schools and in education. I don’t think they did, they were just followers, they were like "oh something new came up, we have to use it.".	

36	Researcher	I think it was touched upon previously but: how do major changes in collaborative tools affect the schools from a learning perspective?	
37	Rsp1	I would say the complexity, the school as an institution, as an organisation is different to any other organisation. Other organisations might be complex as well with many actors but the school is among the most complex ones, I would say healthcare is also the same but education that makes it more difficult. So that's why the schools have been struggling because they can not follow the same approach as you do everywhere else. You have a lot of people that you need to consider who have ideas, thoughts, power relations which makes changing something quite more difficult.	**Co-To** **Or-Le** **So-Le**
38	Researcher	What do you think are the key aspects of creating a learning environment with digital collaborative tools?	
39	Rsp1	The key aspects ….. I would say that you need to have a school leader that understands all the different parts and aspects when it comes to digital tools and digital technologies. Because if they understand that, they can give it to their teachers, they can get it to the parents so that they can get this more positive flow and in that they need to have an understanding of the technology per say, the benefits and the added value. But also understand that there is a need to listen to the teachers, how do they work, what kind of education do they actually need? And what kind of tools? (For example) okay you cannot work on Chromebooks, you need to have iPads, because this is what you use, this is your pedagogical tool. Then we buy that one not because economy allows that or the general research says Chromebooks are better and then to get the teachers to follow. I think that is how you can get to changing or enhancing the environment, because if the teachers are happy then they will get it to the students and hopefully then the students can get it to the parents and it creates this ripple effect. I think it starts with the school leader.	**So-Le** **Te-Le**
40	Researcher	Besides the pedagogical aspects, in terms of technological aspects as an IS-scholar: What do you think would be the key aspects that needs to be considered when it comes to the digital collaborative tools?	
41	Rsp1	You mean in developing and designing the tools?	

42	Researcher	Exactly.	
43	Rsp1	The key aspect would be to understand the educational learning practice. So for you to create and design a tool, you need to either work as a teacher or somehow have an understanding of the everyday practice. I can have great ideas and tools that I believe can be interesting but if I am not working as a teacher, if I don't know how the teachers think, my great idea might not be adopted and have added value. You need to listen to different types of teachers, you need to listen to the one that is interested but you also need to listen to the one who puts the iPad in a drawer not even knowing where the charger is. You need to understand the wide spectra, I didn't do that in my research but you need to understand the kids. How do they learn, what are they interested of, what are their difficulties, we have seen that during the pandemic that the school has led to great progress for some kids while school is being held on a distance, while "super bright ones" are not doing as good anymore. So I think that you as a scholar if you're actually going to design something that is going to be useful, you need to understand the school context to be able to create the requirements for a tool that is going to be useful, because it is different to most other contexts.	**Le-En** **So-Le**
44	Researcher	In terms of social learning theory and a learning environment, in comparison to traditional learning, what is your view on creating a social learning environment through digital tools?	
45	Rsp1	I think it's positive, I think it is going to be beneficial for some students and maybe less beneficial for other students. But on the other hand we have a society that is going more towards the digital, so it's important and you need to have it. Then the big question is, how do you make it? And that I can not answer.	**So-Le** **Te-Le**
46	Researcher	What would you consider to be the primary benefits of using digital collaborative tools for educators and students?	

47	Rsp1	For students, I think, I believe it is that you can reach out to more or wider audience in terms of learning styles. "If you are going to excel you need to be that type of learner.". If you are not that type of learner if you are more creative in terms of drawing or more physical in terms of movement, sports and these kinds of things and don't have this reading, writing, report-writing mindset of learning you don't get as big of a chance. So I think that with these tools you can reach a wider type of student. Because you can adapt the learning and teaching a bit more. When it comes to the teachers, I would also say, similar. Because teachers can find other approaches than what is stated that you should do, and you can do more with the digital technology than you can do traditionally. Also, I think that if it is done right, if it is done with a pedagogical idea, if the tools are integrated, if I do have support from my school leader, if I have technical support it can also reduce my work. Because then I can use the tools in a smart way which reduces some of my workload so I can put it on my students in a different way. That, I would say, would be the benefits.	**Di-Co-Le** **Di-Co-To** **Te-Le**
48	Researcher	To recap, do you think then that digital technologies as you have studied in the context of primary schools education actually influences learning?	
49	Rsp1	Definitely.	
50	Researcher	Could you give any examples related to that?	
51	Rsp1	What you can do is you can make learning more active, you can make learning more interactive. It is not that you sit and listen to a teacher talking or you're not sitting and reading. You can actually be doing something, you can be creating knowledge. Which I think is more difficult in comparison to the traditional way. An example, I was sitting here thinking of …. if I have seen any examples in the research .... That I've done. The only thing that comes to my mind is the HandyCraft teacher, then the students simplified their way of working, they didn't create knowledge in those terms. Now I got out of what the question was, sorry. Could you take it again?	
52	Researcher	Do you think that digital technologies as you have studied them in the context of primary school education, influence learning?	

53	Rsp1	Yes definitely, both positive and negative. But I would say mostly positive. It has potential for it at least.	
54	Researcher	We have a final question as well, what is your suggestion on how primary schools should envision their future of digitalisation?	
55	Rsp1	I would say that they need to adapt the use of systems-thinking. Which is, I am biased, it is my research area. But for them to do this it's understanding and accepting the complexity of schools. And accepting that you cannot give the same digital solution, the same digitalisation approach, the same digital transformation to all schools. And what they talk about with equality and that they should have the same so that it becomes equal. Equal is not having the same, it's looking at what preferences or what circumstances are there and then adapt to that. So for me, I would say that understanding and accepting the complexity of schools as a dynamic changing learning organisation.	**Le-En** **Or-Le**

Appendix IV: Rsp2 - Interview transcription

Respondent: Rsp2

Position: Senior Lecturer

Date: 15th April, 2021

Interview Duration: 46:02 minutes

Line	Individual	Questions/Responses	Theme
1	Researcher	The first question is in the topic of digitalisation in the context of education, What do you think of the current process of using digital tools in the context of education at primary schools (particularly Sweden), give a general and a quick perspective?	
2	Rsp2	As I said I don't have that much of experience lately, with primary schools but I can give you some overall inputs in terms of what do I think about it is that I think Sweden stands quite good comparing to the rest of the world in terms of digitalisation. So we could see this especially from the impact of this pandemic right, so I think part of the k-12 schools, the last four years they were also running, some schools also digitally in distance so I think digitalisation is already happening and pandemic kind of pushed a lot towards digitalisation in every aspect including k-12 schools and this has changed the perspective into, ok how should we move forward now because we did, there was a lot of research in digitalisation. Like different technologies used, what happened is that when the pandemic kind of came we were pressed to move totally digital. A lot of teachers, despite that there are theories, methods, approaches, tools, a lot of teachers, they did not know things how to utilise, like technologies. So they had trouble when it comes to this kinds of things. But, that was quickly recovered after a couple of months, all of them they learned, so what is something that is needed is let's say professional education to kind of keep up with the development of technologies and the societies so that all the teachers in k-12 schools should be aware of the digitalisation, of the digital tools of whatever is needed to be digital, right.	**Di-Ed** **Di-To**

3	Researcher	So it's like a kind of discrepancy between the strategies of using digital tools to just having the technologies?	
4	Rsp2	Yeah, exactly. So because I mean, technology was there, but some struggled. So we need to make this kind of awareness programs, or something that would constantly educate teachers to kind of competence development for digitalisation, I think it's a must. And this should they should all the teachers despite is it K-12 or university teachers, because not only, I mean, we from computer science department, we were ready for digitalisation. But other departments that were like more social kind of research. They were not ready. So some, some teachers, lecturers, they also kind of had issues in that. And I have no doubt that also k-12 schools and teachers there, they had some issues. So that's why I'm saying there is a need for because the tools are there. The technology is here. It's just what we need is the proper, let's say educational program that will keep up with the digitalisation processes that is happening globally.	
5	Researcher	Very good. Yeah, so so getting more into details here we're looking at learning methods, and specifically blended learning. So what's your experience of blended learning methods in primary school or education, k-12 education in comparison to strictly digital learning?	
6	Rsp2	So I think blended learning, it's, it's an interesting concept. And this concept is like for not only now but for several, let's say decades. I remember that I was teaching. So what is blended is that you teach physically, so somebody can participate physically in your classroom, and some can be digital. So you need to have the technology ready to accept to kind of have this both of this aspects. This is one way of blended learning. Another way of blended learning is perhaps you can you could do some lectures, totally physically, some lectures, totally digital, or assignments or whatever.	**Bl-Le**
7	Researcher	Yeah, exactly. We've identified that there's different definitions of what blended learning is. And there's literature on that. Yeah, exactly. So So we have, and what would you say? Just like a question there? Well, how would you, what would be your definition or what would be your optimal, according to your research in regards to blended learning?	

8	Rsp2	So for me, blended learning should involve the concept of flexibility. And that's why I would call it blended because you blend both physical and digital, right? Even though the lectures and everything can be can be synchronized, but it doesn't have to be right. So for me flexibility, in terms of let's say, people that want to participate in the course can be somewhere else, but they can still participate in your course. Right? Or in your lecture. Wherever they are independent of the of the location. And this is, and flexibility in terms of like, it provides the ability to students as well, so they could choose to be physical or digital. It doesn't matter. And same for the teacher. So that is what I mean, flexibility. Constantly blended learning, I think it's great.	**Bl-Le**
9	Researcher	Oh, yeah. So the next component we have is in like TEL and collaborative learning. So like, we would like to ask you what implications you see to your empirical studies TEL having in the learning environment of primary school?	
10	Rsp2	So it is about collaboration?	
11	Researcher	Yeah, technology, enhanced learning and collaborative learning	
12	Rsp2	So I think there is a lot of research tons of research regarding collaborative learning in technology enhanced learning area. So. So your question is with digitalisation, right?	
13	Researcher	Yes, like in terms of the implications that you saw during your research, like TEL having on the learning environment?	
14	Rsp2	So it depends, you know, what kind of collaboration first? So is it the collaboration between the students? Is it the collaboration between teachers? or What do you mean? Student collaboration, right student collaboration in digital world, I think it's still possible to do some sort of collaboration. I am a bit skeptical that the totally kind of digital way of doing things and the collaboration I know that a lot of students, for example, are doing some sort of collaboration in their assignments. But I get a feeling that it's not the same. It's not the same as it is a physical kind of collaboration, but looking at other ways of	**Te-Le** **Di-To** **Di-Co-To**

		collaboration .... In terms of technologies. I know from my previous research, when we provided tools to students like data collection tools to collect data around lakes to measure the water quality, let's say the collaboration has been increased in comparing to when they just did the, let's say more when they use just traditional methods, right, not not tools . So the technology itself made the students to collaborate better. Right? Because it was more interesting for them to use digital tools.	
15	Researcher	Was it because or just thought there? Was it? Because it was? Do you think that like it was measurable? More what they were doing? Was it thanks to it being like, very so to say, graspable? Or was it but	
16	Rsp2	..it was more practical, right Because there was a tool, you got the results immediately, then you went to the classroom, the collaboration continued, because there was some sort of discussion between peers, like, okay, this big screen projections, like, Okay, why is this? Why do we have, in this point of the lake .... kind of the quality of the water is worse than at the at the other point of the lake? So why do you think is that so there was like group discussion, and that is what I consider also collaboration, right? Technology kind of makes students collaborate. And they were like, ah, we can see the Google Maps points out, so please zoom, zoom in, and they see there is a road. So when the cars' passing, they released the gases, and the water kind of is, you know, polluted in that area of the part of the lake. We understand, ... so this was the case. And this was how students kind of more very more engaged. Because they were like, oh, this is amazing. You know. So you could you see, by observing, you see some great results already there with the impact of, let's say, digitalisation. So this is the level that I know about k 12 schools of collaboration, but not collaboration like in a distributed settings. I don't have that much of experience on that.	**Di-Co-Le**
17	Researcher	Okay, I think you just covered this, but still want to go through the question, could you provide us with the example of the collaborative tools for learning used by you in your empirical studies for primary schools?	
18	Rsp2	We have always developed our own tools. So we, we didn't use I don't know what kind of tools I could provide. But I know	

		that nowadays, we assume we are using a lot of digital tools, but it's a different kind of age. And I know that also k-12 schools, they use zoom if they are stuck with this kind of pandemic aspects, issues. So I don't know which tools to be honest. I cannot answer maybe they give a clear answer to that question.	
19	Researcher	You could give us an example, a tool that you developed, that, if Is it possible to talk about?	
20	Rsp2	The tool that we have developed was mainly a, let's say, a platform, which kind of had different systems in it. Like data collection system, data analytics system, data visualization systems, kind of so and data integration, where where students in k-12 schools, they were just using the phones, attaching different sensors, uploading the data into the cloud somewhere, and then they were having access to different visualizations. And this visualizations, kind of the, I think we're the main input when it comes to providing them with new insight, but also enhancing the collaboration in terms of like, reflections. Yeah.	**Te-Le** **Di-To**
21	Researcher	To ask a follow up question to what is it like when you talk about data, what data are you referring to?	
22	Rsp2	When I talk about data, I refer the data about let's say, say sensors, sensor data, like pH whatever levels but also picture, audio, text	
23	Researcher	So the inputs that the students put in	
24	Rsp2	Yeah, because they were kind of working, collecting the data and they were like documenting all the all the activities that they were doing, like, with pictures, audio and different stuff	
25	Researcher	So, to follow up even on that, like, could you elaborate on why this tool was optimal in your studies?	
26	Rsp2	Well, this study has happened a while back. And back then we were at a different different level of, of digitalisation. So already back then this tools that we have developed were kind of innovative in that sense. But nowadays, it might sound trivial, right? Because I mean, back then we didn't have iPhones in	

		2009. So we used other kinds of phones, to provide the students to collect the data, right? You understand the point? So it's a different kind of?	
27	Researcher	Yeah. Yeah. So then we actually talked about earlier, you were not that into organizational learning theory. But I can just try to one of the questions we have here: How do organizations learn such as when they implement a new technology and start adopting, adopting it and adapting to it? Do you have, if you feel comfortable?	
28	Rsp2	Yeah, I can give you my insights. I think from the organizational perspective, I already mentioned, I think, in the first question that there must be some sort of constant educational programs like for, for career, not career, but for professional development. So teachers, they need to constantly learn about new tools, and about the process as well, not about only the new tools, right, but how do you handle it? What would be the impact if I use this tool? And how do I give my best to kind of do all the work with my teaching, let's say, so that the results in the end will be the same or even better? So I think, definitely some sort of concept. I'm not sure. But if this is happening in Sweden, like having constant kind of development to keep up with the pace of the tools that are coming everyday in our lives. But definitely there is need for some sort of developing programs for teachers, or awareness, or I don't know.	**Or-Le**
29	Researcher	Yeah. But yeah, I understand what you think you made it clear. And then we have, Firstly, we had the organizational learning. Now we have what is learning from an individual perspective. Like when, when kids learn through traditional format versus digital format? How would you say, broadly speaking, how does that differ?	
30	Rsp2	It shouldn't differ. I think digitalisation, perhaps can enhance learning. So that is the role of technology. And that's what we tried to do with our research previously. So we there was no technology when they did the when they did collect the data manually. In the same course, for example, from the previous year in environmental science course or biology, I don't remember.	**Di-Ed** **Te-Le**

		But then when we provided the digital tools, these tools definitely enhance the learning. And that's why we need digitalisation, I don't think that we will, we will ever replicate all kinds of physical teaching. There must be some sort of component when it comes to teaching mostly physical, but definitely we will constantly use digital tools even though you you teach physically we will use digital tools. That is happening in already right.	
31	Researcher	Then our next question is, what do you see as the main challenge of implementing digital technology in primary schools from a technological perspective?	
32	Rsp2	Integration, I think, is the integration and interoperability. I think these are two big challenges. I did a lot of research in integration and interoperability. But still, when it comes to sort of having flexibility of these tools, for example, in terms of, okay, you want to make zoom work, with some other tools, but there is no flexibility. So this is what i what i mean this. So you cannot integrate these tools jointly, like let's say, zoom, and I want to have Google word, Google, whatever, Doc, so that I can integrate it in my platform, because that is the best, but I think as a teacher, then students will enjoy it because they will right at the same time, and I will see the results and we will kind of you know, so I'm just taking this as an example. So this kind of zoom and Google, I cannot integrate them. Because they don't interoperate between each other, right. So this is this is one of the challenges. So a lot of research has been done in integration interoperability. But it's not there. Right? We are not there yet. And that is mainly because I think it's because of the business models. So these companies, they have their own business models, and they don't want to be that interoperable or flexible.	**Te-Le**
33	Researcher	Very good point I think, then let's move on to relevance of tools. Like how for how long do the tools stay relevant you think?	
34	Rsp2	Can you give me an example was you mean, like the tools like that we currently use?	

35		Yeah. The the tools that you use in collaborative learning, or like TEL in terms of teaching and creating a learning environment? Like how long do you think these tools actually stay relevant?	
36	Rsp2	I don't know if I can give you some answer, like how long they will stay in the in terms of relevancy. But definitely, as societies evolve, tools will evolve, as well. So there needs to be some sort of constant development of the tools as well. What is lacking with this tools? If I take an example of zoom, its openness, how open are the schools. Right. And that is a challenge of integration, interoperability, flexibility, right? So this is kind of things that we need. So if if we, if, let's say, technology providers are more open, right, there are tools that they provide, would use open standards, and these open standards would make these tools to be more open, more interoperable and better integrated integration. And that is what I would say that this kind of concepts would keep zoom more kind of alive, let's say or some other tools, collaborative tools, right. If there is a lack of interoperability, open standards, and integration kind of easy integration, then I think we will have the tools will not have long lasting effect. And we we know that there was a lot of other digital tools used become the go because you know, it's hard to follow. And of course, there is also big companies, they have their own business models, and they kind of run their own businesses. So they don't want you to have an openness in the kind of tools. So I know it's hard to say about how long was specific to kind of last? It all depends how the tools evolved to keep up with pace with the society, the needs of the society, especially now with the pandemic.	**Rel-To**
37	Researcher	... we had a follow up question on that, but was how the major changes and collaborative tools affect the school from a learning perspective? So I think your previous answer covers most of that.	
38	Rsp2	Yes, yes.	
39	Researcher	So but how do you think like the primary schools adapt to these changes?	

40	Rsp2	Well, again, I will go back to my first answer. It's to keep up with the developments in terms of constant education of teachers as well, like professionals.	
41	Researcher	So what do you think are the five key aspects of creating a learning environment with digital collaborative?	
42	Rsp2	Can you give me an example? Why exactly five, it could be to two	
43	Researcher	It's like a maximum 5, we just kept a limit, like, you could say two completely fine.	
44	Rsp2	But what what what is the one aspects? Like? Because I..	
45	Researcher	Let's say like, one of the aspects would be like how students can effectively collaborate and like, actually bring out positive and like, productive results? Like, from your perspective, like, what could be the aspect like when creating these tools, and having these tools in in a learning environment? And how would they benefit the students? Or organization?	
46	Rsp2	I think it's with digital tools, we are already greatly benefited, as a society around the globe, I mean, you can see the impact of this last pandemic, and that people heavily use digital tools. And despite that, you, some want or some don't want to use digital tools. So ... key aspects are, I think, would be better engagement, maybe. And more intense learning with digital tools. That is definitely what what I think we could have, and why not better collaboration as well? Because you can, you don't need to collaborate only with your colleagues peers in the classroom, but you can do that beyond beyond that. So with digital tools, you are able to collaborate this different people around the globe. And that is something that we need to utilize it. So I think I provided three.	**Di-Co-Le** **So-Le**
47	Researcher	Yeah. and when you like made the technological tools, like, what were the aspects that you would like, consider that the tool should have in terms of having a good collaborative learning environment?	

48	Rsp2	Well, it's a lot. I don't know where to start. Like, if you can give me an example?	
49	Researcher	Let's say like the features of a tool, like what features would you add to the tool to make it the best, let's say,	
50	Rsp2	... for me, I would. It depends what kind of tool you use it like Is it like something like Canvas that we use? like learning management systems? Or is it like zoom? Like?	
51	Researcher	Let's say like learning management system? Like what would you consider?	
52	Rsp2	Well, again, again, I think I would go through the features, as I said, in terms of easy, easy to use system in terms of flexibility, for me is one, one thing that would allow you to not just concentrate only on one tool, but you could integrate other tools also in that tool. And the tools that you as a teacher think, would allow you to conduct your work in a much better way. Because you have experience on that. So how could you integrate different so definitely, I think flexibility is one of the features that either like canvas or like learning management or whatever tool, is there, flexibility should be one of the key features, that should be	
53	Researcher	Yes. So we will also want to get into the learning environment. And here we have a question that is in comparison to traditional learning, what is your view on creating a social learning environment through digital tools?	
54	Rsp2	I don't have that much of experience in that. But I can try to provide my my opinion on this. So... definitely, I think the digital tools and last pandemic kind of forced us to have a learning environment. Even though distributed in different like in a distributed setting where people participate from different locations, still, we as humans, needed some sort of social interactions. So yeah, I think it is possible it has proven it has been proven, but digital technologies can give us some sort of social input as well. Right? Your your home, but still you need your friends. You have a drink, or whatever. And, or you do the assignment at the same time. And even kids like four or five years old, they with iPads, they could play Lego in different locations.	**Le-En**

		So that is definitely happening. And this was again, kind of seen from the practical examples that we see on everyday news, or our everyday life what is happening with with this digital proof, so definitely. Yeah, it can be a good learning environment also in a digital settings.	
55	Researcher	The second question here is, what would you consider to be the primary benefits of using digital collaborative tools for educators and students and we have touched upon this a bit, but if you would say like the primary benefits if we take firstly the educators point of view, and then the students	
56	Rsp2	well, I think, I think we're now on we must have maybe we could not see him. I'm so sorry. We could not hear you. You were your connection was interrupted. Yet, but now Do you hear now? Okay	
57	Researcher	So to recap the question, primary benefits of using digital collaborative tools, we can start with educators and then we take students	
58	Rsp2	I think, easy to reach, right? Easy to reach. Easy to create the content, more easier to it's much more easy easier to manage the course content that you develop,	
59	Researcher	in comparison to having like papers.	
60	Rsp2	Exactly. Exactly. That is what I mean. So I mean, you have seen even for the consent form I didn't print out, I just digital version still works, right? So, definitely there is, it's easier. And it also kind of protects, let's say, the world, the world in terms of like not printing out, as you have pointed out. So that is what I think it's good.	
61	Researcher	Would you say go as far as saying that it's like the flow of information. So to say like, it's easier to	
62	Rsp2	manage information, it's much more easier to manage the information and to distribute the information in a structured way	

		as well. So in terms of teaching, you organize everything digitally. Today, even if we if I have a classroom with you, physically, I still will put all the content in some sort of digital collaborative tool where you would have different forums there for collaboration in a certain concept or whatever. So definitely. That kind of this kind of digitalisation enhances collaboration. That sense.	
63	Researcher	And then from a student perspective, what would you say is the primary benefits from a student perspective to use digital collaborative tools?	
64	Rsp2	So I think it's almost the same actually. They could keep up with the content, like the latest content constantly. With the peers. Right, you don't have to be at the same location, but still you collaborate with your peers with assignments, easy. Management of easily managing your, your, let's say, submissions, and grading as well like you see it in real time. Yeah.	
65	Researcher	Yeah, that's pretty much we have some conclusion or future research questions here. So to recap what we have discussed so far, do you think then that digital technologies, as you have studied them in the context of primary schools, primary schooling, education influenced learning? So I can try to dissect or. But, yeah, we want to know if what you have researched has influenced this, ... the studies that you have conducted Have they influenced how primary schools create their learning environment, so to say?	
66	Rsp2	So if I go back, not not nowadays, but go back to what I did, in this, let's see, case study that I have with this case, schools, I think definitely. The digital tools that we have provided, have definitely enhanced both learning and collaboration. And nowadays, with this more modern tools, I think that's definitely happening. But of course, we need to be careful when it comes now, especially nowadays with the privacy and security aspects of using this digital tools. Right. so these are some things that we need to be careful, especially in k-12 context.	

67	Researcher	Do you think that it has like become more secure, like a bigger emphasis on security than it was? Or do you think that it's better managed today? Just a curious questions like?	
68	Rsp2	It's a good question. I think back then we didn't think that much of security and neither privacy maybe to some extent. Now, I think a lot people are more aware of distance	
69	Researcher	because this is also like factor in the inter operability. Having like having a very secure system, you have nothing. So it's interesting because the studies before just to to understand where we are at today in comparison. But yeah, as you said, it wasn't as big of a factor than then than it is today.	
70	Rsp2	Yeah, because phones now it's a part of everyday life, take their production. When we were kids, like we have a TV turned on the whole day, right? Like almost, and TV was one medium. Now, at your home, you don't have only TV, but you have like seven mediums at least, or I don't know. You have a phone, you have one more phone, and then you have a smart TV, then you have your computer, then you have a smart refrigerator, smart bulb like lights, and smart everything. You see, I mean, in years, a lot of thing has been has been changed. And of course, when things change, there is more questions regarding privacy and security. Because the environment is changed. And in that case, also the learning environment is being changed, right? Because things talk to us, like Internet of Things, right? So in that sense. Again, privacy security might be sort of challenges that we will face because also people are more aware. And we have better regulations regarding these things that companies should comply with, or organizations or end people as well.	
71	Researcher	And then we have the absolutely final question here. And that is finally what is your suggestion of how primary schools should envision their future of digitalisation? And then again, we have talked about this in a way but if you would like to summarize your … How would you suggest to if you were in a situation to suggest to a school board in a primary education? How should they envision their digital future?	
72	Rsp2	I think first thing is that they should envision the digital future. Because we we will not go back to the same set things up to	

		this pandemic. Right. We will use more digital tools. And they should make better strategies in terms of digital tools, so they should have experts. In terms of okay, we need an expert that will guide us with digitalisation tools. I guess, I'm not sure if the schools have but I think it's something that they need to make a strategy on how to follow up with the newest technologies, and how these technologies will impact in 20 2030-2035 what kind of impact these technologies will have. So yeah, strategy development is something that the schools should have should think about the digitalisation	
73	Rsp2	it's here to stay and we will become more digital and that's for sure. Okay, even if you don't want to take the case, like okay, I I don't want to use Google services. You cannot use Google search. Okay, you can find some alternative. Alternative is the same, you cannot escape nowadays, you go to IKEA, they have all the section with smart lights. And I'm sure after five years, all the lights will be smart. So all of them will be connected. So we need to keep up with the development. So we need to have strategies in every kind of aspect when it comes to digitalisation.	

Appendix V: Rsp3 - Interview transcription

Respondent: Rsp3

Position: Associate Professor

Date: 16th April, 2021

Interview Duration: 43:51 minutes

Line	Individual	Questions/Responses	Theme
1	Researcher	In terms of digitalisation in primary school education, what do you think of the current process of using digital tools in the context of primary school, could you give a general and quick perspective?	
2	Rsp3	"I think it is an important part for children to learn how to use these digital tools, I think that school plays a good role model to show how these sort of like ipads, chromebooks, laptops and mobile phones can be used you know for sort of other things other than entertainment, it can be used for productive activities. They can be used for creating other digital materials, they can be used for exploring the world so I think it is an important part of primary school education. I think you know part of the problem in countries like Sweden and scandinavia is that the tools students might have in the classroom are really as nice as the tools they have at home, so they're sort of a dissonance between their school experience with the learning materials and the games experience of playing games and sometimes also the tools aren't used in the best possible ways because of lack of teacher training or lack of insight to how these tools are used. In general its a good thing if you need to sort of prepare the kids for what the future holds and to develop 21st century skills using this. But I also think that the traditional skills are also important such as social skills, physical space skills and other types of learning how to pay attention to another person, you know communication skills, it's part of what kids should learn. It's not the whole thing."	**Di-Ed**
3	Researcher	We get into the learning methods, especially blended learning. What is your experience with blended learning methods	

		in primary school education in comparison to strictly digital learning?	
4	Rsp3	"I think you can see in the last few months with the pandemic the importance of the social and physical aspects of learning you know that is important for kids to go to school and to interact with their peers outside of their family I think blended learning can also be a strong thing for kids because that means they can learn in their own pace, part of the materials. If you're struggling with reading you know then you can read it over and over again if you have a decent management system, maybe it can read it to you. So I think there are a lot of positive things about blended learning in terms of pacing and how you as a student interact with the learning material in your own way. But in the end of the day the relationship with the teacher and the student is the best way and much more important than the good material because you have a child that is struggling does not really matter how good or bad the material is, they're still not going to understand it. Or in the opposite way if you have an exceptional or gifted child, you should also be able to recognize that so you can give the child more types of materials. In Sweden it took a really long time to recognize academically gifted children if you were a gifted athlete, and you wanted to play table tennis there was a gymnasium for you. or even badminton or orienteering or skiing. But if you were gifted in math or science, it wasn't until 15 years ago that they established gifted high schools so i think ... there is a need to have blended learning but I think in the end it falls back on to the school, compared to digital learning which I think is problematic. Sometimes, specially when you do not have the learning skills.	**Bl-Le**
5	Researcher	Yes that is an interesting thing you point out, just a follow up here, according to your scholarly work what is your picture on what has been the best approach or what is your takeaways from your scholarly work	
6	Rsp3	My scholarly work is based more on Technological Enhanced Learning and sort of building interventions that originally started with sort of mobile activities so the idea was to engage students into sort of the real world with mobile devices, so to learn about math and science in the real world or engage with history by ... running around and sort of doing like a treasure hunt or 'skattjakt' or orienteering experience. .. My	**Bl-Le** **Te-Le**

		later work is more focused on computational thinking ... so it's involved a lot of physical computing and types of open ended design things, and there I think that technology can play an important role in those uses like that, you know education should be a place where people can take a risk and you can learn how to fail, because it is much easier to fail in school than it is in the playground playing sports or in your life. ... But I think on the flip side you know it is very hard to build a good digital system that you know ... sort of encourages you to sort of have what we would say academically as productive failure and so I think you know what I try to do with my own work is create those spaces where students can learn to sort of reflect on their actions and learn from it	
7	Researcher	That's an interesting point there a much of like computer systems is very right or wrong and that there is the potential to learn from failure and that is one risk when you implement some of the systems that is very black and white	
8	Rsp3	Yeah sometimes especially when you think about learning analytics and sort of basing some type of assessment and basing it on click stream data saying okay well Oscar always submits his papers at the last minute so potentially he could be a bad student according to the algorithm. Maybe they don't know that Oscar likes to work in the evenings or he has another job or you know he does his work and when he gets home he reads it over and then submits it. You know it can be very one sided, I mean it's not to say that teachers don't have bias right, algorithms that have bias are just a representation of the people that make them or the short-sightedness of that but I mean in the end of the day if I say that you're a bad student, that's my word against your word you have the right to say to me, you know **** actually I am a good student this is the situation but how do you say that to an algorithm when no one is really responsible to it. Is it the company? is it the commune that boarded it? Is it the system, the tool? So yeah, to get back to your point yes I think that there is a lot of benefits to adapt from personal learning, there's also a lot of risks in terms of you know shutting out the creativity and cutting off what makes school you know sort of a good place to learn, you know that's a struggle for a lot of kids today and so there is always these risks.	**Le-Pr**

9	Researcher	So circling to TEL, What implications do you see (through your empirical studies) TEL having in the learning environment of primary school?	
10	Rsp3	I think when I see sometimes the technologies that maybe when kids spend a lot of times using technology at home and that they spend a lot of time using technology in the classroom and they forget about what's outside the world. I mean Sweden is still a pretty good country for that because you can send kids outside you know and its part of the culture but I still think that sometimes the risk is that you know a lot of the stuff that you do in primary school technology, you don't need to do with a chromebook or tablet or a mobile phone you could do it with paper and pen you know or physical materials. So I think the risk is that we forget that, we become dependant on having kids have a device outside in nature when maybe its good to take kids in nature where there is no devices. You know they actually get the feel the park instead of take a picture of it. I think that especially for a younger kids because that connection to nature you know if you don't kind of develop that at an early age then you might not feel connected to nature later on in your life and it has huge ramifications for society, So I think that there is a risk for that, I don't really know how and the reason why I stopped making mobile kind of learning materials is i felt that, originally I felt mobile phones would sort of engage people over the world but you see it is sort of done the opposite	**Te-Le**
11	Researcher	Could you provide us with the examples of the collaborative tools for learning used by you in your empirical studies for primary schools?	
12	Rsp3	"I haven't done that much work recently but some but maybe like middle school would be better, say um we had a European project where we developed some type of like physical computing devices which you know children could easily sort of build interactive type and experiences, you know, it was designed in a way that you did not need to write the code by textual things it was a flow based language, so could sort of you know say I get a signal from a sensor like a light sensor and I could decide you know what to do with that in terms of a little bit of logic and then I can output that into an actuator like you know a motor so if it was, if the temperature got warm then the motor could move something or turn on a light or you know play a sound and these projects were about sort of engaging you know school children or older primary	**Di-Co-To** **Co-To** **Te-Le** **Bl-Le**

		school children to sort of explore you know different topics you know like that related to computational thinking so that was like you know understanding how to sort of do the logic to do a color sort or to build something that's responsive to light or sound ... or to make device drive around. So I think the mobile devices that was different I worked well I guess it was still Grundskola, we had a project where we worked with kids who were interested in gym class who were sort of like a mobile treasure hunt game you know like orienteering so instead of doing orienteering in the forest, Oscar will tell you the joys of running around as far I don't think you grew up in Sweden so you know the joys of orienteering you know its not always that nice for kids and we wanted to sort of create a situation where you could do with a more urban environment and learn a little bit of history but also get some exercise and so the idea was that it was a project with kids where you built games for younger kids. So it involved the computational thinking but it also involved the physical activity so the types of activities to do with younger children, that sort of engaged you know in the minds and in the body"	
13	Researcher	Can you let us know what the first tool was called and what the second was?	
14	Rsp3	"The first tool was part of this project that was called M-learn to Go, and it was sort of a mobile thing it was part of a larger project funded by the Knowledge foundation and about like young communications, it was part of this large project in Smaland and you know and Malmo that engaged children and digital technologies. The second project was called PBELARS, Practice based experiential learning analytics research and support, and that project was more about learning analytics but we developed tools that we used with all different ages of kids. I can send you the links later."	
15	Researcher	Why were these tools optimal in your studies?	
16	Rsp3	"Depends on how you define optimal, its quite hard from going from researching in the classroom there are many barriers in that partly because researchers don't always understand the needs of an everyday teacher in sort of the situation on schools, is also that we generally are pretty bad at creating	**Or-Le** **Rel-To**

		technology that's sort of sustainable and robust enough to you know become a product and thirdly you know teachers they have a lot of things they need to do and sometimes learning new things is not first on their list because they do not get the in-service training,.. so they don't have the time they have a lot of other things to do. So I think that getting technology into the classroom you know on the sustainable level you know that's good comes from research can be a little difficult, I mean you see products but generally they sort of been somewhat deluded by the time they get a wide-spread adoption and they might run into problems like interactive you know whiteboards which every school in sweden has and not a single one has ever been used. That's a little bit of an overstatement but its sort of an example. There is a nice book by this guy named Larry Cuban which I cannot remember the name that talks about this. So I think its quite hard as a researcher sometimes to get things into school	
17	Researcher	From a learning perspective or Organizational perspective, how do organisations learn as they implement new technologies and start adapting to it	
18	Rsp3	"Well I think it depends on the organisation of course I mean if you talk about you know like swedish public school its quite difficult sometimes in that sense because you know its sort of a long arch you know public entity, and sometimes its driven by teachers and by ... innovative schools. It's also driven by sometimes you know things like avi media or sort of in sweden there sort of government office that supplies the original materials to school in teacher training. Sometimes it's driven by universities as well in teacher training so I think it's a very complex problem because we need to innovate schools but for good or for worse, the innovation is slow because i think if you listen to a lot of technologists you know they have a lot of ideas that have to innovate education the thing is they don't know anything about the theories of it, and on the flipside if you listen to a lot of the people coming from education, they have a lot of ideas of education and very little ideas about technology so its a very hard thing to create innovations. I mean you can see that at the university experiences as well, it's still primarily like a lecture communicating one person to many and that group work can be sort of inter-	**Or-Le** **Le-Pr**

		active can be really frustrating. So Instead of buying an expert in I give a lecture about deep learning or I'm not really such an expert you know compared to somebody else. So to stream in or buy a module that is unheard of at the moment. But its changing there is a nice company in Sweden called Lubs education that I'm doing some work with, they make this type of learning management system that's more open and visual and students and teachers remix their own learning so I can take a course that you developed and re-mix it for my students. Or I as a student, I can decide how I want to learn so I think innovation is coming, it's slow but maybe slow is a good thing because you don't want to you know create a situation where there could be you know a problem with the learning system or group. There are cases where I built an intelligent tutoring system and I trained the data on one group of students in Lund for instance and I take the system and train those students and then I bring it to Malmo where there is a whole group of students it might not work for them. Its not like a book .... "	
19	Researcher	So in terms of relevance of tools, for how long do the tools stay relevant? How do major changes in collaborative tools affect the schools from a learning perspective?	
20	Rsp3	"That's a complicated question, I think in primary schools the teacher is the fundamental key so if you build collaborative tools, you have to build them with teachers. You have build them in a way that support the teachers, part of primary schools of course is social learning and the teacher has to have feel and powered and enabled and these tools have to help the teachers. ... And they have to help the students and they have to provide a safe and comfortable way for the teachers to feel secure you know in using them and ... Ettine Vegno who is a learning scholar wrote that ""learning happens design or no design"" learning happens technology or no technology, what you need at the core is the process behind it. You can see that many students that are coming from countries that aren't as wealthy as Sweden you know just as capable and sometimes more capable. Students that come from countries that have a lot of money, I mean Sweden's a little bit strange as it invests the most money in primary education in the EU. But you look at upper secondary education and	**Rel-To**

		gymnasium its the european country that invests the least money so you have this weird dichotomy so when you get to university a lot of the students are fairly unprepared because gymnasium was a bad experience. So even as a technologist I would say what's more important is the investment in people and processes. I mean technology doesn't help you if you don't have the understanding to apply in a creative and productive way"	
21	Researcher	How do you think the primary schools adapt to the changes? In a technological way	
22	Rsp3	"I think it really depends on the school and the culture of the school and the willingness of the teachers, you know some teachers I've worked with are very advanced, and very open and very innovative and some teachers they just don't have the time or the skill, I mean sometimes or the interest ..... there's a lot of teachers in Sweden that believe that technology shouldn't be in the classroom and they might have a point, but I also think that technology is very interesting and attractive to kids. And, I believe that school plays an important role in giving them other role models than their family, this becomes important across socio-economic minds because in Scandinavia we do not have a digital divide, everybody has devices but we have a divide on how people use these devices and if you come from a lower socio-economic background, you're only using the devices for entertainment. You're not using it to get knowledge to make informed decisions because you don't have any role models and this is what's most important about the technology in school because they can provide that. And that has a ripple effect, and the child goes like no mom let's look it online and do it this way. So there is ...that's the role of teachers and technologies. It's not important if you teach the kid how to program in primary school but if you can help the child to understand technology and try to use technology to make informed decisions then the child that wants to learn the program it can do that.	**Le-En** **Le-Pr**
23	Researcher	So like the relationship to technology or computation or what you want to call it this, kind of potential it has?	
24	Rsp3	I think that's more of the potential than the technology itself because that changes. Right I mean six months from now the	**Rel-To**

		new iphone12 you bought is old ... or Python isn't the right language anymore it Julia or Rust .. or Kotlin so I don't think that's so important, to me what's more important is that primary school teaches how to navigate the digital tools and how to solve problems using multiple means whether it's computational thinking or design thinking or systems science thinking or whatever. They should learn all of that and then it is up to you as a student to figure out what works for you.	**Le-En** **Or-Le** **Le-Pr**
25	Researcher	What do you think are the key aspects of creating a learning environment with digital collaborative tools? Also technological?	
26	Rsp3	"I think that the benefit is you can collaborate with a lot of different people, you can collaborate in ways to make it work for you, so if you ... like watching videos these tools can provide that way so I can take advantage of the fact that you might ... find easier to learn something from a video, I might find it easier that I might you know I can write something and I can get feedback, like if you think about learning the program, right, like some of these tools that you can learn to program online are pretty good because it automatically tells if you have a mistake. It's quite hard as a teacher to look over someone's shoulder and say oh you're missing a semicolon, ... but now with these tools, one can collaborate, one can share things, one can work at home like and add different things to it, I mean the principals ... of collaboration what's important not so much the tools but these tools give you that ability. Good tools can give you feedback or teach you how you give feedback in terms of peer review, that's also something that's important in school. And I originally went to design school you know every week we had our assignment, we hung it up and we had a critique ... that was a really great way to learn because you learnt how to get feedback and give feedback. You know I think that the collaborative digital tools could provide that and there are tools like Peergrade for instance you know which help students give feedback to each other so I thnk there is a lot of advantages to it and ofcourse a disadvantage is that you know cyber bullying or you know if I don't look you in the face and say I really disagree with you, like this is a really stupid idea. It's much harder to say that	**Di-Co-Le** **Di-Co-To** **Le-En**

		face to face right cause I have to think about ... I have to understand that there is a person you know sometimes online tools do not have that. There is also a need for that in education as well	
27	Researcher	So learning environment, In comparison to traditional learning, what is your view on creating a social learning environment through digital tools?	
28	Rsp3	I mean I always advocate for both, for children they need to experience both, I mean even for adults ... the social collaborative tools are really nice because it can connect children from all over the world so I can get insight what it's like let's say in the united states or you know all over the world.	
29	Rsp3	I think that's a really strong thing I can get access to experts so if I'm doing a project I can arrange for an expert like you're doing now, you don't have to travel to Copenhagen, we can talk over a digital mediated platform and I think that's a really strong tool. There's a lot of nice projects where children can do scientific experiments in real labs by controlling a equipment remotely. You know I can get a picture of what it's like on the other side of the planet or in space, I can hear the wind in Mars. So you know I think there is a lot of affordances to these technologies ... where people can come together. I can get knowledge, I can get different opinions, I can find out that the earth is flat or not.	**So-Le** **Le-En**
30	Rsp3	But there is also the disadvantages of like learning how to decipher what is misinformation and propaganda. It could be a look learning experience, turns out that research done that a lot of kids are pretty aware of this, much more that adults think but that doesn't mean that they fall victim like you know anyone else. So I think that it's okay that it's dangerous, you know we need sort of risk in the world, children have to understand that there is the potential of danger out there and that it could be a good way to do it whether it's like virtual reality or using these materials to discuss them in the class or investigating them.	**So-Le**
31	Researcher	Another question here, what would you consider to be the primary benefits of using digital collaborative tools for educators and students from a learning environment perspective	

32	Rsp3	"I think its that sharing a material, you know the feedback and getting help. As we build systems that provide analytics then as a student or as a teacher I can either support or either self-regulate. I'm just attending the learning analytics and knowledge conference which is a conference that looks at tools like this. .... If we look at like how do we support lets say women in STEM subjects, you know you can support them by having more women mentors or you know you can support them by putting them in groups that can be more supportive but you need the numbers, you need the analytics you need the collaborative tools to provide that so it has the potential of providing those sort of information for better decisions about how to organise, support and make better learning experiences. Just from kind of a analytics or process perspective but from a social perspective of course, I can find people that can help me or I can learn how to help other people, I can get additional information that might be beyond the knowledge and skills of my teacher ..... I can organise things in a way that can work for me, so I think there is a lot of advantages, even for younger children to get support or offer support or to like identify patterns that might be disruptive then figure out how to make the correct intervention but it's complicated due to the ethics and the privacy and the ownership of the data and the risks of that	**Te-Le** **Le-En**
33	Researcher	To recap what we have discussed so far, do you think then, that digital technologies as you have studied them in the context of primary schools' education influence learning?	
34	Rsp3	I think collaborative technology can definitely support education, as I said in the beginning I think it's more up to the, it has to be done in a way it empowers both the teachers and the students. As opposed to like solving a pain, I think learning is a difficult task you know and technology doesn't make it easier, it just makes it more effective. You still have to carry the baggage yourself as a learner, you still have to put the work in . But I think the technology can you know find ways that it could be better suited for you or better ways to support you or on a social side, better ways to make you feel you belong. Because if you feel like you belong and you get value from	**Di-Co-Le**

		the education and you're likely ... to pay more attention and to get better results.	
35	Researcher	Finally, what is your suggestion of how primary schools should envision their future of digitalisation?	
36	Rsp3	Well I think I'm going to opt for a kind of a swedish concept of consensus a little bit, but I think what's really important is that these decisions are made by teachers and students and parents and researchers and not just by any one party alone, you know and society. I think I can envision a future with technology but I'm not a primary school teacher, I've taught some classes in primary schools, my parents were teachers but it doesn't make me a teacher, doesn't make me an expert. And I think what's really important is we have to think about you know the real problems that existed in the everyday classroom, not the perceived problems we might see from the outside as researchers or technologists or companies. You know while we have to solve those problems ... those are not trivial right, those are much harder to solve and ... creating a learning management system that predicts a student's performance based on clickstream data which is only a small part of what is happening in the learning experience. So I would really sort of opt for much more sort of a participatory, consensus driven sort of approach to figure out what is exactly needed in the classroom for primary schools, what is actually important for children to learn. It may not be about technology we have to also you know admit that it might be about social interaction, might be more important for younger children. Or it might be learning how to use technology in a different way than other than entertainment	**Or-Le**

Appendix VI: Rsp4 - Interview transcription

Respondent: Rsp4

Position: Associate Professor

Date: 22nd April, 2021

Interview Duration: 40:37 minutes

Line	Individual	Questions/Responses	Theme
1	Researcher	What do you think of the current process of using digital tools in the context of education at primary schools, particularly Sweden, give a general and quick perspective?	
2	Rsp4	Well, I think the digital technology is being used quite well, to the large extent within the primary school sector, it has become a tool of both the teachers and the students. Nevertheless, I still feel that a more comprehensive systemic perspective of the impact of the integration of the digital tools within the overall learning process needs to be made. Secondly, I think there are other issues more technically related to interoperability of the different tools and the providers because the regions in Sweden, as far as I know, they have their own autonomy to decide about the service providers. So some regions might have gone with Google. Some with Microsoft, and that greater diversity on also the learning platforms, as well as the tools that they use in, for example, there is a use of Google services and the Google Chrome is the actual device that is provided for the students the in the primary school center. I think, to a large extent, it is good because we need to be working with digital natives and educating the primary school but overall, I think there is still need the research in ordering to see what are the systemic perspectives in terms of adoption, integration and the wider impact of integrating the tool, the approach of just giving a laptop out to a student without having a full strategy of integrating multiple services, a doubles application might not be the right one.	**Di-Ed**
3	Researcher	So going out, further, getting into learning methods, what's your experience of use of blended learning methods in primary school education in comparison to strictly digital learning?	

4	Rsp4	Well, I can't say that they have much experience on the blended learning, at least not during the period of the pandemic, that it has been mostly a necessity to be used. In the previous research project where they had the blended learning, it was more an exception rather than a rule when it comes to the education setting. The blended approach was typically combined with some sort of case study or outdoors activity where we needed to collect the data and gather those data and reflect afterwards in the classroom. So I can't give you a more kind of in depth perception. With regard of the primary school, I have a far more knowledge when it comes to the university teaching. But I guess that is out of the scope of your question.	**Bl-Le**
5	Researcher	We are interested in your scholarly work and we can we can go we can just talk a little bit about higher education. But like, according to your scholarly work, what was proven to be the best approach, even though it's higher education?	
6	Rsp4	The best approach is the approach that secures kind of students engagement, that's the most important for the learning to happen. So for that reason, you need to see the technology as a facilitator of the engagement, not a purpose in itself. So, from my point of view, I would say that the best approach has been the blend, where you might have parts that are not so engaging, which could be for example, lectures and readings and exercises that do not ask for too much interaction between the teacher and the student. Because predominantly, for example, in the lecture, in the best case, you might have 2,3,4 questions, but not much. So there is a little interaction. So I would outsource that completely through the digital mode. So why not record a half an hour or 45 minutes instead of having to drag to two hours lecture. Students can watch it at home at their own pace, whenever they have time while waiting for a bus while preparing dinner, whatever. And actually, you have a hands on workshops on the topics that has been presented in the lecture in the in the classroom. So the blend works when you have the activities and interaction in the classroom, while other parts that are not necessary that much engagement for the students they can be with a mean of technology being outsourced. If I can use that, yeah, we have to understand that we understand them. So that is from my kind of current point of view. And it depends, of course, it's not a single approach that fits	

		all the problems. There's no silver bullet solution, it will depend a lot on the teacher, it will depend on the type of course, type of the students planned activities, how the blend should happen. It's not that yes, you just flip the classroom and it will work fine. No, it doesn't work like that. So, you need a bit more profound and individualized solution for each cases in order to reach the maximize and maximize the effect of the learning experience.	
7	Researcher	So in terms of technology enhanced learning and collaborative learning, what implications do you see through your empirical studies TEL having in the learning environment of primary schools?	
8	Rsp4	Technology Enhanced Learning in the primary schools and in my experiences, have been primarily based on helping the students to to conduct inquiry based learning regarding scientific aspects in like biology and so on. And that has been very much facilitated through the technology, so data collection activities, etc, but I cannot say that the collaboration aspect has been technologically facilitated because they have been all the working in the groups and together and as they have been moving forward, so them had the kind of the sensors to do the probes to measure the pH value, some of them have the phone to kind of record that. So it was not technologically facilitated interaction or collaboration. So the collaboration was more in real life, while the activity has been supported with inclusion of the technology to support these particular activities. And in that case, we have seen a very good feedback because the technology has been very supportive, because students nowadays are quite fluent in, in the digital devices. So remove all of them from the need to write in a piece of paper and pen but easily kind of typing the numbers and the readings from the sensors in a in a mobile phone app. They could be quite far further and fast. And offering through technological means an ability to aggravate those data so they can when they go back to the classroom reflect upon that was also an added value. But we didn't have at least the my experience any collaborative instances where that has been technologically facilitate.	**Te-Le**
9	Researcher	But could you provide us with the examples of like we had a question about collaborative tools, but the TEL related tools that you guys used in your studies on primary schools?	

10	Rsp4	I haven't continued looking into this further and I have no research done on fully digital education in schools. So, I don't have any experience in terms of neither doing research or working with it myself. So I wouldn't be able to give you an honest reply on that.	
11	Researcher	Could you provide us with the example of the technology enhanced learning tools that you guys used for your studies?	
12	Rsp4	Yes. Well, there have been a different tools, but I recalled here in the previous answer, it is about the let's go project which has been using the technology open source technology developed by University of Washington, which was open data kit software, which is a data aggregation software base for Android phones. Then we have using Google services in order to visualize all the data and we have been using Microsoft powered classmate PCs that has been supported with number of probes, though the subjects the students can work with the sensors and read the sensor values that they couldn't be after typed into the application and Android phone.	**Te-Le**
13	Researcher	Can you elaborate more on like why these tools were the most optimal in your studies?	
14	Rsp4	Well, we I cannot say that these tools are the most optimal for the study. But we have designed the activities and the best tools in order to support and facilitate that activities plan together with the teachers seems to be the application that I just mentioned. So basically, when we work about talk about technology enhanced learning, I would say that it's important to see it from the perspective of the learning is not the technology that is the driving force. Technology is the facilitator of the learning activity. So basically, you design the learning activity with the teacher. And then you can see which parts of those activities or the total activities can be facilitated by the means of the technology. Because if you have the other way around, that you have a technology and you need to push it down to the students. That doesn't work. It might be fun, but it's over engineering compared to the purpose of having a more learning, because now we could give the students a Chromebook. You can give an iPad and you can give a phone. But they will not be using all of these tools for the purpose of learning. So right now, maybe only the Google Chrome because it's integrated with a Google Classroom provides the sufficient technological means because more technological means more screen means distraction. And that would be contrary	**Te-Le**

		to the what the learning purposes.	
15	Researcher	How do organizations learn such as when they implement new technology and start adopting and adapting to it?	
16	Rsp4	How do new organizations learn? Is it on general for organizations or for educational organizations, to schools?	
17	Rsp4	Well, I think the most important aspect is to work with the actual users of that particular technology. If you try to enforce any piece of technology without consulting and working with the users, the chances for failure will be much harder. Because you, you, we have now the capacities we have the capabilities of all the different technologies and devices. But if we don't have the students and the teachers capability of making use of that, we have a preference discrepancy of knowledge levels on the use bar, which will be kind of contributing to the potential failure. So I think it's very important that the introduction of the technology in the learning processes is basically a bottom up approach, not an up down. Not that we make a decision of that from now on, you use iPads, but rather to see from the bottom up what are the Of course, I cannot say that you can ask to each one of child individually or each one of the teacher, but you need to have a sense where the overall average of the potential users of the technology lies and make use of that. Because it will, it will be given too much of the support demands, which will generate a lot of costs for the schooling system in general. Because if the users do not have the capabilities, they might have troubles actually using and with improper use that may cause more trouble than actually the benefits. So you need to have the systemic perspective of what are the effects of wrong design choices in the interaction of the technology within the learning organization.	**Or-Le** **Le-Pr**
18	Researcher	So what would you say is learning from an individual perspective? How do kids learn and start using these systems? How would you say that, that functions in primary schools?	
19	Rsp4	Well, I think there are two dimensions that you need to kind of see from the perspective of learning is the first one is the engagement. And the second one is presence. So you need to have a technology which enables the student to be present in the learning, but also technology engages them. Because if it's boring, they will lose interest. But if it's like completely immersed, they will be immersed in that and those presents.So those two dimensions are quite important	**Le-Pr** **Te-Le**

		the the engagement and presence and sometimes they might be contradictory to each other. So trying to find a balance between those two is the key of having a successful learning experience for the students. Because this, for example, if I may, there have been studies now, recent research with regard of the use of VR, virtual reality. And one of the study has shown that the students actually learn less, they are less engaged, but more present, because they are immersed into the virtual reality, it does not necessarily support the learning, and their cognitive load is much higher. So you need to kind of balance out things in order. There is not more technologies better, more, the better is not true. So you need to have a balanced perspective in order to see how the bits of pieces fit together in a meaningful scenario. So for that reason, is the pedagogical strategy. instructional strategy is so crucial to be an underlying strategy for the implementation of Technology Enhanced Learning scenarios, where it's really interesting that you can't escape the human factor. You have no but I think the the what we do whatever we do with regard to technology, we should always have human in the loop. Doing the technology for the sake of the technology is not will not necessarily advance.	
20	Researcher	Do you see any challenges of implementing digital technologies from a technological perspective in primary schools?	
21	Rsp4	Well, yes, of course, there are both non functional and functional difficulties, the non functional is that more deal with aspect of overall infrastructure, then we have this GDPR, how to handle those aspect when the storing of the old data, then is the aspect of interoperability between the platform's devices and so on. And the last known place is also the ability of students to actually get into the use of technology itself. I think, nowadays, the, the youth, the teenagers and the younger, are quite familiar, because they were born in a time when the smartphones have been around so they are. they perceive that as a natural technology for them, while compared to my time, and natural technology has been a regular form, you know, with the wheel that you need to turn on. And for them, the first thing in order to interact with the technology is touching. For me, it was not. So you need to understand that the sort of the paradigm shift in terms of the interaction models that have	**So-Le** **Le-En** **Or-Le**

		changed, and you need to take to account that into the design of the technological solutions as well.	
22	Researcher	So in the context of relevance of tools, how long do you think those tools stay relevant? And how do major changes in these tools affect the schools from a learning perspective?	
23	Rsp4	Well, adoption of the tools it takes time, but the the resistance to the adoption of the tools can be usually a problem for the this kind of system to succeed. And from my point of view, I would say that nowadays with younger students, as we see that adoption will not be a challenge. It will be more with the teachers part, to see how to adapt to this ever changing technology because one thing that we need to keep in mind is that the youth have a different speed when it comes to the digital literacy compared to the adults, which are typically their teachers. We might have a technology but after two years that technology becomes boring children has moved on to different kinds of technology. So in order to keep the engagement level, you might need to consider upgrades. But these upgrades will be costly, both in terms of technology, but also in terms of the resistance from the teachers to use them. Because the teachers at my age or even older, they have a resistance to move outside the comfort zone. And we need to understand that this technology enhanced learning but also with the digitalisation of a society, the only constant is change. So there will be a constant perpetual need for change. And sometimes some people are more flexible to change. Some are not the same as with the systems and organizations.	**Rel-To**
24	Researcher	So I think you answered the other question we have they help primary schools adapt to the changes?	
25	Rsp4	Well, I don't know per se, because I have been not working in the primary school recently, but I can see a lot of challenges and I think that we need to understand it the primary school there is a generation gap. And this generation gaps actually reflects on the digital literacies. The children nowadays are quite frequently they type very fast on the on the smartphones using this what is called Snapchat TikTok or whatever, apps that they use, and i can't keep that speed. So there is a discrepancy on the abilities that are driven using the technology.	**Or-Le** **Le-Pr**

		So for that reason, the adoption time is not a singular variable, but effects of multiple variables both on the teacher side on the student side on the policymaker side. So it's for that reason, I mentioned in the beginning that we need a bit more systemic perspective on this. Because sometimes, some teachers can be very kind of refrained to use an introducing new technology, some teacher are more innovative, they keep introducing it. And that's great. Also the friction between the organization themselves. Because some teachers become more cooler, some teachers become less cool. Some teachers that is using more technology advancing in a cool way becomes more popular with the students, they will not become so it can have a multiple level implications in the the schooling system, a lack of strategy of how the adoption should be best reported.	
26	Researcher	So what do you think are the key aspects key technological aspects of creating a learning environment with digital collaborative tools? And could you also talk about the technological aspects that would influence?	
27	Rsp4	Well, the I think, first and most important that I see it right now is our lifestyle. lifestyle requires for us to have introduced the digital learning tools. Second, I think that the need of having right here right now access to the learning content implies the need of the use of the digital tools. So I think, overall, the learning experience and the teaching experience has changed over time. Now, before a school was both an activity and an object, so you went to school to learn, but nowadays, the physicality of it has been disappearing. You can learn at home, you can learn by waiting for a bus, you can listen to a podcast, you can listen to an episode on YouTube or vlog or whatever you want. And all this are as a part of having access easy access to multiple screens.	
28	Researcher	Yeah, more like in a technological aspect. What key things would you look for in a digital tool?	
29	Rsp4	Okay, the from the technological point of view? Well, I think the most aspect is the usability of the tools itself. First, ability or interoperability of the tools to be able to exchange and roam between the different system platforms. And so accessibility of that to be adopted. To the format, the news and other aspects is security. So how to handle the data are secured. And because as you know, I don't know if	

		that applies in, in a primary school, but to the university world, we are obliged to make sure that we can examine rightfully a person. So the security of the examination need always to be prevailed. And that has been a main challenge during the pandemic time of making sure how to confirm the that we are examining a rightful person. If this would be an exam, what would you know that I am **** And what would you know that I'm not reading from somewhere? So it's very difficult. So for that reason is the security aspect is quite important.	
30	Researcher	And building on that a bit in comparison to the traditional learning, what is your view on creating a social learning environment through digital tools? That's kind of what we've talked about, but creating the same environment? Is it what we want is we want to create, do we want to create what we have traditional traditionally to digital? Or is it something else we need to think about?	
31	Rsp4	Well, I think we need to rethink, it is not so easy just to kind of see how you do it, and you work you write on the whiteboard. So we make a digital whiteboard. It's not that simple. I think that you need to see the complete purpose from us in order to increase the efficiency, but also the levels of engagement. And I think, personally, I believe that the social learning can help. And especially in the among the youngsters we're together, they collaboratively construct new knowledge as they move along. And I think that ability to create tools and platforms where they can share, discuss, question each other about the lectures or about what the phenomena they have been investigating is a good way forward. Now how this social platforms for enabling this collaboration on this should work, I think we should learn from the mainstream social media that makes the children and youth adult so addicted to so the ability to use the top of like, top notch technologists, interactions, ability to adopt the language to different multi concerns, et cetera, that are very much a useful could be because I believe that also could help the creativity of the students themselves.	**So-Le** **Le-En**
32	Researcher	So yeah, this is kind of a follow up here. From an educators point of view, what would you say is the primary benefit?	
33	Rsp4	I consider myself as simple as a teacher, the primary benefit will be ease of communication with with a student, you can access distribute contact students at any time at any place and still be able to continue with a learning experience, which makes it so important, especially in the time	

		where nowadays we have seen, especially during the pandemic, that objects, the facilities themselves, do not necessarily secure the learning is the people activity interactions and communication that enforces that. If we would not be in the zoom, we'll probably have difficulties organizing these kind of meetings for you to conduct the study. So for that reason, I see that it's the ease of communication is so crucial for learning. The other part that I think it's also quite important is the content part, the reusability of content. It makes much more easier in the digital world. Because I believe and I think that there are research indicating that the future is not about more content that we produce, but smarter to be reused nowadays I'm reflecting on the university level, you can watch a lecture from an MIT researcher, Harvard or Stanford researcher, at YouTube, and so on, which means that you can basically get a top notch great research lecture on any platform at any time. So basically, the content production will not differentiate that much, I might still teach the same course with the same slide that **** teaches in the same course, in Lund university, I can't say that you are doing the same job, ****, maybe you'll be much better in creating an engagement atmosphere compared to me. So the future will be on, not on the content production. So technology will kind of remove the content from the equation of the learning experience, but it brings a new one, teachers engagement. How we as teachers are able to engage with these kinds of digital platforms in order to provide a very engaging, interactive learning experience for the students.	
34	Researcher	Would you say it's the same for the students? Are those things that you just said? Are those also the primary benefits for students? Or is there something else for students to think about?	
35	Rsp4	Well, definitely the communication is a benefit. Second is a benefit is the ability to have their work saved constantly, because it will be stored on the clouds. So they will not be Oh, I missed my notebook, or I forgot this, or I forgot that. So it's a it's a convenience, I will say, of the use of the technology. But also, we need to understand that the technological tools will have the serendipity effects, they will provide the students with new learning experiences, maybe that are not thought of, they will find a YouTube video while they were researching for something and that will contribute. So with the technological tools, we provide them with a gateway to new knowledges and so on. The	**So-Le** **Le-En**

		problem that is also the technology bring is that the quality of information, because not everything that there's an internet is true. So that brings also a bit of the challenge of like, Oh, I have read this on internet or somebody, a YouTuber has done it like that, that does not constitute a truth. So we need also to invest more time to kind of have the ability of being self critical. Okay. Not everything that comes to your computer screen is true. And not everything that comes to your computer screen is believable. Yeah, and as a student to navigate in that is, of course, a maybe a bigger challenge than for some educators who are Yes, of course, because the the thing is that as educator, you are used to kind of value the source of information. Yeah. In order to assess the trustworthiness of the piece of information, compared to the student as well. A Youtuber did this because that is more than the entertainment part. And in the entertainment part, there are loose regulation, what you can say and how you say it, and so on.	
36	Researcher	So yeah, we have, we have a final, we're gonna wrap it up. And finally, what is your suggestion of how primary schools should envision their future of digitalisation?	
37	Rsp4	Well, yes, I think it's big but also crucial questions. I think the schools primarily should not see that digitalisation of primary schools and educational system as an independent entity, they should see it more in the functional digitalisation of a society. And as support of that strategy, they also need to see what are the benefits and the cross fertilization that can be reached between different disciplines when it comes? How that should look like I'm not sure that I can say it for now. But I know that why, how it should not look that it should not look at investing more money on the pieces of technology, like just buy more bigger screens or better laptops and so on. That is not necessarily the solution. The solution is to think through activities, learning and pedagogical instructional strategies that the teachers are used. And last but not least, is The digitalisation without the training and the competence development, that the the educators might be prone to failure. So it's a it's a multi dimensional problem space that needs to be investigated. And also it needs to be found a solution that is more systemic rather than individualist striving for innovation. Because yes, I can introduce a new tool in my class, my students can be happy. Of course, we can say that we are digitalising, but if that solution is not properly propagated	**Di-Ed** **Or-Le**

		throughout the rest of the system, that's an isolated motivation that is prone to failure.	

Appendix VII: Rsp5 - Interview transcription

Respondent: Rsp5

Position: Professor

Date: 26th April, 2021

Interview Duration: 61:02 minutes

Line	Individual	Questions/Responses	Theme
1	Researcher	Okay, so the first question is, in the context of digitalisation in primary school education. So we start off with a broad question. What do you think of the current process of using digital tools in the context of education at primary school, particularly in Sweden? Give a general and quick perspective.	
2	Rsp5	This is not a new challenge or new topic. Already. If you look back in time, Samrachna, you may have a problem with maybe I don't know, how are your Swedish skills in terms of writing or mostly reading, this issue of digitalisation of Swedish school is not new. Back in time started, even when I was in school, but in the last 20 years, if you look in the beginning of the year 2000, it was a program called ITIS that was mentioned as IT in Schools, in Swedish IT en skolan, and was launched by the Minister of Education and skolverket. That is a National Agency for education in which almost every teacher but many of the teachers that were given a laptop to start working with in their schools. But it was not it was a much more top down approach this Okay, here is technology we're giving you but you have no idea. I mean, the teacher said What on earth are we're going to use in this world? Because it was not user driven or process driven was more technology driven. Because Sweden, for the last 30 years, has the goal always to be an IT leading nation doesn't matter, is it in health care or IT in education. So it didn't work so well, you there are many reports. Because there was not a need from the teachers about how the digitalisation should take place in schools to replace some of the processes that could be improved by adding information technology. So this created the many other prob-	**Di-Ed**

		lems, because this is this is comes to the core business of informatics because this organization organizational learning technology, process oriented workflow. So if you meet people that they are not skilled to use something when they are not clear picture about whether it's going to be improving the work, it creates some work overload so it didn't work so good. So as other fields starting to improve with IT, so suddenly, some 10 years ago started with programs for teachers competence development, so to increase their digital literacy skills to try to understand why this is needed. And this is what we are now a little bit accelerated by COVID. Suddenly, the combination of all these variables and the possibility of not being able to run sinks on site. But it's more like the need is bringing to the teachers their idea. Now we need to use nowhere force. But why you should use information technology. But still, for me, the processes, the challenges, in which way teachers can see that part of the processes that are doing in terms of learning, teaching and content management could be used to improve what they're doing, because in many cases, you will see that teachers are replicating the use of technology for what they have been doing before. For instance, instead of giving away paperwork or text base books on paper, now they're just uploading PDF files or such as things instead of doing annotations or learning analytics. So there is a good there are good efforts underway, but there is a lot of work still needed to make teachers aware of what the technology could be used to improve on which new problems are generated. Because I can give you with a concrete example. If you have textbooks that are interactive books, or your teaching now, kids from age from grade six to nine programming, because now it is in the curriculum is obligatory in the math curriculum in Sweden for children, grades six to nine to learn programming. But teachers are not aware of that. About how to they don't know first programming. This is according to the law already since July 2018. But not many people In what programming things, especially in Python that is written in the national curriculum, they have no idea how to assess that. And they have no idea how to use it in the classroom. So there are many new challenges that teachers are faced with, for things that they're not skilled to do so it's good. But also, there is a need for doing teachers competence, development, for working with new skills, and also a little bit of visionary work about what is the what, which are the future roles of teachers, principals, and other people in educational system? So I hope this answers they give you a little bit. My insights, I'm trying to combine those what's happened in the past, what has been happening in the last 10 years, and what may happen in the future	

3	Researcher	Yeah, that's a very good picture of the current situation. I totally	
4	Rsp5	because I can I can give you another link. And I don't know if you have been in contact with something called the Swedish ethic industry. No	
5	Researcher	No, I don't	
6	Rsp5	I'm going to, I'm going to give you this because this is a national, like a branch or like a sector. This is a new branch organization that is called the Swedish educational technology industry, and already brings together more than 100 plus companies that they're developing digital solutions for schools. But you should look at them because they have this very idealistic view that information technology is going to revolutionize everything. And it's good, because you see, if you look at the bottom of a page in Swedish is written, our view is that Swedish will be the leading country in this blah, blah, blah. So this is again, my	
7	Researcher	Grand vision	
8	Rsp5	Exactly. So ambition, but but the issue is how connected he is to the reality of the schools. And even in the Swedish schools, there is a kind of aristocracy about our the schools in the big cities, or the schools that are under private regulation, even if they're public, because also there is something in Swedish, i don't know, let me see. ..... Yeah. So in Sweden, we have private schools, that they don't cost anything for the parents or the teachers or the students because they're paid with public funding. So they have access to technology in one way public schools, administrative, but municipality money they have other way. And even rural schools, in the North of Sweden, before COVID in places like Dorotea, something in the very north, since there are not enough children, and there are not enough teachers, people have been running online teaching in the school before COVID, because they're not teachers. So they there is no other way you cannot drive children to 100 kilometres to the closest town. So it's also a major difference between the different schools and even the the social and geographical aspects of the school. And Sweden is a very advanced country.	**Di-Le**

		But you need to think about this, because it's not one view that all the schools are the same in Sweden.	
9	Researcher	Yeah, you also want to offer the same quality among all schools. That's also the vision of the Swedish school system like they want to have.	
10	Rsp5	And this is a this is a philosophical foundation of the school system that we should give everyone the same opportunities. But the way it has been developing, if you look in the major gap is what is called the digital divide. In Sweden, if you look even at schools that are mostly with immigrant children in problematic areas, like in Rinkeby, in Stockholm, Rosengard in Malmo, I cannot say 100%, for sure, but I think that they're not as well equipped with access to technologies, other places. So this vision that everyone has the same is much better than other countries, but it's not as good as the political system should like to be. So my message is, try to be very critical in not presenting a monolithic view about what Sweden is because this is part of the Swedish. Very good marketing of showing a view about what reality it is not. And if you want to know a little bit it's a it's a nice view about even Swedish people looking at Sweden. If you look in YouTube, the Swedish theory of love If you haven't read if you have seen these,	
11	Researcher	No I haven't but I will look into it	
12	Rsp5	But Oscar, have you seen this movie? I have not. But this is a very critical view about Sweden as a society, from people from Sweden. And just to give you some numbers, three years ago, 25% of all the people that died in Sweden, no one claim, no one came to claim their body because they were living very, So independently so Sweden has a very this characteristic to try to show a nice and naive picture, but it's not so nice. It's very well planned, that things were very nice. So we need to be very critical. So it's also my message to you also. So you cannot do a master thesis, a doctoral dissertation, but at least try to think, as critical as you can show.	
13	Researcher	Keep in mind, the culture, the	

14	Rsp5	Exactly, the culture, and also that sometimes the goal does not justify the means. Because if you look at the Swedish tech industry and say, well, Sweden should be the leading country, blah, blah, blah. Which metrics do you use to prove that? And how do you apply these to your own country when there is a major difference between children in Rosengard and the Malmo and children in Djurgården than outside in the nicer of Stockholm, this is the same country, all of them, they have public access to school. So these are things that, at least you should think about, because you have the chance to do it. And you don't represent the news sector, you you should be quite neutral in what you write. Yeah.	
15	Researcher	So getting into the second question here, it's about learning methods, under specifically blended learning, what's your experience of blended learning methods in primary school education, in comparison to strictly digital learning?	
16	Rsp5	Honestly, I don't have any recollection of facts that blended learning has been applied in primary school elementary schools before COVID. Yes, in some way, if you if it's a school outside Stockholm, called Sofia Hemet, that they were offering access to learn into Swedish people working abroad. So they could be a little bit online. But for my experience, at least in the in the south of Sweden, I don't recall many places doing in elementary school, blended learning. Some years ago, 10 years ago, one of the local schools in Vaxjo where I mostly work, there, were starting using an LMS in sixth grade that was at that time was like, they started to use Moodle as a way to communicate with the students with the children. But they never was to replace the physical meetings. So was in ..computing, in a sense, as an added value, but I don't recall, I'm not Wikipedia. So I don't recall any school working with blended learning in elementary school. Before before March last year, I can imagine that and I think can imagine all the school system since May last year, was forced to work in blended learning. And now even some one to sixth grade schools. They also because they were forced to close because children getting infected with COVID.	**Bl-Le**
17	Researcher	And we were just a follow up question, since you've done some research. According to your scholarly work, what was proven to be the best approach would you say in terms of learning methods	

18	Rsp5	In terms of learning methods, and again, my experience is mostly within the field of STEM that this stands for science, technology, engineering and math. This is the subjects we have been working for many years. I cannot say nothing yet, because now we're starting to work into social science Swedish language. So in Swedish language will work but not the in social life in science or geography. But what it works are methods that they use. IT as tools to promote innovation and especially theories like, discovery learning, social constructivism, Problem Based Learning and challenge based learning. So we provide a subject to be explorer as the challenge, and then need to find what is the main problem to be investigated. And this is very different from problem based learning because in problem based learning, you give a problem that needs to be solved in challenge based learning, you give a challenge an area that needs to be identified, and one of the goals is to find what the problem is. So it's very different. But in all these methods, which is more those mentors provide providing a kind of scientific approach to, to explore things, IT tools are good. And especially, I'm not talking about Office package what I'm talking about simulation tools, using sensors. being actively involved in doing activities outdoors, I don't know if you had the chance to read a little bit about what we did.	**Te-Le**
19	Researcher	We're familiar with	
20	Rsp5	with, even in one of the projects, even ***** was involved with me when he was doing his **** in doing measurements outdoors visualization sensor work. Yes, so. So this is if you want they could I could share site in which we have more than 20 short themes that they describe summaries of work that you can look later. Here you can find the kind of taxonomy if you want about in which ways which methods could be used with which technologies	
21	Researcher	That's great, thank you	
22	Rsp5	that they go even historically, if you look at this page, you could see even movies from like 10 years ago, you've seen in math, and then another one I can give you also. Because here we have these two is still that they're willing to share their two movies, they're a little bit very more digital storytelling in the field of history and Swedish language.	

		So so but there if you look a little bit, and again, these are research projects that they were more ambition in how the future could look like. These are not big scale was even if we try with 500 children is very different to 100,000. So it's a very different type of research. But yeah, definitely. But still you can see it kind of kind of patterns about okay, which are the learning approach or methodology, which are the technologies and which can be done.	
23	Researcher	Okay, so moving on to technology enhanced learning and collaborative learning. What implications do you see through your empirical studies TEL having in the learning environment of primary schools?	
24	Rsp5	In which sense the implication from which point of view a research point of view from the school's point of view?	
25	Researcher	Yeah, fom the from a research, IS researcher point of view	
26	Rsp5	Okay. That the ultimate solution from a Information System point of view will be, again, I am not myself an IS researcher. So I'm more in the field of computer science and media technology, but still I'm very familiar with the field of informatics is that when you conduct this type of studies, you should have a kind of multiple stakeholder point of view. So you have who are the different actors in the scene that you're exploring, like? teachers, students, policy owners. So if you're familiar with the notion of information ecosystems, so that view and also more systems thinking point of view that is pure informatics which is okay. Which if you see the whole entire scenery as a learning ecosystem, because this is the way things .... work today, you have software ecosystem, applications ecosystem, if you look at learning as an ecosystem, then you have the different components, you have the organization apart, you have the theological part, you have the logistical part. from, from an Information Science point of view, what is what has been missing is more like the business model point of view, like if you have all these things working together, what is the business model behind that and this is now crucial, because in all these examples that I told you before from this ITIS 20 years ago, one from competence development but what is missing, it was something that chose, okay. We think together in order for this to run from the financial point of view, because someone needs to pay for this.	**Te-Le**

		When we have that, we need to think also, what are the effects. And again, this is not the information system for a bank or for a travel agency or for for the social media. Because in those things, they'll persevere, they'll they'll come directly if you're a financial institution, you can measure how much it costs to have the system running for you, you delegate the task, to the client, humanitarian things, the same with tourism. But with learning with the outcome is knowledge and education. How can you measure this against money, and this is a very difficult problem for IS research, because you can come from the business informatics point of view, and you can and human, human kind. A lot of studies from this OECD or UNESCO about the value of business models in this field, technology enhanced learning, but then, what are you measuring? Can you claim that if you invest to yourself, two crowns a day per student brings you better learning and teaching that if invest four kroner. Today sizes, it's very difficult, but this is something that you cannot forget anymore, as the information IS researcher to have the business model behind. And I don't know if this gives you a clear a good answer to what you ask.	
27	Researcher	Yeah, it does, like it gives the right context.	
28	Rsp5	Because if you can this is something that you could describe in your thesis, like in the problem, which are the different dimensions if you do it with the bubble chart, you can put in one technology dimension, the another one pedagogical dimension, logic, logistical dimension, because you need to orchestrate needs. And another one is the business to financial bubble. So you have four bubbles interconnected. And there is errors in some of them their interrelation, some of them not, not but it covers almost all these social aspects of learning organizational aspects of learning. So and I'm drawing things on the air because I'm not drawing nothing, but I hope you see what I'm saying. Like if you say like you have four circles, interconnected. One is business and the one is logistics. Other one is pedagogy. The other one is technology. This is a kind of holistic view to see this IS structure or infrastructure.	
29	Researcher	To follow up with that, like could you provide us with the examples of collaborative tools for learning used by you in your empirical studies for primary schools?	

30	Rsp5	Yes, almost all of us, all the short videos that you will see they contain the collaborative aspects and there are different dimensions. One is like in the one that they send you the second link that this collaborative storytelling there the idea is that the collaboration takes place for the human interactions through the technology. So the tools are in itself, the artifacts for collaboration, not the technology, because one imagine in this one this digital storytelling, the goal is that by using an app that we develop, children should tell the story and create a narrative story that is totally digital but someone needs to take pictures, someone needs to take notes that I want you to do the storyboard. And the other one needs to operate the app and on purpose within give each one of the children one mobile, but on the contrary, we went, we wanted to promote the physical collaboration by using the tool. So if you look at the second, I will, I will give you an example of the one collaboration use as a tool for planning activity. I suggest if you have the chance later on to watch it, this is very short. But this is an example, that was used more than 10 years ago in which we use outdoors navigation, augmented reality and more than that, I guess you're familiar with the notion of augmented reality, augmented reality, and geo positioning with children in mathematics. Here, we use collaboration as a tool, that guy did the design of the application. And I can give you an example that's But that's, that's, that's the reason we do research and not consulting. We try to try to forsee how the future could look like. So imagine, in this example, that we work together with teachers in mathematics and with experts in math, education. And children, in this age, they have a problem to understand proportions and relations and fractions. So what do we give them? It's an application in which they need to take a picture, and they were working outdoors. And they need to measure how tall the buildings were around their school. So there are many ways to do this. And that's the nice part because we didn't tell them how to do it, but we gave them the challenge look, go to this place in the map. And with both a physical and a digital map. There you will find a building and try to assess how tall it is 24, 36. And there it was a list with a lot of possibilities. And before they choose, if it was only four meters or 36, the three of them in the group, they need to agree on recording an argumentation in the phone using one one function that we're developing the phone that there was an agreement on why they're choosing this answer, independent of the answer is right or wrong, you see. So in that sense, we're forcing collaboration to come to an agreement, even if the answer was not right, because the idea was not so much answering right or wrong, but	**Te-Le** **Di-To**

		to discuss kind of scientifically, or arguing why and then you will see the dialogue in with between the children. So yes, a person is about 160. And then we estimate that the balcony is one and a half person. And then the children. Yes, I think it's correct, but not. And the important part is that they agree. The agreement between the three of them that is the collaboration part, guiding the technological decision, and not the other way around. So do you see how collaboration can use to design technology	
31	Researcher	Yeah, definitely	
32	Rsp5	This is what you're asking then. And we have, and we have different directions in which how collaboration, another party's in another game we gave through the different when people were running around playing something called orienteering. So it's a Nordic sport depend, depending on the location to some of the teams, we gave them part of an answer. And to the other team, part of other part answer. And this is called jigsaw, that is a model jigsaw puzzle. So people need to start to talk to each other using the mobile phone to see how the different basis of the question that they were given to them in different locations could be combined to solve the problem is that that's another way of using that kind of pedagogical method, but supported by the technology. And all these ideas are inspired by what happens in real life where the companies I mean, if you work for a consulting company, and you have clients in two different places and you're working as a service engineer, for for instance, Alfa Laval, a company that you have close to Lund, and one client says that ""Yeah, I have this problem"" and another one from another place can, ""yes, I have this problem"", you will need to be good enough to provide to your two clients a good answer because this is what they expect from yourself. This type of collaboration patterns that they're build on what is called 21st century skills have been used to provide the design. So we have all these always this kind of theoretical foundation is okay. There are skills that people will need now, and in the future in the coming 10 years. So how we can create systems that allow people to start thinking in that direction.	
33	Researcher	So continuing on with with learning perspectives, how do organizations learn such as when they implement new technology and start adopting and adapting to it? This is what how it's	

		very broad. It's a broad question, but in the terms of organizations of educational organizations or schools.	
34	Rsp5	Yeah, I mean, what I can recommend because we could talk about hours and you need something concrete this ... I don't know if you one of your courses, you check out something called the Diffusion of Innovation did you study about this?	
35	Researcher	no, I don't think we did	
36	Rsp5	Okay, but let's see if we can find the reference. .... Because if you look if you're writing Google diffusion of innovations, Everett Rogers. And there, I want to show you with an example of what what I'm saying, but you can you can have here the definition of a Wikipedia that this is a model that was developed in the 60s by economists in ... mostly in California near the US was checking okay, how innovation gets diffused. The idea was that firstly, you have people that are innovators, that they do in a micro scale something that start to catch up, then you have early adopters early majority and all this responds to an S curve. But this will be saying, okay, apply these ideas to a school you see, and at the beginning someone like they did with us they are in their experimented with this and they're just one or two classes and then they see that they get some results and then the other then you have a late majority, I don't know the word laggards that there are those that there are what this means Kalka after, so this is one but ... but then is the other one that is if you look at that if you look for something called the hype cycle from innovation, see if I'm looking for it.	
37	Researcher	It's just Gartner's	
38	Rsp5	Yeah, exactly, yes. So they be talking about something else that there is something called that some trigger. And then there are people that have lots of expectations. And then suddenly something that you thought will work starts going down and then suddenly after some event goes up, and then suddenly it gets introduced. And then if you found that that rough with this call.	
39	Researcher	Yeah. Yeah.	

40	Rsp5	Yeah. And I will give you in the context of what you were impressed about the AR okay. So we experiment with this in 2009. That is 12 years. And at that time the concept of air was launched back because it could be used with mobile phones. Because the notion of AR exists for a long time. I mean, some of you they like sports	
41	Researcher	Yeah	
42	Rsp5	yeah. If you look at if you look at basketball, for instance, in the United States of football, one example of AR is when you play basketball, and then you superimpose the graphs in the, in the page, and you see the numbers, this is the same phenomena, because you have a layer of information over the other with a mobile phone, they started to do the same. This notion appear in some of the falls in 2009 But my point is that I want to give you an example of, to your question with, with what happens in organizations. So imagine, this example that we gave you, I gave you with an AR in the school from 2019 is outdoors mathematics. This, it worked fine, but then it worked in some particular phones. Because the camera because the operating system, they for the coming two years between 2009 or 10, to the 2012 nothing happened because was an issue of hardware. Suddenly, 2014, some started to produce better phones, suddenly, these things launched. And if you think, okay, in 2009, was a kind of trigger, then suddenly, or nothing happened. People were saying, it will happen a lot. But then it didn't. Suddenly it came again, a boost in the technology and opportunities. And then suddenly, you see that this starts to be integrated into almost not almost in many fields like in, in mechanical engineering or medicine, and suddenly becomes a kind of productivity.	
43	Researcher	So the adoption can occur a lot earlier?	
44	Rsp5	This is a little bit and answer to your question there will be use on adoption models, with more of like, if you want to talk about IT as a catalyst for change in schools, there is some kind of innovation because we want to do more, kind of, I will not call digital learning, but learning supported by digital technologies, because learning is Learning with or without technology. So in one way, okay, how these innovative practices diffused. And in order to diffuse, they need to diffuse because they show us that they produce good results, that will be the common sense because they could refuse also because they're bad. This	

		is bad, then we don't use it. But usually. And there are two ways to analyze it and is difficult also to have said, which set of criteria to use to assess whether this is early first adopted or not? Because it's what are you measuring? So I cannot give you a decisive answer just to give you that there are processes and the way that the one of Everett Rogers, his diffusion of innovation was less was more measuring numbers. But if you look, for instance, at the diffusion of innovation using that model, and you take China in 1998, they were just 7 million mobile phones in China. A less than 20 years later, they were more mobile phones than people in China. So can you apply that model? No, because he said on all model about how things move. So so I think you could discuss there that this one we're going to I guess you're familiar with is the technology adopted or the technology adoption model TAM, are you familiar with that?	
45	Researcher	Technology acceptance model?	
46	Rsp5	Technology acceptance already as from Davis from 1900 this is one core piece of reference in informatics. I will suggest you also because this is important in learning with each other technologies, how technologies are accepted and what needs to be discussed. I think in the context of your thesis is not so much the quantitative and the qualitative, what does it mean for digital technologies to be accepted in school and I will bring that dimension but more from the process oriented the just one thing went in because he's you can start looking at like process oriented like technology oriented because until five or six years ago, what has been happening is just technology driven. Okay, some new technology comes. Like, in the beginning of the 18 schools, what has been what has happened, Microsoft came with the Office package, it had a good implication for the organization, this matter was public sector or industry, industrial sector, but this was not conceptualized for the school. But this is what the first wave of digitalisation in the school, okay, let's make teachers to learn Word, Excel. This has nothing to do with how the school works. Word has to do with as an office work. So the issue of acceptance is important. The other one is technology driven against the processor. So I don't know it's a little bit abstract, but I hope it gives you something.	
47	Researcher	Yeah, but it's a good answer. Second question is what is learning from an individual perspective, when kids learn through traditional format versus digital format?	

48	Rsp5	It's again, it's to follow. Then the answer I gave you before about different theories of social constructivism discovery learning problem is learning. In cognitive science, learning is defined as the capability of solving new problems. So that's, that's a cognitive science point of view of what learning is or another one is learning is the acquisition of knowledge, expertise, so your novice as everyday passes. So from a digital learning point of view, what I see is that used in a correct form digital technologies, they help individuals to augment the possibility to discover new ways of acquiring knowledge that are not possible without the digital technologies. So either life gives you a good answer.	
49	Researcher	Yeah, it does. So what do you see as the main challenge of implementing digital technologies in primary schools, from our technological perspective? Is there any technological perspective that is too hard today?	
50	Rsp5	I will rephrase your question. And I will put it first which is the goal and which are the objective of trying to implement something origin is concerned so to identify which are the problems we want to solve? Because what is happening, what has been happening in the last 15 years is or more is that IT is the solution. But what is the problem? Especially when you give this IT solutions to people that they don't know what they're solving? Because then when when you provide this you create even more problems. And then the natural reaction is that people will become reluctant say, Yeah, what what the heck, I need something that is creating more problems. In the problems, I have some something that is evidence basis that a Swedish Foundation, called the kk Foundation, they did like 10 years ago, a survey between 6000 teachers in Sweden, there are about 150,000 teachers, but still is quite valid the number do you know which teachers? They took people from teachers from 25 to 3535 4545. See 55 and the pension? What is in your under what is your estimated guess, that who were the most in favor of using digital technologies for digital learning? And who was who were those against using?	
51	Researcher	I mean, the obvious one is that the younger they are, the more positive like the more more positive they are to technology. But my guess is 35 to 45 are most positive.	
52	Rsp5	There was even more striking. Also there were more positive and smarter and the use of technologies were those between 45 and 55. Because they are very well, experts in what they are	

		teaching. And they know how to handle the classroom so they know where the problems are, and how technologies could be used to do things that are impossible with technology. Like if you use a simulation, if you use sensors with measuring, and those are the were more reluctant they were the youngest one because they don't have no knowledge on the technology. They were not trained not in the schools, in the teacher training, they have no experience how to handle the class. And they have no knowledge about how to teach a subject. So if in all this complexity, you bring another dimension of this, okay, on the top of all your ignorance you need to bring to work with it when you never were trained on that. So it is like a threat. So, things are not so logical as they always look.	
53	Researcher	Yeah, definitely. And and also, the fact that that's exactly that you have to be comfortable in your position as a teacher, and then you could evolve further.	
54	Rsp5	Yeah, but but this could be generalized to any professional because if you look at the result of this technology, acceptance. Even in in the initial introduction of what it's like today, Google Drive or Google Docs, or collaborative tools that were develop more than 25 years ago or something. But since I got the word called Lotus Notes, the word people working together in in corporations about how to collaborate online, it took quite a while for people to understand that this could be a way to work in the future, and people who were against these in the beginning, so he's not only in the school in, in every organization, when you try to change patterns of work, without involving the stakeholders about why these changes are done, you will get always a negative answer because you, you need to bring the users with you in the in understanding why you're doing this. This is something very difficult in in this way school. Not at least I work with a lot International. In Sweden, the teachers union, they put a lot of, because since everything is regulated the work. So Samrachna do you come from India or from where?	
55	Researcher	From Nepal	
56	Rsp5	I have been in Asia many times but not in Nepal. But I learned that many teachers there we put many hours of their own time free time to learn new things, because it's a way to keep competitive. And in Sweden, no one will do that. Because if you do something to improve your skills, this is part of your work.	

		And if this is not regulated by the union, there are plans like okay, if a teacher works 1700 hours a year, so between five to 8% should be competency development. So it means maybe 100 hours. But usually these 100 hours are used for learning these new scale systems, what is called boutique system and rubberband. So they will refuse to learn things about how they will improve the professional life. And few of them will learn this on their own. And it's not that teachers are not willing using Facebook, social media, Twitter, they're incredible. But they are not. They don't know how to do it in their professional life. So it's, it's the cultural aspect of the of the system that regulates when, as I said, I am lucky enough to travel around the world and I have been in some years ago in Colombia. I was invited to be a keynote speaker at a conference and they came to teachers from the Amazonas. They were coming in working in the rural school, from the Colombian part of them as soon as because he's very big. They were given computers by the government and was a kind of public private enterprise. And was a rural school that was using solar energy, and radio frequency. And they were getting international radio waves. So imagine compare with a normal Swedish school that has fiber optic. And they never had a computer before. And suddenly the children with the old people there. They were working on digital storytelling, and the outcomes of what they saw, were much more creative, what they haven't seen in 15 years of working with rich teachers, because the lack of infrastructure and needs allowed to be the people more creative. So this is something that is hard to generalize, because there's so much culture dependence.	
57	Researcher	Yeah	
58	Rsp5	So one rule of thumb is that more access to resources, and more regulations, the level of innovation is not linear. Steel for me, as a scientist is a puzzle how Sweden is still for the last 15 years number three in the world in the innovation index, with with this background is obviously school. But it's very interesting. If you if you look at if you look at innovation index, you will see always in the last five years is Switzerland, Singapore, Hong Kong, Israel and Sweden that there's a shift in in the places. But I have invested in all this and the school system compared with the switch one is much better compared to innovation in those countries. So, for me, it's kind of it's a mystery, it's a mystery. But the assumption in this way a system that promotes because it's also it's also magic, this waste switch system is built on social responsibility and some kind of code	

		of collaboration that allows this happen. It could be even better. Yeah. But my point to this question is again, do not forget the social cultural background of of this implementation. What is the political message because you should have a local elected official documents from the Swedish government, even in 2000 in March 2017, the Swedish Parliament took a decision about the national strategy for the digitalisation of schools. If you check in this, the DigiPlan a lot in speech not so much in English, but now 'Nationell Handlingsplan för Digitalisering i Skolan' does plan for the 2020 school, they are one thing is the discourse that comes to the political label, because this has been taken by the Parliament and the other one is how the teachers interpret what is written there, because he say, there is a kind of dichotomy like one one some of the things that are not compatible, what the government says how the things are implemented, and how teachers first know if they know how they interpret that. So, these are important they mentioned from him is point of view this infrastructure they mentioned cultural dimension political dimension.	
59	Researcher	Okay, so, moving on. So, in terms of relevance of tools for how long do the tools stay relevant, like how do major changes and collaborative doors of schools from a learning perspective?	
60	Rsp5	Very simple, very complex question, but very simple answer, it has not so much to do with the tools but has to do with the methods not how the tools are used. It has to do also with What does what is your learning be or your epistemological beyond learning because he's if you believe in collaborative learning, this type of discovery learning approaches, then you start thinking, which are the methods I should use to promote to achieve my goals. And based on that it's okay, which are the IT tools they're most suitable for. And I can give you an example. We had developed last year mobile AR application for discovering archeology. So you go to the ruins of a castle. And then you explore the place you get the kind of poster on the table that replicates what you're seeing and suddenly pointing to different parts of the physical place you can start see through the object of archeological findings that exist in reality, but because they cannot be exposed, because they are saving the museum people can learn. So this is not just done because the technology is there, but because there is a need to see. Okay. There are archaeological findings that cannot be share, because otherwise we'll destroy them because they need to be kept into a special condition.	**Te-Le** **Di-Co-Le**

61	Researcher	So what do you think are the key aspects of creating a learning environment but digital collaborative tools in terms of technological aspects, mostly	
62	Rsp5	I get I will come back to. First is, which are the learning goals and what you'd like to achieve a learning outcomes. Then the second, I mean, assuming that you want to I'm talking from the point of view of a designer or a teacher or principal, from all these different stakeholders in schools, we assume that you want to use digital tools to support digital learning, okay, that's a point of departure. Then the first step is, which are the learning goals and the learning activities that you have that the second is, which are the methods you want to use, which are the strategies and based on that, you can start thinking about, which are the different tools, digital tools that you could use to support those activities. So I'm trying to give you an example of that. And then I'm going to share my screen.	**Co-Le**
63	Researcher	Yeah, so I kind of have to final finalize this. So to recap what we have discussed so far, do you think done that digital technologies as you have studied them in the context of primary schools, influence learning? So in the sense that do you think that the digital In what way? Do you think that it has influenced mainly?	
64	Rsp5	Very hard question	
65	Researcher	I can I can expand the question or just finally, what is your suggestion of how primary schools should envision their future of digitalisation? So if you have a sort of say, give some feedback to a school? How should they envision their future with it?	
66	Rsp5	rethinking what is the goal of schools and the goal of schools is to prepare children to be the best citizens for the 21st century. And it's not just for recalling, having memorizing things. So one thing is to reshape in the golf school or in the latest changes in the switch curriculum, some of the things are in that direction, that that is a positive thing. But the second is that you need to prepare the teachers for being asked, Well, how to tackle those changes in this finished curriculum. Because I can give you some examples. Are you familiar with this IQ issue? If you go on your phone home?	

		We're recording it for you remember, you know, what is this iQ? The anti intellectual? Yeah, it's an it's a measurement that is a quantitative measures measures intellectual capacity of people like this. If you have more than 100, the guy that created that concept is called flame that is a researcher from New Zealand that is still around, I think he has more than 85 years old. So so he did a quite nice paper in the journal called intelligence that is a studying where IQ has declined or not in the latest years. So he showed that in Scandinavia, he has some examples of Norway and Denmark, the IQ in children has declined in the last 20 years compared with how it was in the past. And because some misuse of digital technologies, you see, so because if you look a lot of visual things, you don't put so much emphasis on text analysis or text recognition, or text sensitizing things, then you lose some of your critical thinking skills, because you connect too much in visuals that actually is like kind of primitive thinking that we use in the caves, I mean, in the caves. Before using language, we use drawings. And this has some bad impact about how we understand reality. So if technologies use in, in a way, like again, I'm not I'm not against Snapchat or loss, no, not at all. But if we overuse these things in everything we do, this may have some not so good consequences, because we know there's there's already some studies. So this is something that we need to be careful with the tech some of the technologies and what they can do.	
67	Rsp5	Yeah, because if you look now at some progressive schools, for instance, in Silicon Valley, they're going back to pen and paper because this shows that the writing on paper in the long term is much more has clear effects about how the brain process information, if compared with how we use digital tools. So we have been working on spelling a lot on digital paper and digital pens. So there is the challenge is to find a balance between what we know from the old time that works, because written on paper is something that we know for at least 600 years, almost. And we cannot just extinguish it because we have the digital tools when you will know the effects of digital bonds for the brain. So that's something that you need to think not here but we need to think about your foot about how to combine those things.	
68	Researcher	That's great. And I think we shall wrap it up here.	

Appendix VIII: Rsp6 - Interview transcription

Respondent: Rsp6

Position: Associate Professor

Date: 26th April, 2021

Interview Duration: 44:56 minutes

Line	Individual	Questions/Responses	Theme
1	Researcher	This leads us a bit into the first question, which is, what do you think of the current process of using digital tools in the context of education at primary schools in Sweden, give a general and quick perspective.	
2	Rsp6	Yeah, well, I think that there has been a progress, right, because now it's like, we have this Digi plan, right? The Digi plan. And, and I think that skol in you know, other actors have been working, so to try to have a more centralized strategy for digitalisation. So I think that that's positive, it's a, ... I mean, I think that I see a progress. We are dealing with a structural challenge in Sweden, that has to do with this the enormous power that municipalities have, that means that So, it is it is quite decentralized. When it comes to digitalisation, because depending on the money that the municipality wants to put on the on the technology, then there will be some schools, which will have more access to certain types of technologies and competence and, and others, which perhaps, design other municipalities decided to put the money in other areas. So so I think that that's, you know, in '89 I think that it was when Sweden decided to go and decentralize and, and give this power to the municipalities in relationship to education. So I think that that's, that's the challenge, then, you know, you have this läroplanen plan, the planner, the curriculum, the curriculum, of course, that you have very, very different conditions.	**Di-Ed**
3	Researcher	So the goal is to have a very, the goal is to have equality among the Swedish schools, but it's even harder maybe then with digital, like, when it's such a Yeah, when digitalisation looks so different.	

4	Rsp6	Absolutely. I think that that's, that was that that's what put, yeah, I guess, of course, equity and inclusion, and it's something that is super connected right, very good, really connected to the Nordic values in education. But unfortunately, the way in which how, how money goes to the municipalities is actually, you know, deciding a lot of things. So it is so centralized that makes makes quite difficult to talk about equity. And yeah, it's very complicated. But yeah, so yeah, I don't know. centralizing maybe, maybe, and I think to test,	
5	Researcher	Yeah, so learning methods. What's your experience of if you have an experience, but I do have an experience with blended learning methods in primary school education, and how do you do it in comparison to digital learning?	
6	Rsp6	Okay, what do you mean by methods? Because for me, you know, method design methods, research methods, data collection methods, and methods. What, like digital and physical?	
7	Researcher	When we say blended learning methods, we mean, like, yeah, the blended learning idea for education. So do you have any experience with in your research about blended learning, for example, or digital learning and how they compare or?	

8	Rsp6	Yes, of course. And then we had a big project some years ago. And you have talked with ***** So he probably has, has told you about the same project funded by the Swedish Research Council, and we were working with the schools in Vaxjo in schools here in Stockholm. And my, ... we were working with the schools, which are in Stockholm are in, you know, in the suburbs of Stockholm. So, that means that the schools receive a lot of immigrant children and refugees, so they have very concrete challenges. And for these schools, and **** he was working with schools, where there were, you know, the majority of the students had different types of diagnosis. So and so that means that these schools have very concrete challenges. And in our experience, a digitalisation of some of some of the teaching, some of the practices work very well, because they have a clear objective of, for what they wanted to use in, you know, that time where these mobile devices, the where the iPads, you know, coming into the, in the classroom, and, and for example, in and the classes of Swedish, and also Swedish as a second language. So the teachers had, I mean, it was very helpful to, to work with specific applications, that helped children who have, who were developing the Swedish language competence, it was very helpful for them, because they could translate in their own language, they could visualize terms that otherwise difficult, you know, and they were training, they were training, you know, grammar and, and those in those are things that are important. And, and, and the teacher could, for example, divide the groups and say, you know, okay, you take this application, you work with this application while you do another thing. So it was it was worked very well. So in other classes, or in other schools, when, you know, talking, and looking at what other projects were doing, and following the debate on digitalisation, what I understood is that if you don't have a really a concrete objective, and a strategy, you, you, you get trapped, because you don't really know what you do. So, that's my experience, I will say that I saw super interesting things in these schools, seeing how the, you know, the children were developed, and mostly how the teachers I mean, those are schools that are a little bit special, because the teachers, they care so much, and they were well, that's general for I think the for Sweden, I mean teachers are special in this country, I mean, they do they do what they have to do and more. So, so,	**Di-Ed**
9	Researcher	So from your experiences, they are more open to using different methods.	

10	Rsp6	They are oh absolutely they are open and and to test I mean the teachers in general they do ask us you know, the government comes and say, well now you know is is programming or now as mobile devices and the teachers in this country data on refuse or non protest don't do anything, they just, okay, that's the way that's the way it is. and I have also been involved in a project you know, for competence development for teachers. For programming, and it was really very brutal, because the government decided that Well, yeah, programming is now obligatory mandatory and mathematics and technology. And, you know, the teachers had I don't know, three months, they had to study during the, the summer. Because oh suddenly they had to integrate that in their classes. So. So in that respect, I think that, yes, people here the teachers are really very open minded and really collaborate. And, and, and sometimes they think that they do too much. They should perhaps, you know, refuse a little bit more. Yeah.	
11	Researcher	Yeah. So in terms of technology, enhanced learning and collaborative learning what implications do you see through your studies TEL having in the learning environment of primary schools?	

12	Rsp6	Yeah, well, I can tell you about different examples. So for example, the use of YouTube .... in mathematics, and it also was in Swedish. And, for example, the students were making their own videos, and acting as they were the teachers, you know, it's like a, they were making these videos. Yeah. I don't know, what's the name of the genre of this. But to you, they were like, imitating a little bit, you know, the players when they tell you about the game, and they tell you, you know, how to do it. And so, they did similar firms that for explaining a Swedish grammar. And also, I have seen it in physics, explaining, you know, equations and, and it was very interesting to see, especially with children, having Swedish as a second language for them to be able to do that. And, and the school portraying these films on the website, and seeing themselves explaining things in Swedish, that are in a bit complicated. It was, it was a way to give them an agency to give them a little bit of, you know, self esteem. So I think that, that, that was absolutely, very interesting to see. So I have seen that children with dyslexia, they get a lot of help from specific apps, and, and children, you know, talking with the children during the breaks, you know, some of the ones having dyslexia, they confess to me, Well, you know, now I can cope. Because I can, you know, I have this app, and I can do, you know, I can go through and everything is very well structured for me. So I think that in that respect is is, has been very, very helpful. Then I have the other side that is mobile devices, containing social media, and that happened, you know, some years ago when it was at the beginning of introducing these mobile devices and into the classrooms. So the social media was part of that, and children were, it was really very chaotic, because they were looking at Instagram notifications were on and and if the teacher didn't have a proper strategy, or code of conduct, or saying no social media is not allowed here. It was really very chaotic. So it was really very chaotic, especially at the beginning. And now, I think that there are some apps that are not installed any any any longer in the devices that are given by the Stockholm stad. And I think that that's very good. Because it was really, it was really very confusing and for the teachers was it was disrupting the learning, yeah completely.	**Te-Le** **Di-Co-Le**

13	Rsp6	Then the other thing that you see so when you go you enter the schools, especially the ones that they are using their own, you know, their, their own mobile devices, their own telephones, you know, some schools here in Stockholm, you are not allowed to use to use the telephone. So you need to put the telephone, you know, in a place, and then, the school provides you with the computers, but in some other schools you have, you can use the telephone. And then anyway, and one of the things that I observed was that in some cases, especially the beginning, the school didn't have a strategy about when to use the telephone when not to use the telephone. So it was each class had had a difficult or sorry, had a different a different say about allowing or not the telephone, so the students were completely confused. It was okay, what what is the theme? Well, yeah, "vad gäller här?", I cannot use it or not? Or what is the thing?	
14	Researcher	So? Yeah, like? Yeah, I know that like the norms	
15	Rsp6	Not exactly. Yeah, the norms, the norms, and then what what will be the norm, the Code of Conduct? So that was how you behave exactly. Because in. And the other thing was during the breaks, as I was saying, as soon as you enter the school, and in the schools, where the children can use the telephone, and the only thing you see during the breaks, is everyone just playing games, and sometimes, you know, well, talking to each other, but otherwise, everyone is playing games, this is what they integrate. So, yeah. So that that's also you know, you have you have the good side. And you have also the other side, that that requires a lot of discipline.	
16	Researcher	So could you like provide us with the example of the collaborative tools for learning used by you in your studies, like specific collaborative tools that you guys used?	
17	Rsp6	Collaborative tools, yeah. Oh that the school was using, oh, I don't know, collaborative tools. There were so many. I mean, Kahoot, they were using Kahoot, a lot. They were using Gleerups they were using, I don't know how to, you know, exactly what, what are, you know, which tools that we're using.	**Di-Co-Le**
18	Researcher	Maybe like one of the best ones that you guys got the expected results? Maybe we'll talk about that.	

19	Rsp6	The kids ... that we have observed that we're using a lot of tools to construct and to make presentations, for example. they were working with film and we I mean video with audio, so that they were you know, very good at doing this multimodal presentations. Then I have a bunch of applications that they were using for training the language and mathematics like a specific. So I have to, to look at those because you know, there are so many different apps. So	**Te-Le**
20	Researcher	yeah, maybe you can email us back regarding those. Yeah. More about them. Yeah	
21	Rsp6	Yeah	
22	Researcher	Yeah. Okay. So in terms of organizational learning theory and learning perspectives, how do you think organizations learn such as when they implement new technology and start adopting and adapting to it?	
23	Rsp6	I mean, what do you mean by organizational learning? You said?	
24	Researcher	Yeah, organizational learning, like we wanted to, like see how organizations such as schools, how they learn when they implement new technology and adapt to it, like, what's your perspective on that?	
25	Rsp6	Yeah, I tell you it's, uh, yeah, you know, there is this researcher and I think that is in Mittuniversitetet, ****. Okay, **** he says that very well. And I mean, he says, you know, digitalisation is not an, it's not an IT project. A digitalisation is a social technical revolution in the school. So if you think that you are going just to put, you know, a new tool to enhance learning, it's, it's, it's not the whole story is probably wrong, because these tools are influencing the way in which the teachers organize their work organize themselves, for example, in the schools that I have, I have been working with when the mobile devices arrived, they had to form new groups to try to understand which applications they wanted to use to discuss them to filter, which were the ones that were useful, and why. And also, they have to organize this kind of workshops for competence development, because the word some, some of the teachers, they didn't, they didn't know how to use the tools. And that that was one thing, and then just to talk about how we use these tools at school, this is something that you have to	**Or-Le**

		construct, and this is a collective project. So I say that it's not like, okay, let's, you know, introduce this tool in the class-room, no, and on and the kids will learn much better, no, it's, it's much more deeper than that is, it's a, it's a new way to work together. It's an it's a way to, also to reflect on what you have been doing. And, and, and which are the problems that that you have. And just try to see if technology that technology can help you or not. So it's it's a big, big, social, technical change in schools, also the schools, you know, you, you choose a tool, and then if you choose a tool, then that means that because of interoperability issues, you cannot, or you can use another tool. So that means that you have to think, again, about the platforms, and the technical infrastructure that you are build-ing in your school. And that's also a big thing. So yeah, I mean, we are talking or you are more interested in learning ap-plications, I have seen that. That is one side of the story. The other side of the story is that because of the teachers need to manage this application, and the content that is produced in applications, they have to have platforms, like you know, I don't know, school soft, or there, there were other like, you know, learning management systems. And that is more admin-istrative, but it's super important for the teachers, for the teach-ers to make sense of what they're doing with the applications. So, some some of the applications, you will get like, assign-ments, right? Well, where do you put the assignments? Where you? Yeah, yeah, how you document what, the learners are do-ing. So so you need to have, you know, these administrative tools, so the teachers can manage their work. So in that re-spect, it is a big change, for how to work in school with these tools. That, of course, have effects. And the learners then yeah.	
26	Researcher	So what would you say if that was a bit about the school as an organization? What would you say that learning is from an in-dividual perspective, such as one of the kids use, use these platforms? How do you how do you see the learning being dif-ferent in a digital environment to traditional format?	

27	Rsp6	Yeah, well, I don't know if, I mean, for me, it's the same learning. It's not like we are talking about different kinds of learning. I mean, people learn with different tools in different ways. Perhaps some aspects of the learning of the learning activity or the learning processes are more salient with, ... a specific, you know, with specific tools, for example, I will say that, ... you see with the digital tools, it's, it connects very much to the formation of the identity or the development of the students identity, I have seen that in games. So, how they, how they use the tool, of course, to become good at something and to create a competence that they can be proud of, and, and games are excellent for that, because they are telling you all the time, they are really very clear the goals and everything, and you get the credit, and then suddenly you are good at something that is very easy for, for the, for the children to understand and to show, right. So, in that in that respect, and then I will say that reading something or reading content, through, for example, a game or, or a story, or a or interactive story is actually very powerful in terms of the graphics in terms of, you know, technology, as you probably I don't know, you, you have seen the social dilemma in Netflix is very, very connected to our behavior. And it's very connected to our emotions. So and I have seen that in the, in the, in the, in the classrooms, so. So it connects with your emotional aspects. And that's why people are ill children, you know, like so much. And sometimes, you know, they can consume many things that are probably not really very good, because it's this kind of attraction and interactivity, the power of this incredible graphics and beautiful images. So that's not the same thing, you know, when you're in front of a book, because then you need to work much more with decoding and interpreting, and much more complex, they cannot come with you	**Or-Le**
28	Researcher	Would you say also that the measurability than when you're using digital tools is much more clear than you would like measuring how far you've gone in an assignment, for example, that would be?	
29	Rsp6	Yeah, you have you have the, you know, <u>the feedback, and you have criteria that is much more, more and more and more, to me, more interactive is, of course, it's more interactive, and the feedback is clear, like, for example, you know, classes groups working or playing with Kahoot.</u> And then they they see very quickly, you know, who are the ones who knows about ..., sorry about this topic. And so, in that respect, then I don't know if they learned so much right, during this session,	**Te-Le**

		but but it's absolutely as it's engaging, is providing very, very clear feedback. Yeah.	
30	Researcher	Yeah, so a little bit more technical, or like, what do you see as the main challenge of implementing digital technologies in schools from a technical technological perspective? Do you see ... are there any challenges nowadays, like, technologically speaking?	
31	Rsp6	Oh, well, I don't know. I mean, it depends on in each school will probably say different things. But I don't know at that time, ... I remember that there were many problems with connectivity. Incredible in Stockholm, because of this kind of they have a provider and there were so many problems with the contract. And so I don't know now it is, of course solved. But ... it is very political, you know, technology, technology that gets to schools, has to do with a political decision and that, in turn has to do with a an economic decision. So I don't know nowadays, which specific technical ones technical problems, It depends on each school depends on the municipality.	
32	Researcher	So in terms of relevance of tools, for how long do they stay relevant? And how do major changes and collaborative tools affect the schools from a learning perspective?	
33	Rsp6	What is the collaborative tool? So how are you defining the collaborative tool?	
34	Researcher	So, let's say, let's say google docs for an example, like can be coined as a collaborative tool, like multiple students work on the same thing at the same time and teachers give feedback, like generally speaking	
35	Rsp6	Hmm.. I haven't seen so much of collaborative work. Like, you know, collaborative applications like that. I see more like a more individual, you know, the students doing things on their own with the same application, something like that, that test. So the question was about collaborative tools?	
36	Researcher	Yeah, tools, like how long do these to stay relevant? Like, maybe not just collaborative tools, like tools that are engaged in technology enhanced learning, as well?	

37	Rsp6	I don't have any idea. I mean, that's a question for a teacher. Because then how can I know, I don't know, it's, you have a new app. You know, apps come and go. And, and I don't know, for me, this is something that is so related to the content of your classroom and your learning goals. So I don't have any any way to, to, and we've been there I didn't have a focus on if they were changing the app, there were so many apps. So I don't know how much how long they have used the same app to change, I don't have, I don't know	
38	Researcher	Alright. So, moving on, What do you think are the key aspects and when you create a learning environment?	
39	Rsp6	when you create a learning environment, what are the key aspects, I think that, as always is to catch or to, ... connect with the students motivation. At this is something that I think it's it's important to kind of atmosphere that you create in the group. And I think that it's also super important for learning. Learning, so not only, you know, a mental process, learning is changing yourself, as a person is changing, your identity is becoming, you know, another one, you know, before I couldn't do that, and now I can, so it's a set identity transformation as well. So learning environments should be a safe place, it's a place where you can take risks, it's a place where you can express yourself and and take the risk to, to change. ... So in that respect, I think that is very interesting. All the other things are, you know, going on with the students data nowadays, and artificial intelligence coming into the school, and who owns the data, and that are very related to my current project, that that's a big concern. Because if the students, you know, don't feel that they don't feel this safe place, that a learning environment, you know, by definition should be done, there will be something that will be really very wrong in the relationship with teachers. So .... who is looking at what the students are doing? This is super relevant, it's very important, it's only the teachers or is there a third party included? And how safe is the data? Yeah, guys, I need to speed up.	**So-Le** **Le-En**
40	Researcher	Yeah. Okay. In comparison to traditional learning, what is your view on creating a social learning environment in a digital setting?	

41	Rsp6	In social environment, yes absolutely. This is super important. Otherwise it's not going to work. I mean, we are so social ..... I mean, take into consideration the social aspects in the learning environment, right, yeah of course. Learning is social, as I said before, is that we are not only epistemic subjects, you know, we are social beings. So, and we learn in conversations with others, so. So otherwise, you know, we are machines, and we learn things with others and for others. So ... the social is super important, you know, all the the teacher, the teacher, or thank you that you believed in me, you know, you know, these kind of things. So they're so important, these social cues.	**Le-En**
42	Researcher	So, traditional, like a traditional learning, when we say that it's completely physical with no digital platform, how would you say that the social learning environment differs in an online setting with the use of digital tools, even digital tools, basically, and using a lot of digital tools to support that So collaboration or in an online setting, from your, from your experience, how would you say that that is different? Yeah.	
43	Rsp6	To the physical, of course, you are much more constrained. So depending on the medium, you use you're really constrained. And depending on the perspective, for example, if I take, let's say, the teachers perspective, when I teach in zoom, I don't know so much about the students. So I don't know, sometimes where I'm in a physical classroom, I can just looking at the students, you know, I know who is thinking about another thing, who is really focusing on what I'm saying. So I know if the conversation is something that is of interest for the students or not, I lose, we lose the social cues, in a video conference tool. So it's like you have to recreate and you have to make sure that Oh, are you here? Are you listening? Or did you hear that? What are you doing? Are you working? I mean, it's so it's like a you have to confirm all the time. So if we take the video conference, right, the zoom, and another is I mean, it depends if you have to collaborate via text is really very tiring. Right. So but, again, I think the key is to think about the the task that that you are doing, because depending on what what you are doing, you know, social things I would say so you can adapt and then have more margin of maneuver. So	

44	Rsp6	There is for example, Dewy talking about experience, right, and as the pragmatist, pragmatist, philosopher, There you go. And he talks about experience, and I don't, don't we, and I don't think that the experience is something that you feel right. And I think that we have developed cues, indicators in the system. And we know them, we know this face to face cues, cues much more than the digital ones. We are still experimenting and recreating them and, and trying to understand how we make sense of the other through a medium. So in that respect, I think that as we have is, you know, okay, so much experienced, you know, reading person's face to face, as it's a little bit more challenging to do that, because it takes time to reconstruct what are the indicators that we need to have to read the other through a medium	**So-Le**
45	Researcher	Do you have time for one more question?	
46	Rsp6	The last one? Yeah	
47	Researcher	Yes. So finally, what is your suggestion of how primary schools should envision their future of digitalisation?	
48	Rsp6	Oh, my goodness, this is so huge.	
49	Researcher	Talk from you can talk from what you are researching currently, like your perspective, as you're researching certain areas, just to get your point of view of what you find is,	
50	Researcher	I mean, like, thinking about a school or schools in general,	
51	Rsp6	Yeah primary schools in general, so the age group of primary schools, like what what is it that they can do that? Yeah, what do you see	
52	Researcher	I mean, like, thinking about a school or schools in general,	
53	Researcher	Yeah primary schools in general, so the age group of primary schools, like what what is it that they can do that? Yeah, what do you see	

54	Rsp6	Okay, well, as I'm working now, you know, with this the ethical and legal concerns and, you know, machine learning, and I will say that, it is very important that this the school, the primary school remains a place for experimentation and exploration for the children and not for performance. So that, I will say that, that's the first thing. And then schools, I mean, the school is not only, of course, where you learn how, you know, mathematic and Swedish, and all these different subjects, of course, this is so important, but at the same time, it's the way in which children learn to become a citizen, right. So learn other, you know, other you learn values about how you respect the other, how you collaborate with each other. So it's a they experiment. This is a socialization process. So I think that that's important that this school think about this the social aspects of, of learning, and the goal that schools have a epistemic purpose, but at the same time, I mean, we are we are teaching we are working with future citizens so and so I think that those goals should be also very, to be more present in, in schools. So, I know that there are, for example, some schools working with the Sustainable Development Goals. And it's like, they changed a little bit the curriculum related to Okay, you know, what is important what it matters for, for the future, and, and they, and they put much more emphasis on the on skills that have to do with critical skills and collaborative skills and citizen literacy and ethical literacy. So those are things that I think that will be really very important in, in the future	

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