University of Stavanger

MINTTU MINNA SIRENA JOHLER FACULTY OF ARTS AND EDUCATION

"Take the plunge and give it a try"

Primary school teachers' perceptions of their role and pedagogical practices in technology-rich classrooms

PhD: Thesis UiS No. 729

“Take the plunge and give it a try”

Primary school teachers’ perceptions of their role and pedagogical practices in technology-rich classrooms

by

Minttu Minna Sirena Johler

Thesis submitted in fulfilment of the requirements for
the degree of PHILOSOPHIAE DOCTOR (PhD)

Faculty of Arts and Education
Department of Education and Sports Science
2023

University of Stavanger
NO-4036 Stavanger
NORWAY www.uis.no

ISBN: 978-82-8439-197-7
ISSN:. 1890-1387
PhD: Thesis UiS No. 729

«Digitaliseringen endrer oss, enten vi vil eller ikke. Men vi skal være med på å styre endringen, og vi må ha som mål å ligge i forkant.»

(Tonje Brenna & Gunn Marit Helgesen in *Strategi for digital kompetanse og infrastruktur i barnehage og skole 2023-2030*)

Acknowledgements

And scene.

This thesis may have my name on the cover, but it never would have happened without a village around me. I am blessed with great friends, colleagues, and family, who in so many ways supported me during this journey.

I have been lucky with incredible teachers, supervisors, and colleagues throughout my teacher years. Special thanks to Margarita Vinagre, Linda Duevel, Len Duevel, Jill Raven, Gareth Jones, and Rebecca Vetnes for your support and inspiration along the way, before and during my years in academia. Without you, I never even would have started a PhD. And thank you, Wim Keereman, for being my guinea pig at the very beginning of my PhD path.

Thank you, PEL colleagues at UiS. You lent me books, recommended articles, gave advice, and cheered me on from the very beginning, when I was just writing my proposal. Thank you for being so kind and supportive with a newbie – you made me feel that perhaps I *can* do this! And thank you, colleagues at SePU, for rooting for me at the end of it. I was very fortunate to land on a job with such an inspirational community around me.

Thank you, fellow *stipendiats,* both at UiS and HINN. Peer support is the best, and discussions, reflections, and many good laughs with you made my PhD period a great one. Special gratitude is extended to Eirik Skjelstad and Pamela Helder Naylor, who made me feel most welcome and included when my office got moved from Stavanger to Hamar. It gave me a real writing boost throughout the winter and spring!

My supervisors Rune Johan Krumsvik, Hans Erik Bugge, and Nina Helgevold worked wonders with me. Their patience and expertise were greatly appreciated throughout the project. Rune's knowledge about the field, publishing, and PhD process in general was irreplaceable. His concrete and detailed feedback helped me step up my game and imagine the unimaginable. Hans Erik was my excellent *sparringspartner* on several occasions when I got stuck in the process, and he helped me sort out my thoughts and get back on the horse – on weekdays *and* weekends. Without Nina I would not have even started. I almost gave up at the application phase, but she made sure that I submitted my proposal – with its (very obvious) imperfections. Throughout my years as a PhD fellow, she was also very good at challenging me and asking insightful questions that I had not thought about before, and this way, helped me expand my perspectives. All three supervisors all had a distinct role in the process – and each one of them made me a better researcher.

Finally: family. Thank you, Tobias and Nils. Nils, who every single day reminds me why my work matters, and who cheered me on, even though

he really didn't know what I was working on: he kept asking when I will be *lääkäri* (*lege,* a medical doctor). And Tobias, who has believed in me all the way, even the times when I did not believe in myself. Tobias, who has entertained the kid countless of evenings and weekends, so that I could focus on writing. Tobias, who in more ways than I can describe here, made this thesis happen.

My parents have always emphasized the importance of education, despite choosing a different path themselves. They have supported me in countless ways throughout my studies and career, which I am forever grateful for. *Kiitos!* One day, perhaps, we will also be able to explain to Grandma what I do for a living.

In Hamar, May 25th, 2023
Minttu Minna Sirena Johler

Abstract

The goal of this study is to shed light on how primary school teachers perceive their role in technology-rich learning environments and how they enact this role in their pedagogical practices. This thesis consists of an extended abstract and three articles. The extended abstract introduces the background and purpose of the study, research questions, the choice of theoretical framework and other relevant concepts, as well as prior research on the theme. The design of the study, methodological choices, and analysis are explained in detail in the method chapter, before discussing the main findings and their affordances at the end of the extended abstract. At the end of the thesis, the three articles delve into some of the main aspects of the study in greater depth and detail.

The majority of previous research regarding the use of digital technologies in teaching and learning has been conducted in schools with no heightened focus on digital elements. In an attempt to make new discoveries, the study was conducted in a school that sets high priority to digital competence of their staff and pupils and takes advantage of the opportunities that digital technologies can offer. Therefore, framing the project as a case study was considered a well-founded approach. Furthermore, the case is defined as *intrinsic*, because the fundamental goal is to understand the case itself, without greater ambition to generalize from the results. In this context, it required an investigation of the case using several instruments, in order to gain a holistic

understanding of how teachers with significant training and experience within digital technologies perceive their role and practice their profession.

To have a comprehensive and versatile data base for the study, the project was designed as an *exploratory sequential study* (Creswell & Guetterman, 2021). In contrast to explanatory sequential design, where the cumulative data collection process proceeds from the quantitative to qualitative, an exploratory sequential design explores the case first through qualitative data. Quantitative data – collected in a survey – was thus used to extend and enrich the findings in qualitative data – individual interviews, observation, and focus group interviews. This step was undertaken to improve reliability of the study by confirming some of the qualitative findings and to develop new aspects of the qualitative findings (Creswell & Guetterman, 2021; Hesse-Biber et al., 2015).

As the Norwegian educational system builds heavily on the principles of sociocultural learning, sociocultural views are used as the theoretical base for the study. Most importantly, this theoretical approach highlights that learning happens in interaction with others. This not only emphasizes the importance of communication but also the collective nature of learning: we learn best when we learn together. Vygotsky's theory of *zone of proximal development* highlights this, as well as the role that the more knowledgeable other has in the interaction and learning processes. In this study, it was discussed how a teacher as the more

knowledgeable other approaches their role managing the classroom and instructing pupils as someone who sets structure and helps pupils scaffold and construct new knowledge. Fruitful interaction and collaboration also require an inclusive learning environment where everyone feels safe and able to participate. This is also an obligation for Norwegian schools, stated in Norwegian national core curriculum and legislation. To create such an environment, a teacher needs to practice authoritative classroom management that ensures social, emotional, and academic growth for all learners. Differentiating instruction and promoting pupil participation are prerequisites for such work.

There were many findings that partly confirmed findings from previous research, but also provided interesting new perspectives on the topic. The overall perception of the informants regarding how digital technologies influence teacher's role and enactment of it in their pedagogical practices can be described as both positive and realistic. The informants were well aware of the ideals related to the new role and practices – such as having a more facilitating, exploratory, and inclusive approach – while being realistic about the change and processes related to it being complex, time-consuming, and ever-changing. The staff found that the school leadership advocated for and supported the development of teachers' *professional digital competence* (PDC) and development of mutual practices at a high level, while they also encouraged teachers to experiment with new things without the fear of failing. This, together with close and systematic

collaboration with colleagues, were found to be some of the key elements for finding success in exploring and developing their roles and practices.

The results were viewed through the lenses of teacher's role perception, inclusion, differentiated instruction, communication, and collaboration. One of the most interesting findings was that, in contrast to many previous findings from the field, these teachers experienced very little disruptive behaviour or other inappropriate behaviour related to pupils' use of their personal devices. Not unexpectedly, but surprisingly clearly, given the overall digital profile of the school, teachers with formal education in PDC at a higher education level had a more positive perception of how digital technologies impact the learning environment. They found more advantages regarding the use of digital technologies and were less concerned about challenges, such as distractions or unexpected technology malfunction, than their colleagues with less formal training. Overall, the teachers found that their role had become that more of a facilitator than a traditional role where teacher is the primary source of knowledge. This was modelled in multiple examples, particularly amongst older learners, where the pupils had many opportunities for influencing the learning process and product. On several occasions, teachers modelled exploratory learning, which seemed to encourage pupils to have a somewhat more adventurous approach to the subject matter and activities, as well. Teachers, particularly in grade one, often focused on teaching and discussing strategies that supported

pupils in becoming more independent and efficient learners, for instance in communication and collaboration.

Despite high ambition and PDC level, the teachers and school leadership acknowledged that there is still a lot more to learn and develop – and there always will be. While digital technologies were weaved in to almost all aspects of teaching and learning and employed in a variety of ways, the pupils could have used some more guidance in developing their competences when given more autonomy in their learning processes. At grade level 1, there was less pupil participation in the learning designs but significantly more emphasis on learning different strategies. In grade level 5, teachers offered pupils multiple opportunities to participate and influence the learning designs and processes, but with less focus on how to refine and developed strategies learned in lower grades. This was evident, for example, in the collective production of multimodal representations of knowledge and approaches to collective learning models.

Sammendrag på norsk

Målet med denne studien er å kaste lys over hvordan lærere i barneskolen oppfatter sin rolle i teknologirike læringsmiljøer, og hvordan de utøver denne rollen i sin pedagogiske praksis. Denne avhandlingen består av en kappe og tre artikler. Kappen introduserer bakgrunnen og formålet med studien, forskningsspørsmål, valg av teoretisk rammeverk og andre relevante konsepter, samt tidligere forskning om temaet. Designet av studien, metodiske valg og analyse blir grundig forklart i metodekapittelet, før hovedfunnene og deres implikasjoner blir diskutert på slutten av kappen. Ved avhandlingens slutt går de tre artiklene mer grundig inn på noen av hovedaspektene ved studien.

Det meste av tidligere forskning om bruk av digitale teknologier i undervisning og læring har blitt utført i skoler uten spesiell vekt på digitale elementer. I forsøket på å gjøre nye oppdagelser ble studien gjennomført ved en skole som høyt prioriterer digital kompetanse hos både ansatte og elever, og i stor grad utnytter mulighetene som digitale teknologier kan tilby. Det ble derfor ansett som hensiktsmessig å ramme prosjektet som en case-studie. Videre er «case» i denne studien definert som intrinsisk, da det grunnleggende målet er å forstå denne casen i seg selv, uten ambisjoner om å generalisere fra resultatene. I denne sammenheng betyr dette å undersøke casen ved hjelp av flere instrumenter for å oppnå en helhetlig forståelse av hvordan lærere med

betydelig opplæring og erfaring innen digitale teknologier oppfatter sin rolle og utøver sitt yrke.

For å ha et omfattende og allsidig datagrunnlag for studien, ble prosjektet designet som en utforskende sekvensiell studie (Creswell & Guetterman, 2021). I motsetning til en forklarende sekvensiell design, der den kumulative datainnsamlingsprosessen går fra kvantitativ til kvalitativ, fokuserer en utforskende sekvensiell design først på kvalitative data. Kvantitative data, samlet inn gjennom en spørreundersøkelse, ble dermed brukt for å utvide og berike funnene i de kvalitative dataene: individuelle intervjuer, observasjon og fokusgruppeintervjuer. Dette steget ble tatt for å forbedre studiens pålitelighet ved å bekrefte enkelte av de kvalitative funnene og bygge nye aspekter ved de kvalitative funnene (Creswell & Guetterman, 2021; Hesse-Biber et al., 2015).

Ettersom det norske utdanningssystemet bygger sterkt på prinsippene om sosiokulturell læring, blir sosiokulturelle perspektiver brukt som det teoretiske grunnlaget for studien. Det mest sentrale er at denne teoretiske tilnærmingen understreker at læring skjer i samhandling med andre. Dette legger ikke bare vekt på betydningen av kommunikasjon, men også den kollektive naturen til læring: vi lærer best når vi lærer sammen. Vygotskis teori om nærmeste utviklingssone retter oppmerksomheten mot dette, samt *the more knowledgeable other* sin rolle i samspill og læringsprosesser. I denne studien diskuteres det hvordan en lærer som *the more knowledgeable other* tilnærmer seg sin rolle med å håndtere

klasserommet og instruere elevene som noen som skaper struktur og hjelper elevene med å bygge ny kunnskap. Et fruktbart samspill og samarbeid krever også et inkluderende læringsmiljø der alle føler seg trygge og i stand til å delta. Dette er også en forpliktelse for norske skoler, som er lovfestet i den norske nasjonale læreplanen og opplæringslovens §9. For å skape et slikt miljø må en lærer praktisere autoritativ klasseromsledelse som sikrer sosial, emosjonell og faglig vekst for alle elever. Å tilpasse undervisningen og fremme elevdeltakelse er forutsetninger for dette arbeidet.

Det var mange funn som delvis bekreftet funn fra tidligere forskning, men også ga interessante nye perspektiver på temaet. Informantenes generelle oppfatning av hvordan digitale teknologier påvirker lærerens rolle og utøvelse av den i deres pedagogiske praksis kan beskrives både positivt og realistisk. Informantene var godt klar over idealene knyttet til den nye rollen og praksisen, for eksempel å ha en mer tilretteleggende, utforskende og inkluderende tilnærming. Samtidig som de var realistiske rundt endringene og prosessene knyttet til dette og vurderte de som komplekse, tidkrevende og stadig skiftende. Lærere opplevde at skoleledelsen støttet utviklingen av lærernes Profesjonsfaglige digital kompetanse (PfDK) og utvikling av undervisningspraksiser på et høyt nivå, samtidig som de oppmuntret lærere til å eksperimentere med nye ting uten frykt for å mislykkes. Dette, sammen med nært og systematisk samarbeid med kolleger, ble ansett å være blant de viktigste elementene

for å oppnå suksess med å utforske og utvikle lærerrollen og de pedagogiske praksisene.

Resultatene ble sett gjennom linsen av lærerens rolleoppfatning, inkludering, tilpasset opplæring, kommunikasjon og samarbeid. Et av de mest interessante funnene var at, i motsetning til mange tidligere funn innen feltet, disse lærerne opplevde svært få forstyrrelser eller annen upassende atferd knyttet til elevenes bruk av personlige enheter. Gitt skolens overordnede digitale profil, hadde lærere med formell utdanning i PfDK fra universitets-/høgskolesektor en mer positiv oppfatning av hvordan digitale teknologier påvirker læringsmiljøet. Dette var ikke uventet, men var allikevel overraskende tydelig. De fant flere fordeler knyttet til bruk av digitale teknologier, og var mindre bekymret for utfordringer som distraksjoner eller uventede teknologifeil enn kollegaeer med mindre formell opplæring. Generelt opplevde lærerne at deres rolle hadde blitt mer tilretteleggende enn en tradisjonell rolle der læreren er den primære kunnskapskilden. Dette ble modellert i flere eksempler fra klasserommene, spesielt hos eldre elever som hadde mange muligheter til elevmedvirkning. Lærerne modellerte ofte utforskende læring, noe som oppmuntret elevene til å ha en noe mer eksperimenterende tilnærming til fagstoff og læringsaktiviteter. Lærere, spesielt på første trinn, fokuserte ofte på å undervise og diskutere strategier som støttet elevene i å bli mer selvstendige og effektive lærende, for eksempel innen kommunikasjon og samarbeid.

Til tross for høye ambisjoner og nivået av PfDK, erkjente lærerne og skoleledelsen at det fortsatt er mye å lære og utvikle – og at det alltid kommer til å være slik. Selv om digitale teknologier var innlemmet i nesten alle aspekter av undervisning og læring og ble brukt på forskjellige måter, hadde elevene hatt behov for mer veiledning i utviklingen av deres kompetanse når de fikk større autonomi i sine læringsprosesser. På første trinn var det mindre elevmedvirkning i læringsdesignet, men betydelig større vekt på læring av ulike strategier. På femte trinn tilbød lærere elevene flere muligheter til elevmedvirkning, men mindre fokus på hvordan de kunne utvikle kompetansene sine innen strategiene som ble lært på lavere skoletrinn. Dette var for eksempel tydelig i den kollektive produksjonen av multimodale representasjoner av kunnskap og tilnærminger til kollektive arbeidsformer.

Table of contents:

1 Introduction

1.1 Background of the project

Teachers all over the world are facing new pedagogical challenges, as digitalization of learning environments accelerates and one-to-one digital devices amongst pupils have become a common sight in many classrooms. In Norway, digital infrastructure is considerably developed and a vast number of pupils in all levels of schooling have access to educational technology (Fjørtoft et al., 2019; Munthe et al., 2022; Norwegian National Directorate of Education and Training, 2022). Norwegian pupils, teachers, and their classrooms are equipped with laptops, tablet computers, smartboards, and other educational technology; however, it is common that digital resources and more traditional materials still exist side by side (Gilje, 2017). Teachers tend to see value and potential in digital technologies, but in their everyday practices, it is still common to use them in a more conventional way as a mere tool (Blikstad-Balas & Klette, 2020; Munthe et al., 2022; Säljö, 2010). The importance of keeping up with the fast-developing technologies and particularly teachers' ability to utilize the potential of digital tools in education has been emphasized in international and national research, reports, and policy documents throughout the 21st century (Ala-Mutka, 2011; Albion et al., 2015; Ananiadou & Claro, 2009; Ferrari, 2013; Krumsvik et al., 2013; Ministry of Education and

Research, 2017; Munthe et al., 2022; Norwegian Ministry of Education and Research, 2015; OECD, 2015; van de Oudeweetering & Voogt, 2018; van Laar et al., 2017).

In Norway, the most recent curriculum reform sets expectations for teachers to keep up with the digital development and interpret the new curriculum in a such way that takes digital society and development of pupils' digital competence into consideration (Norwegian National Directorate of Education and Training, 2021). Teachers' and pupils' ability to use digital technologies in education was defined as one of the core skills, implemented in all subjects, already during the curriculum reform of 2006 (Norwegian Ministry of Education and Research, 2006). However, a state report published almost a decade later concluded that significantly more attention needed to be paid to this essential area in the upcoming curriculum reform of 2020 (Norwegian Ministry of Education and Research, 2015).

In the 2020 curriculum reform, two subjects in particular were given more responsibility in the implementation of digital technologies: social studies and science (Norwegian National Directorate of Education and Training, 2020). In social studies, the subject gained five core elements in which it is natural to weave in technology: sustainable development, democracy and citizenship, critical thinking and connections, identity and community, and inquiry-based approaches. In science, technology itself is one of the five core elements, and as the science curriculum is now more based on inquiry and practical approach than its predecessors,

technology can be integrated into many levels of practical experiments and projects. Also, programming is now set to be a mandatory part of the curriculum. However, an important aspect of digitalization of schools is understanding the conceptual nature of it. Although some of the curricula have more responsibility in digital implications, technology is rarely the actual topic of a lesson or a unit (Blikstad-Balas & Klette, 2020). When treated as such, the use of digital technologies has a tendency to be both limited and technical (Blikstad-Balas & Klette, 2020). However, digitalization impacts all subjects in various ways, which are not always explicitly defined in curricula or other policy documents: for instance, the culture of production, sharing and participating has transformed, and the access to information challenges many previous conceptions of literacy and learning (Erstad, 2015). The current trend calls for a more holistic approach, where digital technologies are naturally weaved into various topics, activities, and methods. This is built on understanding and embracing a digital culture where digital technologies are not seen only as tools but artifacts, which have cultural significance and come with the potential of transforming the cultures they're introduced to (Säljö, 2010; Lund & Aagaard, 2020, p. 59). This kind of development inevitably changes teacher's role and the way they carry out their pedagogical work.

There is much research available on how teachers perceive and use digital technologies in their daily practices. During the past ten years, both Norwegian and international researchers have investigated teachers' beliefs, competence, identity, and pedagogical practices in terms of

digital technologies. Mishra and Mehta (2017) found that teachers appreciate and see the importance of digital competence, particularly in relation to the 21st century competences. The OECD report *Students, Computers and Learning – Making the Connection* (OECD, 2015), however, concludes that the true value of using digital technologies in education have not been fully realized. The teachers who do succeed in exploiting these opportunities are generally more inclined to change their pedagogical approach and steer away from conventional teacher-centered teaching designs (OECD, 2015). Such a shift can be a challenging one, as teacher attitudes and beliefs tend to sit tight and are often difficult to change (Tondeur et al., 2017). However, it is necessary, as digital competence is much more than mastering a set of specific technical skills. A teacher also needs to be able to exploit the opportunities offered by a variety of digital technologies in multiple ways and contexts, which is why teachers' professional digital competence (PDC) has been found to be a key factor in this development (Colás-Bravo et al., 2019; Krumsvik et al., 2013; Mishra & Koehler, 2006).

21st century competences (also 21st century skills) are often mentioned when teachers' role, digitalization, and curriculum reforms are discussed; thus, there are many frameworks and definitions that attempt to identify and define such competencies. Amongst others, Voogt and Roblin (2012) have analyzed a plethora of well-known frameworks for 21st century competences and identified categories that they have in common: collaboration, communication, ICT literacy (digital competence), and

social and/or cultural competencies. Furthermore, most frameworks also emphasize the necessity of creativity/innovation, critical thinking, productivity, and problem-solving skills (Voogt et al., 2013a).

Many such skills are also highlighted in official Norwegian reports and policy documents, and digital competence is seen as a core factor when gaining many other competences (Norwegian Ministry of Education and Research 2015; Norwegian National Directorate of Education and Training, 2020). In Norway, similar findings were made already about a decade ago. As a part of the SMILE study, Krumsvik et al . (2013) found that Norwegian upper secondary schools have good access to digital technologies and that school leaders are eager to implement digital technologies in their media and methods; however, to realize the potential, more than devices and ambition is needed. The key for successful implementation was found to be teachers' digital competence, classroom management skills in digitalized learning environments, and teachers' ability to employ a vast array of pedagogical approaches in their daily work to instruct, assess, and differentiate learning. The great variation in teachers' digital competence was found to be of significance when looking at the different aspects of digitalization of schools, and working systematically to improve that competence was one of the key recommendations of the report (Krumsvik et al., 2013).

SMILE is not the only Norwegian study mapping how teachers and students in Norwegian schools use and think about digital technologies. Monitor studies have been conducted every second or third year since

2003 in order to investigate the digital development in schools. Monitor studies have evolved throughout the years, and what once was a study of upper secondary school status and development has now become a study arching all the way from early childhood education to upper secondary schools – a natural expansion as digital technologies have increased and evolved in all levels of education. When looking at the Monitor studies from the past decade (Egeberg et al., 2016; Fjørtoft et al., 2019; Hatlevik et al., 2013), the findings portrait a development of more versatile use of digital technologies than ever before, while common challenges, such as getting distracted by digital technologies, are decreasing. At primary school level, the results suggest that digital technologies are still mostly used for writing texts, finding information online, and making digital presentations. While teachers in general are positive towards digital technologies and are becoming more competent in using them in their pedagogical work, these results still reflect a lenience to employ digital technologies in a narrow manner, adjacent to traditional teaching methods. What is encouraging in the results is that pupils reported that they had been taught also more creative and contemporary uses of digital technologies (such as coding, composing music, and making animations), as well as evaluating the reliability of information found online (Fjørtoft et al., 2019). While a vast majority of teachers found that there are clear goals in place for the digital development of their schools, they were not in equal agreement regarding the systematic work to actually realize those ambitions: less than 30% of the informants agreed fully or somewhat with the statement '*we work systematically to develop*

lessons which are based on digital technologies' (Fjørtoft et al., 2019). A little under 40% of the teachers agreed fully or somewhat with having systematic sharing practices and developing their digital administrative responsibilities. In simple terms: more than half of the teachers either don't know if such systematic work is happening in their school or believe that such practices and procedures are not in place (Fjørtoft et al., 2019). The most recent overview of the digitalization in schools, GrunDig report, published by the Knowledge Center for Education in Norway, confirms many of the previous findings and that schools are, on many occasions, going in the right direction. However, their literature overview and survey results also reveal that, in spite of ambition and generally positive attitudes, many municipalities and schools still lack concrete plans for securing teachers' PDC and pupils' learning goals (Munthe et al., 2022). In this context, the findings suggest teachers generally have an unfortunate tendency to take little initiative on their own to develop their PDC (Munthe et al., 2022).

In summary, both international and national research finds that in order to successfully exploit the potential of digital technologies in schools, systematic work within the school regarding digitalization and developing teachers' digital competence are essential. In the Norwegian context, Monitor studies from 2013 (Hatlevik et al., 2013), 2016 (Egeberg et al., 2016) and 2019 (Fjørtoft et al., 2019), as well as GrunDig (Munthe et al., 2022), suggest that the schools are moving in this direction, but that they are still rather far away from the ideal digital

competence and practices – which also are ever-changing in nature, as digital technologies keep advancing. Initially, such international and national conclusions sparked the interest for this investigation in 2017: would it be possible to study teachers at a school where such systematic work actually happens, and where teachers' PDC can be considered higher than in an average Norwegian school? In other words, how does the situation regarding digitalization look like in a school that is acting according to the recommendations?

1.2 Research questions and articles

One of the premises for this study – supported by evidence from previous research – was that using digital tools *can* and even *should* influence teacher's role, classroom dynamics, and pedagogical practices, and that digital technologies have significant potential to not only enhance learning, but challenge and change the method of teaching itself (Säljö, 2010; Voogt et al., 2013a). Such transformative properties of digital technologies are of critical importance: dynamic digital practices should not only be integrated or adapted to fit existing practices and methods, but rather, a teacher should be able to design, enact, and develop digital learning environments and activities that support their pupils' learning (Brevik et al., 2019; Lund et al., 2019).

In this study, the aim is to identify and understand how the use of digital technologies influences pedagogical practices at primary school level,

and gain more insight regarding teachers' perceived role in technology-rich classrooms. The main research question for this study is as follows:

How does the use of digital technologies influence primary school teachers' perceptions of their role and its enactment in their pedagogical practices in a technology-rich primary school classroom?

This research question was thereafter divided into three different subthemes that emerged not only from the theoretical and conceptual frameworks but from the data collected for this study. The analysis revealed that there were areas where the informants found that digital technologies had had a particularly notable influence in regard to teacher's role and how they carry out their pedagogical work: classroom management, differentiated instruction, and collaborative aspects of working.

Firstly, the role of a teacher was in the spotlight in this study. When discussing the influence of digital technologies in their role perception, classroom management and its importance was a recurring topic in all interviews, as well as in the survey. Previous research finds that classroom management has a crucial role in succeeding in technology-rich classrooms, but paradoxically, it is a little-investigated research area in the field of digitalization in education (Bolick & Bartels, 2015; Krumsvik, 2023; Spiteri & Chang Rundgren, 2020). The first article in this PhD project addresses this research gap. The aspect of classroom management was framed in the following research question:

How does the use of digital technologies influence teachers' perceptions of their role and pedagogical practices in terms of classroom management in a technology-rich primary school classroom?

While the first article has a great emphasis on teacher's contemporary role in a technology-rich classroom, the second article focuses more on realizing this role perception in pedagogical practices. During the data collection, it quickly became obvious that the area where the teachers most embraced educational technologies was creating variation when teaching their subjects, particularly when differentiating instruction. Previous research has identified the same advantage (Krumsvik et al., 2013; Mølster & Nes, 2018). As inclusive learning environments are highlighted in the national curriculum (Norwegian Ministry of Education and Research, 2020), and differentiated instruction is a prerequisite for such environments (Tomlinson, 2001), the second research question is:

How do teachers perceive the role of digital technologies when differentiating instruction to facilitate an inclusive learning environment?

Digital technologies have had a great influence on society, and the way people communicate and collaborate in particular has evolved rapidly during the past few years. This development is equally true in a school context, as the basic principles of sociocultural learning theories and digitalized world merge (Erstad, 2015; Gouseti et al., 2020; Hillman &

Säljö, 2016). The COVID pandemic forced all teachers to reconsider the way they communicate with their pupils and how pupils can collaborate from a distance. However, digital technologies have their affordances – and pitfalls – also in blended learning and physical classroom settings, which is the focus of the final article. The final research question is:

> *How do teachers perceive the influence of digital technologies in communication and collaboration in a technology-rich classroom?*

While this case study is framed as an intrinsic case study and as such has no ambitions regarding generalization or theory development, the insights the case offers can have many affordances. Firstly, the case provides us with comprehensive descriptions from Norwegian 21st century classrooms, which during the past decade have developed immensely. These descriptions can help us to better understand the complexity of what happens in schools every day and provide us with glimpses and insights to advantages, opportunities, *and* challenges. On the other hand, the schools leading edge positioning, based on substantial professional development, rich resources, and other investments in the attempt to offer pupils better learning with the help of educational technologies, can also encourage us to look for possible best practices. As the teachers in this school have vast, long-term experience in this field, their reflections and perceptions can be highly valuable for teachers who have not quite come that far yet, but have aspirations in gaining more competence and perspectives in using digital technologies in a

more innovative and well-substantiated manner. And – while generalization is not a goal of this study – findings from a study like this and other similar studies can help in building a more comprehensive, conceptualized, and nuanced understanding of the impact of digitalization in Norwegian schools. Additionally, both in-service and pre-service teachers need to develop competencies that match with the current needs within the classrooms. Therefore, one could argue that also Norwegian teacher education – which currently is often being criticized for not preparing students enough for the digital dimensions of classroom management and didactics – could benefit from descriptive data such as the findings presented in this study. The data collected for this study is from 2020, and thus, still rather fresh. However, because of the increasingly rapid advancements in digital technologies, new studies need to be produced continuously in order to gain a comprehensive and current state of the art knowledge at any given time. When it comes to studies regarding the use of digital technologies in education context, much of it tends to have a somewhat short expiration period.

1.3 Research design

The goal of this study is to find out how primary school teachers perceive their role in technology-rich learning environments and how they enact this role in their pedagogical work. In order to avoid merely repeating findings of other similar studies, the main principles of purposeful sampling (Bryman, 2016; Creswell & Guetterman, 2021) were selected. In other words, in this study, the goal was to find informants with a

higher-than-average PDC, working in a school with access to a wide array of digital technologies. The main idea behind the purposeful sampling was to get a glimpse beyond the usual challenges and general approaches and study the perceptions and actions of teachers at a school that has chosen digital technologies as an area to focus on.

In order to gain a comprehensive understanding of teachers' perceptions of their role and how digital technologies influence their pedagogical practices, the study was framed as a case study with a cumulative mixed-methods approach. Seven teachers at two grade levels, one in lower primary school and one in upper primary school, were first interviewed individually and thereafter observed. Individual interviews provided necessary background information that helped prepare for the observation period, and also enabled the informants to express their own attitudes, beliefs, insights and experiences regarding the topic, within the frames of a semi-structured interview (Bryman, 2016). The observation period was executed to see how the perceptions expressed in the interviews were realized in practice, as well as to detect potential discrepancies and other interesting perspectives. After a completed observation period of four weeks, the same teachers were interviewed in their respective grade level teams, in order to pose further questions regarding the individual interviews, observations and the synthesis of the two. After a tentative analysis of the qualitative data, a survey was administered to validate prior findings and develop new aspects.

The theoretical framework for the study derives from the sociocultural views on learning, which are highlighted in many contemporary curricula, including the newly reformed Norwegian curriculum (LK20). The driving force in the sociocultural view on education is that we learn better in interaction with others (Säljö, 2014). Teacher's role is to facilitate and be the more knowledgeable other, helping their pupils to scaffold and gradually become more independent and proficient in the learning matter (Säljö, 2014). Similar definitions, goals, and ideals are echoed in the literature regarding 21st century classrooms, as well as in the data gained from the informants of this study.

The theory also ties the research questions and articles together.
Teacher's role as the more knowledgeable other, who also facilitates learning (Wertsch, 1998), is closely linked to their role as a classroom manager. Acknowledging the importance of interaction and having more capable peers or teachers to learn from and with (Säljö, 2014) not only challenges the traditional role of a teacher but also highlights the importance of inclusive learning environments and collaboration. In interaction, language has a crucial role (Vygotsky, 1978), so investigating the communication and collaboration practices is of deep relevance. The zone of proximate development (Vygotsky, 1978) is relevant in many accounts, but in this thesis, its role in differentiated instruction and inclusive learning environments has been particularly in focus, as it can be speculated if digital technologies – artificial intelligence (AI), for example – could enhance, supplement, or even replace a human as the

more knowledgeable other (Abtahi, 2014; Abtahi et al., 2017; Putman, 2014; Säljö, 1999)

1.4 Personal stance and starting point

For a long time, I have identified myself as a teacher. I earned my first master's degree in teacher education in 2006, without digital technologies even being mentioned during my education. However, already in my first teacher job, my employer was looking to engage teachers who would be willing to investigate the possibilities of a digital learning platform. I had never been particularly interested in technology, but I was intrigued by the opportunities digital technologies could offer in teaching and learning. After a couple of years, I changed to a different employer, and in my new position, I ended up piloting the use of interactive whiteboards. At that time, the focus was on making the work more effective, rather than transformational with the help of digital technologies (Bolick & Bartels, 2015), and much of the work was therefore focused on non-instructional activities. However, moving to a different country a couple of years later and being employed at a private school that rolled out class sets of iPads and PCs early on in primary school was the turning point. While still being more interested in pedagogy than technology, I began to develop ICT curriculum together with highly proficient colleagues and became increasingly interested in how the role of digital technologies was perceived and conceptualized amongst educators. During the next few years, I held different technology-related roles on the side of my teaching position. In 2014, as

I began my second master's degree in education, digital technologies were already much more discussed in the practice field, and educational use of digital technologies was also explicitly studied in my program. Soon after completing my degree, I moved to a teaching position at a university and continued to investigate how digital technologies could add student interaction and positively influence learning. That is the path I am still exploring.

Why is all this personal history important? The qualitative, exploratory nature of this study highlights the role of the researcher in the analysis and interpretation of the data, and my own beliefs, prior experiences, and knowledge of the topic guide and influence every step of the research process (Bryman, 2016; Creswell & Guetterman, 2021; Stake, 1995). This places emphasis on personal reflexivity throughout the study; in other words, my ability to discuss my role and reflect over how my beliefs, assumptions, biases, and sometimes just mere presence during the data collection has influenced the project (Bryman, 2016; Creswell & Guetterman, 2021; Olmos-Vega et al., 2022). In case study design, the researcher takes up the roles of an advocate, gatherer, interpreter and evaluator (Stake, 1995). It is therefore impossible for the researcher not to affect the process, but in qualitative research, that is not necessarily seen as a disadvantage (Stake, 1995), nor should neutralizing subjectivity be a goal (Olmos-Vega et al., 2022). The prior knowledge and experiences of the researcher can be considered an asset in interpreting the results, as they help construct best possible conclusions and

descriptions (Bryman, 2016; Olmos-Vega et al., 2022; Stake, 1995). From an epistemological standpoint, this kind of an approach manifests interpretivist approach, where – in contrast to positivism – the goal is not to merely explain human behaviour but rather understand it (Bryman, 2016). In this study, I do not seek to confirm theories or find generalizable explanations to the phenomena, but rather interpret a unique case and offer descriptions that can help us learn more about this particular case.

2 Previous research and literature

2.1 Implementing digital technologies in education

There is a plethora of studies and other literature focusing on implementation and use of technology in schools, as well as the expectations digitalization sets to teachers. What is common to many of these studies is that they conclude that teachers tend to use technology in a way that promotes more conventional pedagogical approaches, and digital technologies are often facilitating reproduction or distribution of knowledge (Blikstad-Balas & Klette, 2020; Krumsvik et al., 2016; Voogt et al., 2013a). In the ever-changing landscape of digital technologies, the field generally recognizes the need for more research focusing on how the fast development of digital technologies changes the roles and dynamics in the classroom and how they create new opportunities for transforming pedagogical practices, as well as how this changes the teachers' role in the classroom (Erstad & Hauge, 2011; Krumsvik, 2014a; van Laar et al., 2017).

In Norway, digital tools have been used and studied more extensively than in many other countries, and longer in lower and upper secondary contexts than in elementary grades. Now that digital technologies have found their way even to the lowest grade levels, there is need for studying this level of education more closely, as it seems that the approaches and effects digital technologies have in learning can vary significantly. Furthermore, at the global level, research on the application of digital

technologies in teaching and learning is predominantly focused on secondary and tertiary education. Studies that examine the use of these technologies in primary school settings are less common, albeit on the rise in tandem with the increasing adoption of digital technologies at this level.

Despite the ambition of all stakeholders, implementing digital technologies in a meaningful way in education at any level has not been easy. Research identifies several factors that can either promote or hinder this development. First and foremost, the stakeholders need to have a shared vision and willingness to work collectively towards realizing their vision (Albion et al., 2015; Røkenes et al., 2022; Tondeur et al., 2008, 2017). The school culture in general has to be open and the stakeholders willing to commit to the change (Tondeur et al., 2008, 2017). Naturally, teachers' personal attitudes, skills and knowledge are important influencing factors (Spiteri & Rundgren, 2020). Knowing that teachers' personal beliefs and attitudes can cause resistance and that such standpoints have a tendency to be rather stable, it is important that professional development is systematic and long-term, with the aim of helping teachers understand how their role has changed during the past couple of decades (Erstad et al., 2021; Røkenes et al., 2022; Tondeur et al., 2017). Collegial collaboration and strong focus on building a professional learning community seems to be important to both teachers themselves and the actual outcomes (Røkenes et al., 2022; Tondeur et al., 2017). This kind of work requires time, and school leadership has a great responsibility in making sure that a sufficient amount of professional

development time gets allocated to this purpose (Bondie et al., 2019). In Norway, the infrastructure is generally well developed, and schools have sufficient digital resources available, such as digital devices and software, and thus, the importance of increasing teachers' PDC is of the essence (Erstad et al., 2021; Fjørtoft et al., 2019). Teachers' PDC is further defined and discussed in chapter 3.3 as a part of the conceptual framework of the thesis.

While the future of classrooms remains uncharted, we can realistically expect that digital technologies will continue to develop in a fast-moving pace, which will impact both material and social aspects of the society (Glassman & Burbidge, 2014). The relationship between humans and digital technologies consists of fear of the unknown, recognition of contemporary artefacts, and integration of those into our everyday lives – reflected also in education (Glassman & Burbidge, 2014). Artificial intelligence (AI) presents a good example of this. Adaptive algorithms and sophisticated AI chatbots, for instance, may feel intimidating, but in our everyday lives, we already often rely on them. In schools, they are used to provide variety, individualized learning experiences, and authentic problem-solving situations, but the rapid and never-ending evolution of these technologies challenges teachers to continuously keep up-to-date with the advancements and reconsider their own pedagogical practices (S. J. H. Yang et al., 2021; Zhai et al., 2021). The amount of information and easy access to it is a true game-changer in education and should force educators – perhaps more than ever – to make a shift from conventional reproduction and recital of knowledge to applying the

knowledge in authentic problem-solving (Säljö, 2010; van de Oudeweetering & Voogt, 2018). This inevitably keeps challenging teachers' perception of their role, as well as their choice of pedagogical practices. No longer is it enough for teachers to adopt designs from other educators; they must be able to both design learning processes themselves and facilitate their pupils acting as learning designers (Kuure et al., 2016; Levinsen & Sørensen, 2019; Mirra et al., 2018).

2.2 Teacher's role

According to Kim (2019, p. 19) adopting a designer role requires ability to empathize, think creatively, collaborate productively, experiment, and communicate effectively. A more advanced teacher designs learning where pupils themselves become designers of their own learning (Levinsen & Sørensen, 2019), highlighting their agency (Virkkunen, 2006), process-oriented pupil active learning (Levinsen & Sørensen, 2019) and opportunities for pupil participation. In this study, pupil participation is defined as pupils' possibilities to influence matters regarding their own learning (Shier, 2001). Whether a teacher is participating in designing of teaching and learning with their colleagues or pupils, learning by leading others can broaden their own competence when incorporating digital technologies in their designs (Blau et al., 2020). In this context, their active and collective agency is crucial (Blau et al., 2020; Haapasaari et al., 2016; Virkkunen, 2006).

Literature, inclusive of research, reports, and policy documents, demonstrates that the expectations set to teachers in 21st century classrooms are vast. Lifelong learning has generally been acknowledged as an important attribute (Ferrari, 2013; van Laar et al., 2017), requiring teachers to adopt a dynamic role and reflect on their beliefs and choices on regular basis. Teacher's role in a classroom is nevertheless still central: a teacher facilitates learning, implements instruction, supports students' social and academic growth, and creates a supportive and caring environment for all learners (Evertson & Weinstein, 2006; Sabornie & Espelage, 2023).

Teachers' perception of their own role and teacher identity is often a combination of these aspects and varies, depending on context, experience, and self-image (Beijaard, 200; Ben-Perez, 2003). Although some teachers still consider themselves primarily as subject experts and a source of knowledge, other aspects of the role of a teacher seem to have become prioritized by teachers during the past decade (Brown, 2017; Bullough, Jr. & Richardson, 2015; Poom-Valickis et al., 2012). Teachers often highlight the didactic and pedagogical expert role, with a focus on planning strategies to facilitate best possible learning, which is reflected in understanding the importance of social and emotional dimensions of learning (Bullough, Jr. & Richardson, 2015; Poom-Valickis et al., 2012). As classroom managers, teachers still often conceptualize classroom management with rules and discipline, but increasingly also as being guides and facilitators for pupils' academic, moral, and emotional

growth, while focusing less on control and discipline (Ben-Peretz et al., 2003; Bullough, Jr. & Richardson, 2015; Evertson & Weinstein, 2006; Kuure et al., 2016).

How teachers perceive their role is directly related to their professional identity (Makovec, 2018). The development of teacher's professional identity is influenced by many factors. Teacher's own personal beliefs and attitudes, experiences, characteristics, and professional contexts are some of the defining factors when teacher identity is being formed, and it is a process that continues throughout the teacher's career (Beijaard, 2000; Pillen et al.,2013). Beliefs and attitudes in particular are often emotionally loaded and do not necessarily operate adjacent to cognition and knowledge (Jenssen & Nordahl, 2022; Nespor, 1985; Pajares, 1992). As a result, they cannot be easily changed (Nespor, 1985; Pajares, 1992) – an attribute that can hinder all kinds of change, including digital.

How a teacher perceives their role is also related to how they manage a classroom, and in this study, leading learning in technology-rich learning environments was of primary focus. Classroom management in the 21st century is not only about managing the physical classroom but also the digital learning arenas – and the combination of both. One-to-one coverage is still rather new, particularly in primary schools, and that is why there is still relatively little research focusing on teacher's role and classroom management in blended learning environments (Bolick & Bartels, 2015; Hrastinski, 2019). Munthe et al. (2022) find that access to one-to-one devices has been a revolutionizing factor in Norwegian

schools, but that teachers don't always know how to fully take advantage of this resource. These technology-rich environments, where traditional and digital learning arenas merge and are being employed parallel to one another, require multitude of new competencies from the teachers (Graham et al., 2019; Vaughan et al., 2013; Y. Yang et al., 2022) . Teachers are expected to make use of the many opportunities of the digital world while understanding its ever-changing nature, forcing them to constantly keep themselves up-to-date with the technological advancements (van de Oudeweetering & Voogt, 2018). Teachers are encouraged to experiment and take risks, which can make many teachers uncomfortable (Desimone, 2009; Goodwin et al., 2015).

When discussing teacher's professional identity, this continuous need for professional development and experimentation challenges the traditional perception of being "ready" as a teacher once completing teacher education and having a few years of teaching experience. An obstacle for adopting a new role can be found in teachers' personal beliefs and attitudes, as those can influence professional practices and development more than scientific knowledge (Pajares, 1992). A teacher who finds digital technologies unfamiliar or questions their importance often lacks digital competence, and paradoxically, is also often among those most in need but least willing or likely to participate in professional development to gain such competence (OECD, 2009; Rogers, 1995).

2.3 Pedagogical practices in a 21st century classroom

One of the central roles which teachers have in classrooms is facilitating a safe environment where all pupils can learn. In Norway, inclusive principles were first noted in the national curriculum in the 1970's, but more attention was directed to it only after signing the *Salamanca statement* in the 1990s (UNESCO, 1994; Karlsen, 2020). *Fellesskolen* is a Norwegian concept, highlighting that Norwegian public schools are meant for all children, and that it is the school's responsibility to adapt to meet the needs of each individual learner in order to promote the wellbeing and learning of all children (Norwegian National Directorate of Education and Training, 2020). To create inclusion, the teacher needs to plan and facilitate learning that increases participation and decreases exclusion by addressing barriers that may hinder participation (Tomlinson, 2022). A prerequisite for an inclusive learning environment is that teachers differentiate instruction, so that each pupil can participate, learn and experience mastery.

In the light of the current state of knowledge, teacher-led, strictly framed learning situations are urged to be phased out and be replaced with a more open-ended settings, where the teacher's role is more that of a facilitator who designs and organizes such environments and guides the pupils while they are experimenting, problem-solving and initiating possible solutions themselves (Beijaard et al., 2000; Mishra et al., 2013; Munthe et al., 2022). This inevitably changes also the expectations set to the

learners, rather than only the teachers (Krumsvik et al., 2018). Currently, digital elements of our society contribute significantly to the development of pupils in and outside school, as learning is no longer restricted to school environments (Hillman & Säljö, 2016). The importance of reproduction and repetition are challenged, and 21st century competences, such as collaboration and innovative approaches, are emphasized (Hillman & Säljö, 2016; Kereluik et al., 2013). To describe this shift, Hillman and Säljö (2016) use the term *performative understanding* of what it means to know: foundational knowledge – the repetition and reproduction of it – creates an essential foundation for other, more creative approaches (also Mishra & Mehta, 2017). In other words, in the 21st century, instead of occupying the role of the main learning outcome, reproduction and repetition serve as the first step of the learning process, paving the way for what comes after: what does this knowledge mean? What can we do with it? How does it help us solve problems?

2.4 Blended learning

Technology-rich classrooms enable blended learning. Blended learning as a term is somewhat ambiguous, evolving in many directions, together with the many developments of digital technologies and infrastructure (Hrastinski, 2019). Terms mixed-mode learning, hybrid learning, and blended learning are complex and often used interchangeably, and different educational traditions and levels have led to different interpretations of what the term entails (Bozkurt, 2022). The term

blended learning originates from higher education and the corporate world, strongly rooted in distance and remote learning combined with face-to-face instruction (Garrison, 2006). In time, as technologies and learning modes have evolved, the concept of blended learning has adopted new meanings. At its simplest, blended learning can be understood as any type of education that combines face-to-face learning with digital technologies (Hrastinski, 2019; Paniagua & Istance, 2018). Garrison and Kanuka (2004, p. 96) specify the definition by highlighting that the integration of the two must be *thoughtful* – well designed, purposeful, and meaningful – while Deschacht and Goeman (2015) emphasize the systematic and integrated design of online and offline components. While there have been attempts to set a ratio to define how much of the instruction should take place online and what amount should be face-to-face, a more fitting description would perhaps be viewing different models of blended learning as a continuum (Hrastinski, 2019; Watson, 2008). Watson (2008) presents a blended learning continuum divided in seven categories. These categories range from pure online models to designs with few or no online resources involved. While Watson's (2008) continuum refers to being online as the digital element in blended learning, one could speculate if being online is a necessity. The definition of Graham et al. (2019) does not include a mandatory online component – only computer-mediated activity, which isn't necessarily happening online. At the same time, as Hrastinski (2019) points out, a vast majority of educational technologies today are online – or at least have an opportunity to be online – at all times. Therefore, in

this study, no differentiation is made between online and offline components, as long as digital technology was in one way or another involved in learning. Accordingly, blended learning in this study is defined as a combination of face-to-face instruction and educational use of technologies.

Under ordinary circumstances in a primary school setting, blended learning often refers to using digital technologies alongside face-to-face instruction (Hrastinski, 2019). In Watson's continuum (2008, p. 6) such a model is represented in three categories where the online to face-to-face ratio varies from classroom instruction with significant required digital components that go beyond the classroom space and instruction time to a traditional setting with few or no online resources or communication. These categories allow a vast array of different approaches to blended learning: flexible changes between learning modes (teacher-led and pupil-led), parallel use of digital and physical learning space, and combination of different pedagogical methods (Y. Yang et al., 2022). Pulham and Graham (2018) find that all such elements can highlight the opportunities that allow more pupil participation and initiative in task designs and execution. From a teacher, blended learning requires mastery of classroom management in digital and physical learning spaces, understanding pitfalls, potential, and features of a variety of digital technologies, and competence that combines pedagogical, technological, and content knowledge (see *TPACK model* in 3.3.1).

2.5 The more knowledgeable other – teacher vs. AI

Digital technologies have changed the means of interaction in educational contexts. Pupils no longer interact only with each other or the teacher but also with digital technologies. The development of adaptive algorithms and AI in particular challenge us to study and discuss the role of digital technologies in this interaction more. Säljö (1999, p. 153-154, 158) has previously stated that digital technologies can provide experiences similar to interaction with a teacher or someone else more knowledgeable, but that as technology cannot guarantee specific interpretations and is always limited in its responses, a human facilitating the process would still be required. As technology has quickly evolved and adaptive algorithms and AI have developed rapidly and significantly since this statement was made, it is worth investigating in which capacity digital technologies today can supplement or even replace interaction between humans in sociocultural learning contexts. Furthermore, how should this be taken into account when designing learning in the future?

Subsequently, according to Säljö (1999, p. 159), digital technologies have a lot of value in adding to the range of experiences and forms of interaction, but ultimately, digital technologies cannot replace conversations and reasoning among humans, which subsequently lead to learning. Many researchers since have shared their views on technology being a powerful mediator in social learning (Cicconi, 2013; Roschelle, 2021; Rienties et al. 2020), while some researchers have seen more indications of digital artefacts being able to facilitate a learner's ability

to advance to the ZPD in certain contexts (Abtahi, 2014; Abtahi, 2017; Putman, 2014). This would enable the placement of digital technologies in the role of the more knowledgeable other, which, according to Putman's (2014) research, appears to work in contexts where basic skills are being learned through drills and repetition. In more complex situations, Putman (2014), too, has found that digital technologies supplemented or enhanced interaction and learning, but not in the role of more knowledgeable other.

However, since Säljö's (1999) article and Putman's (2014) study on the role of technology in sociocultural learning, AI has advanced in leaps. It is therefore necessary to re-evaluate the role of digital technologies in learning in comparison to the traditional role of a teacher, as highly developed human-centered artificial intelligence (HAI) (S. J. H. Yang et al., 2021) inevitably changes the role and didactic considerations of a teacher. Already, drills and repetition are often "outsourced" to digital technologies: for example, times tables practice and decoding when learning to read and write can be performed digitally in applications that provide instant feedback and adaptive algorithms (S. J. H. Yang et al., 2021). This can free teachers' time for other important tasks, as prepping and going over the drills is automatized (Moltudal et al., 2020). In turn, pupils get instant feedback and level-appropriate assignments on a regular basis. However, modern AI is fast approaching more human-centered patterns of interaction and can provide believable reasoning and new authentic learning experiences, for example through role play and gamification (S. J. H. Yang et al., 2021; Zhai et al., 2021).

In November 2022, Open AI's ChatGPT took the Internet by storm and impressed users around the world by providing thorough, varying, and sophisticated answers to a variety of complex questions and themes. Since then, ChatGPT has been significantly improved to solve complex problems, provide multiple perspectives in its replies, and discuss a large variety of topics with a human party substantially better than any AI before. While AI-based digital technologies have been in use in Norwegian schools for many years, largely for personalizing and increasing volume of pupil activity (Moltudal et al., 2020), such a leap in the development of AI challenges teachers and researchers to reconsider the didactic design in their pedagogical work, seek opportunities to take advantage of developed technologies, and identify potential pitfalls in this context. After all, it is not the possession of information or replicating teacher's actions that is considered learning: you have learned when you know how to use the information to solve a problem – either through mastery or appropriation (Säljö, 2014; Wertsch, 1998).

2.6 Ethical and juridical challenges in technology-rich classrooms

2.6.1 Some juridical challenges

As digital technologies continue to evolve and their role in education increases, it forces us to also more closely consider the ethical aspects of technology, even though the main focus of this study lies elsewhere. For

instance, social media, easy access to multiple medias, new avenues for sharing, a growing amount of personal devices, and digization of content all contribute towards this development (Norwegian National Directorate for Education and Training, 2022). Ability to make good choices online – and teachers' ability to model this – has for a long time been a central area of focus when discussing pupils' digital competence at policy level (Kelentrić et al., 2017; Norwegian National Directorate of Education and Training, 2017). In 2018, The General Data Protection Regulation (GDPR) was introduced to streamline legislation within European Union and its closest European partners. GDPR is a component of European Union's legislation targeting human rights and privacy laws and is also to be followed in Norwegian municipalities, including schools (Mæhle et al., 2021). In 2019, only about half of the municipalities reported that school staff has been trained in GDPR-related matters (Fjørtoft et al., 2019). In 2020, the COVID pandemic increased the use of digital platforms in education drastically, which led schools and teachers to use and experiment with a variety of new websites, applications and software (Federici & Vika, 2020; Mæhle et al., 2021). This introduced multiple risks regarding breaches of privacy, and both increased awareness and streamlining of practices securing privacy are still needed today (Mæhle et al., 2021). While GDPR contextualized some aspects of online lifestyle in a safer and clearer manner, some questions remain to be discussed at local levels. Ethical and juridical dilemmas are presented in many of the possibilities that digital technologies offer. Boundary issues are an example of such dilemmas and were present also in this study. For

instance, teachers these days often have access to applications which allow them to view and/or take control of pupil devices (e.g. Apple's Classroom and Zulu Desk). In the name of keeping their pupils safe and focused on what they are supposed to be focusing on, teachers can access pupils' devices to view content and even steer actions. While some call this surveillance and breach of privacy, others find it necessary and in the child's best interest (Buchanan, 2019). Levinson and Fay (2019) find that discussing such dilemmas in the professional community is essential. In this case, it is important to discuss what the difference between viewing pupils' screens in the classroom versus remotely is, which aspects are found ethically problematic, if everything is juridically in place, and the reasoning behind the use of such applications and software. Legislation allows access when teachers have pupils' or their guardians' consent, and in cases when the devices need to be monitored or controlled for system security (Norwegian Data Protection Authority, 2021). Without consent, teachers are not permitted to access pupils' devices remotely - not even to prevent or detect inappropriate activity or for purposes of education, such as formative assessment or to follow up pupils' progress – no matter how good their intentions are. Consent from pupils or their guardians would remove juridical issues but will still leave teachers with the ethical dilemmas to discuss.

2.6.2 Some ethical challenges

Data security and integrity are juridical questions, but discussions related to ethical perspectives are also extremely valid. In addition to the above-

mentioned issues, for example online conduct and consequences, and pupils' health perspectives have been discussed in media and scientific publications.

Bullying in schools happens parallel in physical settings and online. During the past few years, cyberbullying has increased globally (Zhu et al., 2021), and the problem is also acknowledged in Norway: approximately one third of 9-18-year-olds in Norway have experienced different forms of cyberbullying (Medietilsynet, 2020). For the victims, the expansion of bullying from physical to digital space often means that bullying is not restricted to school settings, but the time and space expands, and bullying can continue in evenings, nights, weekends, and on vacations (Sjursø et al., 2020). Bullying has also found new forms online, for example, mean comments, exclusion, sharing photos without permission, and threats on social media channels and games (Medietilsynet, 2020). Such forms of bullying are often characterized by anonymity from the perpetrator's side and publicity from the victim's side (Sjursø et al., 2020; Zhu et al., 2021). Cyberbullying – like any other form of bullying – can have serious short-term and long-term consequences for everyone involved, including the bystanders, and can be considered a serious public health threat (Smith et al., 2019). While only 12% of the 9–18-year-olds informed an adult, such as a parent or teacher, about the hurtful acts aimed at them online (Medietilsynet, 2020), the nature of cyberbullying can also make it very difficult for parents and teachers to detect. It has been found that adopting and

enacting an authoritative teacher role can help teachers prevent, detect, and interfere with bullying (Schuster & Bogart, 2013).

Other ethical issues related to teacher's role in technology-rich classrooms are, for example, risky behaviour online and exposure to harmful and sexual contents. Also in these contexts, research shows that pupils are hesitant to bring up such encounters with adults, and it is common that adults find out about harmful themes and contents accidentally (Lafton et al., 2023; Ševčíková et al., 2014). However, recent research also found that previous studies had a tendency to over-emphasize the harmful aspects of pupils' online behaviour (Lafton et al., 2023, p. 11). To promote safe online behaviour amongst children and adolescents, teachers could to a greater extent discuss the themes with their pupils, and include them in the decision making regarding the use of digital technologies in education (Aldrich et al., 2022). For teachers, this means having to increase their competence, as pupils themselves often feel that their digital competence surpasses that of their teachers' (Aldrich et al., 2022).

Findings that reveal pupils' views on themselves having higher digital competence than their teachers (Aldrich et al., 2022), combined with their reluctancy to discuss harmful and inappropriate encounters online with adults, also make following the chapter 9a of Norwegian Education Act challenging from the digital perspective. This chapter states that all pupils are entitled to enjoy a good physical and psychosocial environment and highlights that all teachers and other adults in schools

have an obligation to follow up, interfere, notify, investigate, and act when a pupil expresses that they find their learning environment unsafe (The Education Act, 2019). The vast role and use of digital technologies in Norwegian schools causes learning environments to become more informal, which in turn highlights teacher's role as a facilitator of self-regulation and a safe and supportive learning environment, both in physical and digital space (Kongsgården & Krumsvik, 2019). This requires that teachers possess high levels of knowledge and competence in digital learning environments.

3 Theory and conceptual frameworks

This chapter presents the conceptual and theoretical frameworks that have inspired, shaped, and defined the research questions, and later been applied in analysis of the findings. Bryman (2016, p. 12) states that a successful research project needs concepts and theories, which are "the ideas that drive the research process and that shed light on the interpretation of the resulting findings". Furthermore, he defines concepts as building blocks for theory, which can either provide an explanation of a certain aspect, or alternatively stand for things we wish to explain (Bryman, 2016, p. 151). A conceptual framework can therefore be defined simply as main topics to be studied, or as a system of concepts that can consist of assumptions, expectations, beliefs, key factors, constructs, variables, and theories (Maxwell, 2013; Miles et al., 2019). Theoretical framework on the other hand can be considered a conceptual framework or, in a narrower sense, as a set of concepts validated through evidence, which has been formed into an established understanding of the state of knowledge (Maxwell, 2013).

The overall theme in this project was teachers' own perceptions of how digital technologies influence their role and the enactment of that role in their pedagogical practices, and there are several concepts that meld together when discussing this theme. Regarding the theoretical standpoint, sociocultural learning perspectives offer relevant main principles for framing, designing and analysing the study for a variety of

reasons. Firstly, Norwegian curricula have for the past couple of decades been influenced by the main principles of sociocultural learning theory (Dysthe, 2001; Ministry of Education and Research, 2019; Norwegian Ministry of Education and Research, 2006) and a safe learning community that supports each pupil's academic, social, and emotional growth is considered a key component in learning (Norwegian Ministry of Education and Research, 2019).

As teachers' competence is seen as a central factor in the work of building and maintaining such learning environments – physical, digital, and blended – teacher's PDC is an important underlying concept in this study. Finally, 21st century competences define and discuss the expectations set for the teachers in contemporary classrooms and are therefore an important concept to build on.

To facilitate a supportive learning environment where learning processes are characterized by collective construction of knowledge, rather than behaviouristic models with the aim of memorizing and reciting knowledge, concepts such as classroom management, differentiated instruction, inclusive learning environments, and collaboration are vital. These were discussed in the literature overview (chapter 2).

3.1 Sociocultural learning theory and digital technologies

While institutional interpretation of learning has a long tradition of relying on copying, memorizing, and reciting (Säljö, 2010), Norwegian

curricula from more recent decades highlight the values of sociocultural approach (Dysthe, 2001; Norwegian Ministry of Education and Research, 2019). This tradition is heavily based on the work of Lev Vygotsky (1978), and later researchers like James V. Wertsch (1998) have further interpreted and developed the work within the discipline. These two are used as the main references in this study, while fully acknowledging the influence that, for example, Bloom (1984), and Marton and Säljö (1976) had in forming the sociocultural perspective. Some of the most central elements of learning in the sociocultural tradition are language, culture, and the collective nature of learning. As opposed to cognitive learning theories, in sociocultural views, learning is considered a far more complex process than an individual merely remembering or reciting information; it is a comprehensive process where the individual is in constant interaction with culture and constructs knowledge in interaction with others (Dysthe, 2001; Vygotsky, 1978; Wertsch, 1998).

3.1.1. Collective nature of learning

From a sociocultural perspective, the collective nature of learning is central. Culture and context are seen as inseparable factors in learning, and thus, it is necessary to see an individual as a part of a sociocultural environment (Dysthe, 2001). Interaction with others is seen as essential for learning, and learning and development in general are considered intertwined (Martinez Rodriguez, 1999; Vygotsky, 1978). A key element regarding interaction is the *Zone of Proximal Development (ZPD)*, which

suggests that interaction with peers is not enough – one also needs to interact with someone more able, a more knowledgeable other (Martinez Rodriguez, 1999; Vygotsky, 1978). This person – or people – aid the learner in moving from the level of their actual developmental level - what they already can do – to a level where they can solve a problem with support from someone more proficient, such as a teacher or a more capable peer (Vygotsky, 1978). This level is called the Zone of Proximate Development – not too easy but within the learner's reach (Vygotsky, 1978). The more knowledgeable other aids the learner by offering support and "controlling" the elements of learning that are outside the learner's reach, allowing the learner to focus on the aspects within their capacities and eventually, build on those when acquiring and constructing new knowledge and competences (Vygotsky, 1978; Wood et al., 1976). This is generally known as the process of *scaffolding* (Wood et al., 1976). However, the developmental level of the learner sets some boundaries to learning, and even with support, there are limits to what can be learned. Vygotsky (1978, p. 87-88) exemplifies this with a case from mathematics: if a learner needs help with an arithmetic problem, they can grasp the solution by imitating what the teacher is doing, as long as the teacher is using mathematics at the right level. If the teacher uses very advanced mathematics, the learner may still be able to imitate, but would not understand the solution, regardless of how often they imitate what the teacher does.

3.1.2 Internalization of cultural tools and artefacts

Through interaction, an individual can internalize for example language, attitudes, and the use of tools and artefacts. This study makes a distinction between a *tool* and an *artefact*. A tool is often considered as something instrumental, an object with a certain – potentially limited – purpose (Lund & Aagaard, 2020; Orlikowski & Iacono, 2001). An artefact, however, can be viewed as something with broader cultural significance. Artefacts have the potential to not only influence how a certain task is performed but to transform situations and practices and thus, have a broader influence on the culture (Lund & Aagaard, 2020; Säljö, 1999). An example from the digitalized world could be for example googling: the name of a search engine, once used as a replacement for encyclopaedias and libraries, is now being used as a verb and has revolutionized access to information worldwide. While it can still be purposed as a mere tool, one could argue that Google has become more than just that: it's an artefact that has transformed not only the practice but also the culture and implications of information searches. Gillespie and Zittoun (2010, p. 44) point out that the relationship between the user and the artefact defines whether something, indeed, is experienced as an artefact or a plain tool – the same object or symbol can serve as both, depending on the person or people. Gillespie and Zittoun (2010), together with Cole (2019) discuss Wartofsky's (1973) categorization of *primary, secondary* and *tertiary* artefacts. In short, primary artefacts translate to tools – instruments if you will. Secondary

artefacts, on the other hand, are representations that involve conveying information about how primary artifacts are used. These representations are not concerned with abstract knowledge. Tertiary artefacts, however, are more complex and involve attributes such as imagination, contemplation, and reiteration. Their uses, meanings and values vary across cultures and can change over time and go beyond their physical properties. Digital technologies can, indeed, fall into all of these categories, but in this study, when referring to digital technologies as artefacts, it is their function as tertiary artefacts that is begin discussed and linked to the concept of appropriation (Wertsch, 1998, p. 53). Tools, in this study, refer to both primary and secondary artefacts, and are connected to the notion of mastery (Wertsch, 1998, p. 51).

Internalization happens through mediating tools and artefacts, which help the individual to interpret and make meaning of the knowledge taking place in the surrounding world (Säljö, 1999). Wertch (1998) finds that this internalization can be divided into two separate, albeit partially overlapping, concepts: mastery and appropriation. When discussing internalization in the context of mediated action carried out on a more operational level, Wertsch (1998, p. 50) prefers the term mastery. He defends this definition by dividing actions happening on external and internal planes. Internationalization, according to him, would suggest that operations happening on external planes eventually shift to some kind of invisible internal plane, while in fact, some operations always remain on the external plane (Wertsch, 1998). In such cases, he argues, it is more appropriate to talk about mastering something; in other words,

simply knowing how to use something (Wertsch, 1998, p. 51). While Wertsch (1998) points out that it is impossible to entirely separate mastery and appropriation from each other, he finds that there is a significant difference. Appropriation goes beyond mastering a tool and defines the process of making something belonging to others, for example, an attitude or language, your own (Wertsch, 1998). It means that using the tool has taken new forms across purposes and disciplines and has perhaps even become a part of one's identity, instead of being used only in contexts that require compliance (Instefjord, 2014, p. 316; Wertsch, 1998).

When discussing the influence of digital technologies in teacher's role and pedagogical practices, Wertsch's (1998) views on the distinction between mastery and appropriation become particularly interesting. Mastery, knowing how to use a cultural tool, does not necessarily mean that the skill can be transferred creatively across disciplines and be applied in ways that reflect appropriation (Polman, 2006; Wertsch, 1998). Appropriation, on the other hand, can also happen without mastery. Such cases are often characterized by high motivation and interest but lack comprehensive understanding and sophistication (Polman, 2006). When discussing the use of digital technologies in education, this distinction is significant. A multitude of teachers can achieve mastery of digital technologies: they can use devices, software, and applications in certain tasks and contexts, and yet, digital elements are not truly intertwined with the curriculum as a whole: there is always digital elements and "other" learning. Such teachers could, for example,

use digital technologies to merely continue the tradition of reproduction in learning, instead of attempting to expand and develop the "old" information into something new and interesting (Säljö, 2010). A teacher who has appropriated digital tools, however, operates parallel on physical and digital spaces, without making a distinction which part of a lesson is digital and which is not. These teachers would change the way they teach, understanding the full impact of digital technologies not only in schools but in the society at large. These teachers are also more likely to choose methods that support the so-called 21st century competences in learning, such as creative problem-solving and collaboration. To put it simply, using digital technologies has been appropriated and thus, become a part of their teacher identity (Instefjord, 2014).

To return to the above-mentioned notion of tools and artefacts, one could argue that at a mastery level, the concept of tools seems more appropriate, while appropriation of tools, on many occasions, better reflects the definition characterizing artefacts. When mastering digital technologies in a school context, they are used as tools to complete various tasks without a full conceptual understanding, often for a limited purpose (Blikstad-Balas & Klette, 2020). When appropriated, digital technologies operate as artefacts, changing the way teachers teach and naturally merging with the rest of the school culture, forming a contemporary 21st century school culture (Erstad, 2015; Instefjord, 2014).

In the context of distinguishing between mastery and appropriation, the concept of *resistance* also becomes relevant: it is possible to master cultural tools at a high level, but due to resistance, never truly appropriate the tool (Wertsch, 1998). Wertsch (1998) illustrated this resistance with examples of history, religious traditions, and language use. This concept can also be applied in the use of digital technologies. One can use digital technologies for a necessary purpose, for example in a professional context, but due to personal attitudes or viewpoints, one does not even wish to take the mastery to the level of appropriation. Knowing that in schools, one of the greatest barriers to taking advantage of digital technologies is teachers' personal attitudes (Spiteri & Chang Rundgren, 2020), the concept of resistance becomes particularly interesting. Tondeur et al. (2017) find the lack of sociocultural awareness as one of the great challenges when providing professional development for teachers to become more proficient in using digital technologies, and one could argue that when relevant conceptualization is lacking, the resistance hinders mastery from becoming appropriation. Teachers may for example regularly employ software that they know how to operate and have been told to use (mastery), even when it does not entirely suit the purpose, either because they do not know what else to use or deliberately choose to ignore more appropriate alternatives (lack of appropriation). Lund & Aagaard (2020) tie this together with the concept of affordances: teachers' and pupils' perceptions of how well digital resources being used match with the goals and purposes, influences the

level of internalization and thus, whether a digital resource is used as a tool or becomes an artefact.

3.2 Digital competence in a 21st century blended learning environments

Digital technologies continue to shape and reshape our society and thus, schools. The values, skills and identities of pupils can no longer be separated from the concepts of being online or offline – these concepts continuously and naturally merge in the daily lives of young people (Hillman & Säljö, 2016), which inevitably also reshapes the trajectories of sociocultural learning in schools (de Oliveira Nascimento & Knobel, 2017; Säljö, 2010). Although it seems that there is no one agreed-upon manner to discuss the role and influence of digital technologies in sociocultural learning, the practical implications and conceptualizations seem to be recognized, particularly in educational research (de Oliveira Nascimento & Knobel, 2017). Learning creatively, as an active citizen, engaging in dialogue with one's own ideas, and reflection of learning are some examples of this transition in learning paths, which leads to new configurations of what learning is (Pearson & Somekh, 2006).

The increase in rolling out digital technologies in schools have created *blended learning* environments in schools around the world. While terms blended learning, hybrid learning, and mixed-mode learning can often be seen used interchangeably, the term blended learning was chosen for this study, as previous research highlights its attribute to not just simply shift

between online and face-to-face modes, but to combine them in such way that one can get "best of both worlds" by merging the two (Graham et al., 2019; O'Byrne & Pytash, 2015; Y. Yang et al., 2022). Such shift is often reflected in teachers' role as the leader of learning, as well as optimizing their chosen pedagogical methods, which ideally allow more pupil initiative, flexibility and strong teacher PDC (Graham et al., 2019; Raes et al., 2020; Y. Yang et al., 2022). Designing and leading learning processes in blended learning environments is still in its infancy, due to the novelty of the phenomenon, but in order to develop the field and improve pedagogical practices it is essential to take a close look at teachers' digital competence and their perception of teacher's role in a technology-rich learning environment. Simultaneously, it is important to define the expectations set to 21st century learning, as the frameworks regarding the concept are numerous and versatile.

3.3 Teachers' Professional Digital Competence (PDC)

Digital technologies and the rapid development they are associated with have inevitably changed our society. In the past, digital technologies were mostly seen as tools, which refers to their purpose of making something easier or more effective (Lund & Aagaard, 2020). While they still can, in many ways, contribute towards this aspect, for example when discussing classroom management and communication (Cho et al., 2020), their current status in our society is much broader. Digital technologies today have many functions as artefacts, as they carry social

significance and historically and collectively developed insights (Lund & Aagaard, 2020; Säljö, 2010). By examining trends in digitalization and research on the relationships between artifacts and human agents, Lund and Aagaard (2020, p. 67) found that digitalization involves transformation, not only augmentation or reinforcement of existing epistemic practices. This transformation is becoming more and more visible also in the way teachers perform their pedagogical work: digital resources are not used merely to replace books, and an understanding of a teacher's role as the main source of knowledge has become somewhat dated. Expectations for teachers in the classroom in general have shifted from being sole authorities to a more authoritative and supporting direction (Martin et al., 2016). In addition, teachers must adopt a dynamic role where they continuously keep themselves up-to-date with new educational technologies (Albion et al., 2015; Martin et al., 2016).

Digital technologies in schools advocate and reflect ongoing social change, and in order to respond to that need, it is imperative to reassess the tradition of reproductive agency of digital technologies in the ever-changing educational landscape. When teachers collectively take initiative to search for and experiment with activity and approaches that challenge the current status quo, their shared transformative agency challenges the prevailing paradigm (Virkkunen, 2006). It is often initiated by an individual, but in order to survive and expand, a collective aspect is required (Haapasaari et al., 2016). This activity needs to be based on informed agency, as the activity of expanding the repertoire needs to be intentional, purposeful, and knowledge-based (Lund et al.,

2019). Therefore, teachers' PDC becomes of essence. While teacher's PDC is not explicitly studied in this project, it is one of the underlying concepts in all three research questions, as digital technologies alone offer few advantages and improvements in education – it is the teachers and their PDC that direct the learning towards the 21st century in technology-rich classrooms (Hattie, 2023).

Several different frameworks have been developed in the attempt to define and evaluate teachers' digital competence, both in research literature and in policy documents, for example TPACK (Mishra & Koehler, 2006), SAMR (Puentedura, 2015), DigCompEdu (Punie & Redecker, 2017), and Professional Digital Competence Framework for Teachers (Kelentrić et al., 2017). As PDC is not explicitly studied in this project, these frameworks have gained little attention. However, two of them have been used throughout the project, to help frame and define different aspects of teacher's PDC and to explain their relevance: (Mishra & Koehler, 2006) and Professional Digital Competence Framework for Teachers (Kelentrić et al., 2017).

3.3.1 TPACK

In this study, the understanding of how digital technologies influence teaching and learning derives from TPACK framework (Mishra & Koehler, 2006). TPACK framework by Mishra and Koehler (2006) is a wide-spread framework that aims to explain the interaction between the different components of teachers' PDC: content, pedagogy, and

technology. In 2019, an element of contextual knowledge was added to the model (Mishra, 2019). Koehler and Mishra (2009) based their model on the descriptions of how teachers' pedagogical content knowledge and understanding of educational technologies interact with one another.

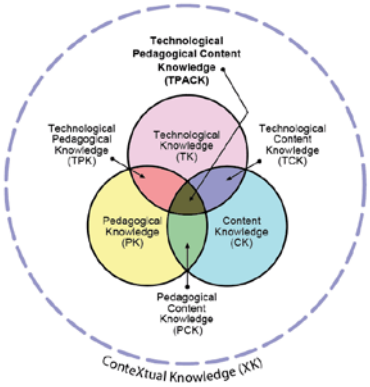


Figure 1: The updated TPACK framework with its knowledge components (Mishra, 2019).

Mishra & Koehler (2006) argue that at their best, teacher's digital abilities reflect technological pedagogical content knowledge, in which their knowledge about the subject matter, pedagogical processes and competence related to operating digital devices come together. This requires a large body of competences that highlight the understanding of different concepts that take advantage of digital technologies. These include: how different pedagogical techniques use digital technologies in constructive ways, how digital technologies can assist in a situation

where a pupil finds something hard to learn, how technologies can be used to build on existing knowledge and to construct new knowledge, knowledge of pupils' prior knowledge and theories of epistemology, and finally, to develop new epistemologies or strengthen the old ones (Mishra & Koehler, 2006). To best gain such competences, they suggest learning technology through design, in other words, by engaging in collective processes requiring inquiry, research and design, which involve reflection, collaboration and creative processes. Such an approach should be implemented already in teacher education, in order to train pre-service teachers in developing lesson design models that support a more contemporary approach, for instance, by generating and iterating new ideas (Koh et al., 2015; Voogt et al., 2013b). The more recent update to the model highlights the situational and organizational aspects that teachers need to have knowledge of, in order to successfully apply TPACK in their work (Mishra, 2019).

Viewing the TPACK framework together with concepts of sociocultural learning is another way to explain the interaction between the different parts of the model. The essence of the model is understanding how the three elements – content knowledge, pedagogical knowledge, and technological knowledge – come together. One can have mastery in all three areas, but the true potential of digital technologies in education is not realized until they merge. This could be viewed as achieving appropriation: it goes beyond knowing how to do or use something, or employing digital technologies for specific, limited activities or themes, and contributes towards a conceptualized understanding of the 21st

century learning culture. And in the true spirit of sociocultural learning, also Mishra and Koehler (2006) find it essential to develop such understanding in collaboration within the professional community.

Many educators and researchers use TPACK as an instructional model in order to assist them in incorporating all three knowledge areas in one pedagogical approach, which is the optimal way of applying the model (Polly & Orrill, 2012; Urbina & Polly, 2017). However, despite the widespread applications of the framework, TPACK framework has been criticized for offering little practical and concrete indication and instruments on how to best develop and assess one's TPACK and its applications (Hjukse et al., 2020; Voogt & Roblin, 2012).

3.3.2 Professional digital competence (PDC) framework

A Norwegian framework and an important policy document, developed for The Norwegian Directorate for Education and Training, is Professional Digital Competence Framework for Teachers (Kelentrić et al., 2017). After the publication of the framework, more attention has been drawn to the possibilities, challenges and consequences of digital technologies in schools (Røkenes et al., 2022), and the framework will undergo a comprehensive review within the current calendar year. In this PDC framework, teacher's role is seen as the key factor in facilitating learning of digitally competent pupils in the 21st century, and the framework aims to explain these different competence areas in detail. It

is divided into seven categories, which in the visualization are arranged in a circular formation to reflect their equal nature and role in the model.

Figure 2. Visualization of the Professional Digital Competence Framework for Teachers (Kelentrić et al., 2017).

The *Subjects and basic skills* category focuses on teacher's understanding of how digital technologies change and expand the contents of subjects. This inevitably means that the teacher themselves must be digitally competent, be able to see potential, and keep up with and utilize different educational technologies to facilitate best possible 21st century learning for their pupils. *Pedagogy and subject didactics* delves into the pedagogical practices and *how* something is being taught: planning, organizing, implementing, and evaluating in a technology-rich classroom requires a broad repertoire of working methods, as well as a clear understanding of aims, content, means, assessment, and pupils' individual preconditions (Kelentrić et al., 2017).

While this entire framework focuses on the teacher and their role and digital competence, the category *Leadership on learning processes* highlights the role that a teacher carries in regard to classroom management – a highly relevant perspective, particularly for research question 1. Whereas *Pedagogy and subject didactics* concentrates on the actual means and practices in the classroom, *Leadership of learning processes* highlights the necessity of a teacher who understands how the digital learning arena is in a state of constant change and is able to manage it, challenge their own role and adapt to the changes. It also highlights the need for creativity, innovation and teachers who foster their pupils' curiosity and desire to learn.

The *Interaction and communication* part of the framework calls for a teacher who understands the potential and possibilities of digital technologies in interaction and communication and is particularly relevant for research question 3. It focuses on good relationships with and between pupils and developing a supportive sharing culture in a digital environment, where pupils can contribute in a variety of ways (Kelentrić et al., 2017).

The category *School in society* highlights the role of digital technologies in today's society and why it is important that the use of technologies in school reflects the needs of society (Kelentrić et al., 2017). The category *Ethics* in this framework refers not only to laws, rules, and guidelines that a teacher must be aware of, but also to personally exercising good judgement and influencing and contributing towards a healthy digital

environment and pupils' own digital identity (Kelentrić et al., 2017). Being familiar with the signs of digital bullying and initiating ethical discussion and reflection is an important part of educating digitally competent citizens.

Being a teacher in the 21st century requires a mindset that embraces an understanding of a teacher's role that is dynamic, flexible, and a lifelong learning journey (Kereluik et al., 2013; van Laar et al., 2017). That is also what the final category in the PDC framework, *Change and development*, is all about. A digitally competent teacher, however, does not only concentrate on their own professional development but participates in and contributes towards a shared culture of teaching and learning in a digital environment in their professional community (Kereluik et al., 2013). Transferring existing competencies to new contexts, reflecting on old and new practices and staying up-to-date with recent, relevant research, steering documents and technological developments are all important dimensions of a teacher who has reconsidered their conventional views and embraces their role as a 21st century teacher (Kelentrić et al., 2017).

3.4 21st century competences

Over the past couple of decades, educational research and policy documents have discussed the importance of learning 21st century competences. Simply put, such competences are skill sets, abilities, and dispositions that have been identified to hold particular importance and relevance in the ever-so-digital 21st century (Ananiadou & Claro, 2009;

van Laar et al., 2017; Voogt & Roblin, 2012). In research, one can see the same concept framed and discussed in three different terms: 21st century skills (Mishra et al., 2013), 21st century competences (van de Oudeweetering & Voogt, 2018), and 21st century competencies (Voogt et al., 2013a). Ultimately, all discussion around these frameworks has a mutual goal and purpose: to better define and understand what pupils need to learn at school in order to be prepared for and able to participate in modern society. Oxford Learner's Dictionaries (n.d.) defines skill, competence, and competency the same way: the ability to do something well. Cambridge Dictionary (n.d.) defines skill and competence the same way as Oxford Learner's Dictionaries, but competency is defined as an important skill that is needed to do a job. Merriam-Webster (n.d.) defines the terms in several different ways, but competency stands out also in this dictionary as "specific area of competence". Based on the definitions and how the terms are often used interchangeably in literature, one could conclude that skill and competence are more generic terms, while competency refers to a more advanced or specific skill or competence needed to perform a particular task. In this thesis, competence has been chosen as the primary term, as it has been argued that skills might refer to generic abilities with a focus on physical or cognitive attributes, while the term competence offers a better conceptualization by emphasizing the cognitive dispositions in varying contexts (van de Oudeweetering & Voogt, 2018). In other words, skills can be considered as specific abilities needed to perform particular tasks, while competences foster also a new kind of thinking and understanding (van de Oudeweetering & Voogt,

2018). Competencies, as mentioned, can be considered advanced and specific competences, which could suit the purpose of this study, especially when discussing mastering and appropriating digital technologies. However, in literature, this term is less common and may in some cases exclude important aspects of employing digital technologies in education.

21st century competence frameworks are plentiful and their contents vary. Nevertheless, different meta-reviews and systematic overviews (Chalkiadaki, 2018; van de Oudeweetering & Voogt, 2018; Voogt & Roblin, 2012) recognize various similarities between different frameworks. In spite of different types of categorization and terminology, the vast majority of the frameworks converge on a common set of competences: communication, collaboration, digital competence, and social and/or cultural awareness (Chalkiadaki, 2018; van de Oudeweetering & Voogt, 2018; Voogt & Roblin, 2010, 2012). In addition, problem-solving, creativity and/or innovation, critical thinking, and productivity are considered highly relevant skills in the current era (Chalkiadaki, 2018; van de Oudeweetering & Voogt, 2018; Voogt & Roblin, 2010, 2012). In their synthesis, Van Laar et al. (2017) largely agree on the core competences in 21st century learning, but also identify contextual skills, which are needed to acquire and take advantage of the core competences. These skills – ethical awareness, flexibility, self-direction, and lifelong learning – are equally important to the teachers and their students. Van Laar et al. (2017) also categorize cultural

awareness as a contextual skill, while in many other syntheses such competence is discussed under the core competences (Chalkiadaki, 2018; van de Oudeweetering & Voogt, 2018; Voogt & Roblin, 2012). This kind of categorization finds support from the synthesis of 21st century review by Kereluik et al. (2013) and the study of Mishra et al. (2013), despite the differences in categorization. Ethical awareness, empathy, flexibility, and self-direction are highlighted as a part of humanistic knowledge and meta knowledge, which are needed in the world. This is because although the aims of education have remained the same, how to get there has transformed drastically – largely due to the rapid technological advances in the society (Kereluik et al., 2013; Mishra et al., 2013; van de Oudeweetering & Voogt, 2018).

The role digital technologies have in learning has been highlighted in much research, and additional studies and analyses among 21st century competences find that ICT, in many ways, is a true game-changer. While 21st century competences are not solely digital skills, they are particularly significant in digital contexts (van de Oudeweetering & Voogt, 2018; van Laar et al., 2017). Flexible learning environments and inquiry-based approach to learning require pupils to develop strong skills in collaboration and communication, while having a firm grasp on self-regulation and flexibility (Mishra et al., 2013; Mishra & Mehta, 2017). Critical thinking, foundational knowledge, and cultural and ethical awareness are essential when evaluating information and what to do with it, and cultural and social competence in general have transformed in a

society that operates as much in digital as in physical environments (Kereluik et al., 2013; Mishra et al., 2013; Mishra & Mehta, 2017).

Teacher's role in the 21st century school can therefore differ significantly from the conventional role known from previous decades (Mishra et al., 2013).

3.5 To sum up

When designing this study, it quickly became obvious that when attempting to paint a comprehensive picture of teacher's role and the enactment of it in contemporary technology-rich learning environments, many relevant concepts converge. Sociocultural views on the theory of learning carry a lot of relevance in a Norwegian school context: the national curriculum highlights the importance of interaction and the collective nature of learning (Norwegian Ministry of Education and Research, 2019). Moreover, the sociocultural approach to learning can be considered very relevant when discussing the digital elements in education. Internalization of digital competences, particularly appropriation, is a prerequisite for sustainable development of digital competence (Colás-Bravo et al., 2019). Digital technologies can also be viewed as mediating artefacts when working towards 21st century competences (Colás-Bravo et al., 2019). These competences encompass a range of abilities and attitudes that have been recognized as highly significant and applicable in current society (Ananiadou & Claro, 2009; van Laar et al., 2017; Voogt & Roblin, 2012). In a school context, it is therefore vital to understand contemporary learning environments, which

in our time are characterized by different combinations of physical and digital learning arenas (Graham, 2006; Hrastinski, 2019). This requires teachers to possess dynamic and contemporary competences that enable them to optimize the use of digital technologies in their work and reflect on how the digitalization of schools influences their role. PDC is therefore a highly relevant concept when discussing the main topic of this thesis – despite the fact that it is not explicitly mentioned in the research questions.

4 Methodology

4.1 Case study design

The complexity of the phenomenon being investigated in this research project advised a qualitatively driven mixed methods study, where the data was collected by employing individual interviews, observation, focus group interviews and a survey. Due to these factors, a constructivist approach highlighting the interaction between individual experiences, ideas and environment was considered a relevant epistemological standpoint. While many methodologists provide valuable insights, definitions, and framings for case study research, in this study the epistemological commitments, definitions and design procedures derive mainly from those of Merriam (1998) and Stake (1995). Their constructivist approach to case study research with somewhat broad definitions, and especially Merriam's education-related positionings, were found particularly relevant for the aims and purpose of this study. While case studies generally do not aim to confirm prior theories or develop new ones, they are often framed by theories or concepts from their own or other disciplines (Bryman, 2016). Immersing themselves in framework, which draws upon concepts, terminology, definitions, alternative models, theories, and prior research in general, a researcher generates the "problem" to study (Merriam, 1998). A selection of relevant research, as well as theoretical and conceptual framings, have been presented in chapters 2 and 3.

This case study was predominantly defined using Stake's defining characteristics for qualitative research (p. 47-48): it is holistic, empirical, interpretive, and empathic. Firstly, this study is holistic, due to its overall goal to understand the interrelationship between the phenomenon – teacher's role and the enactment of it – in its specific context, namely a Norwegian technology-rich leading edge primary school. These two elements – the teachers and the context – also make the bounded system that define and frame the case itself. Secondly, Stake (1995) points out that a qualitative case study is empirical. Field work is observation oriented in a natural context, where also informants' own views and observations are heard. This leads to the third characteristic: case study research is interpretive. In this study, the researcher, indeed, carries a responsibility to not only record but interpret the events of the field. The research-subject interaction carries a crucial role, and as the data collection had an emphasis on semi-structured interviews and observation, the process resembled a dialogue at times, and allowed the researcher to complement the observation data when questions should arise. Finally, case study research is empathic. In this regard, the emic aspect is essential and highlights the experiences of the participants. This causes a progression based on not only the original design but also in response to the emerging data.

4.1.1 Intrinsic case study design

The aim of this study was to generate a holistic picture of how teachers generally perceive their role in a technology-rich primary school environment, and to investigate how using technology has influenced the

enactment of this role by observing their pedagogical practices. The case itself was an object of primary interest, and thus, the study was designed to follow the principles of an *intrinsic case study* (Stake, 1995). According to Stake (1995), this means that the case, rather than its outcomes, is dominant and of highest importance. Merriam (1998) refers to a similar design by pointing out that in interpretative case study approach, the interest is in the processes, context, and discoveries, rather than in the outcomes, variables, and confirmation. For the very same reason, field work in intrinsic case studies trumps the research questions, and this dynamic orientation may lead to making some changes to the initial research questions as the case develops (Hancock & Algozzine, 2011). According to Stake (1995), in intrinsic case study design the case is pre-selected and the carrying power of the study, and what we learn from the case, may not always be what we thought we would learn from the case. Despite the many differences in their framings and definitions regarding case study research in general, Stake (1995) and Yin (2018) both find that as long as research questions change to a desired direction, such flexibility can be considered as a strength in a case study, provided that the main issue or phenomenon remains unchanged. In this case study, the main research question, *"How does the use of digital technologies influence primary school teachers' perceptions of their role and its enactment in their pedagogical practices in a technology-rich primary school classroom?",* has for the most part remained unchanged throughout the process – only the wording has been adjusted for accuracy. However, the sub-questions – or what Yin (2018) calls subunits – have been developed and refined before and during data collection and analysis, to have a more specific, rather than generic, approach to the

theme. These sub-questions are closely linked to the main research question and the theoretical framework but investigate some of the central themes within sociocultural learning and educational technologies more closely.

The case in this study – teachers' perceptions and enactment in this particular technology-rich school – is a complex one. Although this study focuses on teachers' perceptions and practices, it is impossible to investigate this meso level without taking also micro and macro levels – pupils and school leadership – into account, as they are intertwined and impossible to be investigated separate from one another. Therefore, the research questions were defined, but left open enough, so that one could be prepared for findings that were not taken into account during the design phase. At the same time, the intertwined and dynamic processes offered unique perspectives to the case, complemented with the teachers' own narratives. Such descriptions of the design support the choice of an intrinsic approach: the aim to learn from this particular case, and its unique context, without the ambition to generalize but rather produce descriptions and interpretations that can expand or refine our existing knowledge (Merriam, 1998; Stake, 1995). Thomas (2011) introduces the concept of *exemplary knowledge* – not as an example of the general or the ideal, but a representation and understanding of knowledge in a specific context. Such aspiration is particularly suitable for an intrinsic case study, and supports the ambitions set for this research project.

4.2 Mixed methods design

A mixed methods approach has become an increasingly applied research design over the past years (Creswell & Guetterman, 2021). The purposes of mixed methods design are many, but it is largely used to provide a broader perspective and results from the research data. While qualitative data often gives a more complex in-depth understanding of a phenomenon, quantitative data can help assess patterns and frequencies, as well as offer perspectives unattainable through qualitative research methods (Creswell & Guetterman, 2021).

In this case study, a mixed methods approach was chosen for a variety of reasons. While the study relies heavily on qualitative data, introducing a quantitative element has its advantages. Firstly, a larger sample size offers confirmation, validation, and credibility to qualitative results collected from a smaller sample (Bryman, 2016; Creswell & Guetterman, 2021; Fetters et al., 2013; Hesse-Biber et al., 2015). While external generalization was never an aim in this intrinsic case study, internal generalization could offer a broader understanding of the collective processes and practices that had led to the individual teachers' perceptions (Maxwell, 2013, 2021). Secondly, combining these two designs could also contribute towards offsetting the strengths and weaknesses of each approach, and this way, help obtain a sample that is more representative of the case (Bryman, 2016; Hesse-Biber et al., 2015). For instance, interviews and observations were necessary for a deep, nuanced, and complex understanding of the case, but the fact that the principal of the school chose the sample for interviews and observations could be seen as a threat to the validity of the data. What if they purposely

picked teachers who can be considered innovators or early adopters (Rogers, 1995), and who would not represent the wider scope of the school's values and practices? Executing a survey collecting data from all teachers in the school addressed this issue and thus, the mixed methods approach helped both validate and expand the findings of the study (Fetters et al., 2013). Thirdly, the quantitative element offered perspectives that were unattainable through interviews and observations (Bryman, 2016; Hesse-Biber et al., 2015). In this case, the seven teachers who were interviewed and observed, for the most part, represented the part of the teacher population with higher formal training in PDC: six out of seven informants had either completed or were in the process of attaining 30 ECTS points in higher education regarding PDC. In the survey, it was possible to study the perceptions of those with and without this additional PDC training, seek patterns, and make comparisons. As qualitative data collection was executed and tentatively analysed first in this sequential approach, quantitative data collection could also be used to explain and extend results gained from the qualitative data.

This study is qualitatively driven, and the role of the quantitative data is first and foremost to reinforce, expand, and reveal discordance in qualitative data. A qualitatively driven mixed methods study in its simplest model could look like this:

QUAL > quan

When discussing the integration of multiple data sets and forms in a complex case study where the goal is to provide comprehensive and holistic descriptions and understanding of the case, achieving coherence is an integral and simultaneously a challenging task (Fetters et al., 2013;

Merriam, 1998; Stake, 1995). In this study, this issue was addressed with a cumulative data collection process, where each step built on the previous step:

QUAL > QUAL > QUAL > quan

This design is described in more detail in the following visualization:

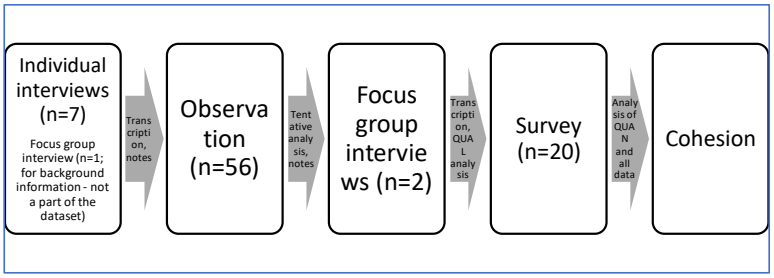


Figure 3: Exploratory sequential mixed methods design in this study.

This exploratory sequential design (Bryman, 2016; Creswell & Guetterman, 2021) begins with collecting qualitative data to truly explore the complexities of the phenomenon. Creswell and Guetterman (2021, p. 605) state that in an exploratory sequential design the researcher

1. *First explores qualitatively*, in order to determine which questions to ask and who to ask in the quantitative part of the data collection.
2. *Emphasizes the qualitative data* in a broader, over-arching question and/or discusses the qualitative results in more detail than the quantitative.

3. A sequential process where *qualitative data is being collected first* from a smaller number of participants, followed by a quantitative data collection with a larger sample.
4. Plans on the *quantitative data to explain or build on the initial qualitative findings*.

To gain comprehensive, in-depth results that support and honour the intrinsic case study design, the goal was to achieve integration of data through embedding (Fetters et al., 2013). Qualitative data collection begun with individual teacher interviews, followed by observations and finally, focus group interviews. In this cumulative process, each part of the data collection built on the previous steps. After collecting qualitative data from all seven informants, several months were spent on thoroughly analysing this data. Based on the qualitative data analysis, a survey was designed to provide answers to questions that emerged from qualitative data, to validate and complement some of the qualitative findings, and to make comparisons between groups (e.g. grade levels and teachers with and without higher education training in PDC). At the end, thematic analysis principles were used to draw all data together and merge qualitative and quantitative findings thematically for further analyses (Bryman, 2016; Fetters et al., 2013) (explained in more detail in chapter 4.4). The sample size in the survey was larger than in the qualitative part of the study, but the results nevertheless are discussed to a smaller extent than results from qualitative data collection, due to the aspirations of gaining nuanced and descriptive understanding of the case. When reporting the results, integration of qualitative and quantitative data was achieved in a weaving approach (Fetters et al., 2013) that utilized the

categories from thematic analysis, as the results were, indeed, weaved together in a series of reports – in this case academic articles.

4.3 Data collection

Data collection for this study was executed in 2020 – the very year when the COVID-19 outbreak paralyzed the world. In Norway, all schools closed their doors for months, starting March 12, 2020, and once opened again, the teachers and pupils had to follow strict restrictions throughout the day. From a research point of view, being able to complete the field work only a couple of weeks before the schools shut down was incredibly fortunate. However, the pandemic delayed the execution of the survey, as the teachers had no capacity for any kind of extra work, nor was it fair to cause them any additional stress at a time when they were already working beyond their ordinary capacity. Later that year, they were so tired of answering surveys regarding teaching during the pandemic that it was decided to wait a few months, in order to have potentially collect a higher amount of completed surveys. Additionally, staff absences due to the pandemic provided some challenges regarding the survey, but in December of 2022, the survey was shared with all the teachers on duty at the time, and all 19 teachers and one member of staff with joined responsibilities in teaching and administration submitted their answers.

4.3.1 Sample and instruments

Triangulation was used to increase validity and reliability when analysing and interpreting the results. Due to the nature of this case study, it served the purpose to apply the principles of *purposeful sampling* (Bryman, 2016; Maxwell, 2009) and so, the data was collected in a

primary school in which the teachers had received substantial training in PDC and had access to a wide array of educational technologies, such as one-to-one devices for all staff and pupils, a variety of robotics, minicomputers, miniature drones, a podcast studio and more. Purposeful sampling was chosen with the goal of avoiding repeating similar results from other studies where the data was collected in "ordinary" schools, and to look for exemplary knowledge (Thomas, 2011) that would provide descriptions from this particular leading-edge school. It is important to highlight that the study does not attempt to offer generalizations, descriptions of "average" teachers, or best practices.

4.3.1.1 Individual research interviews

Individual research interviews are usually executed to understand the subjects' views, experiences and perspectives better (Bryman, 2016; Merriam & Tisdell, 2015). In this study, where teachers' own perceptions of their role and practices are in focus, individual interviews were found a natural choice for allowing the teachers voice their thoughts before observing them in action. The first completed data collection step consisted of seven individual interviews, ranging from 35 to 45 minutes and following a semi-structured interview guide, consisting of questions revolving around the teachers' role and practices (see appendix 4). The informants were teachers teaching grades 1 and 5. These interviews were conducted in order to map out how the teachers themselves perceived the influence of digital technologies in their role and pedagogical practices. Teachers who took part in the interviews had been working in education for varying lengths of time: while the most novice member of the staff

had a little over five years of work experience behind them, the most experienced one had worked in education for 35 years. They were all well acquainted with educational technologies and used them in a variety of ways in their everyday pedagogical work. An abductive design, which simultaneously sought to confirm and discover data (Kennedy & Thornberg, 2018), enabled a semi-structured interview format where it was possible to collect data about some of the preselected topics, while also enabling elaboration and ranging out when the interviewees brought up other perspectives. One of the well-known disadvantages of individual interviews is *social desirability*: that the informants can present somewhat deceptive data by providing answers based on their assumptions of what the interviewer wants to hear or describing situations that rather reflect their intentions than actual practices (Bryman, 2016; Creswell & Guetterman, 2021). To address this disadvantage, and to gain nuanced exemplary data about the enactment of the teacher's role, the interviewees were observed for a duration of approximately four weeks.

4.3.1.2 Observation

The second completed step of the data collection was observation, to attain more knowledge about how the role perceptions were enacted in practice. Altogether, 56 lessons were observed (3515 minutes in total) over the course of approximately four weeks. 22 observations were conducted on grade 1 and 34 on grade 5. The observations were based on Merriam and Tisdell's checklist (2015, pp. 140–141) of things to observe:

1. *The physical setting:* such as context, physical environment, design and purpose of the physical setting, allocation of space and resources.
2. *The participants.* Such as who is in the scene, roles, how many people, relevant characteristics and expectations to the participants.
3. *Activities and interactions:* Such as what is going on, is there a definable sequence of activities, people's interaction with the activity and each other, connection between people and activities, norms and rules, typical or unusual and duration.
4. *Conversation: Such as* contents, who speaks and who listens (In this study, conversations were not audio recorded during the observation period).
5. *Subtle factors:* Such as informal and unplanned activities, nonverbal symbolic and connotative meaning, unobtrusive measures and notion of what is *not* happening.
6. *Researcher's own behaviour:* Such as role, actions and influence to the scene.

A semi-structured observation guide was built on some of the defining frameworks and concepts presented in chapters 2 and 3, as well as the above-mentioned aspects of Merriam and Tisdell (2015) (see appendix 5). Observation data could confirm or challenge the interviewees initial replies. It was also used to exemplify and to get a more in-depth understanding of the information the participants provided in the interviews.

4.3.1.3 Focus group interviews

Focus group interviews were carried out for two purposes: firstly, to obtain information regarding the school's resources and philosophy regarding technology, teaching and learning in general. To gain a foundational understanding of these aspects, the very first focus group interview was carried out with the school's development team (three members of the school leadership and a teacher member). In this interview, it was of primary interest to not only acquire information about the resources and views but to find out how individuals discuss the matter as a group, building up an understanding from the interaction between the group members (Bryman, 2016). The interview guide used in this focus group interview was the same one applied in individual interviews (appendix 6).

Secondly, focus group interviews with teachers were conducted to gain more in-depth information and understanding of the individual interview and observation data. The interview guide was built around tentative findings and discussions from individual interviews and observation (see appendices 7 and 8), and the same participants who were interviewed individually and thereafter observed in action were also interviewed in groups. A semi-structured interview guide was developed in line with the conceptual framework and tentative analysis of the individual interviews and observation data. A focus group approach was considered relevant, as talking to the teachers as a group allowed them to challenge and elaborate on each other's answers, as well as help the researcher understand how they collectively made sense of their role and pedagogical practices in technology-rich environments (Bryman, 2016;

Creswell & Guetterman, 2021). Focus group interviews also helped in avoiding misinterpretations regarding the observation and in validating previously collected data from individual interviews and observation through confirmation and elaboration.

4.3.1.4 Survey

While this study was mainly of a qualitative nature, a survey was administered after a tentative analysis of all qualitative data. Its purpose was to verify or reject interpretations and conclusions drawn from of the data and to obtain a more representative sample of the data (Hesse-Biber et al., 2015; Maxwell, 2010). While some scientists reject the quantitative elements in social studies and education research, claiming that a quantitative approach fails to grasp some of the important human aspects, others support its role in providing a better understanding of the research topic (Creswell & Guetterman, 2021; Ringdal, 2013). Not only can a mixed methods approach confirm a conclusion, but it can also add alternative perspectives to the data (Greene, 2007).

The survey was sent to all teachers teaching in the school after a thorough analysis of interview and observation data, and all 19 teachers working at the time submitted their answers, as well as one informant with a combined role as a teacher and administrator. The survey consisted of 56 questions (appendix 9). Five of these questions were administered to obtain more knowledge about the participant demographics, and nine of the questions were open-ended, allowing the informants to comment freely or elaborate on their other answers. The main part of the questionnaire consisted of 42 questions where the informants reflected

on their personal beliefs, experiences, and practices in regards to education and technology. They used two different scales to provide their answers: one to express their personal beliefs, and another one to reflect on their own practices and experiences. These scales were converted into numeric values in the analysis as follows:

	1	2	3	4	5
Reflecting on beliefs	Strongly disagreed	Somewhat disagree	Not agreeing or disagreeing	Somewhat agreeing	Strongly agreeing
Reflecting on practices and experiences	To a very small extent	To a small extent	To some extent	To a great extent	To a very great extent

Table 1. Conversion of the scales used in the survey.

4.4 Data analysis

A simultaneous analysis and collection of data was used during the project, which allowed different parts of data collection to inform the choices regarding the subsequent steps (Merriam, 1998). Such approach to the analysis is both relevant and necessary in a case study with constructive epistemological commitments and holistic perspectives as some of the foundational characteristics (Merriam, 1998; Stake, 1995). The analyses of the qualitative data were organized following the main principles of thematic analysis (Bryman, 2016) – or codes, according to Stake (1995) and Saldaña (2021). Multiple examples of the coding processes can be viewed in the three articles and appendices. Some of the codes were preselected and organized employing a conceptual framework, while some were based on findings that emerged during the process (Stake, 1998, loc 1943; Bryman, 2016). Stake (1995) finds it essential to establish such new codes especially when working on the

most pivotal data, as new aspects may surprise the researcher and offer important information about behaviour, issue or context. In this study, for instance multimodality was a perspective that unexpectedly surfaced in different contexts, such as communication and differentiated instruction, and was an element that had been overlooked prior to the data collection.

When searching for new themes, categories of Ryan and Bernard (2003) were employed. They recommend that one looks for:

1. *Repetition*, i.e. topis and perspectives that recur
2. *Indigenous typologies and categories*, i.e. local expressions used in a familiar or unfamiliar way
3. *Metaphors and analogies*, i.e. the ways in which the interviewees represent their thoughts
4. *Transitions*, i.e. how topics shift in transcripts and other material
5. *Similarities and differences*, i.e. exploring how interviewees might discuss topics in a different ways or how they themselves differ from each other
6. *Linguistic connectors*, i.e. looking into how the informants express causal connections (for example 'because' or 'since')
7. *Missing data*, i.e. reflecting on what's *not* there
8. *Theory-related matter*, i.e. using scientific concepts as a source for themes

Repetition is the most commonly used criterion in general (Stake, 1996; Bryman, 2016) and was also utilized in this study, particularly when doing the first and second cycles of coding. Following Saldaña's (2021) cycles of coding and analysis, theming the interview data in preselected

categories was employed as the interviews were transcribed, in order to advise possible edits in the observation guide. During the observation period, notes were coded according to these first cycle categories, and the combined data informed the development of a focus group interview guide. Focus group interview data was coded similarly with individual interviews, and once all data was coded initially, the second cycle of coding pulled the data together for a more meaningful, coherent analysis. At this point, also new categories were derived from the data. In this phase, other points from Ryan and Bernard (2003) were given more attention, albeit some of their notions (particularly transitions and linguistic connectors) were little applied.

The survey responses were analysed using basic descriptive statistics such as mean, median, and range, due to the small sample size. Specifically, the mean score was calculated to represent the average response on the five-point scale, and often provided a rather descriptive overall summary of the informants' responses, as in many questions rather little variation was detected. The range was calculated to show the spread of responses across the scale. Additionally, the median score was calculated to represent the midpoint of the distribution and was particularly useful in questions with a larger range, as it is less affected by extreme values than the mean.

4.5 Research quality

Case study research approach has often been criticized for lack of rigour and generalizability (Flyvbjerg, 2006). Qualitative scientists in general often find themselves defending their method: its fluidity, flexibility, and

researcher's role, and a broad range of written reports occasionally bring up the question of its reliability and validity. Amongst qualitative researchers, those who have chosen case study as their method often find themselves defending their choice of approach more than others. A conventional way of looking at case studies is that they work as examples or grounds for forming a hypothesis, but without true scientific value (Flyvjberg, 2006). Campbell and Stanley (1966, pp. 6–7) went as far as claiming that "such studies have such a total absence of control as to be of almost no scientific value---". However, there is a reason why case study has held its position in the world of academia and science. Yin (2018), for example, points out that there are situations when case study method surpasses other methods: if the research topic is a contemporary phenomenon or if you ask *how* or *why* rather than *what*, case study is probably able to provide you most valuable knowledge. Stake (1995) and Merriam (1998) find that case study is usually chosen because of the researcher's interest in insight and interpretation, rather than for testing a hypothesis or generalizing findings.

Bryman (1984, p. 75) writes that one of the great difficulties that arises when divergences between quantitative and qualitative studies are being discussed is that their philosophical and technical aspects are being treated simultaneously and occasionally confused. Generally, however, reliability, validity and ethics are considered as criteria for quality research designs (Merriam, 1998; Bryman, 2016; Yin, 2018), but how they are realized in different designs vary.

In this study, it is the intrinsic interest to the case that sparked the research project and advised the design and method of the study.

4.5.1 Reliability in case study

Reliability in case study is a complex issue. While reliability generally is identified as one of the main characteristics in quality research (Bryman, 2016; Creswell & Guetterman, 2021; Merriam & Tisdell, 2015), some researchers find that reliability in case study is a somewhat superfluous expectation (Thomas, 2021). Thomas (2021, p. 68) claims that as case study inquiry comes with no expectations of attaining the same results should the study be repeated in a different context, the expectation of reliability drops out. Merriam and Tisdell (2015) also find the traditional definition and demand of reliability problematic when human behaviour is being studied through qualitative designs. As human behaviour is never static, repeating the study and expecting the same results is never reasonable (Merriam, 1998). Even repeating the study in the same context with same subjects would likely produce different results, as human behaviour, beliefs, attitudes, and actions are of dynamic nature. Thus, it would be unreasonable to expect, for example, the observed lessons to be identical, despite identical design and lesson plans.

Yin (2018) suggests than even though replicability in case study research is rarely – if ever – the goal, it is still important to reflect over the principle itself. When studying human subjects, this would mean documenting the procedures rigorously (Yin, 2018). Merriam and Tisdell (2015) find that this can best be realized by paying careful attention to the conceptualization of the study, as well as the way in which the data has been collected, analyzed, and interpreted. In this thesis, these aspects have been documented above in order to increase transparency and rigour. While rigour in case study design may look somewhat different

than in quantitative studies, it is still an important factor in research quality, and reliability is a part of it (Flyvbjerg, 2006).

4.5.2 Validity

Validity in general refers to the question if the research measures what it is intended to measure and if the results reflect what they were intended to reflect (Bryman, 2016; Merriam & Tisdell, 2015). In Maxwell's (2013, p.5) interactive model of research design, validity is seen as one of the main components of a research project, together with goals, research questions, conceptual framework, and methods. Validity of research has many dimensions: measurement validity, ecological validity, internal validity, and external validity (Bryman, 2015, p. 62). Aspects of measurement validity – which is very closely linked to construct validity (Yin, 2018) – have already been discussed earlier in the method chapter when justifying case study as a method and the used instruments as means of measurement (see 4.1. and 4.2). Ecological validity is briefly discussed in the context of external validity and generalizability (see 4.5.3).

Internal validity, in simple terms, is related to how well the research findings represent the reality (Merriam & Tisdell, 2015). It represents the part of the validity that reflects trustworthiness of causal relationships, and which are not due to methodological errors (Bryman, 2016). As the researcher in qualitative research has a crucial role in analysing and interpreting the results, reflexivity is an important element of internal validity (Bryman, 2016; Merriam & Tisdell, 2015; Olmos-Vega et al.,

2022). It spans from the personal stance discussed in chapter 1.4 to methodological and contextual perspectives, which inform the use of methods. This entails critically considering the social context, the research paradigm, and the options that they offer (Olmos-Vega et al., 2022).

A variety of validity threats – alternative conceptualization of interpretations and conclusions – can be identified in qualitative research, as no method can completely assure that validity has been gained: it depends on the relationship between the reality and researcher's conclusions (Maxwell, 2013, p. 121). When studying people, their perceptions, practices, and interactions, such validity threats are often related to "the people factor" (Cresswell & Guetterman, 2021). Likewise, in this study, bias, reactivity, and selection of a sample presented the three main validity threats. *Researcher bias* is a validity threat always present in qualitative research, as it is the researcher's job to interpret results and draw conclusions (Maxwell, 2013). In this context, critique about researchers using qualitative research to verify their preconceived notions is not new, particularly when discussing case study approach (Flyvbjerg, 2006). However, such critique can often reflect lack of knowledge regarding case study, as case study approach has its own rigour which perhaps cannot be characterized similarly as in other research, but nevertheless, is equally strict (Flyvbjerg, 2006). Morgan (2014) finds that following factors increase validity and decrease bias:

- Consistency within all the detected evidence

- Coherence within the elements, i.e., how all the "bits and pieces" fit together
- Credibility of the explanation

According to Morgan (2014), it is these factors together that do not only validate the results but that, in fact, *are* the results, and as they are intertwined, we need to investigate and report the case as a whole, instead of focusing on some aspects and leaving other observations and findings out. In this study, consistency was created by using triangulation, as well as the same categories (codes) throughout the data collection and analysis, which derived from relevant policy documents, frameworks, and previous research. Coherence became more obvious during the coding process, as data could be coded in several categories, and therefore, finding out which "bits and pieces" go together became more visible.

Finally, credibility of explanation – and alternative explanations – were considered when drawing conclusions. For example, collaborative learning approach was very different between grade levels 1 and 5: grade 1 teachers demonstrated more structure in their collective work instruction, such as guidance in taking turns in talking and listening and how to contribute rather evenly. Grade 5 teachers had less structure and established practices in their instruction of working collectively, and the quality of collaboration varied greatly from group to group. Grade 1 teachers reported that they discuss and practice collaboration on a regular basis, and indeed, such practices were observed during many lessons during which collective learning methods were employed. Grade 5 teachers had a more reactive approach and were observed using

significantly less instruction time on guiding their pupils in collaboration, and their interview data also implied that while they valued collaboration as a pedagogical method and employed it to a great extent, they spent relatively little time in proactively guiding their pupils in collaborative practices in context with other curricular activities. The most credible explanation here is that because grade 1 teachers dedicate more instruction time in discussing, modelling, and practicing organized forms of collaboration, collective learning flowed more smootly in grade 1 than in grade 5, where teachers did not allocate much instruction time to facilitating organized collaboration practices. Alternative explanations might include relevant considerations, for example, about how the pupils' age or teachers' competence influenced collaborative learning practices, but nevertheless, it can be argued that the most credible explanation is that more time dedicated to collaboration instruction had led to more effective collaboration practices.

Reactivity, the researcher's influence on the settings and individuals studied (Bryman, 206), was another validity threat in this study. The informants who were interviewed and observed knew about the researcher's background as a teacher and that the research project was administrated as a part of a PhD study. This added the risk of social desirability – the teachers providing "textbook answers" in the interviews, whether they reflected their actual practices in reality or not – and "showcasing" practices that differed from their everyday practices during the observation period. This validity thread was addressed by executing a cumulative data collection process over time, and the four-week long observation process was executed to ensure observation of

ordinary everyday practices instead of selected lessons of extraordinary technology use. As for sample selection, teachers who choose to participate in a study where their perceptions and practices regarding a new phenomenon are of primary interest tend to be somewhat more motivated and willing to "showcase" their competence than those at a more emerging level. In this study, this was not found to be a major threat, as one of the premises for the research project was to study teachers at a leading edge school with more competence within PDC than an average primary school teacher in Norway. Acknowledging the heterogeneity among the staff in this school was nevertheless an important aspect of validity, and the survey conducted to round up the data collection process functioned to address this validity threat.

4.5.3 Generalizability – or the lack of it

External validity of research refers to the concern of whether the results can be generalized beyond the context in which it was conducted (Bryman, 2015). A conventional way of viewing knowledge is that there is a universal theory that can be applied, and generalizations can be derived from that theory (Flyvbjerg, 2006). However, when studying human actions and affairs, it is not possible to find universal theories that would apply in all cases (Flyvbjerg, 2006; Thomas, 2011). A case study can provide knowledge that is much more relevant for the context than an attempt to find a predicative theory. Many case study experts, such as Stake (1995), Merriam (1998) and Yin (2018), defend the role of case study and the value of the knowledge gained from case study approach

as a method that is exploratory but also descriptive and a source for nuanced knowledge that, in many contexts, can be even more valuable than a generalized knowledge. Theoretical, generalizable knowledge has its place as a foundation on which such nuanced knowledge builds on. Flyvbjerg (2006), however, points out that using case study as a design and method doesn't automatically mean that the knowledge obtained isn't generalizable – it depends on how one understands the concept of generalizability.

Stake (1995) argues that while case studies focus on interpretation of what is relevant in a certain bounded system (case), generalizations can be found also in case study research. While findings from a single case study hardly can represent a wider sample from the field, they can modify existing generalizations (Stake, 1995). Instead of offering new theory or new generalizations, findings from case studies can modify existing generalizations for example by refining and expanding them. In a similar context, Maxwell (2021) highlights the importance of knowing the difference between internal and external generalizability: generalizability does not stand for transferability from one context to another alone – it can also mean transferability within specific settings or groups. Together with the arguments of Thomas (2011), Stake (1995), and Flyvbjerg (2006), Maxwell's (2021) conclusion of generalizability supports a view of opportunities for generalizability existing also in case study designs investigating in the field of social sciences. However, how generalizability is defined and conceptualized in qualitative studies is the key factor.

Delmar (2010) investigates the epistemological and ontological aspects of generalizability and what it means in qualitative research in general. Traditionally, replicability and applicability characterize a generalizable study, and replicability in particular has been viewed as a central scientific requirement. However, studies where human affairs are being studied cannot be repeated under the exact same conditions (Morgan, 2014). Therefore, rather than simply considering the criteria for generalizability, Delmar (2010) urges academics to place themselves in the scientific field and think about the *significance* of their study. Is the significance a universal theory, or is it something more particular? This is closely linked to the concept of ecological validity; in other words: are the results applicable in real life and to what extent (Bryman, 2016)? Qualitative research in general has the potential to develop from its own premises and needs, and instead of aiming blindly towards generalizability – or at least what it means in quantitative research – asking questions and finding the significance of the study that should be unique and typical at the same time is central (Delmar, 2010). Thomas (2011) finds that in social sciences, the "general" is, in fact, often uninteresting from the research point of view, and thus, he highlights the role of phronesis instead of theory. In this study, the choice of design – intrinsic case study – reflects these aspirations, and seeks to look for exemplary knowledge (Thomas, 2011) instead of generic or generalizable knowledge.

Flyvbjerg (2006) finds that the concept of generalizability is often overvalued, while the force of example is undervalued. This is supported also in Gadamer's (1975) definitions of knowledge. His viewpoints

derive more from hermeneutics, and he believes that every small experiment takes us closer to the truth in a broader picture. In that regard, one case study alone can be an important factor in forming broader knowledge of what we know about the world, and each case study lays ground for the next case study, which together add on to knowledge and our understanding of the world (Gadamer, 1975). To extend this, Thomas' (2011) concept of exemplary knowledge can support internal generalizability (Maxwell, 2021) and help us expand and refine existing generalizations (Stake, 1995).

In summary, qualitative and quantitative research often set different goals and aims to define different types of knowledge. Therefore, what generalizability means in quantitative research is not necessarily what it means in qualitative research. Additionally, the aspirations regarding generalizability in social sciences are not the same as in natural sciences because of the need to consider the ratio of typical and unique. When establishing a case study, the researcher is often leaning more towards the unique than the typical and thus, external generalizability is less in demand (Stake, 1995). In the context of this case study, when finding out how technology-rich environments can influence teachers' perceptions of their role and how their pedagogical practices reflect the enactment of this role, the informants who were interviewed and observed were employed in a school that is considered a pioneer in the field and where resources enforcing the use of digital technologies were prioritized over many other important issues and aspects. The context of the school is unique, and while other schools can learn from this case, it is impossible to draw a universal theory or even generalize to a lesser extent, as each

school, its staff, pupils, resources, and other preconditions differ from each other. However, this study can make other types of contributions: it can offer a more nuanced and indepth descriptions of this particular case in this particular context, which in turn can help question, expand, and refine our current understanding of how digital technologies influence teacher's role and how pedagogical practices reflect the enactment of this role. Therefore, it is easy to join for example Flyvbjerg's (2006) and Thomas' (2011) arguments regarding the value of exemplification, rather than blatantly speculate on which generalizations or theory could be drawn or confirmed from the results of this study.

4.6 Ethical considerations

The European Code of Conduct for Research (ALLEA, 2017) bases its principles on four main values: *reliability, honesty, respect, and accountability*. In this study, these aspects were considered in multiple ways. *Reliability* refers to the quality of research, which was discussed in chapter 4.4, together with aspects of honesty, such as bias and credibility. When discussing accountability, *The European Code of Conduct for Research Integrity* mentions specifically following through with the project from the aspiring idea to the publication. This entire thesis stands for the *accountability* part: since the beginning of the project, three articles have been published and this thesis as whole has been composed to explain the process, research findings and the significance of the study.

Respect for colleagues and research participants comes in many forms, and in this study, this respect was shown particularly through careful

ethical considerations. *Procedural ethics* (Guillemin & Gillam, 2004) were applied in multiple ways. After the design of the research project was in place, it was sent to the Norwegian Centre of Research Data (NSD) to be approved. Their approval can be viewed in Appendix 15. All participants who were interviewed or observed signed a written consent form (Appendix 2). A template provided by Norwegian Centre for Research Data was used to inform the participants before they signed the consent form (Appendix 1). The description of the project was written to reflect the reality as well as possible: the importance of the study was not heightened, and while the description of the study was brief, it was as to-the-point as possible. All data was anonymized already during data collection. Audio files were saved in secure location after transcription and all publications (articles I, II and III) were written with respect for the informants' anonymity.

Ethics-in-practice is an equally important dimension of ethics in research, and it is also the dimension that a researcher, after getting procedural formalities in place, meets more often in their day-to-day practices when collecting and analysing data. This concerns the need to make important ethical decisions based on what Guillemin & Gillam (2004) call *ethically important moments*. These are ethical aspects and dilemmas that often are difficult to foresee and usually are not addressed in research applications Nevertheless, they are important ethical considerations, during which the researcher needs to make a decision regarding an ethical consideration which can require an immediate decision or a decision regarding publishing. Komesaroff (1995) finds *microethics* to be an important aspect of ethics-in-practice: ethics is not

only about dramatic questions or dilemmas, but about what happens in everyday interaction. These create the ethically important moments, big and small, which need to be evaluated every step of the research process. In this project, ethics-in-practice was most relevant when making decisions about publication: how much about the school and participants can be revealed, in order to comprehensively and truthfully report about the findings, while still maintaining the anonymity and integrity of the informants? The pioneer role of the school and its staff, with leading edge technology and high level of professional digital competence, makes the school recognizable for those who have knowledge about the school. In writing, it meant that a certain level of ethics-in-practice needed to be practiced at all times, because while there were no dramatic revelations or dilemmas, there were many ethically important moments which had to be considered. Thankfully, the informants, who were both interviewed and observed, were very open and honest about their role and practices: while it seems safe to say that they possessed higher level of digital competence than a typical teacher in Norwegian public schools, they also acknowledged that they were not "ready": there are always more things to learn and space for more professional growth. Therefore they, together with the school leader, also accepted and even welcomed critical aspects of the study. Some of the results were shared with the school leader before publishing, and some of the results were shared after the publication.

5 Summary and discussion

5.1 Summary of articles

As a part of this doctoral thesis, three manuscripts were written and published covering the main themes (research questions) and findings of the study. The first one was co-authored by all three supervisors and focused on teacher's role and classroom management in particular. The second article was co-authored by the main supervisor and highlighted differentiated instruction and other inclusive aspects. The final article had no co-authors. Communication and collaboration in technology-rich learning arenas were investigated in greater detail in this article.

5.1.1 Article I summary

The first article of the thesis had a specific focus on teachers' understanding of their role and how it was reflected in their choices and actions. The research question for the first article was:

How does the use of digital technologies influence teachers' perceptions of their role and pedagogical practices in terms of classroom management in a technology-rich primary school classroom?

The data used for this article draws on all steps of data collection, but as the focus centres around teachers' perception of their role and choice of pedagogical approaches, interview data was weighed, while observation and survey data had a more supplementary role. Theoretically, the research question draws from the aspects of sociocultural learning views that discuss expectations for teachers and how they organize learning for their pupils. At the same time, this article oriented itself more clearly

toward the current state of knowledge, rather than theoretical aspects. This led to a focus on the aspects of classroom management. When defining classroom management, it is important to underline that it can be defined in a broader sense than merely rules, organization and discipline. It can be understood as the work aimed at optimizing the environment to offer pupils best possible opportunities for academic, social, emotional, and moral growth (Evertson & Weinstein, 2006; Wubbels, 2011). Teachers have faced new challenges in technology-rich learning environments, where they have to lead learning in both physical and digital learning environments – often simultaneously. For years, this has posed many challenges to educators in all levels of schooling (Bolick & Bartels, 2015; Krumsvik et al., 2013; Munthe et al., 2022).

The self-reported data reveals that teachers are well aware of the complexities and expectations set for a 21st century teacher. Of the contemporary competencies needed in a modern classroom, where digital and physical learning arenas merge, one of the most important and challenging perspectives was considered to be the constant *need to keep up-to-date and pursue knew knowledge and competences*. Teachers found that professional development and collegial collaboration were crucial for ensuring sufficient opportunities for improving their PDC. The actual practices reflected a mix of approaches, and it appears that this new teacher role is what teachers worked towards, but that traditional settings and approaches operated in parallel. An interesting observation was that when a teacher modelled a somewhat exploratory and playful approach to a subject or theme, pupil processes and products reflected this approach, as well, even when not prompted. However, when working

with a more teacher-led lesson or project, the pupils also tended to choose less innovative ways to demonstrate their learning, even when given the opportunity to be more creative. This could imply that *modelling* plays a particularly important role in exploring and trialling with pedagogical practices in a 21st century classroom, even though the informants discussed to a lesser extent.

In the self-reported data findings, teachers' own attitude, curiosity and growth mindset were found critical for the professional development aspect, as teachers themselves must be open to becoming learners themselves. This was closely linked to the concept of *cognitive playfulness* (Goodwin et al., 2015; Webster & Martocchio, 1992), which highlights the need to adopt a somewhat playful attitude when experimenting with emerging opportunities and approaches. This means that a teacher must be able to let some of the need for control go and boldly allow themselves and their pupils use trial-and-error method when employing old technologies in new contexts or new technologies in any context. Goodwin et al. (2015) highlight specifically the ability to take risks and allow oneself to fail, learn from it, and, after modifications, try again. While 14 out of 20 teachers reported little fear of taking risks, they also emphasized the importance of being able try things out in advance and plan meticulously. The importance of creating and enforcing mutual rules, routines, structure, and organization of subject matter was found pivotal. This, together with good relationships between teachers and pupils, also led to teachers experiencing very little disruptive behaviour or distractions caused by pupils' access to digital technologies during lessons.

Interestingly, however, the data also revealed some discrepancies regarding the need for *control*. Teachers reported that they were generally open to taking risks and experienced little distractions or disruptions related to the use of digital technologies and highlighted the importance of mutual trust and relationships. Yet, more than half of the teachers agreed with the statement "*a teacher needs to have control over pupils' screens at all times*". Teachers who had no formal PDC training at a higher education level agreed with the statement more often than teachers with formal PDC training. One could argue that such statements are potentially in conflict with each other: if teacher-pupil relationships are good and there is mutual trust, why is it important to have control over pupils' screens all the time – especially when teachers experience that there are very few issues with misuse of digital devices?

The overall conclusion regarding teachers' perception of their role in a contemporary 21st century learning environments with rich access to digital technologies is that they have knowledge, will, and ambition to realize the ideals. They believed they have good systems in place but also acknowledged that in this line of work, there is always space for improvement and development. Observations imply that the teachers worked systematically towards this common goal, but that contemporary and traditional roles coexist. This became evident in many examples of exploratory approaches, allowing pupil participation, and emphasizing warm relationships between pupils and teachers. However, conventional teacher-led lessons with little pupil participation and alternative pedagogical approaches also took place recurrently, in both grade levels and in all classrooms.

5.1.2 Article 2 summary

Article II focuses on inclusive, technology-rich learning environments and examines the role of differentiated instruction in particular. The research question was: "*How do teachers perceive the role of digital technologies when differentiating instruction to facilitate an inclusive learning environment?"* Inclusion was defined as processes that increase participation and reduce exclusion (Booth & Ainscow, 1998). There are many factors that can contribute towards creating an inclusive learning environment. Flexible curricula with evidence-based approaches, adopted school-wide, was found as one of the main elements (Qvortrup & Qvortrup, 2018). This translates to differentiated education, which in this study was framed in Tomlinson's (2001) categorization of differentiated instruction: one can differentiate according to contents, processes, products, and affects. It was also highlighted that inclusion and differentiated instruction should be seen as a continuum, reaching all parts of instruction, from planning to evaluation, and as a normal state of matters, instead of isolated events (Booth & Ainscow, 1998; van Geel et al., 2019).

Interview, observation, and survey data were used to answer the research question. Teachers' self-reported data revealed that teachers find differentiating instruction more effortless with digital technologies: it is faster, easier, and the variation alone – without differentiating contents, processes or products – can have a motivating influence on pupils. However, the teachers recognized potential pitfalls as well: sometimes, the variation and ease of use made them forget why technology was

chosen to the particular task, and if how it was used indeed was the best approach.

At the same time, differentiating elements of digital technologies were weaved into pupils' everyday learning in many positive ways. Adaptive algorithms were used particularly in assignments that required regular repetition, and such applications could often offer instant feedback and game-based designs. Using such applications to a large extent could pose a risk for too much individualization, which would contradict the purpose of creating an inclusive learning environment through differentiated instruction (Gilje, 2017; Klette, 2007). In Norway, individualized instruction has a long traditions in being favored at the cost of more inclusive, differentiated approaches (Klette, 2007; Nordahl, 2012; Olaussen, 2009). Teachers in this study considered the use of applications with adaptive algorithms in individualized instruction motivational and efficient when used for limited periods and as supplementary material – not as the main learning activity.

Multimodality was used to a large extent to ensure pupil participation and to differentiate instruction, both in teacher instruction and pupils' learning processes and products. Its role in teacher instruction was greater in grade 1, where pupils had limited reading competence, while in grade 5, it was the pupils who more often took advantage of the multimodal opportunities. In grade 5, multimodality also often included opportunities for pupil participation, as the pupils themselves could choose many elements of the product that would demonstrate their learning. In such contexts, multimodal e-books and video presentations were particularly popular. As school cultures often tend to rely much on

written texts, allowing pupils to use other elements when demonstrating their learning is certainly motivational and promotes learning, and thus, contributes towards an inclusive learning environment (Hur & Oh, 2012; Jewitt et al., 2016; Tomlinson, 2001). Possibilities of multimodality are countless, but this presented also one of the main challenges: the pupils tended to produce rather monotonous presentations when given the choice, going back to the same solutions time after time. While the pupils seemed motivated and engaged even when staying in their comfort zone, they were often observed spending a significant amount of time on aspects that contributed little or not at all to actual learning, such as choosing fonts and backgrounds. It seemed that while teachers' intentions were good and their pedagogical choices were in line with many evidence-based recommendations, there was space for more teacher guidance and challenging the pupils when choosing the product to demonstrate their learning.

5.1.3 Article III summary

The final article of this study addresses the influence of digital technologies in classroom communication and collaboration. The focus was directed to both teacher-pupil and pupil-pupil communication and to the role digital technologies have in the pupil collaboration. The research question was: *"How do teachers perceive the influence of digital technologies in communication and collaboration in a technology-rich classroom?"* To find answers and descriptions for this research question, both self-reported data and observation data were employed. The

theoretical anchoring lies strongly in the heart of sociocultural learning: we learn best when we learn together, and for that, we need language and communication (Hillman & Säljö, 2016; Vygotsky, 1978; Wertsch, 1998).

Some of the framings for this research question draw on the concept of blended learning environments and definitions of communication, and collaboration in a school context. Communication at its simplest can be seen as the process of interaction, dependent on context, mutual influence, verbal and non-verbal messages, and constant change (Farrell, 2009). Collaboration extends this process of interaction, with its purpose of actively working towards a common goal (Nokes-Malach et al., 2015). Collaboration has been found to carry many advantages for learning, such as gaining complementary knowledge, error-correction, and relearning through re-exposure and retrieval (Johansson et al., 2005; Rajaram & Pereira-Pasarin, 2010; Roediger & Karpicke, 2006). However, collaboration is not a free pass to academic success: "freeloaders" are a well-known disadvantage, different ways of organizing and retrieving knowledge can cause difficulties, and lack of guidance and explicit instruction regarding the act of collaboration itself have been identified as some of the challenges of collective learning (Karau & Williams, 1994; Kirschner et al., 2009; Le et al., 2018; Nokes-Malach et al., 2012). Digital technologies can enhance and change communication and collaboration processes in a variety of ways. Computer-supported collaborative learning (CSCL) is characterized by face-to-face and digital learning happening parallel, and pupils being able to take advantage of both approaches simultaneously (Koschmann,

2001; Y. Yang et al., 2022). Digital technologies can be the mediators in or the target of collective meaning-making, assist in streamlining some parts of a collaborative process, or expand the communication practices (Vaughan et al., 2013). However, previous research indicates that pupils need more explicit advice and guidance in taking advantage of the possibilities digital technologies propose in technology-rich environments (Järvelä & Hadwin, 2013; Koschmann, 2001).

The teachers in this study reported that they employ more collaborative methods in learning in technology-rich environments than before. Moreover, new ways of collaborating were welcomed and pursued, both when learning how to use new technologies, and later in how to employ them in different contexts. Pupils often exhibited motivation and engagement in collaborative learning activities and processes. However, the results also supported the previous findings regarding the challenges in *how* digital technologies were applied in different collaborative contexts. Teachers offered multiple opportunities for creativity and access to various digital resources, but the pupils exhibited the need for more assistance in how to transfer different strategies to blended learning environments and how to take advantage of previously learned digital competences in new contexts.

The two observed grade levels had rather different approaches to communication and collaboration in collective learning processes, which presented an opportunity for some comparative aspects. Grade 1 teachers found it very important to explicitly discuss, model, and incorporate different communication and collaboration strategies when pupils were

set to work together. Grade 5 teachers trusted that their pupils would already possess the necessary knowledge and skills for collaboration, and thus, relied on more implicit instruction, raising issues as they surfaced. The results indicate that a proactive approach in learning led to more composed learning situations where pupils actively employed the strategies introduced to them and used the collaborative working time rather effectively. When a more reactive approach was chosen, teachers' time was often used in "putting out fires", and the quality of communication and collaboration between groups varied greatly.

5.2 Discussion

The primary objective of this study was to investigate primary school teachers' perceptions of their role and the enactment of this role in their pedagogical practices in technology-rich learning environments. The subthemes focused specifically on classroom management, differentiated instruction in inclusive learning environments, and collaboration and communication in technology-rich learning arenas. In this discussion, I return to the main research question and discuss it in the light of all the subthemes combined.

The nature of the phenomenon here, as well as the field in general, is dynamic and changes rapidly. New knowledge, as well as critical discussions and application of that knowledge, surface at a fast pace. Given the purpose and nature of this study – to produce exemplary knowledge (Thomas, 2011) of the contextual practices by looking at a specific case – ecological validity, as mentioned in Chapter 4, was considered an important aspect. Therefore, the study and particularly the

discussion about its empirical findings lean more towards the state of knowledge, rather than conventional theories. However, the theoretical and conceptual frameworks have had an important role in creating a foundation for the study and as lenses through which the findings have been viewed, offering multiple angles for interpretation of the results. This way, the theoretical and conceptual framings have also helped reveal, describe, and discuss aspects that were not explicitly studied in the empirical part of the study. The purpose was to use this approach to obtain a deeper and more holistic understanding of the case and its affordances in a broader discussion of the phenomenon, as stated as in Chapter 4.

The findings reported in the articles and in the rest of the data indeed paint a picture of teachers who consider their role much different than in the past. When referring to a traditional or conventional teacher role, teacher-led approach, reproductive knowledge construction, and discipline-oriented classroom management are some of the defining characteristics (Evertson & Weinstein, 2006; Voogt et al., 2013a). The contemporary teacher role underscores the importance of relationships, supportive learning environment, pupil-led approaches to learning, and actively engaging in developing their own competences (Albion et al., 2015; Martin et al., 2016). In this study, the shift from a teacher being the "know-it-all" in the classroom to becoming a facilitator who experiments and actively develops their pedagogical practices to better match the needs of their pupils and current society was observed on many occasions. Multiple distinct dimensions associated with the role of the teacher and how they enact this role in their daily work were identified,

and most of the findings revolve around teacher's competence, requirements for didactical planning in technology-rich learning environments, and teacher's role in the actual knowledge construction. These results will be therefore further discussed in three primary categories: *teacher as a lifelong learner, teacher as a designer of learning*, and *teacher as a facilitator of knowledge construction*.

5.2.1 Teacher as a lifelong learner

While teachers are understood to ground their choices largely in personal beliefs and values, which are known to be difficult to change, well designed professional development can be of assistance in such line of inquiry (Nespor, 1985; Pajares, 1992; Tondeur et al., 2017). The ever-changing landscape of education in today's society forces teachers to seek opportunities to continuously develop their competences. In this study, teachers had participated in both formal and informal professional development, based on own and their employer's initiative. The teachers themselves were rather unanimous about collegial collaboration and discourse being at the core of their professional development (Article I), and such views are also reflected by sociocultural learning views (Vygotsky, 1978) and the TPACK framework (Mishra & Koehler, 2006). The study also reveals that in some areas, those participating in formal professional development in higher education express more confidence and faith in the potential of digital technologies in contexts that indicate appropriation of digital technologies (Article I). Whether this is a consequence of formal professional development or the initial reason for these individuals to choose to take part in this formal professional development, we can only speculate upon. However, one way of

interpreting the results confirms that systematic formal professional development has its affordances in developing a better understanding of the educational use of digital technologies – particularly when one has several colleagues to turn to for peer support and assistance. One could also argue that having a large body of teachers formally trained in PDC that take part in the collegial professional training can most likely influence the decisions and approaches for more than a few frontrunners, and thus, their competence indirectly impacts the choices and practices of the whole professional community. This is a noteworthy aspect of professional development, given that such progress has traditionally been driven by a small number of individuals, with limited impact on the development of broader school practices.

When discussing the role of a teacher with the informants, observing their lessons, and reading the survey responses, the need to continuously keep up to date with the developments of digital technologies became evident (Article I). For instance, Albion et al. (2015) and Martin et al. (2016) have previously recognized such demand in their research. The need is not limited solely to technological advancements but also the by-products that follow, including a spectrum of potential uses and consequences, without forgetting the juridical and ethical dimensions, when employing digital technologies in teaching and learning. The informants found it crucial to continuously and collectively reflect and innovate on such questions, in an attempt to find alternative solutions and new approaches (Article I). In this regard, the focus on digitalization is not only limited in the use of digital technologies but more broadly in their influence and epistemologies (Lund & Aagaard, 2020). This

highlights teachers' shared transformative agency: the teachers have to take ownership of and initiative for themselves *and* their professional community in the professional development (Haapasaari et al., 2016; Virkkunen, 2006). Previously, the notions of Wertsch (1998) and Polman (2006) have been referred to regarding the difference: mastery of a particular tool does not necessarily guarantee the ability to transfer its applications creatively and effectively across disciplines and other contexts. Appropriation, on the other hand, means that you make something your own, and in this context, means that teachers can apply digital technologies in creative ways, for new purposes, and across disciplines (Instefjord, 2014; Wertsch, 1998). One could therefore argue that a teacher role in a technology-rich learning environment comes with the responsibility of being willing and able to work towards appropriation of digital technologies, which also means understanding their value as more than a mere tool (Lund & Aagaard, 2020). This way, teachers can collectively discuss and develop the perception of their role and transform their practices to match this perception, instead of only enhancing the existing practices.

The informants of this study found that one of their success factors in their school – if success is defined by the ability to enact in line with one's goals and aspirations – was that the core values and guidelines within the school community were based on mutual agreements and practices (Articles I and II). This was evident, for example, in their classroom management practices, which, in turn, helped establish and promote predictability and stability for the pupils. Also, this finding underscores the above-mentioned importance of cultivating a broad base

of teachers with digital competence, rather than relying on a small number of enthusiasts to establish common ground for digital technologies. In the present case, the fact that nearly half of the staff possess formal PDC training suggests a significant institutional commitment to digital education, with potential implications for broader school practices. As the teachers not only have to learn a specific skill, but also develop knowledge and attitudes (Spiteri & Chang Rundgren, 2020), school leadership that supports and participates in such collective development is vital. The informants found it integral that the school leaders offered both opportunities and support in the process of collectively developing practices that supported the mission, while emphasizing the crucial role of learning with and from each other (Articles I and II). They reported that they were offered both ongoing support and opportunities in developing their PDC, as well as a "positive push" in the form of encouragement for experimenting and accountability in developing their own PDC and thus, ultimately contributing towards better learning for their pupils. This was evident in their versatile and systematic use of digital technologies.

While collective aspects of formal and informal professional development have been argued to be crucial for transformative practices (Haapasaari et al., 2016), the informants also suggested that testing and experimenting with digital technologies with colleagues, as well as on their own, is central in their professional development (Articles I and II). The informants reported generally little fear towards failing in front of their pupils when trying out new technologies, and the interviewees in particular highlighted that as long as there is a pedagogically grounded

reason for trying something new, they would be happy to do so. A teacher modelling failing was also found an important learning opportunity for the pupils, as normalizing failure in the attempt to succeed can be considered a valuable learning target. Finding various ways of employing one digital tool was also considered important, to avoid focusing too much on having an application for each purpose and to be able to think more creatively about the available resources. *Cognitive playfulness* can reflect this kind of approach. Based on multiple descriptions of a playful approach in education, Goodwin et al. (2015, p. 134) conclude that a cognitively playful teacher is curious regarding the potential of digital technologies and enjoys experimenting with new ideas. A cognitively playful teacher often has a tendency to interact with technologies spontaneously, inventively, and imaginatively (Webster & Martocchio, 1992, p. 202). Modelling such attitude to learning – with and without digital technologies – can carry many affordances, as it helps create an inclusive and supportive learning environment. It is a concept that perhaps would be worth of a closer look at when developing teachers' individual and collective PDC.

While many glimpses to cognitive playfulness could be observed throughout the study, the element of being spontaneous was significantly less obvious than the other characteristics. The informants' willingness to experiment was grounded in meticulous planning and testing out new ideas either collectively or on their own (Article I). This is, of course, a desirable goal – who would not want teachers to be well informed and prepared for their lessons – but it also limits the use of old digital technologies in new contexts or new digital technologies in old contexts.

A podcast project that was piloted in grade 5 can be shared to illustrate this. While well acknowledging the wide spectrum of possibilities podcasts offer in literature education, collaboration, and communication, the teacher had created very strict frames around the production; for example, all pupils had to read the same book and discuss some of the same questions in their collaboratively created podcasts. When asked about the reason for this, the teacher explained that it was the first time they were trying podcast in literature education, so they had to make sure that the pupils were doing what they were supposed to do. While the reasoning is valid and perfectly understandable – one has to start somewhere – it does indicate a desire to remain in control in a new situation and deprioritizes the elements of experimentation and spontaneity. For instance, in this case, when the pupils expressed ideas outside the teacher's planned framework for the project, they were declined, as the teacher was determined to carry out her plan mostly unchanged. Nevertheless, this teacher had decided to use a new approach in a rather conventional teacher-led context, as that was likely the design that made the teacher feel most in control. Interestingly, the self-reported interview replies of this teacher did not reveal such need – rather vice versa: they were very open for experimentation, risk-taking, and even failing in front of their students. Such discrepancies reflect the complexity that surrounds technology-rich classrooms: the knowledge, willingness, and resources are there, but even then, it can be difficult to fully embrace a contemporary role of a teacher. This example also reflects a certain portion of social desirability in self-reported research responses (Bryman, 2016): the teacher had thoughts about how the podcast unit ideally could have been executed, but their own restrictions

obstructed this line of design. The triangulation of data reveals therefore that despite their ambition to "take the plunge" and fearlessly experiment the opportunities digital technologies offer in new contexts, the reality could also be characterized by the need for control.

To sum up the main findings regarding the category *teacher as a lifelong learner*, it seems that the collective aspect of professional development with strong school leadership is crucial (Articles I and II). Teachers at different levels of ability regarding digital technologies can realize the main principles of sociocultural learning views (Vygotsky, 1978; Wertsch, 1998) by collectively and systematically working towards internalization of digital technologies and thus, together develop the use and conceptualization of digital technologies in their pedagogical work. Not stopping at the mastery level, but pursuing appropriation of digital technologies is what truly has potential in the development of transformative pedagogies. With mastery, the ability to use a tool has limitations, while appropriation of an artefact opens endless transdisciplinary possibilities (Lund & Aagaard, 2020; Orlikowski & Iacono, 2001). Blended learning environments with their many resources offer multiple opportunities for this, as long as the teacher dares: dares to experiment, dares to fail, and dares to seek new opportunities with the risk of not always succeeding.

5.2.2 Teacher as a designer of learning

Teachers in Norwegian schools can be considered designers of learning, as their autonomy and didactical training are at the core of designing meaningful learning for their pupils. However, emerging technologies

and their rapid advancements urge educators to redefine what it means to be a designer of learning in technology-rich learning environments (Kim, 2019). Developers of different programmes, platforms, and applications attempt to make teachers' jobs easier by developing applications and software that target certain aspects of curricula; however, this can be considered somewhat problematic (Munthe et al., 2022). If the teachers rely on platforms and applications designed by developers without pedagogical or didactical training, subject knowledge, or understanding of the curricula, are teachers ceding some of their didactical control and responsibility to people without relevant expertise? In this context, too, teachers' mastery and appropriation (Instefjord, 2014; Polman, 2006; Wertsch, 1998) of the technologies appears relevant. When a teacher masters a digital tool, they adhere to the developer's intended purpose and methodology, which may not always align with the diverse needs of their pupils. In contrast, appropriation allows teachers to creatively adapt and utilize digital tools in ways that reflect their understanding of the pupils and the learning context, resulting in a more flexible approach to instruction.

Designing inclusive assignments, lessons, and units where all pupils can participate equally is a central element of the Norwegian school system: the school needs to adapt to pupils' needs, not vice versa (Norwegian National Directorate of Education and Training, 2020). The informants of this study highlighted the possibilities of digital technologies especially in differentiating education, and their designs employing multimodal elements and pupil participation, in particular, served important descriptions for creating inclusive designs that offer and

enable equal participation of all pupils (Articles II and III). Digital technologies and blended learning environments have opened countless of new avenues for such designs. The main challenge in pupil participation and them being able to choose what kind of a product to create, employing multimodality in their demonstrations of learning, was realizing teachers' intentions and the potential digital technologies offer. Digital pupil presentations had a tendency to repeat the same patterns and format, and creating quality contents was on several occasions observed to be de-prioritized, while time spent on experimenting with for example fonts, backgrounds, and stickers was often unnecessarily long.

Simultaneously, it was observed that when teachers themselves used a more experimental approach, the pupils' processes and products tended to be more characterized by experimenting and creativity (Article II). Notions of learning by leading others (Blau et al., 2020) become particularly relevant in this context, as the design implies that teachers could become more proficient in designing a variety approaches by modelling a design of experimenting, where the process is equally or more important than the product. This requires involving the outside world with its authentic problems and potential solutions in learning, which then collectively are discussed and reflected on (Kuure et al., 2016). In this study, the time spent on guided and explicit reflection varied between teachers and grade levels (Article III); however, in developing and constructing solutions and knowledge, reflection is an essential component in all learning (Kuure et al., 2016). Instead, finishing and presenting a completed product seemed to have a heightened role on many occasions (Articles II and III). This in part

contributes towards a traditional design: pupils creating a product that thereafter will be assessed. While the teachers participating in this study expressed distinct will and aspirations during observations and interviews to have their pupils work in a more exploratory and experimental manner, it remained somewhat unclear how this approach aligned with the more traditional assessment. Ultimately, if a pupil knows that their final product will be assessed, why experiment and take risks? This could also explain the somewhat monotonous representations of learning when given the opportunity to influence the product. In a situation where a pupil is asked to produce a product, it is natural to choose a familiar approach – something one has mastered before – as it is most likely to lead to a satisfactory result. The teacher as a designer of learning has therefore an important task in not only designing units that support their pupils' learning best, but carefully considering how to assess and accomplish those design goals in practice.

The informants of this study also identified the risk of becoming too dependent on certain digital resources and solutions. They acknowledged that instead of trying to find a tailored digital solution for all their needs, they themselves need to be able to utilize the available resources in a more versatile and creative manner – *and* help their pupils to do so (Article II). This notion takes us back to the concepts of mastery and appropriation: has the teacher learned how to use a digital resource for a specific purpose, or do they have the competence to see broader opportunities and the ability to apply the resource in new contexts? Few strategies were used to better take advantage of the creative opportunities, namely the opportunity to influence the formation of the

pupils' own learning process and product, as well as experimenting with various digital resources. This could imply that while teachers had included such opportunities in their designs, their pupils lacked competence to take full advantage of it. Future literacies are multiliteracies (Kervin & Mantei, 2016), and multimodality can therefore be considered a central and yet underappreciated and underutilized concept in Norwegian schools. Its use and potential should be examined more closely, in order to be able to provide efficient education in a digital society.

5.2.3 Teacher as a facilitator of knowledge construction

Teachers today are expected to acknowledge and accept that being an expert in teaching in technology-rich classrooms requires willingness to acquire new competences and collectively reflect on and develop their competences. Realizing national and local curricula also requires teachers to become designers of learning, as personalized learning paths, designs with differentiation opportunities incorporated, pupil participation, and a variety of resources both demand and offer endless possibilities for this line of work. These competences and designs merge in the final category of the discussion, namely *teacher as a facilitator of knowledge construction.* This entails more than providing structure, resources, and ongoing support; it also refers to teacher's role in assisting their pupils in knowledge construction in technology-rich learning environments.

If the teacher no longer poses as the ultimate "know-it-all" in the classroom, pouring their knowledge on their pupils, what is their role in pupils' learning? Firstly, it is important that knowledge is understood more broadly than teacher as the more knowledgeable other regarding subject or content knowledge. Teachers also have knowledge about strategies, designs, and resources, and in the contemporary times, they are also expected to have technological knowledge relevant for their profession. TPACK approach (Mishra & Koehler, 2006) highlights the merging of pedagogical, technological, and content knowledge and can therefore have many affordances in scaffolding the knowledge teachers possess and offer to their pupils. The teachers in this study had spent a lot of time creating inclusive designs and had the competence to employ a vast array of technologies in their work in a meaningful manner. However, strategies other than those that were content knowledge oriented gained visibly less attention as the pupils grew older. Explicit instruction on strategies, such as collaboration and problem solving, were mainly visible in grade 1, after which teachers somewhat expected that the pupils already know how to, for example, collaborate. Article III (p.10) stated that…

> *"One could perhaps compare communication and collaboration skills to learning how to read and write: the job is not done once the child decodes texts and puts letters together into words, and words together into sentences. The skills need to be refined, adapted, and developed further in a variety of contexts throughout the years to come. Learning how to improve and foster communication and collaboration*

> *skills requires lifelong training and development, particularly in a world where rapidly developing digital technologies continuously require adaptation."*

This statement is supported by the views of researchers such as van de Oudeweetering and Voogt (2018), who highlight the significance of teaching new kinds of strategies in schools, in order to support the contemporary goals set to 21st century learning. Together with Mirra et al. (2018), they argue for the importance of teaching strategies for digital multiliteracies, which highlight the pupils' active role in producing and innovating, rather than seeing them as consumers – even critical ones – who mainly use digital technologies as an information or presentation resource. Article III, in particular, reported that grade 1 teachers invested in such strategies, while the data suggests that grade 5 teachers' strategies were largely digital literacy oriented (mainly search strategies and evaluation of data) and had significantly less explicit focus on other 21st century competencies. This line of development is not particularly surprising, as research in the past has shown that the older pupils get, the more teachers focus on subject knowledge (Beijaard et al., 2000; Bru, 2013; Kalin et al., 2017). However, the results give grounds for arguing that explicitly teaching, refining, and developing pupils' broader competences – such as collaboration and problem-solving – could offer more in-depth learning. In this context, *teacher as the facilitator of knowledge construction* can perhaps be viewed as someone who assists their pupils in attaining knowledge about the contents of the subject, but also about strategies, competences, and designs regarding learning.

In this study, the affordances digital technologies offer for differentiated instruction were highlighted, and thus, it was chosen as one of the core themes (Article II). The informants stated that generally, digital technologies made it easier to differentiate instruction, which often meant that the amount of differentiated instruction increased. This is an important finding, as differentiating instruction increases the quality of teaching for pupils with a variety of experiences, needs, strengths, and challenges. Two main strands of differentiated instruction assisted by digital technologies were detected during the observation period: individualized instruction, often observed when using learning technologies employing adaptive algorithms (for example GraphoGame and Multi Smart Øving), and pupil participation, especially when employed adjacent to multimodality (Article II). When using adaptive learning technologies, the teacher in a way outsources their role as a scaffolder of knowledge, albeit the *teacher as a facilitator of knowledge construction* needs to know when applying such algorithms is fitting. Multimodality was more often used in designs where the pupils could influence the product and modes through which they wanted to convey their learning. In such context the teachers practiced different approaches in their scaffolder role; as stated before: some had a clearer focus on subject content knowledge, while others also exercised their role as the one possessing knowledge about broader competences and designs. Other, more traditional ways to differentiate were for example offering texts at different lengths and difficulty levels and offering small group instruction.

Individualizing instruction was a common approach to differentiated instruction, and using adaptive learning technologies was used particularly for repetition and to create variation (Article II). In these contexts, one could interpretate the algorithm as the more knowledgeable other (Putman, 2014; Vygotsky, 1978; Wertsch, 1998). In 1999, Säljö (1999) stated that digital technologies cannot replace a human as the more knowledgeable other, but he did acknowledge their value in enhancing such role. Now, over twenty years and many technological advancements later, it is reasonable to challenge this view. Vygotsky himself (1978, pp. 86, 88) used terms "adult guidance or in collaboration with more capable peer" adjacent to ZPD and wrote that "human learning presupposes a specific social nature". For Vygotsky, mere imitation or assistance was not enough, as according to him, interaction and language together make learning. During the past years, several researchers have either hinted or suggested that digital technologies could adopt this role (Abtahi et al., 2017; Cicconi, 2014; Putman, 2014; S. J. H. Yang et al., 2021; Zhai et al., 2021). Indeed, many examples from this study, too, suggest that an application or software that pointed out pupil's error, aided in correcting it, and helped in coming to the correct answer at the end had adopted characteristics of the more knowledgeable other, particularly in mathematics and Norwegian. However, if following Vygotsky's (1978) core ideas, human involvement is an essential component in being the more knowledgeable other. It is likely that Vygotsky's lack of exposure to advanced technologies of his time constrained his ability to envision the scope of modern digital technologies and the associated debates, such as those surrounding AI assistants like Siri, Alexa, Bing, and ChatGPT. The question of whether

contemporary AI has evolved to the point where it can be considered comparable to a more knowledgeable other, such as a teacher or peer, remains open for discussion.

Teachers in this study found that individualizing was easier with the help of digital technologies, especially with applications using adaptive algorithms. During the observations, several teachers mentioned that it is good that everyone can work together in the same classroom while focusing on their own assignment (Article II). Such a view on differentiated instruction and inclusive learning environments is supported by the views of Mølster and Nes (2018): pupils needing a more personalized learning path do not feel stigmatized when they are not pulled out of the classroom and it is not obvious that they are working on other contents than their peers. Thus, one could conclude that adaptive algorithms can help increase inclusion in the classroom, while still following in the footsteps of sociocultural learning views. However, one could also challenge this perspective: inclusion does not equal to spending as much time in the same physical space as possible with one's peers. Although "all children learning together, regardless of individual differences among the group of children" (Qvortrup & Qvortrup, 2018, p. 806) may imply that the goal, indeed, is keeping all pupils grouped together in the same room, learning together goes far beyond physical space. Learning together requires designs that allow everyone both social, emotional, and academic growth, and is a prerequisite for a sociocultural learning approach (Lane & Menzies, 2015; Qvortrup & Qvortrup, 2018; Wertsch, 1998). In fact, too much individualized instruction can pose a threat to inclusion, as the result might be pupils

sitting in the same physical space but not learning together, because everyone is focused on their own, personalized texts and assignments (Hausstätter, 2012; Nordahl, 2012). Sharing a physical learning space and simultaneously "hiding" the differences behind screens may not promote building an inclusive learning environment where everyone can use their own strengths and get support working on their challenges. In fact, it goes against the very principles of sociocultural learning approach: learning with and from each other (Vygotsky, 1978). In technology-rich classrooms in this study, particularly in grade 5, teachers' appreciation of students, not only teachers, working collectively was evident in both interviews and observed practices. In such settings, they could help each other and – in theory, at least – collectively construct knowledge. As mentioned before, the latter aspect did not always become realized due to great variation regarding time reserved for discussion and reflection, as well as the absence of explicit collaboration strategies. The collaboration level had rather a more technical function, and broader opportunities, such as collective problem solving and collective knowledge construction, often remained unexplored.

One could argue that a far more important characteristic of facilitating inclusive learning environment – rather than just sharing a physical space – is "understanding and accommodating individual differences through appropriate curricula and instruction" (Qvortrup & Qvortrup, 2018, p. 806). While need for more discussion and reflection was identified in many of the observed learning units, the teachers also posed many examples of designs where differentiated instruction was " built-in" to

their designs in such way that allowed for participations of all pupils (Article II). Multimodality in blended learning environments, in particular, offered multiple different approaches to inclusive learning and differentiated instruction that supports the aspects of learning together (Articles II and III). In such designs, instruction, contents, processes, or product were not individualized, but the design itself allowed participation regardless of individual pupils' academic level. This loops back to teacher's role as the designer of learning, which in a technology-rich rich classroom requires both technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). When a teacher can demonstrate such competence, digital technologies can offer endless opportunities for incorporating multimodality into learning designs that promote differentiated learning approach and pupil participation. Teachers' role in such designs and processes evolves toward that of a facilitator: they created structure and frames, strategies, and ongoing support and supervision, but also find new ways to help their pupils scaffold knowledge. Interestingly, while teachers clearly invested in the processes, creating a product to assess at the end was often seen important. Naturally, assessing a product is easier than assessing a process, but simultaneously, it sparks the question if the evaluation methods in technology-rich learning environments have gained enough attention.

Occasionally, teachers also adopted a more conventional role, which highlighted the roles of learners as consumers or reproducesr (Articles I and III). Such lessons were usually teacher-led and offered few opportunities for pupil participation and experimenting. When asked

about this during the observation period, one of the teachers said that a traditional role fits some contents better, or that sometimes there just is no time to plan for something more modern or exciting. In the interviews and survey, lack of time was on several occasions mentioned as a restricting factor to contemporary and exploratory approaches. Such reasonings may indicate that the more conventional role continues to be the internalized "go-to" role that teachers still revert to, even those with high PDC and aspirations in more contemporary learning approaches.

5.2.4 Summary of Findings

To sum up the main findings of this study, one could argue that in order to maximize the benefits of educational technology, it is crucial to foster a culture that encourages teacher appropriation of digital resources, rather than mere mastery. This could be achieved through systematic and ongoing professional development, collaboration, and critical reflection on the use of technology in the classrooms and in their professional community. This requires that teachers accept that conventional role with individual autonomy and teacher-led learning is becoming more and more obsolete. Digitalization of schools forces teachers to collaborate in professional development and designing contemporary learning units for their pupils. Those units should be increasingly inclusive and allow for more pupil participation than more conventional methods. Knowledge as a concept should not be restricted to subject knowledge, but knowledge about broader strategies, such as 21st century competences, and understanding of the potential and pitfalls of digital technologies are equally important. While many advantages of employing digital technologies in teaching and learning have been identified, both in this

study and in a plethora of other educational research, the ever-changing digital landscape continuously provides us also with new dilemmas and challenges. To tackle them, we need competent and curious teachers who are not afraid to try new ideas and learn from the processes.

5.3 Final remarks

Blended learning has become "the new normal" in Norway, but teacher education continues to pay little attention to these aspects and retains a heavy emphasis on traditional face-to-face instruction and classroom management in physical learning arenas (Munthe et al., 2022). For years, researchers, in-service teachers, and pre-service teachers have called for more attention to be paid to the digital aspects of teaching and learning in initial teacher education in Norway (Gudmundsdottir & Hatlevik, 2018; Instefjord, 2014; Krumsvik, 2014b; Røkenes & Krumsvik, 2016). While COVID-19 was an important catalyst for this line of development, a lot of systematic work amongst leaders and teacher educators is required to continue the positive development (Røkenes et al., 2022). This applies for both pre-service and in-service teachers.

A teacher in the 21st century finds different avenues to keep themselves up to date with the potential and pitfalls of emerging technologies, uses their didactical toolkit to design inclusive learning processes, and helps their pupils to scaffold information to gain and develop new knowledge and strengthen their transdisciplinary competences. This can sound daunting, especially amidst the demanding pace of school life, which is why the role of systematic support and collaboration within the professional community is paramount. Paradoxically, as Munthe et al.

(2022) point out, while teachers should be well-versed regarding digital technologies in education, trained in how to design and execute meaningful learning units in technology-rich environments, and use critical didactic consideration when evaluating the choice of digital resources, pre-service teachers get very little training in this during their studies. This study, for its part, confirms the need to include more TPACK (Mishra & Koehler, 2006) in the teacher education programs: currently, pedagogical knowledge and subject knowledge have a tendency to be heavily prioritized, while technological knowledge, and especially its influence in the other two categories, are clearly under-represented (Gudmundsdottir & Hatlevik, 2018; Munthe et al., 2022). Although this has been repeated frequently throughout, it must be reiterated: it is imperative that teacher education institutions pay more attention to the integration of digital classroom components within their curricula, thereby enhancing the preparedness of pre-service teachers for the ever-changing demands of contemporary educational environments. Furthermore, it is not enough to merely focus on the use of digital technologies, but also on their conceptualization and epistemologies (Blikstad-Balas & Klette, 2020; Lund & Aagaard, 2020). The contemporary 21st century education no longer permits viewing of 'the digital' as a distinct category, separate from other aspects of the learning environment. Such divisions that separate content into digital and non-digital domains are no longer tenable in the current technological and educational landscape – the many examples derived from this study alone can defend such a conclusion. Naturally, this has consequences to in-service teachers, as well, as the new requirements and resources of the 21st century challenge conventional pedagogies. This study confirms the

need to expand from knowledge-oriented teaching and strategies to broader competences that allow the pupils to pursue creative and innovative approaches, experimentation, and, ultimately, the thoughtful appropriation of selected digital technologies. The exemplary knowledge derived from the results of this study indicates that the teaching of these competences should be both explicit and systematic – which naturally is not a synonym for teacher-led training but authentic situations where such strategies gain explicit attention. The importance of teachers modelling this mindset is also relevant, although a far less researched element in the study of digitalization of schools, and invites us to direct more attention to this aspect in future research. After all, learning by leading others has already been established to have potential in technology-rich environments (Blau et al., 2020).

Norwegian school has, for a long time, been accused of focusing too much on reading and writing across disciplines. For example, multimodality and oral competences have not gained similar footing in schools as written word, despite digital technologies offering a multitude of opportunities for such approaches. Additionally, in teacher education, essays and exams are still a common means of evaluation, both in the middle and at the end of the term. The new era of sophisticated AI tools, such as ChatGPT and Bing, suggests yet another paradigm shift within the educational sphere, presenting both opportunities and challenges to in-service teachers and teacher educators. These new avenues for learning, capable of generating wellstructured essays, lesson plans, summaries, and creative narratives, raise critical questions regarding teacher's role and potential impact on pedagogical practices. Confronted

with such a transformative technology, educators must grapple with a series of complex dilemmas: should the use of AI be prohibited in educational settings? If not, who can use it: teachers, pupils, or both? Should assessments revert to traditional formats, devoid of any external aids? Or, alternatively, is it possible to harness the potential of such revolutionary tools as valuable resources in the educational process? The recent developments of AI have been extremely rapid, and once again, force teachers to critically evaluate their role as designers of learning and scaffolders of knowledge, as well as work towards new knowledge and competences.

Rather than adopting an outright rejection of AI applications, it is imperative for the academic community to consider innovative ways to integrate these tools into the educational landscape. After all, AI is a part of our current society, and as one of the main purposes of school is to prepare children and adolescence for the society, we need to be able to train them in critical and creative use of such transformative resources. By accepting and – dare I say – even embracing AI as a resource, educators can capitalize on the capabilities of these technologies to improve student learning experiences and expand the boundaries of traditional pedagogical methods. As such, the challenge lies in striking a balance between maintaining the integrity of educational practices and fostering a culture of innovation that encourages the judicious use of AI-driven tools. This approach requires a commitment to ongoing professional development, interdisciplinary collaboration, and well-informed, critical reflection, ultimately ensuring that AI serves as an enabler, rather than a detractor, in the pursuit of educational excellence.

This all rounds back to 21st century competences: communication, collaboration, problem-solving, critical thinking, creativity, and productivity, to name a few. Regardless of the differences in perspective on the role of technology in scaffolding and interaction, recent research – including the results from this study – generally acknowledges that digital technologies have their affordances in supporting sociocultural approach to learning, whether it is in enhancing, supplementing, or mediating interaction. To what extent digital technologies, and AI in particular, contribute in this is an interesting, dynamic, and essential area for future research. Either way, technological advancements, including AI, will force educators to consider major changes in the designs of subject units and assignments, as well as their role as a facilitator, scaffolder, and the more competent other. It could be argued that there will be need to highlight teacher's role as a designer of learning (Kelentrić et al., 2017; Kuure et al., 2016) even more in the very near future and come up with new descriptions to extend this aspect of teacher's role also in teacher education.

This study also offers some methodological contributions to the understanding of 21st-century classrooms, driven by teachers with high professional digital competence. Much of the field has previously been studied through self-reported data. By employing a mixed-methods design, this research project combines self-reported data from individual interviews, focus group interviews, and a survey with observational data, enabling a nuanced and in-depth analysis of teacher's role and pedagogical practices in technology-rich classrooms. Furthermore, this investigation draws upon Gary Thomas' concept of exemplary

knowledge (2011) to provide rich and multifaceted descriptions of contemporary educational settings. The objective is not to capture average or best-case scenarios, but to offer glimpses into the potential of innovative and effective teaching practices. These insights can serve as inspiration for educators to critically reflect upon, develop, and enhance their own digital competencies and pedagogical approaches. At the very beginning of this thesis, I quoted the forewords of the new digitalization strategy for Norwegian schools (Ministry of Education and Research, 2023): digitalization changes us, whether we like it or not, but we have to be able to steer those changes or, ideally, be one step ahead. Ultimately, this study contributes to the ongoing discourse surrounding the role of digital technology in education, fostering a deeper understanding of the possibilities and challenges faced by educators in the rapidly evolving landscape of teaching and learning.

References:

Abtahi, Y. (2014). Who/what is the more knowledgeable other? *For the Learning of Mathematics*, *34*(3), 14–15.

Abtahi, Y., Graven, M., & Lerman, S. (2017). Conceptualising the more knowledgeable other within a multi-directional ZPD. *Educational Studies in Mathematics*, *96*(3), 275–287. DOI 10.1007/s10649-017-9768-1

Ala-Mutka, K. (2011). *Mapping Digital Competence: Towards a Conceptual Understanding*. European Commission Joint Research Centre Intitute for Prospective Technological Studies.

Albion, P. R., Tondeur, J., Forkosh-Baruch, A., & Peeraer, J. (2015). Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice. *Education and Information Technologies*, *20*(4), 655–673. DOI 10.1007/s10639-015-9401-9

Aldrich, R., Ayllón, S., Barbovschi, M., Barbuta, A., Brugarolas, P., Casamassima, G., Drossel, K., Eickelmann, B., Gosme, E., Gudmundsdottir, G. B., Holmarsdottir, H. B., Hyggen, C., Lado, S., Lafton, T., Kapella, O., Karatzogianni, A., Kazani, A.,

Labusch, A., Mifsud, L., … Zinoveva, L. (2022). *Understanding children and young people as digital citizens*. Oslo Metropolitan University. https://www.duo.uio.no/handle/10852/99969

ALLEA. (2017). *The European Code of Conduct of research Integrity. Revised Edition.* All European Academies.

Ananiadou, K., & Claro, M. (2009). *21st Century Skills and Competences for New Millennium Learners in OECD Countries*. OECD. https://doi.org/10.1787/218525261154

Beijaard, D., Verloop, N., & Vermunt, J. D. (2000). Teachers' perceptions of professional identity: An exploratory study from a personal knowledge perspective. *Teaching and Teacher Education*, *16*(7), 749–764. https://doi.org/10.1016/S0742-051X(00)00023-8

Ben-Peretz, M., Mendelson, N., & Kron, F. W. (2003). How teachers in different educational contexts view their roles. *Teaching and Teacher Education*, *19*(2), 277–290. https://doi.org/10.1016/S0742-051X(02)00100-2

Blau, I., Shamir-Inbal, T., & Hadad, S. (2020). Digital collaborative learning in elementary and middle schools as a function of individualistic and collectivistic culture: The role of ICT coordinators' leadership experience, students' collaboration

skills, and sustainability. *Journal of Computer Assisted Learning*, *36*(5), 672–687. https://doi.org/10.1111/jcal.12436

Blikstad-Balas, M., & Klette, K. (2020). Still a long way to go: Narrow and transmissive use of technology in the classroom. *Nordic Journal of DigitalLiteracy*, *15*(01), 55–68. https://doi.org/10.18261/issn.1891-943x-2020-01-05

Bolick, C. M., & Bartels, J. T. (2015). Classroom management and technology. In E. Emmer & E. J. Sabornie (Eds.), *Handbook of Classroom Management* (pp. 479–495). Routledge.

Bondie, R. S., Dahnke, C., & Zusho, A. (2019). How Does Changing "One-Size-Fits-All" to Differentiated Instruction Affect Teaching? *Review of Research in Education*, *43*(1), 336–362. https://doi.org/10.3102/0091732X18821130

Booth, T., & Ainscow, M. (1998). *From them to us: An international study of inclusion in education*. Routledge.

Bozkurt, A. (2022). A Retro Perspective on Blended/Hybrid Learning: Systematic Review, Mapping and Visualization of the Scholarly Landscape. *Journal Of Interactive Media in Education*, *2022*(1), 1–15. https://doi.org/10.5334/jime.751

Brevik, L. M., Gudmundsdottir, G. B., Lund, A., & Strømme, T. A. (2019). Transformative agency in teacher education: Fostering professional digital competence. *Teaching and Teacher Education*,*86*,102875. https://doi.org/10.1016/j.tate.2019.07.005

Brown, J. P. (2017). Teachers' perspectives of changes in their practice during a technology in mathematics education research project. *Teaching and Teacher Education*, *64*, 52–65. *DOI* https://doi.org/10.1016/j.tate.2017.01.022

Bru, E. (2013, November 28). *Elever på høyere klassetrinn opplever dårligere klasseledelse*. University of Stavanger. Research. School. Classroom management. Hvordan påvirker klasseledelse læringsmiljøet? https://www.uis.no/nb/hvordanpavirker-klasseledelse-laeringsmiljoet#/

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

Buchanan, R. (2019). Digital ethical dilemmas in teaching. In M. A. Peters (Ed.), *Encyclopedia of Teacher Education*. Springer.

Bullough, Jr., R. V., & Richardson, M. (2015). Teacher Perspectives on Classroom Management: Rules, Ethics, and "Crime Control." In E. T. Emmer & E. J. Sabornie (Eds.), *Handbook of Classroom Management* (pp. 283–300). Routledge.

Cambridge Dictionary. (n.d.). In *Cambridge Dictionary*. https://dictionary.cambridge.org

Campbell, D. T., & Stanley, J. C. (1966). *Experimental and quasiexperimental designs for research*. Rand McNally.

Chalkiadaki, A. (2018). A Systematic Literature Review of 21st Century Skills and Competencies in Primary Education. *International Journal of Instruction*, *11*(3), 1–16. https://doi.org/10.12973/iji.2018.1131a

Cho, V., Mansfield, K. C., & Claughton, J. (2020). The past and future technology in classroom management and school discipline: A systematic review. *Teaching and Teacher Education*, *90*, 103037. https://doi.org/10.1016/j.tate.2020.103037

Cicconi, M. (2014). Vygotsky Meets Technology: A Reinvention of Collaboration in the Early Childhood Mathematics Classroom. *Early Childhood Education Journal, 42,* 57-65. *DOI https://doi.org/10.1007/s10643-013-0582-9*

Colás-Bravo, P. C.-B., Conde-Jiménez, J. C.-J., & Reyes-de-Cózar, S. R.-C. (2019). The development of the digital teaching competence from a sociocultural approach. *Comunicar. Media Education Research Journal*, *27*(2), 19-30. https://doi.org/10.3916/C61-2019-02

Cole, M. (2019). Re-covering the Idea of a Tertiary Artifact. In A. Edwards, M. Fleer, & L. Bøttcher (Ed.), *Cultural-Historical Approaches to Studying Learning and Development: Societal, Institutional and Personal Perspectives*. *6*, 303–321. Springer. https://doi.org/10.1007/978-981-13-6826-4_20

Creswell, J. W., & Guetterman, T. C. (2021). *Educational research. Planning, conducting and evaluating quantitative and qualitative research.* (6th ed.). Pearson.

Delmar, C. (2010). ”Generalizability” as Recognition: Reflections on a Foundational Problem in Qualitative Research. *Qualitative Studies*, *1*(2), Article 2. https://doi.org/10.7146/qs.v1i2.3828

de Oliveira Nascimento, A. K., & Knobel, M. (2017). What’s to be learned? A Review of Sociocultural Digital Literacies Research within Pre-service Teacher Education. *Nordic Journal of Digital Literacy*, *12*(3), 67–88. https://doi.org/10.18261/issn.1891-943x-2017-03-03

Deschacht, N., & Goeman, K. (2015). The effect of blended learning on course persistence and performance of adult learners: A difference-in-differences analysis. *Computers & Education*, *87*, 83–89. https://doi.org/10.1016/j.compedu.2015.03.020

Desimone, L. (2009). Improving Impact Studies of Teachers' Professional Development: Toward Better Conceptualizations and Measures . *Educational Researcher*, *38*(3), 181– 199. DOI: 10.3102/0013189X08331140

Dysthe, O. (2001). Om samanhengen mellom dialog, samspel og læring. In O. Dysthe (Ed.), *Dialog, samspel og læring* (pp. 9–30). Abstrakt Forlag.

Egeberg, G., Hultin, H., & Berge, O. (2016). *Monitor 2016. Skolens digitale tilstand.* The Norwegian Centre for ICT in Education.

Erstad, O. (2015). Educating the Digital Generation. Exploring Media Literacy for the 21st Century. *Nordic Journal of Digital Literacy*, *5*(1), 56–72. https://doi.org/10.18261/ISSN1891-943X-2010-01-05

Erstad, O., & Hauge, T. E. (2011). *Skoleutvikling og digitale medier: Kompleksitet, mangfold og ekspansiv læring*. Gyldendal akademisk.

Erstad, O., Kjällander, S., & Järvelä, S. (2021). Facing the challenges of 'digital competence.' *Nordic Journal of Digital Literacy*, *16*(2), 77–87. https://doi.org/10.18261/issn.1891-943x-2021-02-04

Evertson, C. M., & Weinstein, C. S. (2006). Classroom Management as a Field of Inquiry. In C. M. Evertson & C. S. Weinstein (Eds.), *The handbook of Classroom Management*. Routledge.

Farrell, T. S. C. (2009). *Talking, Listening, and Teaching: A Guide to Classroom Communication*. Corwin Press.

Federici, R. A., & Vika, K. S. (2020). Spørsmål til Skole-Norge: Analyser og resultater fra Utdanningsdirektoratets spørreundersøkelse til skoleledere, skoleeiere og lærere under korona-utbruddet 2020. Nordic institute for studies of innovation, research and education. https://nifu.brage.unit.no/nifu-xmlui/handle/11250/2656248

Ferrari, A. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe.* European Commission Joint Research Centre Institute for Prospective Technological Studies.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research*, *48*(6pt2), 2134–2156. https://doi.org/10.1111/1475-6773.12117

Fjørtoft, S. O., Thun, S., & Buvik, M. P. (2019). *Monitor 2019. En deskriptiv kartlegging av digital tilstand i norske skoler og barnehager*. SINTEF. https://www.udir.no/contentassets/92b2822fa64e4759b4372d67bcc8bc61/monitor-2019-sluttrapport_sintef.pdf

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, *12*(2), 219–245. DOI https://doi.org/10.1177/1077800405284363

Gadamer, H.-G. (1975). *Truth and method*. The Seabury Press.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education*, *7*, 95–105. DOI https://doi.org/10.1016/j.iheduc.2004.02.001

Gilje, Ø. (2017). *Læremidler og arbeidsformer i den digitale skolen*. Fagbokforlaget.

Gillespie, A., & Zittoun, T. (2010). Using Resources: Conceptualizing the Mediation and Reflective Use of Tools and Signs. *Culture & Psychology*, *16*(1), 37–62. https://doi.org/10.1177/1354067X09344888

Glassman, M., & Burbidge, J. (2014). The dialectical relationship between place and space in education: How the internet is changing our perceptions of teaching and learning. *Educational Theory*, *64*(1), 15–33. https://doi.org/10.1111/edth.12048

Goodwin, A. L., Low, E. L., Ng, P. T., Yeung, A. S., & Cai, L. (2015). Enhancing Playful Teachers' Perception of the Importance of ICT Use in the Classroom: The Role of Risk Taking as a Mediator. *Australian Journal of Teacher Education*, *40*(4), 132–149.

Gouseti, A., Abbott, D., Burden, K., & Jeffrey, S. (2020). Adopting the use of a legacy digital artefact in formal educational settings: Opportunities and challenges. *Technology, Pedagogy and Education*, *29*(5), 613–629.

https://doi.org/10.1080/1475939X.2020.1822435

Graham, C. R., Borup, J., Pulham, E., & Larsen, R. (2019). K–12 Blended Teaching Readiness: Model and Instrument Development. *Journal of Research on Technology in Education*, *51*(3), 239–258.

https://doi.org/10.1080/15391523.2019.1586601

Greene, J. C. (2007). *Mixed Methods in Social Inquiry*. Jossey-Bass.

Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: Implications for teacher education. *European Journal of Teacher Education*,*41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Guillemin, M., & Gillam, L. (2004). Ethics, Reflexivity, and "Ethically Important Moments" in Research. *Qualitative Inquiry*, *10*(2), 261–280. https://doi.org/10.1177/1077800403262360

Haapasaari, A., Engeström, Y., & Kerosuo, H. (2016). The emergence of learners' transformative agency in a Change Laboratory intervention. *Journal of Education and Work*, *29*(2), 232–262. https://doi.org/10.1080/13639080.2014.900168

Hancock, D. R., & Algozzine, B. (2011). *Doing Case Study Research A Practical Guide for Beginning Researchers* (2nd ed.). Teachers' College Press.

Hatlevik, O. E., Egeberg, G., Guðmundsdóttir, G. B., Loftsgarden, M., & Loi, M. (2013). *Monitor skole 2013. Om digital kompetanse og erfaringer med bruk av IKT i skolen*. The Norwegian Centre for ICT in Education.

Hattie, J. (2023). *Visible Learning: The Sequel. A Synthesis of Over 2,100 Meta-Analyses Relating to Achievement*. Routledge.

Hausstätter, R. S. (2012). Grenseoppgangen mellom tilpasset opplæring og spesialundervisning. In *Inkluderende spesialundervisning*. Fagbokforlaget.

Hesse-Biber, S., Rodriguez, D., & Frost, N. A. (2015). A Qualitatively Driven Approach to Multimethod and Mixed Methods Research. In *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry*. Oxford University Press.

Hillman, T., & Säljö, R. (2016). Learning, knowing and opportunities for participation: Technologies and communicative practices. *Learning, Media and Technology*, *41*(2), 306–309. https://doi.org/10.1080/17439884.2016.1167080

Hjukse, H., Aagaard, T., Bueie, A. A., Moser, T., & Vika, K. S. (2020). Digitalisering i grunnskolelærerutdanningen: Om faglige forskjeller i arbeidet med profesjonsfaglig digital kompetanse. *Acta Didactica Norden*, *14*(1), 1–27. https://doi.org/10.5617/adno.8023

Hrastinski, S. (2019). What Do We Mean by Blended Learning? *TechTrends*, *63*(5), 564–569. https://doi.org/10.1007/s11528-019-00375-5

Hur, J. W., & Oh, J. (2012). Learning, Engagement, and Technology:

Middle School Students' Three-Year Experience in Pervasive Technology Environments in South Korea. *Journal of Educational Computing Research*, *46*(3), 295–312. https://doi.org/10.2190/EC.46.3.e

Instefjord, E. (2014). Appropriation of Digital Competence in Teacher Education. *Nordic Journal of Digital Literacy*, *9*(04), 313–329. https://doi.org/10.18261/ISSN1891-943X-2015-Jubileumsnummer-11

Järvelä, S., & Hadwin, A. F. (2013). New Frontiers: Regulating Learning in CSCL. *Educational Psychologist*, *48*(1), 25–39. https://doi.org/10.1080/00461520.2012.748006

Jenssen, M. M. F., & Nordahl, T. (2022). Profesjonelle læringsfellesskap og læreres undervisningspraksis. *Acta Didactica Norden*, *16*(1), Article 1. https://doi.org/10.5617/adno.8144

Jewitt, C., Bezemer, J., & O'Halloran, K. (2016). *Introducing Multimodality*. Routledge. https://doi.org/10.4324/9781315638027

Johansson, N. O., Andersson, J., & Rönnberg, J. (2005). Compensating strategies in collaborative remembering in very old couples.

Scandinavian Journal of Psychology, *46*(4), 349–359. https://doi.org/10.1111/j.1467-9450.2005.00465.x

Kalin, J., Peklaj, C., Pečjak, S., Levpušček, M. P., & Zuljan, M. V. (2017). Elementary and Secondary School Students' Perceptions of Teachers' Classroom Management Competencies. *Center for Educational Policy Studies Journal*, *7*(4), 37–62. https://doi.org/10.26529/cepsj.363

Karau, S. J., & Williams, K. D. (1994). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology*, *65*(4), 681. https://doi.org/10.1037/0022-3514.65.4.681

Karlsen, A. V. (2020). *Flere med i klassefellesskapet. Digitale læringsressurser som støtte.* Universitetsforlaget.

Kelentrić, M., Helland, K., & Arstorp, A.-T. (2017). *Professional Digital Competence Framework for Teachers in Norway*. The Norwegian Centre for ICT in Education. https://www.udir.no/globalassets/filer/inenglish/pfdk_framework_en_low2.pdf

Kennedy, B. L., & Thornberg, R. (2018). Deduction, Induction, and Abduction. In U. Flick (Ed.), *The SAGE Handbook of Qualitative Data Collection*. Sage Publications. https://dx.doi.org/10.4135/9781526416070

Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013a). What Knowledge Is of Most Worth. *Journal of Digital Learning in Teacher Education*, *29*(4), 127–140. https://doi.org/10.1080/21532974.2013.10784716

Kervin, L., & Mantei, J. (2016). Digital writing practices: A close look at one grade three author. *Literacy*, *50*(3), 133–140. https://doi.org/10.1111/lit.12084

Kim, M. S. (2019). Developing a competency taxonomy for teacher design knowledge in technology-enhanced learning environments: A literature review. *Research and Practice in Technology Enhanced Learning*, *14*(1), 1-24. https://doi.org/10.1186/s41039-019-0113-4

Kirschner, F., Paas, F., & Kirschner, P. A. (2009). A Cognitive Load Approach to Collaborative Learning: United Brains for Complex Tasks. *Educational Psychology Review*, *21*(1), 31–42. https://doi.org/10.1007/s10648-008-9095-2

Klette, K. (2007). Bruk av arbeidsplaner i skolen – et hovedverktøy for å realisere tilpasset opplæring? *NPT*, *91*(4), 344–358. https://doi.org/10.18261/ISSN1504-2987-2007-04-08

Koh, J. H. L., Chai, C. S., Hong, H.-Y., & Tsai, C.-C. (2015). A survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with technological pedagogical content knowledge (TPACK). *Asia-Pacific Journal of Teacher Education*, *43*(5), 378–391. https://doi.org/10.1080/1359866X.2014.941280

Komesaroff, P. (1995). From Bioethics to Microethics: Ethical Debate and Clinical Medicine. In P. A. Komesaroff (Ed.), *Troubled Bodies: Critical Perspectives on Postmodernism, Medical Ethics, and the Body* (pp. 62–86). Duke University Press.

Kongsgården, P., & Krumsvik, R. J. (2019). Lærerens didaktiske valg i et teknologirikt læringsmiljø. *Nordic Studies in Education*, *39*(2), 142–163. https://doi.org/10.18261/issn.1891-5949-2019-02-05

Koschmann, T. (2001). Revisiting the paradigms of instructional technology. *Meeting at the Crossroads. Proceedings of the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education.*, 15–22.

Krumsvik, R. J. (2014a). *Klasseledelse i den digitale skolen*. Cappelen Damm Akademisk.

Krumsvik, R. J. (2014b). Teacher educators' digital competence. *Scandinavian Journal of Educational Research*, *58*(3), 269–280. https://doi.org/10.1080/00313831.2012.726273

Krumsvik, R. J. (2023). Adaptive learning tools and artificial intelligence in schools – some trends. *Nordic Journal of Digital Literacy*, *18*(1), 4-7. https://doi.org/10.18261/njdl.18.11

Krumsvik, R. J., Berrum, E., & Jones, L. Ø. (2018). Everyday Digital Schooling – implementing tablets in Norwegian primary school. *Nordic Journal of Digital Literacy*, *13*(03), 152–176. https://doi.org/10.18261/issn.1891-943x-2018-03-03

Krumsvik, R. J., Egelandsdal, K., Sarastuen, N. K., Jones, L. Ø., & Eikeland, O. J. (2013). *Sammenhengen mellom IKT-bruk og læringsutbytte (SMIL) i videregående opplæring*. Kommunesektorens organisasjon (KS).

Krumsvik, R. J., Jones, L. Ø., Øfstegaard, M., & Eikeland, O. J. (2016). Upper Secondary School Teachers' Digital Competence: Analysed by Demographic, Personal and Professional

Characteristics. *Nordic Journal of Digital Literacy*, *11*(3), 143–164. https://doi.org/10.18261/issn.1891-943x-2016-03-02

Kuure, L., Molin-Juustila, T., Keisanen, T., Riekki, M., Iivari, N., & Kinnula, M. (2016). Switching perspectives: From a language teacher to a designer of language learning with new technologies. *Computer Assisted Language Learning*, *29*(5), 925–941. https://doi.org/10.1080/09588221.2015.1068815

Lafton, T., Holmarsdottir, H. B., Kapella, O., Sisask, M., & Zinoveva, L.(2023). Children's Vulnerability to Digital Technology within the Family: A Scoping Review. *Societies*,*13*(1), Article 1. https://doi.org/10.3390/soc13010011

Lane, K. L., & Menzies, H. M. (2015). Classroom management for inclusive settings. In E. T. Emmer & E. J. Sabornie (Eds.), *Handbook of classroom management* (2nd ed.). Routledge.

Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: Teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, *48*(1), 103–122. https://doi.org/10.1080/0305764X.2016.1259389

Levinsen, K. T., & Sørensen, B. H. (2019). Teachers' Designs for Learning Practices when Designing for Students as Learning Designers. *Designs for Learning*, *11*(1), Article 1. https://doi.org/10.16993/dfl.111

Levinson, M., & Fay, J. (2019). Schools of, by, and for the people. Both Impossible and necessary. In M. Levinson & J. Fay (Eds.), *Democratic discord in schools* (pp. 1–11). Harvard University Press.

Lund, A., & Aagaard, T. (2020). Digitalization of teacher education: Are we prepared for epistemic change? *Nordic Journal of Comparative and International Education (NJCIE), 4(3), Article 3.* DOI https://doi.org/10.7577/njcie.3751

Lund, A., Furberg, A., & Gudmundsdottir, G. B. (2019). Expanding and Embedding Digital Literacies: Transformative Agency in Education. *Media and Communication*, *7*(2), 47–58. https://doi.org/10.17645/mac.v7i2.1880

Mæhle, Å., Fjærestad, B., Grimsrud, T., Gravråk, M., & Sommerfeldt, S. (2021). *Digitalisering i skolen. Har vi glemt personvernet?* Bouvet.

Makovec, D. (2018). The Teacher's Role and Professional Development. *International Journal of Cognitive Research in Science, Engineering and Education*, *6*(2), 33–46. https://doi.org/10.5937/ijcrsee1802033M

Martin, N. K., Schafer, N. J., McClowry, S., Emmer, E. T., Brekelmans, M., Mainhard, T., & Wubbels, T. (2016). Expanding the Definition of Classroom Management: Recurring Themes and New Conceptualizations. *Journal of Classroom Interaction*, *51*(1), 31–41.

Martinez Rodriguez, M. A. (1999). The Sociocultural Focus in the Study of Education and Development. *Revista Electrónica de Investigación Educativa*, *1*(1), 16–35. https://doi.org/10.3389/feduc.2020.00128

Maxwell, J. A. (2009). Designing a qualitative study. In *The SAGE handbook of applied social research methods*. Sage Publications.

Maxwell, J. A. (2010). Using Numbers in Qualitative Research. *Qualitative Inquiry*, *16*(6), 475–482. DOI: 10.1177/1077800410364740

Maxwell, J. A. (2013). *Qualitative research design. An interactive approach* (3rd ed.). Sage Publications.

Maxwell, J. A. (2021). Why qualitative methods are necessary for generalization. *Qualitative Psychology*, *8*(1), 111–118. https://psycnet.apa.org/doi/10.1037/qup0000173

Medietilsynet. (2020). *Barn og medier 2020. En kartlegging av 9–18åringers digitale medievaner*. Medietilsynet.

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education: Revised and Expanded from Case Study Research in Education*. Jossey-Bass.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Merriam-Webster. (n.d.) In *Merriam-Webster*. https://www.merriamwebster.com

Miles, M. B., Huberman, A. M., & Saldana, J. (2019). *Qualitative Data Analysis. A Methods Sourcebook* (4th ed.). Sage Publications.

Mirra, N., Morrell, E., & Filipiak, D. (2018). From Digital Consumption to Digital Invention: Toward a New Critical Theory and Practice of Multiliteracies. *Theory Into Practice*, *57*(1), 12–19. https://doi.org/10.1080/00405841.2017.1390336

Mishra, P. (2019). Considering contextual knowledge: The TPACK diagram gets an upgrade. *Journal of Digital Learning in Teacher*

Education.

DOI:https://doi.org/10.1080/21532974.2019.1588611

Mishra, P., Fahnoe, C., & Henriksen, D. (2013). Creativity, SelfDirected Learning and the Architecture of Technology Rich Environments. *TechTrends: Linking Research & Practice to Improve Learning*, *57*(1), 10–13. https://doi.org/10.1007/s11528-012-0623-z

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mishra, P., & Mehta, R. (2017). What We Educators Get Wrong About 21st-Century Learning: Results of a Survey. *Journal of Digital Learning in Teacher Education*, *33*(1), 6–19. https://doi.org/10.1080/21532974.2016.1242392

Mølster, T., & Nes, K. (2018). To What Extent Does Information and Communication Technology Support Inclusion in Education of Students with Learning Difficulties? *598-612*. https://doi.org/10.13189/ujer.2018.060403

Moltudal, S., Høydal, K., & Krumsvik, R. J. (2020). Glimpses Into Real-Life Introduction of Adaptive Learning Technology: A Mixed Methods Research Approach to Personalised Pupil Learning. *Designs for Learning*, *12*(1), Article 1. https://doi.org/10.16993/dfl.138

Morgan, M. S. (2014). Case Studies. In N. Cartwright & E. Mantuschi (Eds.), *Philosophy of Social Science: A New Introduction* (pp. 288–307). Oxford University Press.

Munthe, E., Erstad, O., Njå, M. B., Forsström, S., Gilje, Ø., Amdam, S., Moltudal, S., & Hagen, S. B. (2022). *Digitalisering i grunnopplæring; kunnskap, trender og framtidig forskningsbehov.* Kunnskapssenter for utdanning, Universitetet i Stavanger.

Nespor, J. K. (1985). *The Role of Beliefs in the Practice of Teaching: Final Report of the Teacher Beliefs Study*. University of Texas at Austin. R&D Center for Teacher Education,

Nokes-Malach, T. J., Richey, J. E., & Gadgil, S. (2015). When Is It Better to Learn Together? Insights from Research on Collaborative Learning. *Educational Psychology Review*, *27*(4), 645–656. https://doi.org/10.1007/s10648-015-9312-8

Nordahl, T. (2012). Tilpasset opplæring – et ideologisk mistak i norsk skole? In *Ledelse og profesjonsutøvelse i barnehage og skole*. Universitetsforlaget.

Norwegian Data Protection Authority. (2021). *Barn, unge og skole. Kontrol av elevar*. https://www.datatilsynet.no/personvern-pa-ulike-omrader/skolebarn-unge/skulens-kontroll-av-elevar/

Norwegian Ministry of Education and Research (2006). *Kunnskapsløftet — Reformen i grunnskole og videregående opplæring*. Norwegian Ministry of Education and Research.

Norwegian Ministry of Education and Research. (2015). *NOU 2015: 8 The School of the Future — Renewal of subjects and competences* https://www.regjeringen.no/no/dokumenter/nou-2015-8/id2417001/

Norwegian Ministry of Education and Research. (2019). *Core curriculum – values and principles for primary and secondary education*. Norwegian Ministry of Education and Research.

Norwegian Ministry of Education and Research. (2023). *Strategi for digital kompetanse og infrastruktur i barnehage og skole 2023-2030*. https://www.regjeringen.no/no/dokumenter/strategi-for-digital-kompetanse-og-infrastruktur-i-barnehage-og-skole/id2972254/

Norwegian National Directorate of Education and Training. (2017). *Rammeverk for grunnleggende ferdigheter*. Norwegian National Directorate of Education and Training. https://www.udir.no/laring-og-trivsel/rammeverk/rammeverkfor-grunnleggende-ferdigheter/2.1-digitale-ferdigheter/

Norwegian National Directorate for Education and Training. (2022). *Personvern i barnehage og skole*. https://www.udir.no/regelverk-og-tilsyn/personvern-forbarnehage-og-skole/personvern-i-barnehage-og-skole/

Norwegian National Directorate of Education and Training. (2020). *Curricula for primary, lower secondary and upper secondary education and training*.

Norwegian National Directorate of Education and Training. (2021). *Norwegian national curriculum: Rammeverk for grunnleggende ferdigheter*. Norwegian National Directorate of Education and Training. https://www.udir.no/laring-og-trivsel/rammeverk/rammeverk-for-grunnleggendeferdigheter/2.1-digitale-ferdigheter/

Norwegian National Directorate of Education and Training. (2022). *Grunnskolens Informasjonssystem. Antall elever med tilgang til egen digital enhet (en-til-en dekning)*. https://gsi.udir.no/app/#!/view/units/collectionset/1/collection/97/unit/1/

O'Byrne, W. I., & Pytash, K. E. (2015). Hybrid and Blended Learning. *Journal of Adolescent & Adult Literacy*, *59*(2), 137–140. https://doi.org/10.1002/jaal.463

OECD. (2009). *Creating effective teaching and learning environments: First results from TALIS.* OECD. http://www.oecd.org/edu/talis/firstresults

OECD. (2015). *Students, computers and learning: Making the connection*. OECD. https://read.oecd-ilibrary.org/education/students-computers-and-learning_9789264239555-en#page1

Olaussen, B. S. (2009). Arbeidsplaner i skolen: En kontekst for utvikling av selvregulert læring? – Refleksjoner etter en studie på småskoletrinnet. *Norsk pedagogisk tidsskrift*, *93*(3), 189–200. https://doi.org/10.18261/ISSN1504-2987-2009-03-04

Olmos-Vega, F. M., Stalmeijer, R. E., Varpio, L., & Kahlke, R. (2022). A practical guide to reflexivity in qualitative research: AMEE

Guide No. 149. *Medical Teacher*, *0*(0), 1–11. https://doi.org/10.1080/0142159X.2022.2057287

Orlikowski, W. J., & Iacono, C. S. (2001). Research Commentary: Desperately Seeking the ``IT'' in IT Research—A Call to Theorizing the IT Artifact. *Information Systems Research*, *12*(2), 121–134.

Oxford Learner's Dictionaries. (n.d.). In *Oxford Learner's Dictionaries*. https://www.oxfordlearnersdictionaries.com

Pajares, M. F. (1992). Teachers' Beliefs and Educational Research: Cleaning up a Messy Construct. *Review of Educational Research*, *62*(3), 307–332. https://doi.org/10.2307/1170741

Paniagua, A., & Istance, D. (2018). *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies* (Educational Research and Innovation). OECD.

Pearson, M., & Somekh, B. (2006). Learning transformation with technology: A question of sociocultural contexts? [1]. *International Journal of Qualitative Studies in Education*, *19*(4), 519–539. https://doi.org/10.1080/09518390600773353

Pillen, M.T, Den Brok, P.J, & Beijaard, D. (2013). Profiles and change in beginning teachers'professional identity tensions. *Teaching and Teacher Education*, *34*, 86-97. https://doi.org/10.1016/j.tate.2013.04.003

Polly, D., & Orrill, C. (2012). CCSSM: Examining the Critical Areas in Grades 5 and 6. *Teaching Children Mathematics*, *18*(9), 566–573. https://doi.org/10.5951/teacchilmath.18.9.0566

Polman, J. L. (2006). Mastery and Appropriation as Means to Understand the Interplay of History Learning and Identity Trajectories. *The Journal of the Learning Sciences*, *15*(2), 221–259. https://doi.org/10.1207/s15327809jls1502_3

Poom-Valickis, K., Oder, T., & Lepik, M. (2012). Teachers' Beliefs Regarding their Professional Role: A Gardener, Lighthouse or Circus Director? *Procedia - Social and Behavioral Sciences*, *69*, 233–241. https://doi.org/10.1016/j.sbspro.2012.11.404

Pulham, E., & Graham, C. R. (2018). Comparing K-12 online and blended teaching competencies: A literature review. *Distance Education*, *39*(3), 411–432. https://doi.org/10.1080/01587919.2018.1476840

Putman, R. S. (2014). *Does technology = more knowledgeable other? An investigation of the effects of an integrated learning system on the literacy learning of emergent readers.* Dissertation prepared for the degree of Doctor of Philosophy. University of North Texas.

Qvortrup, A., & Qvortrup, L. (2018). Inclusion: Dimensions of inclusion in education. *International Journal of Inclusive Education*, *22*(7), 803–817 https://doi.org/10.1080/13603116.2017.1412506

Raes, A., Detienne, L., Windey, I., & Depaepe, F. (2020). A systematic literature review on synchronous hybrid learning: Gaps identified. *Learning Environments Research*, *23*(3), 269–290. https://doi.org/10.1007/s10984-019-09303-z

Rajaram, S., & Pereira-Pasarin, L. P. (2010). Collaborative Memory: Cognitive Research and Theory. *Perspectives on Psychological Science*,*5*(6),649–663. https://doi.org/10.1177/1745691610388763

Rienties, B., Køhler Simonsen, H., & Herodotou, C. (2020). Defining the Boundaries Between Artificial Intelligence in Education, Computer-Supported Collaborative Learning, Educational Data

Mining, and Learning Analytics: A Need for Coherence. *Frontiers in Education*, *5*, 1–5. https://doi.org/10.3389/feduc.2020.00128

Ringdal, K. (2013). *Enhet og mangfold: Samfunnsvitenskapelig forskning og kvantitativ metode* (3rd ed.). Fagbokforlaget.

Roediger, H. L., & Karpicke, J. D. (2006). The Power of Testing Memory: Basic Research and Implications for Educational Practice. *Perspectives on Psychological Science*, *1*(3), 181–210. https://doi.org/10.1111/j.1745-6916.2006.00012.x

Rogers, E. M. (1995). Diffusion of Innovations. In *An Integrated Approach to Communication Theory and Research* (4th ed., pp. 432–448). Free Press. https://doi.org/10.4324/9780203887011-36

Roschelle, J. (2021). Intelligence Augmentation for Collaborative Learning. In *Adaptive Instructional Systems. Design and Evaluation* (pp. 254–264). Springer Nature.

Røkenes, F. M., Grüters, R., Skaalvik, C., Lie, T. G., Østerlie, O., Järnerot, A., Humphrey, K., Gjøvik, Ø., & Letnes, M.-A. (2022).

Teacher Educators' Professional Digital Competence in Primary and Lower Secondary School Teacher Education. *Nordic Journal of Digital Literacy*, *17*(1), 46–60. https://doi.org/10.18261/njdl.17.1.4

Røkenes, F. M., & Krumsvik, R. J. (2016). Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education. *Computers & Education*, *97*, 1–20. https://doi.org/10.1016/j.compedu.2016.02.014

Ryan, G. W., & Bernard, H. R. (2003). Techniques to Identify Themes. *Field Methods*, *15*, 85–109. https://doi.org/10.1177/1525822X02239569

Sabornie, E. J., & Espelage, D. L. (2023). Handbook of Classroom Management—Introduction. In E. J. Sabornie & D. L. Espelage (Ed.), *Handbook of Classroom Management* (3rd edition, pp. 3–12). Routledge.

Saldaña, J. (2021). *The coding manual for qualitative researchers* (4th ed.). Sage Publications.

Säljö, R. (1999). Learning as the use of tools. In K. Littleton & P. Light (Eds.), *Learning with computers. Analysing productive interactions.* Routledge.

Säljö, R. (2010). Digital tools and challenges to institutional traditions of learning: Technologies, social memory and the performative nature of learning. Journal of Computer Assisted Learning, 26(1), 53–64. https://doi.org/10.1111/j.1365-2729.2009.00341.x

Säljö, R. (2014). *Lärande i praktiken. Et sociokulturellt perspektiv* (3rd ed.). Studentlitteratur.

Schofield, J. W. (1995). *Computers and Classroom Culture*. Cambridge University Press. https://doi.org/10.1017/CBO9780511571268

Schuster, M. A., & Bogart, L. M. (2013). Did the Ugly Duckling Have PTSD? Bullying, Its Effects, and the Role of Pediatricians. *Pediatrics*, *131*(1), e288–e291. https://doi.org/10.1542/peds.2012-3253

Ševčíková, A., Šerek, J., Barbovschi, M., & Daneback, K. (2014). The Roles of Individual Characteristics and Liberalism in Intentional and Unintentional Exposure to Online Sexual Material Among European Youth: A Multilevel Approach. *Sexuality Research and SocialPolicy*, *11*(2), 104–115. https://doi.org/10.1007/s13178-013-0141-6

Shier, H. (2001). Pathways to participation: Openings, opportunities and obligations. *Children & Society*, *15*(2), 107–117.

https://doi.org/10.1002/chi.617

Sjursø, I., Fandrem, H., & Roland, E. (2020). "All the Time, Every Day, 24/7": A Qualitative Perspective on Symptoms of Post-traumatic Stress in Long-Term Cases of Traditional and Cyber Victimizations in Norway and Ireland. *International Journal of Bullying Prevention*, *2*(2), 139–148. https://doi.org/10.1007/s42380-019-00024-8

Smith, P. K., Bauman, S., & Wong. (2019). Challenges and opportunities of anti-bullying intervention programs. *International Journal of Environmental Research and Public Health*, *16*, 1–3. https://doi.org/10.3390/ijerph16101810

Spiteri, M., & Chang Rundgren, S.-N. (2020). Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning*, *25*(1), 115–128. https://doi.org/10.1007/s10758-018-9376-x

Stake, R. E. (1995). *The art of case study research*. Sage.

The Education Act. (2019). *Act relating to Primary and Secondary Education and Training (the Education Act) 9A-1—9A-16*. https://lovdata.no/dokument/NLE/lov/1998-07-17-61#KAPITTEL_10

Thomas, G. (2011). The case: Generalization, theory and phronesis in case study. *Oxford Review of Education*, *37*(1), 21–35. https://doi.org/10.1080/03054985.2010.521622

Thomas, G. (2021). *How to do your case study* (3rd ed.). Sage Publications.

Tomlinson, C. A. (2001). *How to Differentiate Instruction in Mixed-Ability Classrooms*. Pearson Education.

Tomlinson, C. A. (2022). *Everybody's Classroom. Differentiating for the Shared and Unique Needs of Diverse Students*. Teachers College Press.

Tondeur, J., Valcke, M., & Van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning*, *24*(6), 494–506. https://doi.org/10.1111/j.1365-2729.2008.00285.x

Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Educational*

Technology Research and Development, *65*(3), 555–577. DOI 10.1007/s11423-016-9481-2

UNESCO. (1994). *The Salamanca Statement and Framework for Action on Special Needs Education*. nited Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000098427

Urbina, A., & Polly, D. (2017). Examining elementary school teachers' integration of technology and enactment of TPACK in mathematics. *The International Journal of Information and Learning Technology*, *34*(5), 439–451. https://doi.org/10.1108/IJILT-06-2017-0054

van de Oudeweetering, K., & Voogt, J. (2018). Teachers' Conceptualization and Enactment of Twenty-First Century Competences: Exploring Dimensions for New Curricula. *Curriculum Journal*, *29*(1), 116–133. https://doi.org/10.1080/09585176.2017.1369136

van Geel, M., Keuning, T., Frèrejean, J., Dolmans, D., van Merriënboer, J., & Visscher, A. J. (2019). Capturing the complexity of differentiated instruction. *School Effectiveness and School Improvement*, *30*(1), 51–67. https://doi.org/10.1080/09243453.2018.1539013

van Laar, E., van Deursen, A.J.A.M., van Dijk, J.A.G.M, & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. Computers in Human Behavior, 72, 577–588. https://doi.org/10.1016/j.chb.2017.03.010

Vaughan, N. D., Cleveland-Innes, M., & Garrison, D. R. (2013). *Teaching in Blended Learning Environments: Creating and Sustaining Communities of Inquiry*. Athabasca University Press.

Virkkunen, J. (2006). Dilemmas in building shared transformative agency. *Activités*, *3*(1). https://doi.org/10.4000/activites.1850

Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013a). Challenges to Learning and Schooling in the Digital Networked World of the 21st Century. *Journal of Computer Assisted Learning*, *29*, 403–413. https://doi.org/10.1111/jcal.12029

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge – a review of the literature. *Journal of Computer Assisted Learning*, *29*(2), 109–121. https://doi.org/10.1111/j.1365-2729.2012.00487.x

Voogt, J., & Roblin, N. P. (2010). *21st century skills. Discussion paper.* University of Twente.

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21 st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies*, *44*(3), 299–321. https://doi.org/10.1080/00220272.2012.668938

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wartofsky, M. (1973). *Models*. D. Reidel.

Watson, J. (2008). *Promising practices in online learning. Blending learning: The convergence of online and face-to-face education.* Promising Practices in Online Learning. North American Council for Online Learning.

Webster, J., & Martocchio, J. J. (1992). Microcomputer Playfulness: Development of a Measure With Workplace Implications. *MIS Quarterly*, *16*(2), 201–226. https://doi.org/10.2307/249576

Wertsch, J. V. (1998). *Mind as Action*. Oxford University Press Inc.

Wood, D., Bruner, J. S., & Ross, G. (1976). The Role of Tutoring in Problem Solving*. *Journal of Child Psychology and Psychiatry*, *17*(2), 89–100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

Wubbels, T. (2011). An international perspective on classroom management: What should prospective teachers learn? *Teaching Education*, *22*(2), 113–131. https://doi.org/10.1080/10476210.2011.567838

Yang, S. J. H., Ogata, H., Matsui, T., & Chen, N.-S. (2021). Human-centered artificial intelligence in education: Seeing the invisible through the visible. *Computers and Education: Artificial Intelligence*, *2*(0), 1-5.

https://doi.org/10.1016/j.caeai.2021.100008

Yang, Y., Zhang, H., Chai, H., & Xu, W. (2022). Design and application of intelligent teaching space for blended teaching. *Interactive Learning Environments*, *0*(0), 1–18. https://doi.org/10.1080/10494820.2022.2028857

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6. utgave.). SAGE.

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., Liu, J.-B., Yuan, J., & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, *2021*. https://doi.org/10.1155/2021/8812542

Zhu, C., Huang, S., Evans, R., & Zhang, W. (2021). Cyberbullying Among Adolescents and Children: A Comprehensive Review of the Global Situation, Risk Factors, and Preventive Measures. *Frontiers in Public Health*, *9*, 1–5. https://doi.org/10.3389/feduc.2020.00128

Publications

I

Johler, M., Krumsvik, R.J., Bugge, H.E. & Helgevold, N. (2022). Teachers' Perceptions of Their Role and Classroom Management Practices in a Technology Rich Primary School Classroom. *Frontiers in Education.*

II

Johler, M. & Krumsvik, R.J. (2022). Increasing inclusion through differentiated instruction in a technology-rich primary school classroom in Norway. *Education 3-13.*

III

Johler, M. (2022). Collaboration and communication in blended learning environments. *Frontiers in Education.*

I

Johler, M., Krumsvik, R.J., Bugge, H.E. & Helgevold, N. (2022). Teachers' Perceptions of Their Role and Classroom Management Practices in a Technology Rich Primary School Classroom. *Frontiers in Education.*

frontiers | Frontiers in Education

ORIGINAL RESEARCH
published: 07 April 2022
doi: 10.3389/feduc.2022.841385

Teachers' Perceptions of Their Role and Classroom Management Practices in a Technology Rich Primary School Classroom

Minttu Johler[1], Rune Johan Krumsvik[2], Hans Erik Bugge[1] and Nina Helgevold[1]*

[1] *Department of Education and Sports Science, Faculty of Arts and Education, University of Stavanger, Stavanger, Norway,*
[2] *Department of Education, Faculty of Psychology, University of Bergen, Bergen, Norway*

This case study investigates primary school teachers' perceptions of their role and practices regarding classroom management in technology-rich classrooms. The data was collected through individual and focus group interviews, observation and a survey at a school where implementation of digital technologies has been a high priority over several years. The study identifies complexity and contemporary elements in teachers' perceived role and practices, as the rapid evolution of ICT requires teachers to constantly keep up-to-date, gain new competencies and evaluate their practices to be able to facilitate learning in physical classrooms that have expanded to the digital space. In this process, the role of leadership, collegial collaboration, good teacher-pupil relationships and teachers' ability to adapt and take up a role of a learner have been found pivotal.

Keywords: primary school, technology, teacher's role, pedagogy, classroom management

OPEN ACCESS

Edited by:
Xiaoxun Sun,
Australian Council for Educational Research, Australia

Reviewed by:
Liisa Ilomäki,
University of Helsinki, Finland
Xiaoliang Zhou,
Australian Council for Educational Research, Australia

****Correspondence:***
Minttu Johler
Minttu.johler@uis.no

Specialty section:
This article was submitted to Digital Education, a section of the journal Frontiers in Education

Received: *22 December 2021*
Accepted: *01 March 2022*
Published: *07 April 2022*

Citation:
Johler M, Krumsvik RJ, Bugge HE and Helgevold N (2022) Teachers' Perceptions of Their Role and Classroom Management Practices in a Technology Rich Primary School Classroom. Front. Educ. 7:841385. doi: 10.3389/feduc.2022.841385

INTRODUCTION

Digitalization has advanced in leaps in Norwegian schools, and pupils' and teachers' personal digital devices have become standard pieces of equipment in the majority of classrooms, including primary education (Fjørtoft et al., 2019). This consequently sets new demands to effective classroom management (Bolick and Bartels, 2015; Ministry of Education and Research, 2017). Traditionally, the purpose of classroom management has been establishing a safe, supportive and orderly environment to optimize opportunities for learning and social, emotional and moral growth (Evertson and Weinstein, 2006; Wubbels, 2011). While the definition of classroom management itself is still valid, the rapid development in digitalization at all levels of schooling forces us to reconsider the means to reach its goals. Research shows that in general, teachers have expressed insufficient pedagogical digital competence and fear of losing control when digital technologies have been introduced and implemented (Krumsvik et al., 2013, 2016; Bolick and Bartels, 2015; Moltudal et al., 2019). However, a synthesis of Cho et al. (2020) finds some positive features and implications in both abovementioned areas, in using digital technologies to aid in classroom management, as well as in understanding the role of digital technologies in the overall flow of classroom practices (Cho et al., 2020). Schools have for example implemented applications that

focus on pupil behavior and employed virtual platforms for a variety of classroom management tasks (Pas et al., 2016; Sanchez et al., 2017; Cho et al., 2020). Overall, there is still little research documenting how introducing digital resources actually influences classroom management in primary school level (Bolick and Bartels, 2015; Cho et al., 2020).

The aim of this article is to position the study toward the current state of knowledge, as well as to contribute toward increasing this knowledge base on how teachers perceive their role regarding classroom management in learning environments that are characterized by frequent access and use of digital technologies, and how they practice this role in their everyday classroom management. The context for the case study is particularly related to Norwegian primary schools, and the data was collected in a school that could be defined as a leading-edge school (Schofield, 1995) due to its notable investments in pioneering in ICT implementation. The article examines the following research question:

> *How does the use of digital technologies influence teachers' perceptions of their role and practices in terms of classroom management in a technology-rich primary school classroom?*

NORWEGIAN CONTEXT

In Norway, primary school is divided between lower primary school (ages 6-9, grades 1-4) and upper primary school (ages 10-12, grades 5-7). Norwegian teachers enjoy a significant amount of autonomy compared to their colleagues in many other countries and as a rule, have a fair amount of influence regarding their pedagogical work. The national curriculum (known as LK20) allows a wide spectrum of methods and teaching strategies, while highlighting the importance of educating digitally competent citizens (Ministry of Education and Research, 2019). Teachers and pupils in Norwegian schools have a good access to educational technology, such as one-on-one digital devices, projectors and digital whiteboards (Fjørtoft et al., 2019), and competence in classroom management in technology-rich learning environments has been named as one of the central aspects in the national digitalization strategy for Norwegian schools (Ministry of Education and Research, 2017).

For instance, Blikstad-Balas (2012), Krumsvik et al. (2013), Krumsvik (2014), Fjørtoft et al. (2019) have cast light on the impact of digital technologies to teachers' role and classroom management practices in secondary education. Some of the main findings are that teachers and school leaders both fear and experience that use of technology causes distractions, and that a large body of pupils do not use technology as instructed. Teachers have expressed doubts regarding their pupils' maturity to demonstrate an adequate amount of self-regulation and responsibility when the temptations of digital devices are constantly within the reach, but it has been argued that many of such issues could be resolved by better competence in classroom management (Krumsvik et al., 2013). Although several Norwegian studies have examined the relationship between digitalization and classroom disruptions, a recent systematic review shows that this topic has received little attention internationally (Meinokat and Wagner, 2021). Studies also show that while the access to and the use of digital technologies has increased significantly during the past years, there is still great variation in digital practices within and between Norwegian schools (Krumsvik et al., 2016; Fjørtoft et al., 2019).National studies and international comparison indicate that in spite of teachers' positive attitudes and good access to digital technologies, the use of ICT in Norwegian schools has been generally rather mediocre (Ottestad et al., 2013; Throndsen and Hatlevik, 2015; Blikstad-Balas and Klette, 2020).

TEACHER'S ROLE AND CLASSROOM MANAGEMENT

For a long time, classroom management has been considered as one of the teacher's basic tasks, and in several studies classroom management has been found to be a key predictor of student success (Hattie, 2009; Marquez et al., 2016). While traditional classrooms tend to be rather teacher-centered, a technology-rich learning environment requires a paradigm shift toward a more constructivist approach where technology is no longer treated as a mere tool but viewed more holistically in regards to its potential and influence in classroom dynamics and culture (Säljö, 2010; Bolick and Bartels, 2015). What separates classroom management in elementary grades from classroom management in secondary level is that everything blends with everything: academic, social, emotional and behavioral aspects merge in such manner that individual achievements are often a result of all of the above, rather than a consequence from formal instruction (Carter and Doyle, 2006). Research has also found that quality classroom management has a stronger footing in primary education, and as pupils get older, teachers have a tendency to assume less need for classroom management or focus on subject-related curriculums and educational goals, at the expense of classroom management (Beijaard et al., 2000; Bru, 2013; Kalin et al., 2017).

Carter and Doyle (2006) divide classroom management in elementary level in two main strands: firstly, classroom management has emphasis on procedures (methods, techniques, skills and cognitions) that contribute toward an orderly learning environment by capturing pupils' attention, engagement and focus, in order to allow and execute curricular activities. Secondly, there are the consequences of how classrooms are being managed. This strand consists of the moral and emotional aspect of classroom management, and the outcomes of interacting with children in a school setting. Powell et al. (2001) call this *the social curriculum* of a classroom. This aspect has been considered to be particularly important in successful classroom management (Korpershoek et al., 2016). Researchers argue that authoritative teachers focusing on positive behavior support are more successful in the prevention of unwanted behavior than those employing reactive strategies and attributing problems to external factors (Alter and Haydon, 2017; Hepburn and Beamish, 2019). It is noteworthy that positive behavior support does not rule out negative consequences, as long as they are a logical fit for the rule, and it can be argued that teaching rules with clear positive and negative consequences can be an

effective strategy when managing a primary school classroom (Alter and Haydon, 2017).

Teachers and researchers worldwide generally agree that the march of digital technologies has a major influence on teachers' role in a classroom, and the rapid changes in digital technologies force teachers to adopt a dynamic role where they keep themselves up-to-date regarding new educational technologies (Albion et al., 2015; Martin et al., 2016). As the emphasis in the more contemporary way of viewing classroom management is more constructivist and less teacher-centered, it has a direct influence on teachers' role in the classroom: teachers are urged to become facilitators of learning rather than just transmit knowledge, as well as initiate, guide and influence the way their pupils think about learning (Beijaard et al., 2000). In fact, in order to succeed with digital technologies, teachers themselves should be open to become learners themselves, take some risks, adopt a somewhat playful and curious attitude toward using educational technologies and continuously reflect on the learning and new practices in their professional community (Desimone, 2009). This type of cognitive playfulness, as defined by Webster and Martocchio (1992), Goodwin et al. (2015), is a set of personality traits, affective styles and motivational orientations, which often occur spontaneously in an inventive and imaginary way and has been found to have a positive influence in perceived importance of ICT and sense of competence.

TEACHER'S PROFESSIONAL DIGITAL COMPETENCE AND CLASSROOM MANAGEMENT

There have been many attempts to create a framework that explains, defines or facilitates teacher's pedagogical digital competence, such as TPACK (Mishra and Koehler, 2006), SAMR (Puentedura, 2015), and DigCompEdu (Punie and Redecker, 2017); however, these models offer little concrete recommendations and guidelines for defining and developing teacher's professional digital competence (PDC) and can therefore be seen as quite generic (Hjukse et al., 2020). Professional Digital Competence Framework for Teachers framework, developed by Kelentrić et al. (2017) for The Norwegian Centre for ICT in Education, was launched by the Norwegian Directory of Education and Training and was chosen to frame this study due to its relevance to the context and design that has targeted primary and secondary education in particular. This PDC framework is divided into seven different categories: *Subjects and basic skills, School in society, Ethics, Pedagogy and subject didactics, Leadership of learning processes, Interaction and communication*, and *Change and development*. Particularly the category *leadership of learning processes* offers relevant outlines to classroom management in a technology rich classroom.

> *"A professional, digitally competent teacher possesses the competence to guide learning work in a digital environment. This entails understanding and managing how this environment is constantly changing, and challenging the role of the teacher. The teacher makes use of the opportunities inherent in digital resources in order to develop a constructive and inclusive learning environment—"* (Kelentrić et al., 2017, p.8).

When discussing teachers' pedagogical digital competence, it is noteworthy to point out that the term is more than a compilation of technical skills and knowledge. Krumsvik (2011) has defined teacher's digital competence as their proficiency in using ICT in school with good pedagogical judgment and with their awareness of its implications for learning strategies and the digital Bildung of their pupils. Based on this definition, Krumsvik and colleagues found a significant correlation between teachers' classroom management and their digital competence (Krumsvik et al., 2013). Recent trends in research indicate that in a broader context, teachers should view digital technologies not only as tools but artifacts, which act as cultural extensions and reflect how knowledge and social aspects of our lives are organized and presented in our society (Säljö, 2010; Lund et al., 2014). In other words, a teacher with pedagogical digital competence sees technology as a more comprehensive concept than just a collection of applications, software and devices, and understands how a digital culture in 21st century schools and society influences their role and everyday practices beyond the tool-value of technologies. It is not unusual that variety in teachers' PDC – and their willingness to use technology to facilitate learning – has led to a variety of different classroom practices, which in a broader context could even widen the gap between practices (Moltudal et al., 2019). Therefore, to support a cohesive development of pedagogical competence and practices, school leaders should, through support and supervision, shift the teachers' focus from their individual motives and preferences to a mutual goal, and create a supportive, motivating community (Phelps and Graham, 2014).

METHOD

Case Study Design

This article examines teachers' perceptions of their role and practices regarding classroom management in technology-rich classrooms The data draws from a more comprehensive case study, with the aim of generating a holistic picture of how the teachers generally perceive their role in a technology-rich primary school environment, and how using technology has influenced their perceived classroom management practices. The study follows the principles of an intrinsic case study design, as defined by Stake (1995), with its focus on empirical, descriptive and interpretive knowledge of that one particular case. The complexity of the phenomenon advised a qualitatively driven mixed methods study, where the data was collected cumulatively by employing individual interviews, observation, focus group interviews and a survey. Triangulation of qualitative data was used to increase validity and reliability when analyzing and interpreting the results. This article has a focus on teachers' own perceptions; therefore the main sources

of data for this paper are the interviews and the survey, while observation findings have a more supplementary role in providing examples and adding in-depth information to interview results.

Context and Participants

Due to the nature of this case study, it served the purpose to apply the principles of purposeful sampling (Bryman, 2016; Creswell and Guetterman, 2021). The data was collected in a Norwegian primary school where PDC training of the staff and ICT implementation have a high priority. The school has made significant investments in utilizing digital technologies in a best possible way; thus, a social constructivist approach highlighting the interaction between individual experiences, ideas and environment was considered a relevant epistemological standpoint. Seven teachers on two different grade levels were first interviewed individually and then observed. Focus group interviews rounded the qualitative data collection, and the same seven teachers were then interviewed in their respective grade level teams. The survey was sent to all teachers teaching in the school after a thorough analysis of interview and observation data, and all 19 teachers working at the time submitted their answers, as well as one informant with a combined role as a teacher and administrator. The participants had been working in primary and lower secondary education for varying lengths of time: their seniority ranged from 3 to 27 years, with the median value of 14.

Instruments

Seven one-on-one *interviews* were chosen to start the data collection process, to map out how the teachers themselves perceived their role and changes in their classroom management practices. An abductive approach in their interviews enabled a semi-structured interview design where the interviewer was able to collect data about some of the preselected topics, while also enabling elaboration and ranging out when the interviewees brought up other perspectives. One of the well-known disadvantages of individual interviews (Creswell and Guetterman, 2021) is that the informants can present somewhat deceptive data by answering based on their assumptions about what the interviewer wants to hear. To address this disadvantage, the interviewees were *observed* for a duration of four weeks (56 observed lessons, 3515 min in total) after the individual interviews had been conducted. Observation data has also been used to exemplify and to get a more in-depth understanding of the information the participants provided in the interviews. The observation part was based on Merriam and Tisdell's (2015) checklist of elements important for observation (1) the physical settings, (2) the participants, (3) activities and interactions, (4) conversation, (5) subtle factors, and (6) the researchers' own behavior.

Two *focus group interviews* were carried out after the observation period, mainly for two purposes. Firstly, they were executed to gain more in-depth information and understanding of the individual interview and observation data. The same participants who were interviewed individually, and thereafter observed in action, were also interviewed in groups. A semi-structured interview guide was developed in line with the conceptual framework and tentative analysis of the one-on-one interviews and observation data. Focus group approach was considered relevant, as talking to the teachers as a group allowed them to challenge and elaborate on each other's answers, as well as help the researcher understand how they collectively made sense of their role and classroom management practices in a technology-rich classroom (Bryman, 2016). Focus group interviews also helped avoid misinterpretations and validate previously collected data. The second purpose for focus group interviews was to gain some information regarding the school's resources and philosophy regarding technology, teaching and learning in general. This third focus group interview was carried out with the school's development team (three members of the school leadership and a teacher member). Also in this interview, it was of interest to find out how individuals discuss the matter as a group, building out an understanding from the interaction between the members of the group (Bryman, 2016).

The *survey* was based on an analysis of the interview and observation data and took place approximately 9 months after the focus interviews. The purpose of the survey was to verify interpretations of the qualitative data and to obtain a more representative sample of the qualitative data (Maxwell, 2010; Hesse-Biber et al., 2015). In addition, the intention with the survey was to identify and check for diversity vs. uniformity in the data material, in order to avoid the claim of cherrypicked data for only supporting certain interpretations (Maxwell, 2009). The survey consisted of 56 questions. Five of these questions were administered to gain more knowledge about the participant demographics, and nine of the questions were open-ended, allowing the informants to comment freely or complement their other answers. The main part of the questionnaire consisted of 42 questions where the informants reflected on their personal beliefs, experiences and practices in regards to education and technology. They used two different scales to provide their answers: one to express their personal beliefs, and another one to reflect on their own practices and experiences.

Analysis

A simultaneous analysis and collection of data was used during the project, during which the methodological approaches built on and informed the subsequent steps (Merriam, 1998). This cumulative process was carried out to increase the ecological validity (Gehrke, 2014) and minimize researcher bias and reactivity (Maxwell, 2009). Such approach to the analysis is considered both relevant and necessary in a case study with constructive epistemological commitments and holistic perspectives as some of the central characteristics (Stake, 1995; Merriam, 1998).

The analysis of individual interviews followed the main principles of thematic analysis (Bryman, 2016), and NVivo was used to organize and code the interview data. Once all interviews were transcribed, the data was first organized in main themes that draw from the research questions of the case study. This was done to separate results relevant for this particular article from all case study data and coded using the main themes as codes.

During the second cycle, the data was coded into preselected categories that derive from the most relevant frameworks and literature, which were also employed when developing interview and observation guides. These frameworks and literature define and discuss teacher's role in a 21st century classroom (e.g., Hattie, 2009), teacher's competence in a technology-rich classroom (e.g., Kelentrić et al., 2017) and different aspects of classroom management (e.g., Bolick and Bartels, 2015). The third cycle of interview data analysis prompted new codes, which emerged from the data itself. Ryan and Bernard's (2003) checklist was employed to identify and develop possible new categories, as well as for analyzing the data. During this phase, for instance repetition, similarities, differences, transitions and what is missing from the data were analyzed. The same procedure was used to code and analyze the focus group interviews; however, no new categories emerged from focus group interview data. During the interviews, the topics had a tendency to overlap and emerge several times during one interview. For instance, during the 9 interviews, teacher's competence was discussed – or at least mentioned – 54 times, so 54 excerpts of the data were tagged with the code 'teacher's competence'. All codes and their frequency in data are presented in **Table 1**.

Observation data was coded analogically twice: first, using cycle 1 categories and later, cross-referencing with cycle 2 and 3 categories from the interviews. While many of the categories were present during all lessons, the focus was on how technology influenced either teacher's role or their chosen classroom management practices. For instance, all lessons were organized in one way or the other, and teacher-pupil relationships are an integral part of every single lesson, but when coding and categorizing the contents of the observed lessons, only lessons where technology clearly influenced teachers' role or classroom management practices were coded.

As the interview and observation data were used to develop the *survey*, there were questions directly and indirectly linked to all categories. Due to the small sample size, Microsoft Excel offered sufficient tools for analysis of quantitative data. All multiple-choice survey data was converted into numeric values, after which an analysis was run to detect patterns, repetition and other features. Sorting, filtering, conditional formatting and visualization of data were used to not only detect patterns in general, but also to compare results between teachers with and without higher education PDC training.

Results are presented in **Tables 3**, **4** in the Section "Results" and divided into categories matching the coding cycles and categories.

RESULTS

The main findings regarding classroom management from each stage of data collection were organized in tables, as pictured below (**Tables 3**, **4**). As visible in the tables, the same themes were often discussed in both, individual interviews and focus group interviews, and the participants in both types of interviews were the same teachers. In most cases, a topic was first brought up by the interviewer or the interviewee in one or more one-on-one interviews, and later, the topic was revisited in a focus group interview, in order to elaborate, gain more perspectives and find out about the informants' collective views on it. The actual results from both types of interviews were very similar, with the focus group perspectives commonly offering more detail and exemplification, and that is why all interviews in the Section "Results" are simply referred to as "interviews," without making a distinction between individual and focus group results.

The results of the coding and analysis introduce several interesting aspects of classroom management, such as changes in the traditional role and competence of a teacher. In what follows, these aspects will be further investigated in terms of the categories presented in **Tables 1–4**. All interviewees considered teacher's role in a classroom somewhat different today than what it used to be, prior to the march of educational technologies. Teacher interviews indicated that one of the most notable changes regarding teacher's role as a classroom manager is having to constantly *keep up-to-date* with the rapid developments of digital technologies and understanding how technology can be used – or abused – in a classroom.

> "You have to be ready for change yourself.—. That's how it is with technology, too, all the time. You can't just stop. You have to keep developing yourself to secure learning." (Teacher T, Grade 5).

Some interviewees pointed out that in their busy work days, it could be difficult to find time for keeping up with the rapid developments of educational technologies, finding out about new possibilities and taking full advantage of the existing technologies. They noted that the leadership in the school has a major role in securing enough time for teachers to get the time and training that they need to perform their job in a satisfactory manner. The interviewees found that professional development opportunities offered by the school and particularly sharing in their own professional community had been important sources of new competencies, but that one also has to take initiative oneself and want to learn more.

> «But we have PD time when we sit together and get a glimpse of and learn so that everyone can feel that they can use it [ICT]. And they [leadership] want that we use it, so that all the pupils can use it. So, there is a little bit of pressure, but that just fun. — And it's important to have a little bit of a push, so that everyone learns it." (Teacher S, Grade 1).

In the survey, teachers reported that they gain new competencies through formal professional development, such as attending higher education courses and programs, courses offered by the municipality or a commercial provider, and workshops within their own professional community. Informal professional development channels, such as social media and particularly impromptu collegial collaboration, also held a significant role. In the survey, 18 out of 20 informants reported that their employer offered them opportunities for professional development in regard to educational technologies to a great or very great extent, and 19 out of 20 informants felt that their leaders supported the development of their professional digital competence in other ways to a large or very large

TABLE 1 | Overview of coding of the interviews and observations.

First cycle coding: Main themes		Second cycle of coding: Preselected categories based on frameworks and prior research		Third cycle of coding: Categories emerging from the data	
Teacher's role in the 21st century technology-rich classroom	*Coded 62 times in 9 interviews Coded in 54/56 observed lessons*			Teacher's role in general	*Coded 48 times in 9 interviews Coded in 54/56 observed lessons*
				Experimenting and risk-taking	*Coded 14 times in 8 interviews Coded in 9/56observed lessons*
Teacher's competence in a technology-rich classroom	*Coded 54 times in 9 interviews Observations based on field notes outside teaching time (e.g., PD and prep time) and coded in 54/56 observed lessons.*	PDC in general	*Coded 16 times in 5 interviews Coded in 54/56 observed lessons*		
		Formal professional development	*Coded 26 times in 9 interviews Field notes regarding whole-school PD-time*		
		Informal professional development	*Coded 12 times in 8 interviews Field notes regarding informal PD-time*		
Classroom management practices	*Coded 83 times in 9 interviews Coded in 51/56 observed lessons*	Structure and organization	*Coded 26 times in 9 interviews Coded in 46/56 observed lessons*		
		Rules, routines and interventions	*Coded 20 times in 9 interviews Coded in 50/56 observed lessons*		
		Social and emotional aspects	*Coded 37 times in 9 interviews Coded in 50/56 observed lessons*	Relationships and technology	*Coded 15 times in 9 interviews Coded in 14/56 observed lessons*
				Feedback and assessment	*Coded 15 times in 6 interviews Coded in 22/56 observed lessons*
				Trust vs. control	*Coded 7 times in 5 interviews Coded in 50/56 observed lessons*

TABLE 2 | Example of qualitative interview data coding: classroom management practices.

Qualitative data excerpts	Informant (Interview type)	Codes emerging from data (3rd cycle)	Preselected categories (2nd cycle)	Main theme (1st cycle)
"I use iThoughts every day, I did not say that yet. That's where we present the plan for the pupils and include everything we think they need during the lessons. And we show it to them, throughout the day, so it gives them a good overview."	Teacher S, Grade 1 (Individual)	N/A	Structure and organization	Classroom management practices
"I'm very precise on how things are done. I use a lot of time to practice on directions. Apple up, that's when they need to turn the apple upward right away. If not, I take their tablet computer and they don't get it back until the next task. Apple up means also headset off and where it should be placed. It works really well, but I need to be very clear on this."	Teacher N, Grade 1 (Individual)	N/A	Rules, routines and intervention	
"There is a discussion if we should use this app which can show us pupils' screens. I have said that I don't use it in the classroom and that I expect that they [pupils] know what kind of expectations I have and how we should have it in the class. But sometimes I use it if the pupils are spread out in the base, like, in pairs, and then I can see how much of the work they have done and if they maybe need assistance, instead of me running around and disturbing others to find out."	Teacher B, Grade 5 (Individual)	Trust vs. control	Social and emotional aspects	

extent. 13 out of 20 informants had completed or were in the process of completing a formal PDC training program in higher education (30 ECTS points) and 13 out of 20 teachers reported that they use informal methods, for example social media and other web resources, for professional development to a great, or very great extent.

All interviewees found that while they are just as needed in the technology-rich classrooms than before, the way they

TABLE 3 | Teachers' perceptions of their role and competence in regard to classroom management in a technology-rich primary school classroom – summary of data.

Themes from the interview and observation guides	Individual teacher interviews	Observations	Focus group interviews	Survey (mean) 1 = To a very small extent / Strongly disagree . . .5 = To a very great extent / Strongly agree
Teacher's competence in a technology-rich classroom	Need for staying up-to-date: formal and informal PD Role of leadership: time, opportunities, expectations Importance of collaboration: within own prof. community Own initiative: curiosity, risk-taking, daring	PD time used on workshops to share Planning together during prep time Co-teaching, mixing groups	Need for staying up-to-date: formal and informal PD Role of leadership: time, opportunities, expectations Importance of collaboration: grade level teams and across grade levels Own initiative: curiosity, risk-taking, daring	Leadership: support and opportunities (4.5 and 4.35) Gladly tries out new technology (3.95) Afraid of risks (2) New competencies in CM required (4.7) More challenging CM with ICT (3.3) Formal PD (open-ended) Informal PD (3.7)
Teacher's role in the 21st century technology-rich classroom	Focus on relationships and classroom management Facilitates Models Creates structure Leads	Facilitates Models Creates structure Organizes contents, goals etc. Leads Modeling (experimenting, risk-taking)	Classroom management: clear rules and routines essential in physical and digital environments Different relationships with pupils: collaborating and learning together, more one-on-one feedback Modeling: organization, experimentation, creativity Teaching new ICT skills and judgement	Change in the role (4.3 - everyone agreed) Teacher not less important in tech-rich classrooms (1.2 – everyone disagreed) Changed practices because of digitalization (4.4) Better CM with ICT (3.7)

TABLE 4 | Teachers' perceptions of classroom management in a technology-rich primary school classroom – summary of data.

Themes from the interview and observation guides		Individual teacher interviews	Observations	Focus group interviews	Survey (mean)1 = To a very small extent / Strongly disagree. . .5 = To a very great extent / Strongly agree
Classroom management practices	Structure and organization	Important to be clear and structured, but technology can also contribute Use technology for classroom management Physical and digital space to manage Smoother transitions ICT can contribute toward better structure Common digital platforms used by all teachers (e.g., iThoughts and Showbie)	Routines for use of pupil devices Routines for setting up a class (iThoughts and Showbie) Using technology to create structure, organize, share, supervise, support, intervene Transitions from one subject and/or assignment to another Clear, common structure for all lessons across grade levels iThougts and Showbie as mutual digital platforms for everyone Pupil autonomy and predictability	ICT can contribute toward better organization and structure Applications used for better classroom management Physical and digital space to manage Smoother transitions Easier to have components build on one another Planning and prepping together (teachers) Pupil autonomy and predictability	Better structure (4) Routines for better transitions (3.95) Contributes toward better transitions (3.85) Routines for structure and org. (4.05)
	Rules, routines and intervention	Clarity and consistence essential Mutual rules and routines Distractions rare Inappropriate behavior rare	To protect devices To keep from distracting To improve work flow To communicate Distractions rare Inappropriate behavior rare Consequences/intervention Pupil autonomy and predictability	To protect devices To keep from distracting To improve work flow To communicate Consequences/intervention	Clear rules and routines needed (4.85) Students get easily distracted (2.35) Inappropriate use of ICT (1.85)
	Emotional and social dimensions	Teacher-pupil relationship foundational Trust vs. control Feedback: more frequently in writing and audio format	Teacher-pupil relationships: communication, trust vs. control, authoritative approach	Teacher-pupil relationships foundational Knowing your pupils Trust vs. control Supervision vs. surveillance Feedback: more frequently in writing and audio format	Need for control (3.3): Teachers with more formal PD: rely more on trust (4) Teachers with less formal PD: rely more on control (2.83) Good teacher-pupil relationships (4.55) Trust between teachers and students (4.75) ICT contributes to relationships (3.25) Used to build relationships (2.95 and 2.7)

view themselves as the classroom authority has changed. In the interviews the teachers described how the more traditional leader role, where a teacher should know and be able to do everything, has become obsolete in the 21st century.

" It's always difficult to know what's happening, but we are a little bit more exploratory together with our pupils. Like, we were always the know-it-alls, but we don't have to be that anymore. We are a team with them [pupils], and I think it's a good

thing. More exciting: we can't do this; we need to find out!" (Teacher I, Grade 1).

During the observed lessons, teachers exercised this type of approach for example by allocating time for experimenting and exploring with their pupils, for example when learning about the basic principles of coding and using robotics to measure and define angles. The teachers had created a structure for these lessons and guided their pupils, but had chosen an approach similar to guided inquiry, where they helped their student to learn through exploration, investigation and active dialogue. While there were several examples where the teachers had adopted more of a facilitator role in their pupils' learning process, more traditional use of technologies, such as to search information, create digital products that reproduce old knowledge or using an application targeting specific skills, were also used regularly.

All 20 survey informants agreed teachers are as much needed in the classrooms than before, but that it is necessary to gain new competencies in regard to classroom management, such as knowledge about digital technologies, solid basic skills with technology, student-active approaches to pedagogy, and ability to let go of some of the control in the classroom.

Structure and Organization

All interviewees reported that they use technology in their classrooms to organize contents and create structure for their lessons, and they found that digital technology had made contributions to classroom management in this area, such as better transitions between subjects and assignments, and easy platforms for lesson plans and contents.

> "It can actually create better structure in teaching because the different parts we work on build on one another." (Teacher D, Grade 1).

> "You have lots of tools available right there on your iPad, so when you transition from one exercise to another you use digital tools, so you don't have to get up and fetch things." (Teacher T, Grade 5).

When observing how teachers used digital tools to organize instruction and create structure for their lessons, much of what they did and used was based on mutual agreements of tools used within the professional community. They used the same applications, for example iThoughts and Showbie, to organize and distribute information, resources and assignments, and pupils could find assignments and resources, as well as organize and submit their own work through these platforms. This, according to the teacher interviews, was a result of leadership, collaboration and ongoing professional development, to help teachers feel confident and competent when managing the pedagogical work, and to create predictability and frequent opportunities for self-direction for their pupils. Interviewees found that the ease of access to pupils' work and giving feedback had enabled the teachers to give more feedback to their pupils, which in return had contributed toward better teacher-student relationships. They also felt that they were given the freedom to try out and experiment with new potential technologies or how to use old technologies in a new way.

> "They (leadership) are not going to make you accountable if you have used... you have taught and tried... wanted to try something. They won't make you accountable. They rather say that cool that you tried that, and now you can rather learn from it, how to do it." (Teacher T, Grade 5).

Survey results reveal that only one of the 20 teachers did not believe that technology could contribute toward better structure, and similarly only one informant reported little or no routines in the structure and organization in a technology-rich classroom. 13 out of 20 informants found that digital technologies make transitions easier, and 14 out of 20 teachers had routines in their classroom where technology contributed toward smoother transitions.

Risk-Taking and Relationships

When discussing different themes during the interviews and reading comments on the survey, a recurring aspect of teacher's role was teacher's willingness to take risks and its importance in personal professional development and when using technology to model learning to the pupils. One of the seven interviewees admitted that they sometimes feel somewhat anxious about trying new things, while the other interviewees reported no fear toward technologies, as long as they can test out the new technologies beforehand. Some of the interviewees pointed out that while they had received a significant amount of professional development within educational technologies and felt rather confident about working in technology-rich learning environments, they also found that with technology, unexpected setbacks inevitably happen; however, it did not frighten them or make them shun technology. They found it important to "take the plunge" and dare to model also a trial-and-error approach to their pupils, and be a teacher who takes risks and learns together with their pupils. Such approach was observed for example when using the new podcast studio for the first time and composing music with micro:bit.

Survey results indicate that the teachers in this school are generally not avoiding risk taking, nor are they afraid of making mistakes in front of their pupils: 14 out of 20 teachers reported little or no fear toward taking risks or failing in front of their pupils when using digital technologies, while 5 out of 20 teachers had concerns about this to some or great extent.

While it was emphasized in many of the interviews and comments in the survey that it is important to plan meticulously and be well-prepared when incorporating digital technologies in everyday classroom work, the informants also found that witnessing a teacher fail with their plan could provide learning opportunities for the students.

> «I think that the kids learn also from it, that things don't always work out as they should. That's how it is." (Teacher S, Grade 1).

In the individual interviews, teachers mentioned good relationships in the classroom as the main reason for not being afraid to try something new and take a risk. The importance of having good teacher-pupil relationships in the classroom was also highlighted in the survey, as 17 of the 20 informants agreed that good teacher-pupil relationships are particularly important

in technology-rich classrooms. Also trust between teachers and pupils was seen as an important factor, as 18 of the 20 informants agreed that trust between teachers and pupils is particularly important in a technology-rich environment. When pupils and teachers knew each other and were comfortable in each other's presence, teachers were more willing to take risks.

> "When I have good relationships with them. . . that's important to have first because I understand if someone finds it uncomfortable, pupils that I haven't had much, but now I can luckily say that you know what, this is the first time I try this, first time that you try this, so we'll see together how it works out." (Teacher B, grade 5).

While good relationships and trust were highlighted as a prerequisite for effective work with digital technologies also in the survey, routines where technology actually contributes toward building relationships were found in a great or very great extent in only seven classrooms, and to some extent in ten classrooms. Three teachers reported little use of technology in regard to promoting relationships.

Rules and Routines

Having clear rules and routines has been a classroom management corner stone as long as classroom management has existed, and according to the participants in this case study, this isn't any different in a technology-rich classroom. When asked about such rules in the interviews, teachers listed mostly rules and routines that were created to protect the devices and diminish distractions; however, some teachers focused on rules that were more relevant for ethical aspects of using digital technologies.

> "Perhaps we need to be extra clear with technology. — It can be damaged if it falls on the floor. With a pencil it's not that dangerous if it's lying on the floor." (Teacher N, Grade 1).

> "The importance of privacy and everything that goes with netiquette, yes, we have rules at school about how that works." (Teacher O, Grade 5).

Much like with structure and organization, also with rules and routines the interviewees found it to be important that there are some mutual agreements across the whole school, to create consistence for pupils and assist them with delf-direction and self-regulation. For example, when a teacher called "Apple up" in any of the observed classrooms, all the pupils knew what to do and placed their devices on the desks screen down. With rules also came consequences for not following the rules, and in the few observed violations the consequence was always the same: after a few reminders from the teacher, the pupil had to shift from digital devices to paper and pen.

All the data in this study indicates that the pupils across grade levels had generally a good understanding of how to treat their devices and when and how to use them. Teacher interviews indicated very little distractions and inappropriate use of technology, and the interviewees mentioned single cases where a student had misused their device during class, but none of the interviewees found it to be a recurring problem; however, the interviewees did acknowledge that without clear structures, instructions and routines, technology could become a distraction or lead to accidents with devices. Only few minor incidents were detected during the observed lessons, as well: in a typical scenario, a pupil spend a short time on a website with no relevance to the task, but was quickly returned to the task either by a peer, teacher or themselves. In the survey, 18 out of 20 informants agreed with the statement *«it is particularly important to have clear rules and routines in a technology-rich classroom."* 17 out of 20 teachers reported very or quite little inappropriate use of technology during their lessons, and three teachers reported it to some extent. 17 out of 20 teachers found it to be a good idea to include pupils in the decision-making when the rules and routines where formed.

Control

While the teachers had rather similar thoughts about changes regarding teacher's role, rules, risk-taking and structure and organization, an aspect which they did not entirely agree on was how much they needed to be in control over what was happening on pupils' personal devices. Some interviewees found that younger pupils, who were new to technology and school, had perhaps more need for teacher's monitoring. Some teachers, however, found that it was the older pupils who might have to be monitored more closely, but that teachers can have a great influence on how well pupils follow up by planning ahead well.

> " Yes, yes, one has to create such structure that they actually stay focused. I think this specifically concerns older pupils, as they would like to surf on the Internet and get distracted with other things." (Teacher S, Grade 1).

Observations revealed that it was rather common in this school that groups got mixed and teachers and pupils took advantage of expanded physical learning space outside their classrooms, for instance hallways, library and smaller work rooms. The interviewees found that digital technologies are useful when the physical learning space expands but that it sets challenges to classroom management, as the teacher is no longer physically in the same space with the student. Using applications that allow teachers to view and partially control pupils' devices, such as Apple Classroom and ZuluDesk, was observed mostly in grade 5, where the students were also more often trusted to spread out in the physical space. Using such applications was something that teachers had somewhat controversial views and practices on. Those using them found it important to always inform their students when they were using the apps and explain why. They wanted to emphasize that they used it for supervision, not for surveillance: the purpose was not to "get" pupils that had gotten distracted but to communicate and support the pupils through the application when the teacher could not be physically present. Teachers also used it to get an overview for themselves, and in some rare cases for intervention. The complexity of using such applications was reflected in the interview dialogue:

> " I believe that the pupils should get the. . . they should feel trusted to do what they are supposed to do. But sometimes, you see, like generally in the working environment, it gets a little out of hand. It makes it a little more effective, also for myself. I use it more with some groups than the others, because there is a greater need for motivating. So, the danger with these things is that you

almost monitor the pupils constantly, that they. . . like, that they are under surveillance. But the positive is that you can help those who don't always stick with what they are supposed to. — I use it a lot to, in a way, to get a glimpse myself, where everyone's at. I can't do that if they're using books. — With Classroom app it is easy to see where everyone's at, is it time to move on with the class or do we need to wait a little." (Teacher T, Grade 5).

Also survey results reveal variation, and that teachers with more formal PDC training (minimum of 30 ECTS points in PDC in higher education, either in process or completed) seemed to find it less necessary to have constant control over pupil screens (average value 3) than those who had less formal training (average value 3.86). There were no obvious differences between grade levels; however, during the observations, control-related aspects seemed to play a larger role in lower grades than in upper primary school. There teachers reinforced particularly rules revolving around safety of the device: how to hold it, where to store it and how to carry it. In upper primary grades, pupils were more often taking advantage of an extended physical learning space, and more use of applications that allow access to pupils' devices was more common.

DISCUSSION AND CONCLUDING REMARKS

The purpose of this study was to find out how the use of digital technologies influences the way teachers perceive their role and classroom management practices in a technology-rich primary school. To sum up the informants' perceptions of their role in technology-rich environment, they agreed in many aspects regarding the teacher's role. They found that a teacher has become more of a facilitator, who creates structure and opportunities for learning and models learning processes, for example through experimenting and collaborating with their pupils. An authoritative teacher role in a classroom environment characterized by good relationships and clear routines and rules was considered foundational, and such appreciation was in line in many of the informants' classroom management practices. The informants also agreed that due to the rapid developments of digital technologies, keeping up-to-date and gaining new competences, such as mastering basic technological skills and understanding the possibilities and pitfalls of digital technologies, has become increasingly important. They found that the leadership has a crucial role in not only offering professional development opportunities, but also expecting the teachers to take advantage of them. School leaders that facilitate for a school culture where experimenting with technologies was encouraged, and which builds on collegial collaboration, was found important for supporting teachers in their never-ending quest for those new competencies and skills. These components had helped the informants to "take the plunge" and elevate their PDC in regards to classroom management.

The contemporary aspects of teacher's role as a classroom manager in a technology-rich environment are reflected in many of the classroom management practices of the informants. It is important to emphasize that the data for this case study was collected in a school that can rather be viewed as a frontrunner than mainstream, as they had made significant investments in digital technologies, teacher training and generally building a school culture where digital technologies are a natural part of everyday practices. This can in part explain the generally positive and progressive perceptions the informants had toward classroom management in technology-rich learning environment, as well as explain some of the interesting deviation from previous research. One of such elements is the informants' willingness to adopt practices that demonstrate experimenting and playfulness. The teachers in this study reported very little fear for risk-taking and failing when using digital technologies, in contrast to many previous studies (Blikstad-Balas, 2012; Krumsvik et al., 2013). The reasons can be many, but one could assume that the investment in teachers' PDC has made the teachers more confident when implementing new technologies, and thus, they are also more willing to be more exploratory in their own practices. An indication that supports the abovementioned assumption is that in this case study, teachers with more formal PDC training were generally less concerned about control and more often found that digital technologies contribute toward better classroom management than their colleagues with less formal professional development. Such results imply that although collegial collaboration is often seen as one of the most significant ways of gaining more competence (Borko, 2004; Voogt et al., 2011; Fjørtoft et al., 2019), the role of more systematic, knowledge-based professional development should not be undervalued (Hughes, 2005). A good socio-emotional learning environment has also been found meaningful in technology-rich settings (Nordenbo et al., 2008), and the teachers in this study found good teacher-pupil relationships foundational for establishing an environment where also a teacher can experiment with new approaches, reflecting a somewhat playful attitude, which is in line with the concept of cognitive playfulness and its affordances (Webster and Martocchio, 1992; Goodwin et al., 2015). As mentioned earlier in this article, teacher's ability to build good relationships and an encouraging learning environment can be viewed as one of the key classroom management competences (Powell et al., 2001; Evertson and Weinstein, 2006; Korpershoek et al., 2016) and teachers have a tendency to invest in quality classroom management more in primary level than in later years (Beijaard et al., 2000; Bru, 2013; Kalin et al., 2017). As much of the previous research has been executed in secondary and higher education settings, an intriguing question is how much of the fear and negative experiences teachers have experienced when using digital technologies derive from the lack of time or effort in developing good relationships and a safe social classroom environment.

Results from national mappins of digitalization of Norwegian schools also report about a trend where disruptions and inappropriate use of digital technologies are steadily decreasing in Norwegian schools (Hatlevik et al., 2013; Egeberg et al., 2016; Fjørtoft et al., 2019). While the informants in this study acknowledged that there had been single events where pupils had misused their devices, and that technology *could* potentially cause distractions, none of them found this to be a recurring issue.

The informants in this study could name multiple factors that can contribute toward better engagement and less issues with non-instructional use of technology: teachers' own competence in classroom management, meticulous planning, good relationships with their students and a school culture with mutual and clear rules and routines for technology use worked effectively in preventing such behavior (Erstad, 2012; Wang et al., 2014; Baker et al., 2016; Alter and Haydon, 2017; Tondeur et al., 2017; Moltudal et al., 2019). Bjørgen (2021) suggests that we should in a much larger extent invite pupils' framings and priorities into school-related digital practices, to learn and understand how they engage in digital practices outside school. Building such a connection could assist in creating an engaging and supportive learning environment, which is essential for quality classroom management.

During the past decade, as teachers' awareness and competence regarding digital technologies has increased (Fjørtoft et al., 2019), rules and routines framing how and when to use technology at school have also evolved substantially. While teachers and pupils reported less mutual rules for technology use in class a decade ago (Krumsvik and Jones, 2015), the teachers in this study found that practicing classroom management with clear and consistent rules and routines is foundational in technology-rich learning environments. It could be argued that while there was some variation between grade levels in this study, the mutual ground rules for technology use across the whole school can help pupils internalize the rules and routines and makes it more predictable and consistent for them, which in turn makes it easier for the pupils to follow them and easier for the teachers to reinforce them. A positive socio-emotional learning environment does not rule out negative consequences, should rules be violated (Alter and Haydon, 2017), and logical consequences that the pupils are aware of, such as having their device confiscated, can be effective in preventing disruptions (Baker et al., 2016; Bjørgen, 2021).

A somewhat contradictory finding in this case study is that while the teachers in the interviews and survey highlighted the importance of trust, good relationships and risk-taking, more than half of the teachers still found that a teacher should have control over pupils' screens at all times. A similar perspective was visible in some of the other findings, as well; for instance, some teachers wanted the devices to be placed and held in a certain way in a classroom, to have a visual on the screens, and teachers used applications that allowed them access to pupils' screens from a distance. This invites us to ponder why so many teachers still feel a need to have control over pupils' *screens at all times*, when they self-report very little non-instructional and otherwise disruptive use of digital technologies. Active monitoring can be efficient to prevent disruptions (Storch and Juarez-Paz, 2019), but one can nevertheless speculate if the pupils still feel trusted – a perspective also discussed in the focus group interviews. It is natural that the teachers want to know what their pupils are doing, and not just to find out if they're on-task but also to see how far along they've come, but this alone does not explain why so many teachers find it important to know about their pupils' screen activity *at all times*.

The informants found also that digital technologies have many affordances in creating structure for their lessons. Also in this context, teachers had uniform approaches, in order to create consistency and to support their own professional development, and the findings in all data accentuate the high appreciation of collegial collaboration. In this school, much of the practices, awareness and competence in regards to PDC and digital technologies in general derive from mutual agreements and collaboration. Such approach addresses the risk of widening the gap between teachers' PDC and classroom practices, and helps create a supportive and motivating community – for teachers and pupils (Phelps and Graham, 2014; Moltudal et al., 2019). Meanwhile, the teachers felt that they were allowed and even encouraged to experiment with alternative approaches, and such culture can be highly valuable to make sure that common practices can be questioned, re-evaluated and even criticized.

The results presented in this article confirm what previous research already has suggested: technology-rich learning environments require contemporary competencies and pedagogical approaches to classroom management. A somewhat playful attitude, meticulous planning, frequent opportunities for professional development, collegial collaboration and good teacher-pupil relationships all seem to make considerable contributions toward more effective classroom management in technology-rich classroom environment, while ethical and philosophical questions regarding the overall understanding of the use of ICT in classroom management seem to require further attention. Naturally, as an intrinsic case study (Stake, 1995), these findings have their limitations regarding generalizability, but at the same time, they do provide us with important descriptions and examples regarding teacher's role and classroom management practices in a technology-rich primary school. In this study, we have delved into teachers' perceptions in order to cast light on how they perceive their role and classroom management practices in technology-rich environments, but the field certainly has more space for pupils' voices, as well (Meinokat and Wagner, 2021). In the light of lack of uniform definitions and practices, as well as scarcity of relevant studies from primary education (Bolick and Bartels, 2015; Cho et al., 2020; Meinokat and Wagner, 2021) we find these results promising regarding implications toward succeeding in classroom management in technology-rich learning environments but acknowledge the need for gaining more knowledge and further research focusing particularly on classroom management in primary education.

LIMITATIONS

In this case study certain limitations can be identified. One limitation is related to that the majority of the empirical data applied in this article is based on self-reported data (interviews, focus groups and survey) and might reflect the teachers' intentions more than the actual situation in their daily practices. Another limitation might be that the selected school has a clear digital agenda, the majority of the sample consists of teachers participating in professional development within PDC and the study has been carried out among young pupils (grades 1 to 7) with less pronounced digital lifestyle and with

less digital distractions in classrooms than among older pupils (Fjørtoft et al., 2019). In terms of coding, all coding was executed by a single person. While this eliminates discussion regarding intercoder reliability, it can raise questions about the reliability of the results and a researcher looking to confirm certain expectations or hypothesis. Potential bias related to one coder has been addressed in the design, which relies on triangulation of rich qualitative data, as well as mixed methods design. Executing an excessive cumulative data collection process and analysis during a long period of time allowed the researcher to confirm their interpretations along the way, as well as detect contrary evidence and reach saturation during the coding and analysis (Creswell and Guetterman, 2021).

DATA AVAILABILITY STATEMENT

The anonymized datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the NSD - Norwegian Centre for Research Data. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MJ is the primary author of the manuscript. RJK, HEB, and NH have made significant contributions to article revisions. All authors have approved the submitted version.

FUNDING

This research and the publication fees related to it were funded by the University of Stavanger as a part of Johler's doctorate training program.

REFERENCES

Albion, P. R., Tondeur, J., Forkosh-Baruch, A., and Peeraer, J. (2015). Teachers' professional development for ICT integration: towards a reciprocal relationship between research and practice. *Educ.Inform. Technol.* 20, 655–673.

Alter, P., and Haydon, T. (2017). Characteristics of effective classroom rules: a review of the literature. *Teach. Educ. Spec. Educ.* 40, 114–127. doi: 10.1177/0888406417700962

Baker, C., Gentry, J., and Larmer, W. (2016). A model for online support in classroom management: perceptions of beginning teachers. *Adm. Issues J. Connect. Educ. Pract. Res.* 6, 22–37.

Beijaard, D., Verloop, N., and Vermunt, J. D. (2000). Teachers' perceptions of professional identity: an exploratory study from a personal knowledge perspective. *Teach. Teach. Educ.* 16, 749–764. doi: 10.1016/S0742-051X(00)00023-8

Bjørgen, A. M. (2021). Tablets in two Norwegian primary schools: is it time to consider young pupils' framings of using tablets in education? *Education* 3–13, 1–12. doi: 10.1080/03004279.2021.1929376

Blikstad-Balas, M. (2012). Digital literacy in upper secondary school – what do students use their laptops for during teacher instruction? *Nordic J. Digit. Lit.* 7, 81–96.

Blikstad-Balas, M., and Klette, K. (2020). Still a long way to go: narrow and transmissive use of technology in the classroom. *Nordic J. Digit. Lit.* 15, 55–68. doi: 10.18261/issn.1891-943x-2020-01-05

Bolick, C. M., and Bartels, J. T. (2015). "Classroom management and technology," in *Handbook of Classroom Management*, eds E. Emmer and E. J. Sabornie (New York, NY: Routledge), 479–495.

Borko, H. (2004). Professional development and teacher learning: mapping the terrain. *Educ. Res.* 33, 3–15. doi: 10.3102/0013189X033008003

Bru, E. (2013). *Elever på Høyere Klassetrinn Opplever Dårligere Klasseledelse [University of Stavanger. Research. School. Classroom Management.]. Hvordan Påvirker Klasseledelse Læringsmiljøet?*. Available online at: https://www.uis.no/nb/hvordan-pavirker-klasseledelse-laeringsmiljoet#/ (accessed November 28, 2013).

Bryman, A. (2016). *Social Research Methods*, 5th Edn. London: Oxford University Press.

Carter, K., and Doyle, W. (2006). "Classroom management in early childhood and elementary classrooms," in *Handbook of Classroom Management*, eds C. M. Evertson and C. S. Weinstein (Mahwah, NJ: Lawrence Erlbaum), 373–406.

Cho, V., Mansfield, K. C., and Claughton, J. (2020). The past and future technology in classroom management and school discipline: a systematic review. *Teach. Teach. Educ.* 90:103037. doi: 10.1016/j.tate.2020.103037

Creswell, J. W., and Guetterman, T. C. (2021). *Educational Research. Planning, Conducting and Evaluating Quantitative and Qualitative Research*, 6th Edn. Harlow: Pearson.

Desimone, L. (2009). Improving impact studies of teachers' professional development: toward better conceptualizations and measures. *Educ. Res.* 38, 181–199.

Egeberg, G., Hultin, H., and Berge, O. (2016). *Monitor Skole 2016 Monitor 2016. Skolens Digitale Tilstand*. Oslo: The Norwegian Centre for ICT in Education.

Erstad, O. (2012). The learning lives of digital youth—beyond the formal and informal. *Oxf. Rev. Educ.* 38, 25–43.

Evertson, C. M., and Weinstein, C. S. (2006). "Classroom management as a field of inquiry," in *The Handbook of Classroom Management*, eds C. M. Evertson and C. S. Weinstein (New York, NY: Routledge).

Fjørtoft, S. O., Thun, S., and Buvik, M. P. (2019). *Monitor 2019. En Deskriptiv Kartlegging av Digital Tilstand I Norske Skoler og Barnehager*. Trondheim: SINTEF.

Gehrke, P. J. (2014). Ecological validity and the study of publics: the case for organic public engagement methods. *Public Understand. Sci.* 23, 77–91. doi: 10.1177/0963662513493575

Goodwin, A. L., Low, E. L., Ng, P. T., Yeung, A. S., and Cai, L. (2015). Enhancing playful teachers' perception of the importance of ICT use in the classroom: the role of risk taking as a mediator. *Aust. J. Teach. Educ.* 40, 132–149.

Hatlevik, O. E., Egeberg, G., Guðmundsdóttir, G. B., Loftsgarden, M., and Loi, M. (2013). *Monitor Skole 2013. Om Digital Kompetanse og Erfaringer med Bruk av IKT i Skolen*. Oslo: The Norwegian Centre for ICT in Education.

Hattie, J. (2009). *Visible Learning. A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. London: Routledge.

Hepburn, L., and Beamish, W. (2019). Towards implementation of evidence-based practices for classroom management in Australia: a review of research. *Aust. J. Teach. Educ.* 44, 82–98.

Hesse-Biber, S., Rodriguez, D., and Frost, N. A. (2015). "A qualitatively driven approach to multimethod and mixed methods research," in *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry*, eds S. Hesse-Biber and R. B. Johnson (Oxford: Oxford University Press). doi: 10.3389/fpsyg.2021.547773

Hjukse, H., Aagaard, T., Bueie, A. A., Moser, T., and Vika, K. S. (2020). Digitalisering i grunnskolelærerutdanningen: om faglige forskjeller i arbeidet med profesjonsfaglig digital kompetanse. *Acta Didactica Norden* 14, 1–27. doi: 10.5617/adno.8023

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *J. Technol. Teach. Educ.* 13, 277–302.

Kalin, J., Peklaj, C., Pečjak, S., Levpušček, M. P., and Zuljan, M. V. (2017). Elementary and secondary school students' perceptions of teachers' classroom management competencies. *Center Educ. Policy Stud. J.* 7, 37–62.

Kelentrić, M., Helland, K., and Arstorp, A.-T. (2017). *Professional Digital Competence Framework for Teachers in Norway*. Oslo: The Norwegian Centre for ICT in Education.

Korpershoek, H., Harms, T., de Boer, H., van Kuijk, M., and Doolaard, S. (2016). A meta-analysis of the effects of classroom management strategies and classroom management programs on students' academic, behavioral, emotional, and motivational outcomes. *Rev. Educ. Res.* 86, 643–680.

Krumsvik, R. (2011). Digital competence in the Norwegian teacher education and school. *Högre Utbildning* 1, 39–51.

Krumsvik, R. J. (2014). Teacher educators' digital competence. *Scand. J. Educ. Res.* 58, 269–280. doi: 10.1080/00313831.2012.726273

Krumsvik, R. J., Egelandsdal, K., Sarastuen, N. K., Jones, L. Ø, and Eikeland, O. J. (2013). *Sammenhengen Mellom IKT-Bruk og Læringsutbytte (SMIL) I Videregående Opplæring*. Oslo: Kommunesektorens organisasjon (KS).

Krumsvik, R. J., and Jones, L. Ø (2015). Klasseleiing i teknologirike klasserom i vidaregåande opplæring. *Norsklæreren* 3, 36–50.

Krumsvik, R. J., Jones, L. Ø, Øfstegaard, M., and Eikeland, O. J. (2016). Upper secondary school teachers' digital competence: analysed by demographic, personal and professional characteristics. *Nordic J. Digit. Lit.* 11, 143–164. doi: 10.18261/issn.1891-943x-2016-03-02

Lund, A., Furberg, A., Bakken, J., and Engelien, K. L. (2014). What does professional digital competence mean in teacher education? *Nordic J. Digit. Lit.* 9, 280–298. doi: 10.18261/ISSN1891-943X-2014-04-04

Marquez, B., Vincent, C., Marquez, J., and Pennefather, J. (2016). Opportunities and challenges in training elementary school teachers in classroom management: initial results from classroom management in action, an online professional development program. *J. Technol. Teach. Educ.* 24, 87–109.

Martin, N. K., Schafer, N. J., McClowry, S., Emmer, E. T., Brekelmans, M., Mainhard, T., et al. (2016). Expanding the definition of classroom management: recurring themes and new conceptualizations. *J. Classroom Interact.* 51, 31–41.

Maxwell, J. A. (2009). "Designing a qualitative study," in *The SAGE Handbook of Applied Social Research Methods*, eds L. Bickman and D. J. Rog (Thousand Oaks, CA: Sage Publications).

Maxwell, J. A. (2010). Using numbers in qualitative research. *Qual. Inq.* 16, 475–482. doi: 10.1177/1077800410364740

Meinokat, P., and Wagner, I. (2021). Causes, prevention, and interventions regarding classroom disruptions in digital teaching: a systematic review. *Educ. Inform. Technol.* 1–28. doi: 10.1007/s10639-021-10795-7

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

Merriam, S. B., and Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation*, 4th Edn. San Francisco, CA: Jossey-Bass.

Ministry of Education and Research (2017). *Framtid, Fornyelse og Digitalisering. Digitaliseringsstrategi for Grunnopplæringen 2017-2021*. Oslo: Norwegian Ministry of Education and Research.

Ministry of Education and Research (2019). *Core Curriculum – Values and Principles for Primary and Secondary Education [Forskrift]. Government.No*. Available online at: https://www.regjeringen.no/en/dokumenter/verdier-og-prinsipper-for-grunnopplaringen---overordnet-del-av-lareplanverket/id2570003/ (accessed April 8, 2019)

Mishra, P., and Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. *Teach. Coll. Rec.* 108, 1017–1054.

Moltudal, S., Krumsvik, R. J., Jones, L. Ø, Eikeland, O.-J., and Johnson, B. (2019). The relationship between teachers' perceived classroom management abilities and their professional digital competence: experiences from upper secondary classrooms. A qualitative driven mixed method study. *Des. Learn.* 11, 80–98. doi: 10.16993/dfl.128

Nordenbo, S. E., Søgaard Larsen, M., Tiftikçi, N., Wendt, R. E., and Østergaard, S. (2008). *Lærerkompetanser og Elevers Læring I Førskole Og Skole: Et Systematisk Review Utført for Kunnskapsdepartementet*. Aarhus: Dansk Clearinghouse for Uddannelsesforskning, DPU, Aarhus Universitet.

Ottestad, G., Throndsen, I., Hatlevik, O., and Rohatgi, A. (2013). *Digitale Ferdigheter for Alle? Norske Resultater fra ICILS 2013*. Oslo: UiO, 46.

Pas, E. T., Johnson, S. R., Larson, K. E., Brandenburg, L., Church, R., and Bradshaw, C. P. (2016). Reducing behavior problems among students with autism spectrum disorder: coaching teachers in a mixed-reality setting. *J. Autism Dev. Disord.* 46, 3640–3652. doi: 10.1007/s10803-016-2898-y

Phelps, R., and Graham, A. (2014). Developing technology together, together. *J. Comput. Teach. Educ.* 24, 125–134.

Powell, R. R., McLaughlin, H. J., Savage, T. V., and Zehm, S. (2001). *Classroom Management: Perspectives on the Social Curriculum*. Upper Saddle River, NJ: Merrill/Prentice-Hall.

Puentedura, R. R. (2015). *SAMR: A Brief Introduction. Ruben R. Puentedura's Blog*. Available online at: http://hippasus.com/rrpweblog/archives/2015/10/SAMR_ABriefIntro.pdf (October 14, 2015)

Punie, Y., and Redecker, C. (2017). *European Framework for the Digital Competence of Educators [Policy Report]*. Brussels: European Commission. Publications Office of the European Union.

Ryan, G. W., and Bernard, H. R. (2003). Techniques to identify themes. *Field Methods* 15, 85–109. doi: 10.1177/1525822x02239569

Säljö, R. (2010). Digital tools and challenges to institutional traditions of learning: technologies, social memory and the performative nature of learning. *J. Comput. Assist. Learn.* 26, 53–64. doi: 10.1111/j.1365-2729.2009.00341.x

Sanchez, E., Young, S., and Jouneau-Sion, C. (2017). Classcraft: from gamification to ludicization of classroom management. *Educ. Inform. Technol.* 22, 497–513. doi: 10.1007/s10639-016-9489-6

Schofield, J. W. (1995). *Computers and Classroom Culture*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511571268

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, CA: Sage.

Storch, S. L., and Juarez-Paz, A. V. O. (2019). Efficacy of cell phones within instructional design: a professor's perspective. *Int. J. Mob. Blended Learn.* 11, 12–25. doi: 10.4018/IJMBL.2019010102

Throndsen, I., and Hatlevik, O. E. (2015). *Læring av IKT*. Oslo: Scandinavian Univeristy Press (Universitetsforlaget).

Tondeur, J., van Braak, J., Ertmer, P. A., and Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. *Educ. Technol. Res. Dev.* 65, 555–577.

Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teach. Teach. Educ.* 27, 1235–1244. doi: 10.1016/j.tate.2011.07.003

Wang, S.-K., Hsu, H.-Y., Reeves, T. C., and Coster, D. C. (2014). Professional development to enhance teachers' practices in using information and communication technologies (ICTs) as cognitive tools: lessons learned from a design-based research study. *Comput. Educ.* 79, 101–115. doi: 10.1016/j.compedu.2014.07.006

Webster, J., and Martocchio, J. J. (1992). Microcomputer playfulness: development of a measure with workplace implications. *MIS Q.* 16, 201–226. doi: 10.2307/249576

Wubbels, T. (2011). An international perspective on classroom management: what should prospective teachers learn? *Teach. Educ.* 22, 113–131.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

II

Johler, M. & Krumsvik, R.J. (2022). Increasing inclusion through differentiated instruction in a technology-rich primary school classroom in Norway. *Education 3-13.*

Routledge
Taylor & Francis Group

Education 3-13

International Journal of Primary, Elementary and Early Years Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rett20

Increasing inclusion through differentiated instruction in a technology-rich primary school classroom in Norway

Mintu Johler & Rune Johan Krumsvik

To cite this article: Mintu Johler & Rune Johan Krumsvik (2022): Increasing inclusion through differentiated instruction in a technology-rich primary school classroom in Norway, Education 3-13, DOI: 10.1080/03004279.2022.2143721

To link to this article: https://doi.org/10.1080/03004279.2022.2143721

Published online: 11 Nov 2022.

EDUCATION 3-13
https://doi.org/10.1080/03004279.2022.2143721

Increasing inclusion through differentiated instruction in a technology-rich primary school classroom in Norway

Minttu Johler[a,b] and Rune Johan Krumsvik[c]

[a]Centre for Studies of Educational Practice, Faculty of Education, Inland Norway University of Applied Sciences, Hamar, Norway; [b]Department of Education and Sports Science, Faculty of Arts and Education, University of Stavanger, Stavanger, Norway; [c]Department of Education, Faculty of Psychology, University of Bergen, Stavanger, Norway

ABSTRACT

In this case study, the aim was to investigate how primary school teachers in a leading-edge Norwegian primary school use digital technologies to differentiate instruction in order to promote a more inclusive learning environment in academically diverse classrooms. Seven teachers teaching grades 1 and 5 were observed and interviewed to collect data on their beliefs and practices regarding differentiation. Afterwards, 20 teachers in the same school answered in a survey about teaching in highly digitalised learning environments. The results suggest that teachers find a lot of potential and possibilities in using digital technologies to differentiate instruction to create an inclusive learning environment. However, pupils' digital products indicate that they would need more guidance in taking advantage of the teachers' intentions and flexible curricula.

ARTICLE HISTORY
Received 24 March 2022
Accepted 26 October 2022

KEYWORDS
Differentiated instruction; inclusion; digital technologies; education; primary school

Introduction

Digital competence has been defined as a key education skill in Norway since the curriculum reform in 2006 (Norwegian National Directorate of Education and Training 2021), but mastering digital skills has become even more important during the past decade, as society has changed rapidly due to increasing technological advances (OECD 2015b; Kluge 2021). Having digital competence is important for mastering twenty-first century skills – such as critical thinking, communication and problem solving – but experts around the world also highlight the inclusion perspective of digital technologies. Indeed, an individual who does not possess digital competence can find themselves excluded from society; however, technology has also the potential to actively increase inclusion, and in schools this can be realised through differentiated instruction (OECD 2015a; Ministry of Education and Research 2017, 2019). This article delves into primary school teachers' perceptions of differentiated instruction in a technology-rich classroom and has a particular focus on how they perceive the role of digital technologies in regard to differentiated instruction and inclusion. Inclusion in this article is defined as processes that increase pupil participation and achievement and decrease exclusive practices (Booth and Ainscow 1998; UNESCO 2017; Øen and Krumsvik 2021) and the focus is specifically on inclusion in academically diverse classrooms (Tomlinson 2017). The premise of the article draws from a sociocultural learning theory and its view that meaning is created through interaction with others. The research question is *how do teachers perceive the role of digital technologies when differentiating instruction to facilitate an inclusive learning environment?*

CONTACT Minttu Johler minttu.johler@inn.no

The data for this article was collected in a Norwegian primary school as a part of a larger case study, with the aim to increase the current state of knowledge about teachers' role and pedagogical practices in technology-rich primary school classrooms. Pupils in Norwegian primary schools are commonly between 6 and 12 years of age. The selected school for data collection has had a heavy emphasis on training their teachers in professional digital competence (PDC) and investing in a wide selection of educational technologies, and thus, can be considered a *leading edge* school (Schofield 1995). A cumulative process of data collection employing individual interviews, observation, focus group interviews, and a survey was applied to ensure a thorough and versatile data base.

Norwegian context

In Norway, basic principles of inclusion and thus, differentiated instruction, were first described in a national curriculum as early as the 1970s, but it wasn't until the 1990s, when Norway signed the Salamanca statement of UNESCO that inclusion and differentiated instruction gained more footing in Norwegian policy documents as well (UNESCO 1994; Karlsen 2020). The Norwegian core curriculum promotes *one school for all* (*én skole for alle, fellesskolen*) and states that a school should create an environment that promotes well-being and learning for everyone (18), and that it is the school's responsibility to stimulate each pupil's motivation, willingness to learn and faith in their own mastering (19). To do this, schools should adapt their teaching to ensure all pupils can get equal opportunities for best possible learning opportunities and outcomes (19–20). In spite of good intentions, the system has not been entirely successful in reaching its goals, and there are great differences in quality between schools and even classes within a school (Nordahl 2012; Fjørtoft, Thun, and Buvik 2019). Norwegian schools have a well-functioning infrastructure and both pupils and teachers enjoy a generally good access to one-to-one digital devices, alongside other education technologies (Norwegian National Directorate of Education and Training 2022). Teachers are expected to have professional digital competence to facilitate inclusive learning in digital and physical environments, as well as have a broad repertoire of working methods in a technology-rich environment to produce adapted and varied learning opportunities (Ministry of Education and Research 2017; Kelentrić, Helland, and Arstorp 2017). While previous studies show that teachers find great potential in utilising digital technologies to differentiate instruction and this way, create a more inclusive learning environment (Krumsvik et al. 2013; Fjørtoft, Thun, and Buvik 2019), the actual use of digital technologies does not always reflect this appreciation (Ministry of Education and Research 2017; Blikstad-Balas and Klette 2020).

Literature review

Inclusion

During the past few decades, the importance of sociocultural framing in learning has been emphasised in educational research (Wells 1999; Klette 2007; Karlsen 2020). In technology-rich classrooms, sociocultural aspects require that teachers have the pedagogical digital competence to facilitate and model contemporary approaches that spark for example communication, collaboration and collective approaches to problem-solving among pupils (Colás-Bravo, Conde-Jiménez, and Reyes-de-Cózar 2019). Such an approach to learning relies heavily on the views of Vygotsky (1978) and highlights the collective nature of meaning-making and scaffolding. A key component for such a theoretical approach is a teacher who is able and willing to create a safe and supportive classroom environment which promotes the inclusive nature of learning (Hattie 2010; Navarro et al. 2016). This requires that inclusion is seen as processes – not isolated events events – that increase participation and reduce exclusion (Booth and Ainscow 1998). In their synthesis of a variety of sources, Qvortrup and Qvortrup (2018, 806) find that there are several elements that characterise inclusive schools and classrooms.

(1) All staff supporting a clear school-wide vision and focus on all children.
(2) All children are valued members in the classroom and are educated together (in comparison to traditional 'pull-out' methods).
(3) Comprehensive support for not only all children but also teachers.
(4) An approach supporting collaborative teams
(5) Flexible curricula reflected in quality instruction and evidence-based approaches
(6) Supportive leadership and shared decision making
(7) Focus on teachers' professional development

A more contemporary perspective of inclusion challenges the traditional definition of inclusiveness seen as a synonym for educating pupils in the same physical space, and invites us to consider the opportunities that digital learning arenas have to offer (Øen and Krumsvik 2021). For example, in technology-rich classrooms, pupils can be physically located in the same space, but work on entirely different digital learning environments or assignments. The recent experiences from home-schooling due to the COVID19-pandemic also sparked a growing interest in learning how inclusive learning environments may look in all digital education. A prerequisite for an inclusive learning environment is taking the heterogeneity of the student body into account and differentiating instruction in such way that all pupils can experience both social, emotional, and academic growth (Evertson and Weinstein 2006; Hattie and Anderman 2013; Santangelo and Tomlinson 2012). This article delves into internal differentiation in particular, which refers to differentiated instruction at a classroom level, and has a far less focus on differentiated instruction at an institutional level (Ruys et al. 2013). Furthermore, while inclusion has gained a wide spectrum of definitions, this article investigates primarily participation and learning in academically diverse classrooms and doesn't discuss for example disabilities or special education per se. However, with Norway having a heavy emphasis on addressing learning difficulties and accommodating special education needs within an ordinary classroom environment, it is impossible to entirely exclude these groups from the discussion.

Differentiated instruction

Tomlinson and Imbeau (2010) do not view differentiated instruction as a set of strategies but rather as a 'demographically necessary, ethically focused, pedagogically informed, and empirically tested way of thinking' (11). Differentiated instruction has an important role in creating an inclusive learning environment where all students can grow: struggling, advanced and in-betweener learners; students with valued cultural heritages, and children with a variety of background experiences all grow as much as they possibly can (Tomlinson 2014). Tomlinson (2001) frames differentiated instruction in four categories:

- Content: the knowledge, understanding and skills students should master
- Process: the activities students use to understand and make sense of the contents
- Product: the method the students use to demonstrate understanding of key ideas, transfer of knowledge and application of skills
- Affect: how students' emotions and feelings influence their motivation and learning

In addition to these four elements, teachers need to consider each pupil's readiness to learn, personal interest and generic learning profile in order to be able to differentiate instruction efficiently (Tomlinson and Imbeau 2010, 16–17). van Geel et al. (2019) point out that differentiation during a lesson should never be isolated from planning and evaluation, and thus, when differentiating content, processes and products for pupils, this has to be carried out all the way from planning the whole unit (lesson period) to evaluating student progress.

Differentiating instruction – with or without digital technologies involved – is known to be a challenging task. Researchers have identified several barriers that hinder teachers from successfully

implementing differentiated instruction in their pedagogical practices, such as lack of resources and time, personal beliefs, and limited training, competence, and collaboration (Brighton et al. 2005; Gudmundsdottir, Loftsgarden, and Ottestad 2014; Bondie, Dahnke, and Zusho 2019). Despite meticulous planning, teachers are forced to 'think on their feet' numerous times a day and have to choose from unlimited combinations of different responses continuously. This alone, according to Bondie, Dahnke, and Zusho (2019), can overwhelm teachers to the point that they try to narrow down these response possibilities simply by offering fewer options in form of differentiated instruction. Digital technologies in particular have had a tendency to daunt teachers, and the fear of technological malfunctions and losing control have hindered them from utilising technologies, despite admitting their value and potential in differentiated instruction (Krumsvik et al. 2013; Spiteri and Chang Rundgren 2020).

Educational technologies

School cultures are becoming increasingly digital, and this inevitably has an influence on the means of instruction, pedagogical practices, and classroom dynamics (Harper and Milman 2016; Goodwin et al. 2015). The potential of digital technologies in providing differentiated instruction has been confirmed in many studies both nationally and internationally (e.g. Krumsvik et al. 2013; Gudmundsdottir and Hatlevik 2018; Baron et al. 2019; Haymon and Wilson 2020). Positive attitude towards digital technologies alone has been found to increase teachers' implementation of inclusive practices (Letzel, Pozas, and Schneider 2020) but naturally, teachers are also required to adapt and develop their competences and teaching strategies – with strong support from their leaders (Schleicher 2015). The increase of one-to-one technologies in particular has opened many new possibilities to differentiated learning paths. For instance, using multimodality in teacher instruction, learning processes, and pupils' products have been found beneficial, as it allows pupils to use their strengths to demonstrate learning in various ways and modes (Jewitt, Bezemer, and O'Halloran 2016; Harper 2018). In their synthesis of 46 relevant articles, Harper and Milman (2016) identified that one-to-one digital technologies have indeed prompted an increase of collaborative learning, differentiated instruction and variation. One-to-one technologies were found to be used to differentiate particularly in interdisciplinary contexts and as a supplement to the curricula. On many occasions, teachers have also found that implementing digital technologies has increased motivation and engagement in their classrooms, but some of the previous research findings indicate that such trend is most often detected during the implementation phase and does not always last (Bebell and Kay 2010; Hur and Oh 2012). In their synthesis, Harper and Milman (2016) reported great variation in actual pupil achievement, and while they could not confirm that one-to-one technologies improve pupil achievement, they still detected some positive effects on achievement. Encouraging potential and possibilities have also been found when implementing twenty-first century competences in the curricula with the help of digital technologies, although the challenge of lacking systematic processes is evident also in this context (Sjølie, Strømme, and Boks-Vlemmix 2021; Nemiro 2021; van de Oudeweetering and Voogt 2018; Spiteri and Chang Rundgren 2020).

While all pupils can benefit from differentiated instruction, pupils with special needs are generally using educational technologies more often than their mainstream peers (Mølster and Nes 2018). The affordances of employing digital technologies to promote inclusion within this group of pupils has been documented in a variety of literature, but nevertheless, the practices are not wide-spread or systematically employed (Mølster and Nes 2018; Hughes and Talbott 2017; Edyburn 2014). However, teachers who facilitate learning through the use of digital technology have been found to maximise the use of different strategies (Harper 2018). A wide spectrum of approaches being offered and applied parallel can offer pupils with special needs alternative and adapted learning paths within the mainstream classroom, without the feeling of stigmatisation (Mølster and Nes 2018). Unfortunately, special needs are often used as a reason for exclusion, and the lack of systematic processes that would support inclusion of pupils with special needs in mainstream classrooms often hinders inclusion (Mølster and Nes 2018; Hausstätter 2012). Edyburn and Howery (2014) find

that this is because schools still struggle seeing differences as something normal that should be expected and even celebrated, instead of considering deviation from mainstream as a problem that needs to be addressed.

Design, method, and analysis

Design and selection

This study was conducted within a larger intrinsic case study with a design that follows the principles of an exploratory sequential mixed methods design (Creswell and Guetterman 2021; Stake 1995). This approach seems appropriate, as the aim was to explore a contemporary phenomenon from an abductive perspective (Stake 1995; Thomas 2021). To address the research question *how do teachers perceive the role of digital technologies when differentiating instruction to facilitate an inclusive learning environment,* the principles of purposeful selection were applied to engage informants who were experienced in employing digital technologies in their instructional practices. A leading-edge Norwegian primary school with years of experience in training their staff and utilising digital technologies in pedagogical use was chosen as the arena for data collection. This decision is based on the ambition of investigating the potential and possibilities digital technologies bring to differentiation and inclusive learning environments, instead of the current state of matters in an average Norwegian school. The main source of data in this article is observed lessons in this school; however, as tends to happen in exploratory case studies, the data from the whole study is deeply intertwined, which also influenced the course of the study during the data collection (Yin 2018). Therefore, self-reported data from individual teacher interviews, focus group interviews and a survey are used to complement the observation data.

Instruments

At the very beginning of the data collection, seven grade 1 and 5 teachers were *interviewed* about their experiences, competences, attitudes, and practices in technology-rich classrooms. A semi-structured design for the interviews enabled a dialogue which allowed the interviewees to elaborate on their answers and raise themes that they personally found interesting or important (Bryman 2016). Such approach allows also the interviewer to diverge from the pre-established interview guide when necessary, in order to gain comprehensive data on relevant topics (Bryman 2016). These interviews were immediately transcribed, so that the data collected could be used to further develop the *observation* guide. The observation data consists of 56 observed lessons, and the observations were carried out in the classrooms of the interviewees after their individual interviews. The observations were documented in field notes, recorded in a semi-structured observation guide, and were carried out following the checklist of elements important for observation (Merriam and Tisdell 2015). Elements such as physical setting, participants, activities, interactions, and conversations were included. The observation guide was built around the current state of knowledge in terms of educational technologies, their use and potential, as well as some of the most relevant policy documents and frameworks (Voogt et al. 2013; Bolick and Bartels 2015; Kelentrić, Helland, and Arstorp 2017; Ministry of Education and Research 2017).

The vast observation material and observer's free mobility between grade levels and classrooms addressed the risk of teachers 'showcasing' their best practices and the data reflecting a selected set of practices, rather than ordinary everyday practices. The school hosted student teachers on a regular basis, which meant both pupils and teachers were used to having 'outsiders' sitting in the classroom. Although the researcher's role was primarily non-participating (Bryman 2016), the four-week long observation period allowed the researcher to observe whole class activity, as well as engage in dialogue and activities with smaller groups of students. This could offer the best of both worlds: overview, as well as more in-depth understanding (Bryman 2016).

Focus group interviews with grade 1 and 5 teachers participating in their respective groups took place at the end of the observation period. A tentative analysis of the interview and observation results advised the course of these interviews, allowing the researcher to pose questions to better comprehend what was observed. This step was incorporated to add validity and reliability, as well as to get a chance to elaborate collectively on themes and topics emerging from the observed lessons (Bryman 2016; Creswell and Guetterman 2021). The *survey,* with its 56 questions (42 multiple-choice and 14 open-ended) was administered after the qualitative data had been coded and tentatively analysed. The purpose was to verify interpretations of the qualitative data, to attain a more representative sample of the qualitative data and to increase the internal validity of the study (Maxwell 2009; 2010; Hesse-Biber, Rodriguez, and Frost 2015). The questions discussed primarily teachers' beliefs and practices regarding the use of digital technologies in their pedagogical work.

Analysis

The data was analysed abductively by using literature about the key elements of inclusive learning environments, differentiated instruction, and digital technologies in learning to generate categories and codes (e.g. Tomlinson and Imbeau 2010; Voogt et al. 2013; Bolick and Bartels 2015; Ministry of Education and Research 2017; Qvortrup and Qvortrup 2018). Thereafter, Saldaña's (2021) and Stake's (1995) principles of coding and categorising were applied to organise the data. This involved coding the data in cycles into pre-established codes during the first and second cycle, and finishing with codes that emerged from the data itself (Stake 1995; Saldaña 2021). While interview data was coded and analysed using NVivo, and survey data was analysed with the help of SurveyMonkey and Microsoft Excel, observation data was mostly coded analogically, due to the complex nature of the data recorded (Table 1).

Results and discussion

Through the cumulative process of data collection, we sought to gain an initial understanding of how teachers perceive the role of digital technologies when differentiating instruction to facilitate an inclusive learning environment. A summary of all results is organised in Table 2.

Table 1. Cycles of coding.

Cycle 1: Separating the article data from all data	Cycle two: Pre-established categories	Examples of cycle 2 categories	Cycle 3: Categories emerging from the data	Examples of cycle 3 categories
Differentiated instruction	Inclusive learning environment	Push-in support favoured over pull-out	Multimodality	Systematic and frequent use in instruction across the school (iThoughts)
		Use of multimodality in systematically in daily practices and processes		Multimodal resource libraries created by teachers
	Differentiating contents, process & product	Differentiating text (length and reading level)		Opportunities to create multimodal pupil products
		Use of supportive technology in language learning and mathematics		
	Collaboration and communication	Multiple opportunities for collaboration in physical and digital space	Assessment, evaluation, and feedback	Using audio files in formative assessment
		More frequent teacher-pupil communication on digital platforms		More frequent and informal feedback
	Individualising instruction	Use of adaptive software		Innovative evaluation practices (e.g. game-based)
		Student-centered learning methods		

Teacher survey and interviews revealed that teachers in this school were very content with the leadership, support, and resources they received from their leaders regarding digital technologies, which enabled them to implement digital technologies in school-wide mutual practices. Findings from teacher interviews, observations, and the survey all indicated that the teachers find digital technologies particularly useful for differentiated instruction, which in turn contributes towards a more inclusive learning environment (Tomlinson and Imbeau 2010). In the survey, 85% of the teachers stated that digitalisation of schools has led them to change and develop their pedagogical practices to a great or very great extent, and the survey comments reflected great appreciation for the aspects revolving around inclusive learning environments and differentiated instruction. Such findings are in line with the results of for example Mølster and Nes (2018), who found that teachers generally see a lot of potential in digital technologies when differentiating instruction. However, previous research also finds that in spite of treasuring the potential, the appreciation is not always visible in the daily practices (Edyburn 2014; Mølster and Nes 2018). The results in this study show some promising systematic, albeit local, practices, but also isolated events that have not fully developed into inclusive processes, as described by Booth and Ainscow (1998).

Promoting inclusion through differentiating contents, processes, and products

Teachers who were interviewed reported frequent use of differentiated instruction methods where the goal was to create inclusion by differentiating content, processes or products, as defined by Tomlinson (2001). In the survey, 60% of the teachers reported that they employ assignment types where everyone can work on the same assignment at their own level to a great or very great extent. 40% of

Table 2. Teacher's perceptions of the influence of digital technologies when differentiating instruction.

	Individual interviews	Observation	Focus group interviews	Survey: mean (1 = to a very small extent/strongly disagree … 5 = to a very great extent / strongly agree)
Differentiated instruction in a technology-rich learning environment	Simpler and easier to differentiate with ICT More differentiated instruction Adaptive apps/ software Easy to rely too much on ICT Variety & motivation	Frequent differentiation opportunities Adaptive apps/ software Individualised instruction Multimodality Monotonous use of ICT when pupils choose (products) Motivation & engagement	More variation More differentiated instruction Adaptive apps/ software Game-based individ. instruction a 'fun element' Collaboration	Changed and developed teaching methods due to digitalisation (4.4) Use of adaptive learning technology (3.4) Individualised instruction (4.15) Differentiated inclusive assignment types (3.8) Adapting length or level of contents and assignments per individ. needs (4.3) Teacher uses multimodality for instruction (4.1)
Inclusive learning environment in a technology-rich learning environment	Everyone has an opportunity to create a fine product with ICT More collaboration Teacher who explores with pupils More feedback – more dialogue – better relationships More push-in differentiated instruction (instead of pull-out)	Pupils have influence in process and product (varies between grade levels) Collaboration Experimenting with new technologies Push-in differentiated instruction	Everyone has an opportunity to create a fine product with ICT More collaboration Teacher who explores with pupils More feedback – more dialogue – better relationships	Routines that promote communication and collaboration (3.9) Routines that contribute towards relationships (3.25) Pupils use multimodality to demonstrate learning (4)

the teachers reported that they employ such assignments to some extent. The observation period provided several examples of differentiated subject units that promoted inclusion. An example from grade 1 consists of a resource library, where teachers created, collected, and organised multimodal digital resources for pupils to learn about various animals living in the Norwegian nature. The resources were written texts at different reading levels, text-supporting audio recordings, videos, images, and animations (for example a 'reading finger' pointing the current part of the text as the recorded teacher voice was reading). Pupils could then, with teachers' guidance, search and select appropriate resources to create presentations of their chosen animal in a digital mind map format. Such approach minimises the feeling of stigmatisation for those with learning difficulties (Mølster and Nes 2018), as all pupils were using technology at the same time but slightly differently. Meanwhile, all pupils could work on the same task in the same physical space, but follow a personalised learning path, with their readiness to learn taken in consideration (Tomlinson 2001). In grade 1, where pupils have limited skills in reading and writing, multimodality played a significant role particularly in contents and processes. In grade 5, pupils often got a few website recommendations from the teachers but were also allowed to find their own resources. The contents and processes were often text-based, but the pupils could, on several occasions, choose the product type themselves and apply multimodal aspects to the product. Observations and field dialogue with teachers revealed that using BookCreator, which supports multimodality in a digital book format, was a popular choice for creating a product, as pupils found it familiar and easy to use, while it allowed a wide array of creative opportunities and a clear structure. Also producing shot video presentations was popular. In grade 1, while content and processes were more differentiated, the product was often decided by the teachers and the same for everyone. Allowing pupils to use their preferred means of communication in meaning-making and to demonstrate learning can be a powerful tool in creating inclusion, as it increases pupils' opportunities in participation (Booth and Ainscow 1998; Hur and Oh 2012; Jewitt, Bezemer, and O'Halloran 2016). The many examples of this in the study invite us to look closer into the possibilities of multiple modes when differentiating instruction.

Multimodality

In the survey, 70% of the teachers reported that they use multimodality for instruction to a very great or great extent, while 30% use it to some extent. 75% of the teachers find that their pupils utilise multimodality when presenting their learning to a very great or a great extent, 10% to some extent and 15% to a small extent. While the self-reported survey results confirmed observations regarding pupils' use of multimodality (used more in upper grade levels), they reveal an interesting discrepancy regarding how the teachers take advantage of multimodality: while using multimodality for instruction, i.e. teacher using multimodality, was observed far more in grade 1 than in grade 5, in the survey grade 5–7 teachers reported significantly more multimodal use of technologies (mean 4.5) than grade 1–2 teachers (mean 3.57). There may be numerous reasons for this: there might have been more multimodality going on 'behind the scenes' in grade 5 than what the researcher was able to detect, the self-reported results can reflect intentions and potential for multimodality more than actual practices, the timing of the observation period might have been particularly unfortunate for grade 5 for observing this particular aspect – or particularly fortunate for grade 1 – or in lower grades, multimodal practices have become an established part of the everyday pedagogy, which is why the teachers no longer consciously separate them for other forms of support and instruction. It might also be that teacher's use of multimodality varied between grade levels, and that in other grade 5–7 classrooms it could have been observed more. Either way, the many examples of multimodality in both grade levels reflected what van Geel et al. (2019) and Booth and Ainscow (1998) find central in creating inclusion through differentiated instruction: it cannot be done in isolated events but must become a permanent practice that stretches over the whole learning process, from planning the unit to assessing achievement.

Allowing pupils to have great influence on the product format and outcomes made it possible for pupils to find – in theory at least – different ways of representing their learning and have multiple opportunities to use their strengths to demonstrate their learning (Jewitt, Bezemer, and O'Halloran 2016). Such an approach has been found to be beneficial in creating an inclusive and positive learning environment (Tomlinson 2001). While pupils being able to choose a product type themselves has many advantages, such as higher motivation and ability to use one's strengths and personal interests to demonstrate learning (Tomlinson 2001; Hur and Oh 2012) it also has its pitfalls. While grade 5 teachers in this study were often well prepared and familiar with the contents, as well as engaged in the process of learning by guiding and advising the pupils as they worked, observations revealed that pupils received notably less guidance in choosing the product. This prompted particularly two issues: monotonous use of presentation software and applications, and not always choosing a product that fit the purpose. Some of the interviewees had detected this trend, as well:

> Teacher B: Like, you can't always find a new app, a new thing, right? There won't be any deep learning then. So yes, that's maybe the only disadvantage, that you have to tone down such expectation a little, so that they [pupils] can see potential in what you already have.

Observations confirmed that while creating digital products appeared engaging and pupils were on-task and expressed enthusiasm, as also found by Hur and Oh (Hur and Oh 2012), the quality of the actual demonstration of learning varied greatly. It also happened that pupils wrote or read aloud texts on their chosen format rather quickly, and thereafter spent a large proportion of time changing background colours and font types, as well as adding images, animations, sound effects and other details that added rather little value to the contents or the way it was presented. In other words, teachers and applications chosen to create a product in certain subjects rather systematically allowed a great deal of creativity and freedom in the ways pupils could express themselves and demonstrate their learning. However, pupils' self-chosen representations tended to focus on more monotonous reproduction of knowledge, and thus, they did not utilise the full potential of the digital technology, nor the didactic and pedagogical intentions of a teacher. Intriguingly, it is worth noting that grade 5 teachers chose an exploratory approach in many occasions, particularly when introducing new digital technologies, for example using micro:bit to compose music and Sphero balls (robotics) to explore adjacent angles. Such approach spurred also more playfulness and creativity in the pupils' processes and products. This phenomenon could be explained with new technologies prompting initial motivation and engagement (Bebell and Kay 2010; Hur and Oh 2012). However, it can also invite us to consider if more traditional processes subconsciously prompt more traditional products, and more exploratory processes encourage pupils also to think more creatively about their products. Furthermore, it could be argued that when teachers model exploratory learning styles, it could help pupils experiment and take more risks, as well, which in its turn helps create a more inclusive and tolerant learning environment. This kind of interpretation finds support in Harper's (2018) deduction, as they found that when teachers facilitated explorative learning, participation among pupils that usually expressed less engagement and enthusiasm increased. When considering Edyburn and Howery's (2014) views on us having to create tolerant and inclusive learning environments where differences are celebrated, such approach has a lot of value in demonstrating how all pupils – special needs or mainstream – can try, fail, have a need for support, and learn and demonstrate their learning in various ways. The teachers were eager to implement more exploratory units in their teaching, which implicates that such approach is well on its way to become a permanent practice, rather than an 'isolated event' (Booth and Ainscow 1998) in this school.

Adaptive learning technology and individualised instruction

Adaptive software and applications use algorithms and/or artificial intelligence to analyse pupils' performance in real-time and customise the contents and methods accordingly. Use of such technologies (for example GraphoGame and Multi Smart Øving) to differentiate instruction was most often

observed when teachers' attention was needed elsewhere or as quick drills at the beginning or end of a lesson. The interviewees could find many reasons for adopting adaptive technologies in their pedagogical repertoire, such as offering individualised instruction, variation, and something more fun and motivating. They also found that adaptive learning technologies offered an easy and effective way for the teacher to keep track of individual pupils' performance and development. In other words, they were also used for formative assessment. According to the survey results, half of the teachers use adaptive technologies to differentiate instruction to a great or very great extent. 35% of the teachers report that they use it to some extent. During the observed lessons, adaptive learning technologies were used in 17 out of 56 lessons, most commonly for spelling and phonetics (Norwegian language) and mathematics, and more often in grade 1, which used station rotation frequently as a method (9/22 lessons), than in grade 5 (8/34 lessons). The interviewees highlighted that they must be used as supplementary content and to add variation and repetition when needed, not as the primary source for learning.

Teacher I: It is motivating with games and playing, it is also important for the little ones. But mostly variation, right, that they [pupils] receive [instruction] in different ways. —
Teacher M: Variation, yes, that something is also fun.
Interviewer: So it's not a main activity, to play … ?
Teacher T: No, a supplement, that's what I think.

The discussion within the focus group interview points out an important factor: variation. While individualised instruction once was almost synonymous to differentiated instruction, in an inclusive learning environment it is essential to vary methods and instruction models between individual, group and whole class instruction (Tomlinson 2017). When individualising instruction, teacher can easier collect data regarding individual pupil's progress and use it for formative assessments. However, at the same time, it is important to remember that in an inclusive learning environment, the appreciation of differences and feeling of belonging draw from the more collective aspects of learning (Colás-Bravo, Conde-Jiménez, and Reyes-de-Cózar 2019; Edyburn and Howery 2014; Edyburn 2014). This means that differentiation should not be reduced to individualisation with the help of digital technologies. Instead, teachers should systematically plan and execute contemporary processes that offer differentiation, variation, and inclusion – with a digitally competent teacher as a facilitator (Booth and Ainscow 1998; Colás-Bravo, Conde-Jiménez, and Reyes-de-Cózar 2019; Tomlinson 2017).

In the survey, 75% of the teachers revealed that they use digital technologies for individualised instruction to a great or very great extent, and 25% of the teachers use it for this purpose to some extent. In the interviews, difficulties in reading and writing were named as a specific reason for individualised instruction, and during the observations pupils with such difficulties could, for example, utilise audio aids to support their reading and writing processes. 90% of the teachers reported that they adapt the level or the length of written texts to individualise instruction for pupils with specific needs in the abovementioned area. A common sight during the observations was one or more pupils with headphones on during independent reading time and when working at an independent post during a station rotation setup. Using audio to support in reading allows pupils with reading difficulties to remain in the classroom and read independently just like their peers, instead of being pulled out to read together with a teacher, and it can also be beneficial when learning spelling and phonetics. This follows the recommendations of Mølster and Nes (2018) and Qvortrup and Qvortrup (2018) by having all pupils work on the same activity but with personalised accommodations, which in turn can help pupils with special needs feel less stigmatised. At the same time, trying to 'hide' the fact that the pupils have different needs and require different accommodations does not promote acceptance, normalisation and – eventually – celebration of differences (Edyburn and Howery 2014). While digital technologies can operate as a great aid in individualising instruction when targeting pupil's academic needs, too much individualising can indeed weaken the inclusive aspect (Nordahl 2012; Harper and Milman 2016; Hausstätter 2012). Similar issues have been detected in more traditional forms of differentiated instruction, and it's been found that in Norway teachers

have traditionally favoured individualised instruction at the cost of differentiated instruction that actually could contribute towards a more inclusive learning environment (Klette 2007; Olaussen 2009; Nordahl 2012). Therefore, when using digital technologies to differentiate instruction, it is crucial to be able to make the distinction between differentiated instruction that can promote inclusion and individualised instruction that takes place in isolation – and find a balance between the two (Klette 2007; Gilje 2017). Drawing from the main principles of sociocultural learning (Vygotsky 1978) and the pitfalls of individualised instruction that we know of (Nordahl 2012), it could be argued that individualised instruction should not be the main learning activity. This is in line with not only previous international findings (Harper and Milman 2016) but also with the views of the interviewees. Following Tomlinson's (2001, 2017) categories for differentiated instruction, it could be suggested that pupils work independently on some of the categories based on their individual needs, while collaborating on the others. For instance, a pupil could receive individualised contents, but work more collectively with others during the process and when creating a product.

Evaluation and feedback

Evaluation and feedback processes were less visible during the observed lessons, largely because this line of work often takes place during teachers' individual prep time; thus, these results are mainly based on interview and survey data. The interviewees found that when pupils submit their work in digital platforms or formative assessment tools, such as Showbie and Socrative, it offers teachers more opportunities for following up with their progress and providing feedback. The interviewees mentioned that they, for example, often replace written feedback with audio files, which is more accessible and feels less formal to pupils. They believed that this can have a positive influence on building a more inclusive learning environment. Additionally, teachers have access to significantly more pupil work than before, when everyone stored their work in their personal books and folders, which allows teachers to use this data to advise the planning of future lessons. Such approaches were used across the school and can be described as systemised, albeit local, processes at a whole-school level – a quality that often lacks when looking at contemporary and digital practices in schools (Mølster and Nes 2018; Hughes and Talbott 2017; Edyburn and Howery 2014; van de Oudeweetering and Voogt 2018).

When discussing differentiated instruction in particular, it is essential to keep in mind the importance of evaluation as a part of the process (Tomlinson 2001, 2017; van Geel et al. 2019). Indeed, Tomlinson (2001, 2017) finds that differentiated instruction is rooted in assessment, which advises the next steps of content and process, culminating in a product of some sort. As the teachers in this study find that digital technologies offer them more opportunities for ongoing evaluation and providing feedback, and that this in turn has a positive impact on learning environment, it highlights the comprehensive nature of differentiated instruction. As pointed out also by van Geel et al. (2019), differentiating instruction is not about simply variating contents or giving different pupils different exercises or texts, but about continuously reflecting on chosen content, processes and affects through ongoing evaluation that takes different forms. The final product – or assessment – should be a culmination of this vast process and offer a pupil a way to successfully demonstrate their learning – not to test *if* they have learned (Tomlinson 2001). Such approach is inclusive learning at its best: offering all pupils opportunities to create that 'fine product' that reflects their learning and provides them a feeling of mastery, no matter what challenges they may have encountered on the way.

Concluding remarks and limitations

The aim of this paper was to discuss teachers' perceptions of differentiated instruction and inclusion in a technology-rich primary school classroom. The informants found that digital technologies held many advantages in terms of differentiated instruction, which in turn helped create a more inclusive

learning environment. A common advantage was that digital technologies made differentiating easier for the teacher, which consequently increased variation and differentiated instruction in their classrooms. The informants also found that many pupils found the use of digital technologies fun and motivating, which tends to have a positive influence on the overall learning environment. Digital technologies were also found to promote collective pedagogical practices and gave all pupils an opportunity to use their strengths during the learning process and when demonstrating their learning. These elements were found to increase participation and reduce exclusion, which Booth and Ainscow (1998) find as the defining factors in inclusion.

At the same time, the informants identified challenges and pitfalls in utilising the potential of digital technologies when differentiating instruction to provide an inclusive learning environment. Most of the concerns revolved around losing the focus regarding *why* technology was used and *how* it was used. A common concern was that one begins to rely on digital technologies too much for a variety of reasons: because differentiating – or rather individualising – instruction with the help of digital tools is easy, because of its entertainment value, because pupils prefer it (or a teacher believes that pupils prefer it), or simply because a teacher believes that frequent use of digital technologies is what is expected of them. The interviewees found that teachers' competence has a critical role in making sure that pedagogy and didactic principles come before all else, and to make sure that a digital tool is chosen for its value for learning, which is in line with previous findings and recommendations (Navarro et al. 2016; Kelentrić, Helland, and Arstorp 2017; Colás-Bravo, Conde-Jiménez, and Reyes-de-Cózar 2019). To succeed, it is important that school leaders are supportive and that professional development, expectations and support involve the whole staff, as well as pupils, (Qvortrup and Qvortrup 2018; Schleicher 2015) – something that the teachers participating in this study found to be one of the key factors behind the positive developments they had achieved. The results of this study indicate that even highly competent teachers who plan meticulously and have the necessary know-how need to continuously work on adapting their role from a traditional teacher role towards a more constructive and facilitating direction, in order to fully realise the potential of digital technologies to increase participation, decrease exclusion and thus, work towards more inclusive learning environments.

In this study, teachers used a variety of technologies in multiple ways in their everyday practices and generally had a higher PDC level than an average teacher in Norway. These circumstances, as well as the limited sample size, obstruct the generalizability of the data and can be considered limitations to this study (Yin 2018). It is also somewhat common that self-reported data can reflect intentions and social desirability rather than describing actual practices (Bryman 2016). While the observation data in part addresses this disadvantage, a large proportion of the results of the whole study consist of self-reported data. Nevertheless, we argue that the article has provided important knowledge, descriptions, and reflections on how teachers perceive the influence of digital technologies in differentiated instruction to create an inclusive learning environment in a primary school context in particular. An intriguing dimension missing from this data is pupils' perspective, which invites further research in the respective field in the future.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by University of Stavanger.

References

Baron, Lauren S., Tiffany P. Hogan, Rachel L. Schechter, Pamela E. Hook, and Elizabeth C. Brooke. 2019. "Can Educational Technology Effectively Differentiate Instruction for Reader Profiles?" *Reading and Writing* 32 (9): 2327–2352. doi:10.1007/s11145-019-09949-4.

Bebell, Damian, and Rachel Kay. 2010. "One to One Computing: A Summary of the Quantitative Results from the Berkshire Wireless Learning Initiative." *Journal of Technology, Learning, and Assessment* 9 (2): 60.
Blikstad-Balas, Marte, and Kirsti Klette. 2020. "Still a Long Way to Go: Narrow and Transmissive Use of Technology in the Classroom." *Nordic Journal of Digital Literacy* 15 (01): 55–68. doi:10.18261/issn.1891-943x-2020-01-05.
Bolick, Cheryl Mason, and Jonathan T. Bartels. 2015. "Classroom Management and Technology." In *Handbook of Classroom Management*, edited by Edmund Emmer and Edward J. Sabornie, 479–495. New York: Routledge.
Bondie, Rhonda S., Christine Dahnke, and Akane Zusho. 2019. "How Does Changing 'One-Size-Fits-All' to Differentiated Instruction Affect Teaching?" *Review of Research in Education* 43 (1): 336–362. doi:10.3102/0091732X18821130.
Booth, Tony, and Mel Ainscow. 1998. *From Them to Us: An International Study of Inclusion in Education*. London: Routledge.
Brighton, Catherine M., Holly L. Hertberg, Tonya R. Moon, Carol A. Tomlinson, and Carolyn M. Callahan. 2005. "The Feasibility of High-End Learning in a Diverse Middle School." National Research Center on the Gifted and Talented. https://eric.ed.gov/?id=ED505377.
Bryman, Alan. 2016. *Social Research Methods*. 5th ed. Oxford: Oxford University Press.
Colás-Bravo, Pilar Colás-Bravo, Jesús Conde-Jiménez Conde-Jiménez, and Salvador Reyes-de-Cózar Reyes-de-Cózar. 2019. "The Development of the Digital Teaching Competence from a Sociocultural Approach." *Comunicar. Media Education Research Journal* 27: 2. doi:10.3916/C61-2019-02.
Creswell, John W., and Timothy C. Guetterman. 2021. *Educational Research. Planning, Conducting and Evaluating Quantitative and Qualitative Research*. 6th ed. Essex: Pearson.
Edyburn, Dave L. 2014. "What Technology Trends Could Significantly Alter the Future of Special Education?" In *Handbook of Effective Inclusive Schools. Research and Practice*, edited by James McLeskey, Nancy L. Waldron, Fred Spooner, and Bob Algozzine, 461–463. New York: Routledge.
Edyburn, Dave L., and Kathy Howery. 2014. "How Is Technology Used to Support Instruction in Inclusive Schools?" In *Handbook of Effective Inclusive Schools. Research and Practice*, edited by James McLeskey, Nancy L. Waldron, Fred Spooner, and Bob Algozzine, 167–180. New York: Routledge.
Evertson, Carolyn M., and Carol S. Weinstein. 2006. "Classroom Management as a Field of Inquiry." In *Handbook of Classroom Management*, edited by Carolyn M. Evertson and Carol S. Weinstein, 3–15. London: Routledge.
Fjørtoft, Siw O., Sylvi Thun, and Marte P. Buvik. 2019. "Monitor 2019. En Deskriptiv Kartlegging Av Digital Tilstand i Norske Skoler Og Barnehager." SINTEF. https://www.udir.no/contentassets/92b2822fa64e4759b4372d67bcc8bc61/monitor-2019-sluttrapport_sintef.pdf.
Gilje, Øystein. 2017. *Læremidler Og Arbeidsformer i Den Digitale Skolen*. Bergen: Fagbokforlaget.
Goodwin, A. Lin, Ee Ling Low, Pak Tee Ng, Alexander S. Yeung, and Li Cai. 2015. "Enhancing Playful Teachers' Perception of the Importance of ICT Use in the Classroom: The Role of Risk Taking as a Mediator." *Australian Journal of Teacher Education* 40 (4): 132–149.
Gudmundsdottir, Greta Björk, and Ove Edvard Hatlevik. 2018. "Newly Qualified Teachers' Professional Digital Competence: Implications for Teacher Education." *European Journal of Teacher Education* 41 (2): 214–231. doi:10.1080/02619768.2017.1416085.
Gudmundsdottir, Greta Björk, Marit Loftsgarden, and Geir Ottestad. 2014. "Nyutdannede Lærere. Profesjonsfaglig Digital Kompetanse Og Erfaringer Med IKT i Lærerutdanningen." Senter for IKT i Utdanningen.
Harper, Ben. 2018. "Technology and Teacher–Student Interactions: A Review of Empirical Research." *Journal of Research on Technology in Education* 50 (3): 214–225. doi:10.1080/15391523.2018.1450690.
Harper, Ben, and Natalie B. Milman. 2016. "One-to-One Technology in K–12 Classrooms: A Review of the Literature from 2004 Through 2014." *Journal of Research on Technology in Education* 48 (2): 129–142. doi:10.1080/15391523.2016.1146564.
Hattie, John. 2010. *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Reprinted. London: Routledge.
Hattie, John, and Eric M. Anderman. 2013. *International Guide to Student Achievement*. New York: Routledge.
Hausstätter, Rune S. 2012. "Grenseoppgangen Mellom Tilpasset Opplæring Og Spesialundervisning." In *Inkluderende Spesialundervisning*, edited by Rune S. Hausstätter, 21–33. Bergen: Fagbokforlaget.
Haymon, Clarissa, and Andrea Wilson. 2020. "Differentiated Reading Instruction With Technology for Advanced Middle School Students' Reading Achievement." *Journal of Educational Research and Practice* 10: 1. doi:10.5590/JERAP.2020.10.1.05.
Hesse-Biber, Sharlene, Deborah Rodriguez, and Nollaig A. Frost. 2015. "A Qualitatively Driven Approach to Multimethod and Mixed Methods Research." In *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry*, edited by Sharlene Hesse-Biber and R. Burke Johnson, 3–20. Oxford University Press.
Hughes, Marie T., and Elizabeth Talbott. 2017. *The Wiley Handbook of Diversity in Special Education*. West Sussex: John Wiley & Sons Inc.
Hur, Jung Won, and Jaekyeon Oh. 2012. "Learning, Engagement, and Technology: Middle School Students' Three-Year Experience in Pervasive Technology Environments in South Korea." *Journal of Educational Computing Research* 46 (3): 295–312. doi:10.2190/EC.46.3.e.

Jewitt, Carey, Jeff Bezemer, and Kay O'Halloran. 2016. *Introducing Multimodality*. London: Routledge. doi:10.4324/9781315638027.

Karlsen, Asgjerd Vea. 2020. *Flere Med i Klassefellesskapet. Digitale Læringsressurser Som Støtte*. Oslo: Universitetsforlaget.

Kelentrić, Marijana, Karianne Helland, and Ann-Therese Arstorp. 2017. "Professional Digital Competence Framework for Teachers in Norway." The Norwegian Centre for ICT in Education. https://www.udir.no/globalassets/filer/in-english/pfdk_framework_en_low2.pdf.

Klette, Kirsti. 2007. "Bruk Av Arbeidsplaner i Skolen – et Hovedverktøy for å Realisere Tilpasset Opplæring?" *NPT* 91 (4): 344–358. doi:10.18261/ISSN1504-2987-2007-04-08.

Kluge, Anders. 2021. *Læring Med Digital Teknologi*. Oslo: Cappelen Damm Akademisk.

Krumsvik, Rune Johan, Kjetil Egelandsdal, Nora Kolkin Sarastuen, Lise Øen Jones, and Ole Johan Eikeland. 2013. *Sammenhengen Mellom IKT-Bruk Og Læringsutbytte (SMIL) i Videregående Opplæring*. Oslo: Kommunesektorens organisasjon (KS).

Letzel, Verena, Marcela Pozas, and Christoph Schneider. 2020. "'It's All about the Attitudes!' – Introducing a Scale to Assess Teachers' Attitudes Towards the Practice of Differentiated Instruction." *International Journal of Inclusive Education* 0: 1–15. doi:10.1080/13603116.2020.1862402.

Maxwell, Joseph A. 2009. "Designing a Qualitative Study." In *The SAGE Handbook of Applied Social Research Methods*, edited by Leonard Bickman and Debra J. Rog, 214–253. Sage Publications.

Maxwell, Joseph A. 2010. "Using Numbers in Qualitative Research." *Qualitative Inquiry* 16 (6): 475–482.

Merriam, Sharan B., and Elizabeth J. Tisdell. 2015. *Qualitative Research: A Guide to Design and Implementation*. 4th ed. The Jossey-Bass Higher and Adult Education Series. San Francisco, CA: Jossey-Bass.

Ministry of Education and Research. 2017. *Framtid, Fornyelse Og Digitalisering. Digitaliseringsstrategi for Grunnopplæringen 2017–2021*. Oslo: Norwegian Ministry of Education and Research.

Ministry of Education and Research. 2019. "Core Curriculum – Values and Principles for Primary and Secondary Education." Forskrift. Government.No. April 8, 2019. https://www.regjeringen.no/en/dokumenter/verdier-og-prinsipper-for-grunnopplaringen—overordnet-del-av-lareplanverket/id2570003/.

Mølster, Terje, and Kari Nes. 2018. "To What Extent Does Information and Communication Technology Support Inclusion in Education of Students with Learning Difficulties?" *Universal Journal of Educational Research* 6 (4): 598–612. doi:10.13189/ujer.2018.060403.

Navarro, Silvia Baldiris, Panagiotis Zervas, Ramon Fabregat Gesa, and Demetrios G. Sampson. 2016. "Developing Teachers' Competences for Designing Inclusive Learning Experiences." *Journal of Educational Technology & Society* 19 (1): 17–27.

Nemiro, Jill E. 2021. "Building Collaboration Skills in 4th- to 6th-Grade Students Through Robotics." *Journal in Research in Childhood Education* 35 (3): 351–372.

Nordahl, Thomas. 2012. "Tilpasset Opplæring – et Ideologisk Mistak i Norsk Skole?" In *Ledelse Og Profesjonsutøvelse i Barnehage Og Skole*, edited by Bente Aamotsbakken, 91–107. Oslo: Universitetsforlaget.

Norwegian National Directorate of Education and Training. 2021. "Norwegian National Curriculum: Rammeverk for Grunnleggende Ferdigheter." Norwegian National Directorate of Education and Training. https://www.udir.no/laring-og-trivsel/rammeverk/rammeverk-for-grunnleggende-ferdigheter/2.1-digitale-ferdigheter/.

Norwegian National Directorate of Education and Training. 2022. "Grunnskolens Informasjonssystem. Antall Elever Med Tilgang Til Egen Digital Enhet (En-Til-En Dekning)." Norwegian National Directorate of Education and Training. https://gsi.udir.no/app/#!/view/units/collectionset/1/collection/97/unit/1/.

OECD. 2015a. "Innovation Policies for Inclusive Growth." OECD.

OECD. 2015b. "Students, Computers and Learning: Making the Connection." OECD. https://read.oecd-ilibrary.org/education/students-computers-and-learning_9789264239555-en.

Øen, Kristian, and Rune Johan Krumsvik. 2021. "Teachers' Attitudes to Inclusion Regarding Challenging Behaviour." *European Journal of Special Needs Education*, 1–15. doi:10.1080/08856257.2021.1885178.

Olaussen, Bodil Stokke. 2009. "Arbeidsplaner i skolen: En kontekst for utvikling av selvregulert læring? – Refleksjoner etter en studie på småskoletrinnet." *Norsk pedagogisk tidsskrift* 93 (3): 189–200. doi:10.18261/ISSN1504-2987-2009-03-04.

Oudeweetering, Karmijn van de, and Joke Voogt. 2018. "Teachers' Conceptualization and Enactment of Twenty-First Century Competences: Exploring Dimensions for New Curricula." *Curriculum Journal* 29 (1): 116–133.

Qvortrup, Ane, and Lars Qvortrup. 2018. "Inclusion: Dimensions of Inclusion in Education." *International Journal of Inclusive Education* 22 (7): 803–817. doi:10.1080/13603116.2017.1412506.

Ruys, Ilse, Stijn Defruyt, Isabel Rots, and Antonia Aelterman. 2013. "Differentiated Instruction in Teacher Education: A Case Study of Congruent Teaching." *Teachers and Teaching* 19 (1): 93–107. doi:10.1080/13540602.2013.744201.

Saldaña, J. 2021. *The Coding Manual for Qualitative Researchers*. 4th ed. London: Sage Publications.

Santangelo, Tanya, and Carol Ann Tomlinson. 2012. "Teacher Educators' Perceptions and Use of Differentiated Instruction Practices: An Exploratory Investigation." *Action in Teacher Education* 34 (4): 309–327. doi:10.1080/01626620.2012.717032.

Schleicher, Andreas. 2015. "Schools for 21st-Century Learners: Strong Leaders, Confident Teachers, Innovative Approaches." International Summit on the Teaching Profession. OECD. doi:10.1787/9789264231191-en.

Schofield, Janet Ward. 1995. *Computers and Classroom Culture*. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511571268.

Sjølie, Ela, Alex Strømme, and Juliette Boks-Vlemmix. 2021. "Team-Skills Training and Real-Time Facilitation as a Means for Developing Student Teachers' Learning of Collaboration." *Teaching and Teacher Education* 107 (November): 103477. doi:10.1016/j.tate.2021.103477.

Spiteri, Marthese, and Shu-Nu Chang Rundgren. 2020. "Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology." *Technology, Knowledge and Learning* 25 (1): 115–128. doi:10.1007/s10758-018-9376-x.

Stake, Robert E. 1995. *The Art of Case Study Research*. Thousand Oaks, CA: Sage.

Thomas, Gary. 2021. *How to Do Your Case Study*. 3rd ed. London: Sage Publications.

Tomlinson, Carol Ann. 2001. *How to Differentiate Instruction in Mixed-Ability Classrooms*. Upper Saddle River, NJ: Pearson Education.

Tomlinson, Carol Ann. 2014. "The Differentiated Classroom: Responding to the Needs of All Learners. Alexandria: Association for Supervision & Curriculum Development." http://ebookcentral.proquest.com/lib/uisbib/detail.action?docID=1709534.

Tomlinson, Carol Ann. 2017. *How to Differentiate Instruction in Academically Diverse Classrooms*. 3rd ed. Alexandria, VA: ASCD.

Tomlinson, Carol Ann, and Marcia B. Imbeau. 2010. *Leading and Managing a Differentiated Classroom*. Alexandria: Association for Supervision & Curriculum Development. http://ebookcentral.proquest.com/lib/uisbib/detail.action?docID=624062.

UNESCO. 1994. "The Salamanca Statement and Framework for Action on Special Needs Education." United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000098427.

UNESCO. 2017. "A Guide for Ensuring Inclusion and Equity in Education." UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000248254.

van Geel, Marieke, Trynke Keuning, Jimmy Frèrejean, Diana Dolmans, Jeroen van Merriënboer, and Adrie J. Visscher. 2019. "Capturing the Complexity of Differentiated Instruction." *School Effectiveness and School Improvement* 30 (1): 51–67. doi:10.1080/09243453.2018.1539013.

Voogt, J., O. Erstad, C. Dede, and P. Mishra. 2013. "Challenges to Learning and Schooling in the Digital Networked World of the 21st Century." *Journal of Computer Assisted Learning* 29 (October): 403–413.

Vygotsky, Lev Semyonovich. 1978. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Wells, Gordon. 1999. *Dialogic Inquiry: Towards a Sociocultural Practice and Theory of Education*. Cambridge: Cambridge University Press.

Yin, Robert K. 2018. *Case Study Research and Applications: Design and Methods*. 6. utgave. Los Angeles, CA: SAGE.

III

Johler, M. (2022). Collaboration and communication in blended learning environments. *Frontiers in Education.*

frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 06 October 2022
DOI 10.3389/feduc.2022.980445

OPEN ACCESS

EDITED BY
Mohammed A. Al-Sharafi,
University of Technology Malaysia, Malaysia

REVIEWED BY
Zaleha Abdullah,
University of Technology Malaysia, Malaysia
Dorian Gorgan,
Technical University of Cluj-Napoca, Romania

*CORRESPONDENCE
Minttu Johler
minttu.johler@inn.no

SPECIALTY SECTION
This article was submitted to Digital Education, a section of the journal Frontiers in Education

RECEIVED 28 June 2022
ACCEPTED 24 August 2022
PUBLISHED 06 October 2022

CITATION
Johler M (2022) Collaboration and communication in blended learning environments. *Front. Educ.* 7:980445. doi: 10.3389/feduc.2022.980445

Collaboration and communication in blended learning environments

Minttu Johler[1,2]*

[1]Department of Education and Sports Science, Faculty of Arts and Education, University of Stavanger, Stavanger, Norway, [2]Centre for Studies of Educational Practice, Faculty of Education, Inland Norway University of Applied Sciences, Hamar, Norway

Blended learning environments have become increasingly common during the past few years, and frequent access to digital technologies has influenced many areas of learning and classroom interaction. This paper investigates teacher-pupil and pupil-pupil communication and collaboration practices in a leading-edge Norwegian primary school. In this small-scale case study, seven teachers were interviewed individually and in their respective grade level teams, and two grade levels were observed for a 4-week period to find out how teachers in technology-rich classrooms utilize and consider the role of digital technologies in everyday communication and collaborative processes. Teachers' overall perception in this study was that digital technologies are useful in communication and collaboration and thus, digital elements were frequently incorporated in their everyday classroom practices. However, the results also imply that while blended learning environments have opened new avenues for collaboration and communication happening parallel in physical and digital learning arenas, there is a lot of variation in how teachers guide their pupils in collaboration and communication and how digital technologies are utilized in such contexts. Particularly the comparison between proactive and reactive approaches to instruction regarding communication and collaboration indicates that explicit guidance in such processes can have a positive influence on the pupils' group dynamics and effectiveness. Meanwhile, some of the benefits of supporting the act of collaboration and communication among pupils in a blended learning environment remained unexploited.

KEYWORDS

communication, collaboration, blended learning, digital technologies, CSCL, education

Introduction

The COVID-19 pandemic sparked a growing interest in research investigating online communication and collaboration. However, as technology has become increasingly accessible in the majority of Norwegian classrooms, shifting between physical and digital learning spaces, as well as working parallel in both, has become

rather common. This kind of approach is often referred to as blended learning or blended teaching (Nemiro, 2021; Yang et al., 2022). The purpose of this article is to investigate teachers' perceptions and practices in relation to computer-supported collaborative learning (CSCL) and communication in technology-rich classroom settings, in which pupils and teachers share the physical learning arena and use digital technologies as a natural part of their daily teaching and learning processes. A perspective common to CSCL and communication research is investigating the advantages and challenges information and communication technologies (ICT) bring to ordinary schools, where the digital dimensions are rarely systematically prioritized and worked on (Sung et al., 2016; Blau et al., 2020; Midtlund et al., 2021; Nemiro, 2021). The sample for this study consists of teachers working in a leading-edge (Schofield, 1995) primary school, where staff training and access to a variety of educational technologies have been prioritized significantly over the past years. Therefore, these teachers have the competence and resources to utilize technology in innovative and creative ways to support the aims of the newly reformed national curriculum. Due to these circumstances, their perceptions can be considered highly valuable when reflecting on previous studies and specifically the challenges raised in them. This article discusses how these primary school teachers facilitate communication and collaborative learning in blended learning environments with the help of digital technologies.

Literature review

When examining and discussing communication and collaboration in technology-rich classrooms, several concepts of relevance intertwine. Communication and collaboration are some of the so-called *21st century competencies*. The influence of digital technologies in communication has been significant in our society in general, and schools are no exception. This has presented new ways for *collaboration* as well, as digital competence and access to a variety of digital technologies can enhance and transform interaction between teachers and pupils in many ways. CSCL allows pupils to operate in physical and digital learning spaces simultaneously, which brings us to the concept of *blended learning*–an approach that integrates many elements of digital technologies with more traditional face-to-face learning.

Communication and collaboration in the 21st century

Communication as a concept has gained various definitions over time. At its simplest, communication can mean the *process of interaction* (Farrell, 2009, p. 5). Some common principles of communication are useful when framing the concept in a classroom context in particular (Farrell, 2009): communication is context-dependent, involves mutual influence (awareness, acting, and reacting), consists of verbal and non-verbal messages, and is in a constant change. During the recent decade, one of the most significant changes has been the increase of digital technologies in classrooms and rapid changes in digital advancements (Ferrari, 2013). When referring to 21st century competences, communication and collaboration are almost without exception mentioned as central skills, together with ICT-related competences, regardless of the study or framework (Voogt and Roblin, 2012; Mishra and Mehta, 2017; Redecker, 2017; van Laar et al., 2017; van de Oudeweetering and Voogt, 2018). Previous research and policy documents consider new approaches and opportunities to communication and collaboration as some of the definite advantages of educational technologies (Voogt and Roblin, 2012; Jewitt et al., 2016; van de Oudeweetering and Voogt, 2018). Such findings have also been echoed in other policy documents and research, such as the Norwegian national curriculum (Norwegian National Directorate of Education and Training, 2021), and Professional Digital Framework for Teachers (Kelentrić et al., 2017; Blau et al., 2020; Nemiro, 2021). While some of the relevant educational research from recent years investigates and highlights the potential of online communication and collaboration in particular, the opportunities are certainly not limited to interacting from distance. In many contemporary classrooms, teachers and pupils shift frequently and effortlessly between digital and physical learning arenas and communicate parallel in both. Employing digital technologies in everyday learning has been found to spark playful learning, increase motivation and engagement, and enhance pupil interest (Bebell and Kay, 2010; Hur and Oh, 2012; Harper and Milman, 2016; Gouseti et al., 2020), and therefore offers many exciting opportunities for improved communication and collaboration practices.

However, utilizing digital technologies in pupil interaction in a way that contributes toward developing communication and collaboration skills can be challenging. In fact, the speedy development of digital technologies and new demands for teachers facilitating learning with the help of digital technologies requires constant professional development and other commitments from teachers' professional community (Blikstad-Balas and Klette, 2020; Johler et al., 2022). Many teachers lack the competence and resources in terms of educational technologies and thus, the potential of digital technologies often remains untapped (Krumsvik et al., 2016; Blikstad-Balas and Klette, 2020). It is still common that the development of more innovative and smooth communication and collaboration practices is dependent on a few enthusiastic staff members (Gouseti et al., 2020), so-called front runners (Rogers, 1995), meaning that potential best practices often remain local and short-term. Teachers can also struggle to see

the opportunities and advantages of using digital technologies for collaboration and communication when all pupils and teachers are gathered in the same physical space (Midtlund et al., 2021). Such issues lead to significant variations in how digital technologies are utilized in classrooms, differing from school to school and even from teacher to teacher (Krumsvik et al., 2016; Fjørtoft et al., 2019; Moltudal et al., 2019). Developing pupils' communication and collaboration skills in a rapidly digitalised and developing world is not only necessary but a prerequisite for becoming a citizen who participates and contributes to a society. Therefore, it seems important to learn more about the influence and potential of digital technologies in pupil-pupil and teacher-pupil interaction. Nevertheless, it is common that rather than explicitly teaching efficient collaboration and communication strategies with the help of digital technologies, teachers instead just "let" collaboration happen. The focus tends to be on the digital products, rather than the process of communication and collaboration itself (Midtlund et al., 2021).

Collaborative learning

Collective aspects of learning have a central role in socio-cultural learning theories (Vygotsky, 1978) and collaborative working methods in education have gained significant footing in 21st century curricula. Collaboration can be understood simply as active engagement and interaction within a group of people, with the aim of achieving a common goal (Nokes-Malach et al., 2015) but the wide spectrum of definitions, interpretations, and implications of collaborative learning in 21st century curricula has led to few systematically integrated and assessed collaborative practices (van de Oudeweetering and Voogt, 2018). In their synthesis investigating the advantages and disadvantages of collaborative learning, Nokes-Malach et al. (2015) found reports of many cognitive advantages in collaborative learning. For example, increasing working memory resources (Kirschner et al., 2009), incorporation of complementary knowledge and error-correction (Johansson et al., 2005), and supporting relearning through re-exposure and retrieval (Roediger and Karpicke, 2006; Rajaram and Pereira-Pasarin, 2010) have all been found beneficial to learning. From a social learning perspective, observational learning (Craig et al., 2009), negotiating multiple perspectives (Kuhn and Crowell, 2011), construction of common ground (Nokes-Malach et al., 2012), and increased engagement (Johnson and Johnson, 1985) have been considered some of the benefits of a collective learning approach. However, group work and other collaborative working methods are not a default recipe for success, as research also finds that the method has its disadvantages. Fear of being negatively evaluated by peers can hinder one from voicing and developing their ideas (Mullen, 1987) and "freeloaders" expecting the rest of the group to do the work are not uncommon phenomena in collaboration (Karau and Williams, 1994; Le et al., 2018). Different ways of organizing and retrieving knowledge can disturb cognitive processes (Kirschner et al., 2009; Nokes-Malach et al., 2012) and having to wait for one's turn to speak, negotiate next steps, and give or receive help have generally been found challenging without explicit instruction and guidance regarding collaboration (Diehl and Stroebe, 1988; Le et al., 2018).

While a variety of approaches for effective development of collaborative skills can be identified, previous research shares the view that collaborative skills do not spontaneously develop merely by working in teams, but that they must be consistently and explicitly cultivated (Roschelle and Teasley, 1995). Tammi and Rajala (2018) suggest incorporating deliberative communication as a part of classroom communication and collaboration routines. In their research, they found that having explicit focus on discourse that allows participants to think, listen, discuss, and criticize different viewpoints and arguments in a respectful and constructive manner led to more participation and learning of negotiation skills, while exploring the social, collective, and cognitive aspects of classroom interaction. Previous findings also indicate that such an approach works already in early primary school age, when collaboration is mediated through structured discourse (Chen et al., 2015). Sjølie et al. (2021) highlight the importance of task design with an explicit focus on skills relating to collaboration and reflection as learning goals. This requires a safe learning environment where a teacher can facilitate different aspects of interaction. As collaboration skills consist of many different dimensions, such as cognitive, social, communicative, and motivational (Meier and Spada, 2008; Diziol and Rummel, 2010), Deiglmayr and Spada (2010) suggest deciding in advance which element(s) to focus on, instead of solely having collaboration in general as a learning goal. Nemiro (2021) found that assigning different roles to pupils and discussing collaborative behaviors and conflict resolution approaches explicitly can be effective strategies in focusing on developing pupils' collaboration skills.

Computer-supported collaborative learning

When digital technologies are used in collaborative learning processes, the term CSCL is often applied. Such learning situations are characterized by not having to choose between face-to-face approach or online encounters but being able to take advantage of both approaches simultaneously (Yang et al., 2022). For instance, in a collaborative project, face-to-face discussions may be supplemented with interactive whiteboards, wikis, and other types of digital communication

tools that support and expand face-to-face communication and collaboration practices (Vaughan et al., 2013). Additionally, Roschelle (2021) suggests that employing digital technologies to automate and assist in some of the routine aspects of the work helps raise awareness of the key concepts and other valuable aspects during the process of collaboration. A common characteristic of a CSCL approach is the notion that the *whole* collective process of meaning-making and problem solving is of critical interest, rather than only the final learning outcomes (Roschelle and Teasley, 1995; Koschmann, 2001; Stahl et al., 2014). Using digital technologies, for example robotics, in collective meaning-making processes has been found useful in rehearsing competences needed for effective collaboration (Del-Moral-Pérez et al., 2019; Sung et al., 2022). However, much of the research about CSCL still tends to rely on conventional learning outcomes, rather than constructing an understanding about negotiation, collaborative knowledge building, and dialog (Stahl, 2015). Previous studies report that pupils are often unable to regulate their collective learning processes when left on their own with digital devices, and that productive social interaction for a common goal requires a thorough and careful design and application of CSCL (Koschmann, 2001; Järvelä and Hadwin, 2013).

Blended learning

Blended learning and blended teaching refer to an approach that takes advantage of opportunities to utilize digital and traditional learning materials, methods and environments simultaneously (Deschacht and Goeman, 2015). Further framings vary, but in their synthesis of different definitions of blended teaching and learning, Yang et al. (2022) define the following four dimensions as central elements of blended learning:

(1) Combines online and traditional learning
(2) Mixture of learning modes–teacher-led and pupil-led–that occasionally also merge
(3) Learning environment: not only digital or physical but a combination
(4) Combines several teaching methods to develop a variety of pupil skills

Furthermore, blended learning environments are often characterized by flexibility and personalization of the learning experience, highlighting pupils' own initiative and opportunities to influence their learning path (Pulham and Graham, 2018). Blended learning also tends to embrace the principles of mastery-based learning, allowing pupils to pace their learning to fit their own tempo. Grouping pupils for projects, discussions, or short-term activities is another common setting for using blended learning, while opportunities for collaborative learning approaches are rare in typical online learning (Pulham and Graham, 2018; Graham et al., 2019).

Norwegian context

Norwegian schools and curricula are no exception to promoting education in terms of collaborative working methods. The Norwegian national curriculum expects teachers to employ collaborative working methods in their classrooms at all levels of schooling. This highlights how such an approach can foster and promote creativity and versatility for pupils of all ages, as well as teach them to listen to others and voice their own insights in a constructive way (Ministry of Education and Research, 2019). Digital technologies offer significant contributions toward communication and collaborative learning practices, and teachers are expected to incorporate opportunities for interaction in digital arenas in their teaching (Kelentrić et al., 2017). This requires extensive digital competence from teachers, who must keep themselves up to date with the advances of digital technologies and the new opportunities they offer for the teachers and their pupils (Johler et al., 2022). It is worth noting that employing digital elements for communication and collaboration does not necessarily mean that the interaction happens solely in a digital space. Indeed, digitally competent teachers can incorporate collaborative learning methods and digital elements in learning activities that take place in the same physical space (Vaughan et al., 2013; Pulham and Graham, 2018; Yang et al., 2022). This article delves into the potential and challenges presented in such contexts, as well as other aspects that invite blended learning approaches for collaborative learning and communication in technology-rich classrooms.

Method and analysis

Design and sample

The aim of this study was to investigate collaboration and communication practices in blended learning environments. As the focus lies on exploring the potential, possibilities, and inherent pitfalls of digital technologies in classroom interaction, rather than describing the current state of affairs in an average school, the main principles of *purposeful sampling* (Bryman, 2016) were applied when selecting informants for this case study. Teachers in one Norwegian primary school were chosen to be studied in this research project. The school they were employed at can be defined as a leading-edge school (Schofield, 1995) due to its significant investments in training teachers in professional digital competence and educational technologies

since it was founded several years ago. For instance, each classroom is equipped with a projector and a personal device for all pupils and teachers. The school also has a wide array of other types of digital technologies available, such as a podcast studio, green screen technology, and a variety of robotic technologies and miniature computers. It was also of interest to find a primary school to study, as digitalization is a newer phenomenon in primary schools. This is also why much of previous research within the theme focuses on secondary and tertiary education. At the time when this study was carried out, all informants worked at this leading-edge school. Seven teachers participated in interviews and observation, and 20 teachers submitted their survey answers. The data presented in this article is drawn from a larger case study, investigating the influence of digital technologies in teacher's role and pedagogical practices in general. The study is defined as an intrinsic case study (Stake, 1995), due to the substantial interest in this specific case and what can be learned from these particular teachers.

Instruments

To find out how teachers perceive the influence of digital technologies in terms of collaboration and communication in blended learning environments, seven teachers in a Norwegian leading-edge school were interviewed individually, thereafter observed over a 4-week period, and finally interviewed in focus groups in their respective grade level teams (grade 1 teachers together and grade 5 teachers together), before executing a whole-school survey. The survey was implemented after a tentative analysis of interview and observation data, in order to validate findings deduced from qualitative data, as well as to gain additional and more collective data from teachers of all grade levels (Merriam and Tisdell, 2015; Bryman, 2016).

Individual interviews

To start off the project, seven teachers working in grades 1 and 5 were interviewed individually. The length of the interviews ranged from 35 to 45 min. A semi-structured interview design (Merriam and Tisdell, 2015; Bryman, 2016) was chosen, as it enabled a flexible and abductive dialog between the interviewer and the interviewees (Appendix 1). This allowed the interviewees to answer the questions, as well as share their views of other related topics regarding technology-rich classrooms, in order to assist in constructing a holistic, in-depth understanding of their perceptions. With the help of results from the individual interviews, it was possible to learn about the competence of the teachers being observed, as well as get acquainted with their beliefs, approaches and practices regarding communication and collaboration in their technology-rich classrooms.

Observation

The main source of data for this article is the data collected during the observed lessons, mainly in grades 1 and 5. During a period with a duration of 4 weeks, 56 lessons were observed, each lesson lasting 63 min on average. The type of observation practice applied in this study was predominantly non-participant (Creswell and Guetterman, 2021) but over the weeks, as the observer, pupils, and teachers grew more acquainted, the pupils began to try to involve the observer in their activities. While engaging in a more intense dialog with a small group of pupils could offer a more in-depth understanding of a series of approaches and processes, the trade-off was that the observer's attention was focused on a small group of pupils, and thus, the rest of the events in the classroom could not be recorded. A combination of both practices could, however, offer an overview and comprehensive information about certain approaches and processes (Bryman, 2016) and was therefore applied especially when observing repeated lessons (same lesson plan taught to two or three different groups of pupils). A common but somewhat challenging aspect of observation as a data collection strategy is that recording what is happening in a classroom often requires simultaneous interpretation at some level (Stake, 1995; Bryman, 2016). To address this challenge, a semi-structured observation guide (Appendix 2) was developed using national policy documents [e.g., Norwegian national curriculum and PDC Framework by Kelentrić et al. (2017)] and recent results from relevant research and 21st century competence frameworks (e.g., Voogt and Roblin, 2012; van Laar et al., 2017; van de Oudeweetering and Voogt, 2018) to frame the contents of the lessons in different categories. Using the categories to record observations and note questions and tentative interpretations made the otherwise seemingly unstructured observation situation more organized and orderly and was later also applied in the analysis of the data. Furthermore, in intrinsic case studies that engage with new a phenomenon, it is often advantageous to develop tentative interpretations of the data early on, to get a more comprehensive understanding of what is happening and to be able to adapt the data collection process, should the need arise (Stake, 1995). This principle was applied when having completed the individual interviews and observation period and preparing for the focus group interviews with each grade level team.

Focus group interviews

In this study, focus group interviews offered an opportunity to discuss the individual interview results, observations, and questions that arose during the observations. The questions in the focus group interview guides (Appendix 3) were based on recorded observations during lessons and brief

discussions with the participating teachers during and between lessons. This step of the cumulative data collection process was considered necessary in order to confirm or abandon tentative interpretations to avoid misconceptions and thus, increase the validity and reliability of the results. Focus group interviews also offered a more collective view on the topics at hand (Bryman, 2016; Creswell and Guetterman, 2021).

Survey

The final step of the data collection process, the survey (Appendix 4), was administered after a tentative analysis of interview and observation data. Its function was two-fold: first, to collect more representative data to confirm or refute the interpretations and conclusions from the other data (Maxwell, 2010) and second, to find new perspectives and dimensions in the existing data (Hesse-Biber et al., 2015). The survey was sent to all teachers working in the school in question, and all teachers who were in-service at the time of the survey submitted their answers. The survey consisted of 56 questions regarding the teachers' beliefs, experiences, and practices, of which 14 were open-ended and 42 multiple-choice questions.

Analysis

All data was coded following the main principles of a thematic analysis (Bryman, 2016; Creswell and Guetterman, 2021). Coding was divided in three cycles (Saldaña, 2021): first to separate relevant data from other data collected in this case study; second, to code the data according to pre-established categories based on relevant research, frameworks, and policy documents mentioned above; and third, to establish new categories that emerged from the data itself. The cycles are presented in **Table 1**.

Interview and survey data were collected in a digital format and then organized and analyzed using mainly NVivo. The observation sheets were filled in manually and contained a lot of data, among others questions, ponderings, tentative interpretations and details, which is a common aspect of unstructured observation (Creswell and Guetterman, 2021). These observation sheets were coded manually and supplemented with research notes and reflections during the analysis. Tentative analysis of the data began early in the data collection process, allowing for a cumulative process during which previously collected data guided the following steps of data collection. This abductive process built on the abovementioned policy documents, frameworks and research. Once all data had been gathered and analyzed, an overview of the results was organized in a table format (**Table 2**).

Results and discussion

Overview of the results

Overall, the teachers' perceptions of the influence of digital technologies in terms of collaboration and communication were generally positive. They found that digital technologies had increased teacher-pupil communication and collaborative learning among pupils. The results indicate that digital technologies support communication and collaboration in these blended learning environments mainly in three ways: digital technologies were used as a direct tool for communication, digital technologies were used as a mediator in collaborative activities and learning processes, and digital technologies were used to collectively create digital products.

Communication in a blended learning environment

In the survey, 80% of the teachers reported having routines where digital technologies contribute toward communication and collaboration to a great or a very great extent. 15% had implemented such routines to some extent, and 5% to a very small extent. In terms of teacher-pupil communication, the most common way of employing digital technologies in communication was teachers communicating instruction and feedback to pupils. Showbie was used for this purpose in 17/56 observed lessons, and iThoughts in 38/56 lessons. Most often these platforms supported teachers' oral instruction, but in grade 5 they were occasionally used as the sole source of instruction when returning to a previously introduced topic. Teachers found these platforms particularly useful because of their accessibility and many opportunities for communicating with their pupils in writing, recorded audio files, and multimodal representations. They noted that this led to more versatile communication between teachers and pupils. In fact, all teachers in this school took advantage of multimodal features in classroom communication: 70 % of them to a great or very great extent, and 30% to some extent. Using multimodal elements in classroom communication can have many advantages, as it offers multiple avenues for the same message, allowing pupils to better understand instruction and also express themselves in various ways (Jewitt et al., 2016). Teachers could also use applications to send push-messages to pupils' screens while not sharing a physical space, for example, when pupils were allowed to work in the hallway or library. Finally, teachers found that digital technologies allowed them to model a variety of practices to their pupils more frequently and ergonomically than what would have been possible without access to projectors and screens.

Teachers reported that digital technologies were rarely used for communication among pupils during instruction time: only

TABLE 1 Cycles of coding.

Cycle one coding: Separating article data from all data	Cycle two coding: Pre-established categories	Cycle three: Categories emerging from the data	Cycle three examples
Communication and collaboration	Teacher-pupil communication	Communicating instruction	iThoughts (lesson overviews); Showbie (file-sharing, archive, submission); Instant messages (push-messages)
		Multimodality and modeling	Communication in multiple formats (written, oral, audio, interactive); Sharing (e.g., pupil work to provide examples)
		Digital communication aids	Classroom; Zulu Desktop; AirDrop
	Pupil-pupil communication and collaboration	Sharing (within a small group or to whole class)	AirPlay (whole class); AirDrop (pupil-pupil); Book Creator (small group)
		Multimodality	Book Creator; iMovie; Explain Everything
	Learning about communication and collaboration	Problem-solving	Using robotics to investigate adjacent angles; Building mini-computers to compose music; Trouble-shooting in various contexts
		Reactive approach to learning about collaboration	No explicit instruction in collaboration; Teacher as a conflict/problem solver; Variation in group dynamics and effectiveness
		Proactive approach to learning about collaboration	Explicit instruction prior to group work; Modeling collaboration strategies; Generally well-functioning groups

5% used it for this purpose to a great or very great extent. 55% of the teachers employed digital technologies for pupil-pupil communication to a small or very small extent. Understandably, when sharing the physical learning space, simply talking to each other can often be the easiest and most powerful means of communication. However, as pointed out by Deschacht and Goeman (2015) and Yang et al. (2022), the basic principles of blended learning in technology-rich classrooms give us the freedom to combine digital and non-digital means of communication. While having a verbal dialog in person can certainly be considered a sensible choice of communication in a classroom, interactive platforms and tools can support this communication (Stahl, 2015; Roschelle, 2021). Furthermore, digital technologies can bring new dimensions to the traditional dialog and help pupils organize and negotiate their views more efficiently (Vaughan et al., 2013; Yang et al., 2022). The scarcity of examples in this study, which took place in a leading-edge school, implies that understanding how digital technologies have influenced and can further influence communication is something that may require more awareness and discussion. Blended learning environments and CSCL certainly do not exclude face-to-face communication but rather highlight the potential advantages of digital technologies in elevating such dialog and discourse.

Collective learning activities with computer-supported collaborative learning

While digital technologies were rarely used for direct communication among pupils in the observed classrooms, using technology in collaborative assignments was far more common. In such cases, the role of digital technologies was often being the main learning activity, during which pupils worked together in collective meaning-making and solving a mutual problem (Stahl, 2015). In grade 1, for instance, a collaborative project about algorithmic thinking and programming was carried out to teach the pupils some basic skills about coding, but simultaneously, collaboration was an obvious learning goal. After being introduced to the basic principles of coding unplugged, the pupils used robotics to practice what they had learned. Prior to the activity, the teacher modeled good collaborative practices with some of the pupils, in order to demonstrate turn-taking and negotiation strategies. Bluebots were employed in collective learning activities to rehearse problem-solving, storytelling and spelling in various ways, and pupils also got to experiment with them rather freely in pairs or small groups before setting to a task. Building communication and collaboration skills through digital technologies in general, and robotics in particular, has been found beneficial in developing different roles in teams, rehearsing effective communication and conflict-resolution strategies, sharing between students, and relationships between pupils and teachers (Del-Moral-Pérez et al., 2019; Nemiro, 2021; Sung et al., 2022). The grade 1 teachers in this study seemed to employ digital technologies rather successfully, in order to teach and reinforce the abovementioned competences by having an explicit focus on specific areas of communication and collaboration throughout the collective processes, much like in the recommendations of for example Deiglmayr and Spada (2010) and Järvelä and Hadwin (2013).

In examples from grade 5, pupils for instance explored the relationship between adjacent angles by coding and

TABLE 2 Overview of findings in all data.

Methods	Collaboration	Communication
Individual interviews	Access to digital technologies has increased collaboration	Digital technologies have increased teacher-pupil communication (e.g., audio feedback on Showbie and multiple representations of instruction) Modeling of procedures has become easier with digital technologies Digital technologies have added variation in communication (written, audio, animated, multimodal)
Observation	Much variation in explicit instruction about collaboration: grade 1 teachers teach collaboration (proactive), grade 5 do not (reactive); grade 1 pupils work more harmoniously together, grade 5 pupils with great variation Collaboration on iPads but also often with other digital devices (e.g., robotics and programming) More collaboration in grade 5 than in grade 1, but less instruction and guidance in collaboration in grade 5	Digital technologies support teacher's oral communication (multimodality, e.g., use of iThoughts to present and organize the goals, contents, resources and activities for the lesson; modeling) Little digital communication between pupils (mainly just sharing files, digital products, and other content) Teachers utilized digital communication opportunities when not in a same physical space (e.g., ZuluDesk and Apple Classroom)
Focus group interviews	Grade 5: Teachers believe that pupils know why collaborate without explicit explanation (e.g., why and how use learning buddies) Grade 5: taught separately in a social competence lesson but not in a natural context Grade 5: One digital assessment of the process of collaboration Grade 1: collaboration supports constructivist learning Grade1: teach reflection about own role in a group assignment Grade 1: teamwork difficult for many pupils = work a lot on teamwork skills in a curricular context	Digital platforms (e.g., iThoughts and Showbie) for improving communication between teacher and pupil (mostly for instruction, some for feedback) Digital platform (SchoolLink) for communication with homes
Survey	Q24: I have routines in my classroom where digital technologies contribute toward communication and collaboration To a very great extent 20% To a great extent 60% To some extent 15% To a small extent - To a very small extent 5%	Q39: To what extent do you use digital technologies in communication between teacher and students? To a very great extent 15% To a great extent 45% To some extent 35% To a small extent 5% To a very small extent - Q40: To what extent do you use digital technologies in communication between students? To a very great extent - To a great extent 5% To some extent 40% To a small extent 35% To a very small extent 20% Q46: I use multimodal elements that combine text, audio and/or visual elements in teaching To a very great extent 40% To a great extent 30% To some extent 30% To a small extent - To a very small extent -

experimenting with robots (Sphero Balls), and composed music using miniature computers (micro:bit). In the Sphero lesson, pupils worked either in pairs or teams of three, and coded Shero balls to explore and experiment in mapping out properties of adjacent angles. When making music in groups with micro:bit, pupils initially used sensors and other components of micro:bit to first assemble miniature computers, and then experimented with coding in order to compose their own melodies, as well as some simple versions of popular musical pieces. In their Norwegian classes, traditional book reports were replaced with podcasts during the observed unit. The podcasts were prepared, recorded, and evaluated in groups of 3–4 pupils, and as this was the first time the students were working at the podcast studio, teachers assisted them rather much with the practical aspects of it.

During all these projects it was evident that the teachers' choice to use of a variety of educational technologies in an exploratory way sparked motivation, engagement and pupil-initiative, which is in line with previous research findings (Bebell and Kay, 2010; Hur and Oh, 2012; Del-Moral-Pérez et al., 2019). While the pupils were not explicitly guided in negotiation and other forms of communication in grade 5, such an approach highlighted the role of digital technologies as a mediator (Roschelle and Teasley, 1995). Pupils worked toward

solutions through experimentation by trying out a variety of ideas and adapting their interpretations as they proceeded. From a learning perspective, reflection and meta-discussions about the process can be considered crucial (Deiglmayr and Spada, 2010; Mishra and Mehta, 2017; Sjølie et al., 2021), and while some discussions were definitely happening during the negotiations, teachers prompted few initiatives to boost these elements. During these lessons, teachers set the framings, helped with practical aspects, and interfered when needed, but the learning activities were mainly pupil-led. This allowed the pupils to choose and combine a variety of skills, which Pulham and Graham (2018) and Yang et al. (2022) find as some of the defining factors in blended learning. However, while digital technologies mediated collaboration, pupils' collective processes were rather unstructured and varied greatly from group to group. One can ask if more proactive teacher involvement, and guidance in the act of collaboration in grade 5 could have increased the impact and thus, lead to more effective collaboration processes.

Computer-supported collaborative learning in creating digital products

While innovative, exploratory, and fabrication-focused aspects of educational technologies are often highlighted, an important part of creating something new is the ability to have some mastery of foundational knowledge first (Mishra and Mehta, 2017). During the observation period, also more traditional collaborative projects–among more contemporary approaches–were carried out particularly in grade 5, with a less explorative approach and more conventional reproduction of knowledge involved. In such projects, the pupils were often given a topic and access to the Internet in general or specified digital resources, to find relevant information about their topic. At the end, they created a digital product, such as a digital poster or video clip, in groups of 2–4 pupils, in order to demonstrate their learning. In some assignments, the teachers introduced a variety of presentation opportunities, for example green screen technology, to stimulate curiosity and motivation, as well as to demonstrate learning and presenting in alternative ways that take advantage of multimodality. In general, the teachers were very supportive of multimodal elements in pupils' work, which has been suggested to guide meaning-making through communicating in a variety of ways (Jewitt et al., 2016). However, many of the pupil demonstrations of multimodality in joint efforts were rather monotonous and repetitive, despite the frequent use of multimodality and collaborative digital platforms by both pupils and teachers. For example, Book Creator was used on several occasions for creating digital products collectively, but nevertheless, the pupils had a tendency to use a recurring formula of putting together text, an audio sample, and matching images. Little experimenting and creativity was observed regarding how a group of pupils could utilize the platform to make a different type of a multimodal product or how the platform could contribute to the act of collaboration itself.

When creating a digital representation of their learning, pupils can benefit from effective communication strategies, in order to produce informative–and perhaps even creative–products in a given time frame. However, the teachers rarely spent instruction time on proposing strategies for improving communication amongst the pupils before setting to a task or while working on the digital products, as suggested for example by Tammi and Rajala (2018), Nemiro (2021), and Sjølie et al. (2021). From a technology-specific perspective, the pupils had some difficulties deciding whose device to use for certain steps of the project, as well as in taking advantage of the potential opportunities digital technologies enable in blended learning situations, such as using digital technologies assisting in communication and utilizing the opportunities they offer specifically in collaboration (Deschacht and Goeman, 2015; Roschelle, 2021; Yang et al., 2022). In the light of previous research findings, this is not surprising, as leaving pupils alone on their devices in has been found somewhat counterproductive (Koschmann, 2001; Järvelä and Hadwin, 2013). One can speculate that more focus on for example negotiation and conflict-resolution strategies (Nokes-Malach et al., 2012; Tammi and Rajala, 2018) could have enriched the final product, as well as allowed pupils to communicate and develop their ideas, questions and criticism to other pupils and teachers in a more constructive and effective manner. However, the approach often chosen in grade 5 allowed the pupils to use a variety of skills that allowed them to highlight their strengths and have a lot of influence in the final product, which Pulham and Graham (2018) and Yang et al. (2022) consider as some of the main characteristics of blended learning. At the same time, Roschelle and Teasley (1995), Koschmann (2001), and Stahl et al. (2014) find that often too much emphasis in CSCL-related learning activities is placed on the product and too little on the process of collaboration itself. One could perhaps conclude that while on the way, the full potential of digital technologies was not exploited in this context.

How to learn to collaborate

In the teacher interviews and survey, teachers found that digital technologies did not only increase the amount of collaboration but also streamlined the process through the ease of sharing and finding different ways to work and present results. However, the approach to collaboration varied greatly between the two observed grade levels, and occasionally also among teachers working at the same grade level. While

grade 1 teachers generally taught explicitly and repeatedly how to work collaboratively in context with other curricular activities, in line with the recommendations of for example Roschelle and Teasley (1995), Tammi and Rajala (2018), and Sjølie et al. (2021), grade 5 teachers had a more implicit approach to teaching collaboration. In grade 1, before the pupils were divided into pairs or groups, teachers discussed roles, negotiation strategies, and problem-solving approaches with them. Teachers were conscientious about the role technology played in the collective learning activity and occasionally exemplified how collaboration might look in the task at hand. Following in the footsteps of Roschelle and Teasley (1995), grade 1 teachers had explicit focus on *how* to achieve new understandings in technology-rich learning environments, instead of solely focusing on *what* was learned, and the approach to teaching competencies crucial for collaboration was overall proactive.

> *"We really work a lot on collaboration. Collaboration is very difficult for many.— It would never work out to just send first grade pupils off to work together."*
>
> *(Teacher A, grade 1, focus group interview)*

In grade 5, the teachers' approach was generally more reactive: once pupils were presented with a task, they were commonly sent to work in their respective groups without discussing the act of collaboration explicitly. When asked about this approach during the focus group interviews, grade 5 teachers stated that the choice to assign collaborative learning activities is always pedagogically grounded and that the pupils are aware of the assessment criteria, which also includes expectations for group work. However, instead of explicitly teaching collaboration skills–such as negotiation strategies, roles or how to resolve conflicts (Nokes-Malach et al., 2012; Stahl et al., 2014)–grade 5 teachers mentioned specific learning activities with the aim of improving collaboration skills. These activities had been introduced during a separate social competence class and were not taught in the context of other curricular topics, nor did they feature digital technologies *per se*. The teachers described for example a problem-solving assignment that involved building with Legos and a brainstorming assignment regarding types of cars, which pupils worked on in small groups. Different approaches to these tasks were discussed after the performances, which can be a valuable source for learning when deliberated (Tammi and Rajala, 2018). However, while teachers talked about the aims and learning activities related to developing collaboration skills, they could not exemplify how pupils were guided in these tasks to improve their collaboration in general and CSCL in particular. The teachers assumed that by 5th grade, the pupils would already be familiar with the basic principles of collaboration and thus, implicit learning would be an appropriate approach. Therefore, they did not prioritize communication and collaboration skills during instruction time.

> *"Last year, in programming, when we began... we talked about why you work in pairs, they learned that. And they needed to know that only one of them should not have the iPad and do all the work.— So we talked about it, if they get it. I think that even though they did not explicitly discuss it [recently] they already know why they're always in teams of two or three when they program."*
>
> *(Teacher M, grade 5, focus group interview)*

One could perhaps compare communication and collaboration skills to learning how to read and write: the job is not done once the child decodes texts and puts letters together into words, and words together into sentences. The skills need to be refined, adapted, and developed further in a variety of contexts throughout the years to come. Learning how to improve and foster communication and collaboration skills requires lifelong training and development, particularly in a world where rapidly developing digital technologies continuously require adaptation (Ferrari, 2013). In CSCL, it is important to focus on the design and structure of the learning activities, to ensure that the pupils benefit from the chosen collective learning approach in terms of all learning goals (Roschelle and Teasley, 1995; Järvelä and Hadwin, 2013).

The two opposite models of teaching collaboration from the same school give us an interesting source of comparison between reactive and proactive strategies, or explicit and implicit learning approaches. One can consider to what extent the advantages of collective learning (Roediger and Karpicke, 2006; Kirschner et al., 2009; Rajaram and Pereira-Pasarin, 2010; Kuhn and Crowell, 2011; Nokes-Malach et al., 2012; Le et al., 2018) can be achieved when pupils are not explicitly guided in the process of communication and collaboration during their assignment. As found in many previous studies (e.g., Järvelä and Hadwin, 2013; Midtlund et al., 2021), also some of the teachers in this study had a tendency to just let collaboration happen, instead of guiding their pupils proactively in the process, which can be particularly tricky in technology-rich environments. It appeared that this common approach led to less constructive and versatile negotiations and increased conflicts and other issues within groups. Contrastingly, a proactive approach in grade 1 with an explicit focus on collaboration skills appeared to have many advantages: generally, the pupils contributed rather evenly, they listened to each other, negotiated solutions constructively, and had fewer conflicts than pupils in grade 5. In grade 5, pupils more frequently required a teacher to interfere to resolve a dispute, redirect the group, or prompt an individual to participate more actively. Some groups did not express a need for teacher assistance, but it did not necessarily mean that they could not have benefitted from it.

This was evident for example in some of the rather pedestrian representations of knowledge in contexts that allowed a lot more innovative approach to the task. These results echo the findings of previous research from conventional and technology-rich classrooms (Järvelä and Hadwin, 2013; Stahl et al., 2014; Le et al., 2018; Midtlund et al., 2021; Nemiro, 2021). Naturally, the pupils' age may be a contributing factor, as grade 1 pupils were still rather new to a school environment and had many basic skills yet to learn. Nevertheless, revisiting the main principles of collaboration frequently and ear-marking instruction time to learn about different aspects of collaboration and communication proactively in context with other curricular activities seemed to lead to smoother and more effective collaborative practices among pupils. This also allowed teachers to spend more time guiding all pupils in their assignments, rather than "putting out fires" in the more dysfunctional groups.

Concluding remarks

To sum up the findings, three aspects of this study could be highlighted. Firstly, teachers find that digitalization has *increased collaboration* in their classrooms and offer *new avenues for communication* that fall into the category of blended learning. While some of the use of digital technologies focused on employing digital technologies to improve communication (Roschelle, 2021; Yang et al., 2022)–for instance with multimodality and sharing opportunities–some of the contents were more directly focused on developing digital competencies or using digital technologies as a mediator, for instance, in robotics and programming (Roschelle and Teasley, 1995; Nemiro, 2021; Yang et al., 2022). Teachers used these opportunities frequently in their unit and lesson plans and encouraged collaboration among pupils. However, the results in this study indicate that as pupils become familiar with new digital collaboration opportunities, they should be actively and systematically guided in developing their competences using these new avenues. Expecting that pupils have the ability to transfer communication and collaboration strategies and skills to new digital platforms in a way that adds value to collective learning aspects may be too optimistic. For instance, while multimodality certainly offers exciting opportunities for pupil interaction, the presence of many somewhat monotonous demonstrations of collaboration using tools that allowed multimodality during the observation period implies that how to use these tools for the purpose of communication and collaboration should gain greater focus in classrooms.

Secondly, when using digital technologies for communication and collaboration, development and advantages of blended learning can also be found in smaller units, but *more attention needs to be paid on cohesive assemblages in particular*. Blended learning in technology-rich classrooms does not rule out face-to-face communication, use of pencil and paper, or other more conventional means of communicating. However, digital aspects in combination with the above-mentioned elements have potential in making communication more efficient and highlight new elements in the process of communication and collaboration (Roschelle and Teasley, 1995; Vaughan et al., 2013; Roschelle, 2021; Yang et al., 2022). At the same time, digital technologies can be used as collaboration mediators in learning activities (Roschelle and Teasley, 1995) or prompt pupil-led learning where pupils can demonstrate a variety of skills in collectively created digital products (Pulham and Graham, 2018; Yang et al., 2022). However, it seems that picking out one or two benchmarks from the list of characteristics that define blended learning and CSCL is not enough. When too much focus is laid on merely using ICT as a mediator or creating collective digital products, development of other aspects of CSCL and blended learning tends to remain vague. Learning activities and units should be designed as cohesive ensembles where many of the defining factors build on each other and eventually *merge*. This kind of a constructive process would demonstrate the true potential of CSCL and blended learning environments.

Thirdly, as in other collaborative practices, in collaboration with digital technologies *collaboration itself should be an explicit learning goal* and not just something (hopefully) happening on the side. Incorporating 21st century competences with digital dimensions in curriculums is known to be a difficult task (Voogt and Roblin, 2012; Krumsvik et al., 2016), and the variation among teachers and between grade levels in this study indicates that such challenges can exist also in classrooms led by digitally competent teachers. It is worth noting that the differences in pedagogical choices in first and fifth grade level approaches are not directly comparable, as grade 5 pupils already have many years of school behind them, while grade 1 pupils are only starting to learn the various competences required in school. Nevertheless, the results of this study, combined with findings from previous research, strongly indicate that in technology-rich classrooms, it is important to avoid relying solely on implicit learning when discussing 21st century competences, such as communication and collaboration. Instead, teachers should develop clear designs, goals, and criteria for them in lesson and unit plans in a way that accommodates also for more explicit instruction (Voogt and Roblin, 2012; van de Oudeweetering and Voogt, 2018). Grade 1 unit on programming, for instance, exemplifies a design of how such elements can be implemented in existing curricula. It is equally necessary to systematically develop and refine skills once learned in lower grades throughout different grade levels, to make sure that the pupils get frequent opportunities to expand and reconstruct their knowledge and skills in terms of 21st century competences. Doing this in context with other curricula could help pupils develop transferability of these competences in interdisciplinary environments.

Limitations and further research

As in all research, also this study has limitations that need to be acknowledged. The purposely selected and small sample, together with the qualitative nature of this case study, naturally sets limitations to the application and external validity of these findings. Acknowledging also the well-known challenges of case study approach, such as possible researcher bias and lack of systematized procedures, the aspects of rigor have been carefully considered and addressed with a comprehensive and flexible data collection process and using triangulation in analysis (Stake, 1995; Merriam and Tisdell, 2015; Bryman, 2016). Being an intrinsic case study, the aim was not to produce results for their generalizability but to learn from this specific case, and as such, the study fulfilled its purpose.

All in all, as operating in physical and digital learning environments parallel is becoming increasingly common, it is important to study, discuss, and innovate around communication and collaboration possibilities, challenges, and pitfalls, both in general and from a technology perspective in particular. The results presented in this paper contribute toward this discourse and invite further research–also from pupils' perspective–about the influence of digital technologies on communication and collaboration practices in increasingly common blended learning contexts in all levels of education.

Data availability statement

The raw data supporting the conclusions of this article can be made available in its original language upon request.

Ethics statement

The studies involving human participants were reviewed and approved by Norwegian Centre for Research Data. The patients/participants provided their written informed consent to participate in this study.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Funding

This study was funded by the University of Stavanger.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.980445/full#supplementary-material

References

Bebell, D., and Kay, R. (2010). One to one computing: a summary of the quantitative results from the berkshire wireless learning initiative. *J. Technol. Learn. Assess.* 9:60.

Blau, I., Shamir-Inbal, T., and Hadad, S. (2020). Digital collaborative learning in elementary and middle schools as a function of individualistic and collectivistic culture: the role of ICT coordinators' leadership experience, students' collaboration skills, and sustainability. *J. Comp. Assisted Learn.* 36, 672–687. doi: 10.1111/jcal.12436

Blikstad-Balas, M., and Klette, K. (2020). Still a long way to go: narrow and transmissive use of technology in the classroom. *Nordic J. Digital Literacy* 15, 55–68. doi: 10.18261/issn.1891-943x-2020-01-05

Bryman, A. (2016). *Social Research Methods*, 5th Edn. Oxford: Oxford University Press.

Chen, B., Scardamalia, M., and Bereiter, C. (2015). Advancing knowledge-building discourse through judgments of promising ideas. *Int. J. Computer-Supported Collaborative Learn.* 10, 345–366. doi: 10.1007/s11412-015-9225-z

Craig, S. D., Chi, M. T. H., and VanLehn, K. (2009). Improving classroom learning by collaboratively observing human tutoring videos while problem solving. *J. Educ. Psychol.* 101:779. doi: 10.1037/a0016601

Creswell, J. W., and Guetterman, T. C. (2021). *Educational Research. Planning, Conducting and Evaluating Quantitative and Qualitative Research*, 6th Edn. Essex: Pearson.

Deiglmayr, A., and Spada, H. (2010). Developing adaptive collaboration support: the example of an effective training for collaborative inferences. *Educ. Psychol. Rev.* 22, 103–113. doi: 10.1007/s10648-010-9119-6

Summary and discussion

Del-Moral-Pérez, M. E., Villalustre-Martínez, L., Neira-Piñeiro, M., and del, R. (2019). Teachers' perception about the contribution of collaborative creation of digital storytelling to the communicative and digital competence in primary education schoolchildren. *Comp. Assisted Lang. Learn.* 32, 342–365. doi: 10.1080/09588221.2018.1517094

Deschacht, N., and Goeman, K. (2015). The effect of blended learning on course persistence and performance of adult learners: a difference-in-differences analysis. *Comp. Educ.* 87, 83–89. doi: 10.1016/j.compedu.2015.03.020

Diehl, M., and Stroebe, W. (1988). Productivity loss in brainstorming groups: toward the solution of a riddle. *J. Pers. Soc. Psychol.* 53:497. doi: 10.1037/0022-3514.53.3.497

Diziol, D., and Rummel, N. (2010). "How to design support for collaborative e-learning: a framework of relevant dimensions," in *E-collaborative Knowledge Construction*, ed. B. Ertl (Pennsylvania, PA: IGI Global).

Farrell, T. S. C. (2009). *Talking, Listening, and Teaching: A Guide to Classroom Communication*. Thousand Oaks, CA: Corwin press.

Ferrari, A. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. Luxembourg: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Fjørtoft, S. O., Thun, S., and Buvik, M. P. (2019). *Monitor 2019. En Deskriptiv Kartlegging av Digital Tilstand i Norske Skoler og Barnehager*. Trondheim: SINTEF.

Gouseti, A., Abbott, D., Burden, K., and Jeffrey, S. (2020). Adopting the use of a legacy digital artefact in formal educational settings: opportunities and challenges. *Technol. Pedagogy Educ.* 29, 613–629. doi: 10.1080/1475939X.2020.1822435

Graham, C. R., Borup, J., Pulham, E., and Larsen, R. (2019). K–12 blended teaching readiness: model and instrument development. *J. Res. Technol. Educ.* 51, 239–258. doi: 10.1080/15391523.2019.1586601

Harper, B., and Milman, N. B. (2016). One-to-One technology in K–12 classrooms: a review of the literature from 2004 through 2014. *J. Res. Technol. Educ.* 48, 129–142. doi: 10.1080/15391523.2016.1146564

Hesse-Biber, S., Rodriguez, D., and Frost, N. A. (2015). "A qualitatively driven approach to multimethod and mixed methods research," in *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry*, eds S. N. Hesse-Biber and R. B. Johnson (Oxford: Oxford University Press). doi: 10.3389/fpsyg.2021.547773

Hur, J. W., and Oh, J. (2012). Learning, engagement, and technology: middle school students' three-year experience in pervasive technology environments in South Korea. *J. Educ. Comp. Res.* 46, 295–312.

Järvelä, S., and Hadwin, A. F. (2013). New frontiers: regulating learning in CSCL. *Educ. Psychol.* 48, 25–39. doi: 10.1080/00461520.2012.748006

Jewitt, C., Bezemer, J., and O'Halloran, K. (2016). *Introducing Multimodality*. London: Routledge.

Johansson, N. O., Andersson, J., and Rönnberg, J. (2005). Compensating strategies in collaborative remembering in very old couples. *Scand. J. Psychol.* 46, 349–359. doi: 10.1111/j.1467-9450.2005.00465.x

Johler, M., Krumsvik, R. J., Bugge, H. E., and Helgevold, N. (2022). Teachers' perceptions of their role and classroom management practices in a technology rich primary school classroom. *Front. Educ.* 7:841385. doi: 10.3389/feduc.2022.841385

Johnson, D. W., and Johnson, R. T. (1985). "The internal dynamics of cooperative learning groups," in *Learning to Cooperate, Cooperating to Learn*, eds R. Slavin, S. Sharan, S. Kagan, R. Hertz-Lazarowitz, C. Webb, and R. Schmuck (Berlin: Springer), 103–124. doi: 10.1007/978-1-4899-3650-9_4

Karau, S. J., and Williams, K. D. (1994). Social loafing: a meta-analytic review and theoretical integration. *J. Pers. Soc. Psychol.* 65:681. doi: 10.1037/0022-3514.65.4.681

Kelentrić, M., Helland, K., and Arstorp, A.-T. (2017). *Professional Digital Competence Framework for Teachers*. Norway: The Norwegian Centre for ICT in Education.

Kirschner, F., Paas, F., and Kirschner, P. A. (2009). A cognitive load approach to collaborative learning: united brains for complex tasks. *Educ. Psychol. Rev.* 21, 31–42. doi: 10.1007/s10648-008-9095-2

Koschmann, T. (2001). "Revisiting the paradigms of instructional technology. meeting at the crossroads," in *Proceedings of the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education*, (Carbondale, IL).

Krumsvik, R. J., Jones, L. Ø, Øfstegaard, M., and Eikeland, O. J. (2016). Upper secondary school teachers' digital competence: analysed by demographic, personal and professional characteristics. *Nordic J. Digital Literacy* 11, 143–164.

Kuhn, D., and Crowell, A. (2011). Dialogic argumentation as a vehicle for developing young adolescents' thinking. *Psychol. Sci.* 22, 545–552. doi: 10.1177/0956797611402512

Le, H., Janssen, J., and Wubbels, T. (2018). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge J. Educ.* 48, 103–122.

Maxwell, J. A. (2010). Using numbers in qualitative research. *Qual. Inquiry* 16, 475–482.

Meier, A., and Spada, H. (2008). "Promoting the drawing of inferences in collaboration: insights from two experimental studies," in *Proceedings of the 8th International Conference for the Learning Sciences – ICLS 2008*, (Utrecht). doi: 10.11124/01938924-200907030-00001

Merriam, S. B., and Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation*, 4th Edn. San Francisco, CA: Jossey-Bass.

Midtlund, A., Instefjord, E. J., and Lazareva, A. (2021). Digital communication and collaboration in lower secondary school. *Nordic J. Digital Literacy* 16, 65–76.

Ministry of Education and Research (2019). *Core Curriculum – Values and Principles for Primary and Secondary Education*. New Delhi: Ministry of Education and Research.

Mishra, P., and Mehta, R. (2017). What we educators get wrong about 21st-century learning: results of a survey. *J. Digital Learn. Teacher Educ.* 33, 6–19. doi: 10.1080/21532974.2016.1242392

Moltudal, S., Krumsvik, R. J., Jones, Eikeland, O.-J., and Johnson, B. (2019). The relationship between teachers' perceived classroom management abilities and their professional digital competence: experiences from upper secondary classrooms. a qualitative driven mixed method study. *Designs Learn.* 11, 80–98. doi: 10.16993/dfl.128

Mullen, B. (1987). "Self-Attention theory: the effects of group composition on the individual," in *Theories of Group Behavior*, eds B. Mullen and G. R. Goethals (Berlin: Springer), 125–146. doi: 10.1007/978-1-4612-4634-3_7

Nemiro, J. E. (2021). Building collaboration skills in 4th- to 6th-grade students through robotics. *J. Res. Childhood Educ.* 35, 351–372.

Nokes-Malach, T. J., Meade, M. L., and Morrow, D. G. (2012). The effect of expertise on collaborative problem solving. *Think. Reason.* 18, 32–58. doi: 10.1080/13546783.2011.642206

Nokes-Malach, T. J., Richey, J. E., and Gadgil, S. (2015). When is it better to learn together? insights from research on collaborative learning. *Educ. Psychol. Rev.* 27, 645–656. doi: 10.1007/s10648-015-9312-8

Norwegian National Directorate of Education and Training (2021). *Norwegian National Curriculum: Rammeverk for Grunnleggende Ferdigheter*. Oslo: Norwegian National Directorate of Education and Training.

Pulham, E., and Graham, C. R. (2018). Comparing K-12 online and blended teaching competencies: a literature review. *Distance Educ.* 39, 411–432. doi: 10.1080/01587919.2018.1476840

Rajaram, S., and Pereira-Pasarin, L. P. (2010). Collaborative memory: cognitive research and theory. *Perspect. Psychol. Sci.* 5, 649–663. doi: 10.1177/1745691610388763

Redecker, C. (2017). *European Framework for the Digital Competence of Educators*. Luxembourg: European Commission.

Roediger, H. L., and Karpicke, J. D. (2006). The power of testing memory: basic research and implications for educational practice. *Perspect. Psychol. Sci.* 1, 181–210. doi: 10.1111/j.1745-6916.2006.00012.x

Rogers, E. M. (1995). "Diffusion of innovations," in *An integrated approach to communication theory and research*, 4th Edn. ed. E. M. Rogers (New York, NY: Free Press), 432–448. doi: 10.4324/9780203887011-36

Roschelle, J., and Teasley, S. D. (1995). "The construction of shared knowledge in collaborative problem solving," in *Computer Supported Collaborative Learning*, ed. C. O'Malley (Berlin: Springer), 69–97. doi: 10.1007/978-3-642-85098-1_5

Roschelle, J. (2021). "Intelligence augmentation for collaborative learning," in *Adaptive instructional systems. Design and evaluation*, eds R. A. Sottilare and J. Schwarz (Berlin: Springer Nature), 254–264.

Saldaña, J. (2021). *The Coding Manual for Qualitative Researchers*, 4th Edn. Thousand Oaks, CA.: Sage Publications.

Schofield, J. W. (1995). *Computers and Classroom Culture*. Cambridge: Cambridge University Press, doi: 10.1017/CBO9780511571268

Sjølie, E., Strømme, A., and Boks-Vlemmix, J. (2021). Team-skills training and real-time facilitation as a means for developing student teachers' learning of collaboration. *Teach. Teacher Educ.* 107:103477. doi: 10.1016/j.tate.2021.103477

Stahl, G. (2015). A decade of CSCL. *Int. J. Computer-Supported Collaborative Learn.* 10, 337–344. doi: 10.1007/s11412-015-9222-2

Stahl, G., Ludvigsen, S., Law, N., and Cress, U. (2014). CSCL artifacts. *Int. J. Computer-Supported Collaborative Learn.* 9, 237–245. doi: 10.1007/s11412-014-9200-0

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, CA: Sage.

Sung, Y.-T., Chang, K.-E., and Liu, T.-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: a meta-analysis and research synthesis. *Comp. Educ.* 94, 252–275. doi: 10.1016/j.compedu.2015.11.008

Sung, W., Ahn, J., and Black, J. B. (2022). Elementary students' performance and perceptions of robot coding and debugging: Embodied approach in practice. *J. Res. Childhood Educ.* 1–16. doi: 10.1080/02568543.2022.2045399

Tammi, T., and Rajala, A. (2018). Deliberative communication in elementary classroom meetings: ground rules, pupils' concerns, and democratic participation. *Scand. J. Educ. Res.* 62, 617–630. doi: 10.1080/00313831.2016.1261042

van de Oudeweetering, K., and Voogt, J. (2018). Teachers' conceptualization and enactment of twenty-first century competences: exploring dimensions for new curricula. *Curriculum J.* 29, 116–133.

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., and de Haan, J. (2017). The relation between 21st-century skills and digital skills: a systematic literature review. *Comp. Hum. Behav.* 72, 577–588. doi: 10.1016/j.chb.2017.03.010

Vaughan, N. D., Cleveland-Innes, M., and Garrison, D. R. (2013). *Teaching in Blended Learning Environments: Creating and Sustaining Communities of Inquiry*. Edmonton, AB: Athabasca University Press.

Voogt, J., and Roblin, N. P. (2012). A comparative analysis of international frameworks for 21 st century competences: implications for national curriculum policies. *J. Curriculum Stud.* 44, 299–321. doi: 10.1080/00220272.2012.668938

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Yang, Y., Zhang, H., Chai, H., and Xu, W. (2022). Design and application of intelligent teaching space for blended teaching. *Int. Learn. Environ.* 1–18. doi: 10.1080/10494820.2022.2028857

Appendix 1: Invitation to participate

Vil du delta i forskningsprosjektet

"Lærerens rolle og undervisningsstrategier i teknologirike klasserom"?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å bidra til økt kunnskap om lærerens rolle og undervisningsstrategier i teknologirike klasserom. I dette skrivet gir jeg deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål
I forbindelse med mine doktorgradsstudier ved Universitet i Stavanger gjennomfører jeg et forskningsprosjekt som handler om hvordan digitale verktøy blir brukt blant de minste i skolen (1.-7. trinn). I den forbindelse vil jeg svært gjerne samarbeide med en barneskole i Stavangerregionen, for å få kjennskap til hvordan lærere utfører pedagogisk arbeid med hjelp av digitale verktøy. Fokus er på lærerens rolle og pedagogisk arbeid, og ikke på elevenes prestasjoner.

Hvem er ansvarlig for forskningsprosjektet?
Universitetet i Stavanger (UiS) er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Du får dette spørsmål basert på vurdering av ansatte ved UiS, som er kjent med skolen og synes at samarbeid med lærere i denne skolen kunne bidra til rikelig kunnskap om lærerens rolle og pedagogiske praksiser i teknologirike klasserom.

Hva innebærer det for deg å delta?
Jeg ønsker å gjennomføre individuelle intervjuer med 4-6 lærere og fokusgruppeintervju med ledelsen ved skolen. Hvert intervju vil ta omkring 45 minutter og lydopptak vil bli brukt. I tillegg ønsker jeg å observere lærere i sitt daglige pedagogiske arbeid i en periode på ca. 4 uker (22. januar – 21. februar). I løpet av denne perioden vil jeg være tilstede i klasserommene og ta notater, men ingen lydopptak eller videoopptak vil bli brukt i klasserommene. Jeg vil ikke komme uanmeldt, men det er ikke heller nødvendig å forberede seg til besøkene. To fokusgruppeintervjuer avtales på slutten av observasjonsperioden, for å sikre validiteten i prosjektet. Datainnsamlingen vil bli gjennomført i ukene 4, 5, 6, 7 og 8.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Jeg vil bare bruke opplysningene om deg til formålene jeg har fortalt om i dette skrivet. Jeg behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- Kun jeg (stipendiat) og mine veiledere ved Universitetet i Stavanger og Universitetet i Bergen har tilgang til datamaterialet.
- Alle opplysninger vil bli anonymisert og behandlet konfidensielt i samsvar med personvernregelverket. Ingen enkeltpersoner vil kunne gjenkjennes i den ferdige doktoravhandlingen.
- Alt informasjon lagres i et låst skap og på en kryptert minnepinne.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?
Prosjektet skal etter planen avsluttes i våren 2022. Opplysningene anonymiseres og opptakene slettes når prosjektet er avsluttet.
Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,
- få utlevert en kopi av dine personopplysninger (dataportabilitet), og
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Universitetet i Stavanger har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?
Hvis du har spørsmål om studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:
Stipendiat Minttu Johler, på epost) eller telefon 46795989

- Hovedveileder, professor Rune Johan Krumsvik (rune.johan.krumsvik@uib.no)
- Vårt personvernombud ved UiS, Kjetil Dalseth (personvernombud@uis.no)
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon 55 58 21 17

Med vennlig hilsen,
Minttu Johler
Stipendiat
Universitetet i Stavanger
Institutt for grunnskolelærerutdanning, idrett og spesialpedagogikk
Postboks 8600 FORUS
4036 Stavanger
tel. 4679 5989
minttu.johler@uis.no

Appendix 2: Consent form

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Lærerens rolle og undervisningsstrategier i teknologirike klasserom* og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ☐ å delta i intervju
- ☐ å bli observert i observasjonsperioden
- ☐ å delta i fokusgruppeintervju

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet, ca. til våren 2022.

Dato: _____ Sted: _____

Signatur: _____

Navn med blokkbokstaver: _____

Appendix 3: Information to the parents

Informasjon til foresatte **Dato:**_____

(Skolens melding til foresatte)

Forskningsprosjekt ved XXX skole

I forbindelse med mine doktorgradsstudier ved Universitet i Stavanger gjennomfører jeg et forskningsprosjekt som handler om hvordan digitale verktøy blir brukt blant de minste i skolen (1.-7. trinn). Målet med prosjektet er å bidra til økt kunnskap om lærerens rolle og undervisningsstrategier i teknologirike klasserom.

I den forbindelse samarbeider jeg med XXX skole, for å få kjennskap til hvordan lærere utfører pedagogisk arbeid med hjelp av digitale verktøy. For å finne ut av dette, observerer jeg lærere i sitt daglige pedagogiske arbeid fra 22. januar t.o.m. 21. februar. I løpet av denne perioden vil jeg være tilstede i klasserommene og ta notater, men ingen lydopptak eller videoopptak vil bli brukt. Fokus er på lærerens rolle og pedagogisk arbeid, og ikke på elevenes prestasjoner. Data om elever eller fra elever blir ikke samlet eller lagret, og all informasjon jeg får om elevene på skolen er konfidensiell.

Prosjektet er godkjent av Universitetet i Stavanger og Norsk Senter for Forskningsdata.

Hvor kan du finne ut mer?
Hvis du har spørsmål om studien, ta kontakt med:

- Stipendiat Minttu Johler (minttu.johler@uis.no)
- Rektor XXX
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55 58 21 17

Med vennlig hilsen,
Minttu Johler
Stipendiat
Universitetet i Stavanger
Institutt for grunnskolelærerutdanning, idrett og spesialpedagogikk

Appendix 4: Interview guide for individual interviews

Intervjuguide til lærere

Main research question:
How does the use of digital tools influence teachers' role and their pedagogical choices in a technology-rich primary school classroom?

Tema	**Spørsmål**	**Notater**
Personlig infromasjon	Kjønn Bakgrunn (utdanning, ansiennitet)	
Strukturelle rammer	Kan du fortelle litt om tilgang til og stabilitet av teknologi i denne skolen? Hva slags digitale teknologier er tilgjengelige, hvordan fungerer infrastruktur fra ditt perspektiv ol. Hvordan velger du når og hvordan du bruker digital teknologi i undervisning? Er du for eksempel kjent med et rammeverk eller strategi som styrer pedagogisk bruk av digital teknologi i denne skolen?	
PfDK	Kan du fortelle litt om hvordan du har hentet inn profesjonsfaglig digital kompetanse? - Formelt (for eksempel kurs, workshops ol.) - Uformelt (for eksempel fra kolleger, litteratur, lek med IKT selv ol.) Hvordan ville du beskrive din egen profesjonsfaglige digitale kompetanse for tiden?	
Pedagogical considerations	Kan du si noe om hvilke digitale teknologier (hardware/software) du bruker o Daglig o Ukentlig	

	○ Av og til Hvilke teknologier bruker elevene dine ? ○ Daglig ○ Ukentlig ○ Av og til I det siste har det vært mange skeptiske og kritiske stemmer i media som omhandler bruk av IKT i barneskolen. Synes du at det er nødvendig og/eller viktig å ha en-til-en enheter til elevene i barneskolen? Kan du fortelle litt om fordelene du opplever ved bruk av teknologi i planlegging og utføring av undervisning? Kan du tenke på noen konkrete eksempler der du synes at du eller dine kolleger har lyktes med ang. pedagogisk bruk av teknologi? Når det er snakk om tilpasset opplæring ser du at teknologi på noen måte kan bidra i dette området? Hva slags utfordringer har du eller kollegene dine opplevd ved bruk av digital teknologi i undervisning? Du kan snakke om konkrete eksempler eller mer generelt. Synes du at det er noe ulemper med å bruke digital teknologi i undervisning, spesielt på barneskolenivå? Akkurat nå forbereder skolene seg for den nye læreplanen, som har livsmestring, demokrati og medborgerskap, samt bærekraftig utvikling som kjerne-elementer. Flere andre endringer har også fått plass i fagfornyelsen. Kan du si noe om hvordan du ser rollen av IKT i lys av den nye læreplanen? (Hvis du allerede er kjent med LK2020.)	

	Synes du at det generelt er krav til endringer ang. pedagogiske praksiser i barneskolen? Hvordan tror du at ny læreplan påvirker deg og dine praksiser som lærer?	
Teacher's role	Mange eksperter synes at lærerrollen er i endring og lærere må stadig reflektere over og utvikle sine praksiser. Er du enig med dette? Hvordan ser du på fremtiden for deg som lærer? Kan du fortelle litt om hvordan du ser at ditt arbeid som lærer utvikler seg i løpet av de neste årene? Den nye læreplanen understreker bruk av teknologi i de fleste fagene gjennom hele skoleløpet. Hva er din mening om hvordan dette påvirker lærere i barneskolen? Er det for eksempel noe konkret du skal vurdere eller prøve for å få dette til?	

	Med tanke på lærerrollen og ulike kompetanser, hvilke kompetanser ser du som mest sentrale i nåtidens og fremtidens skole. Disse kan brukes som «prompts»: -relasjonskompetanse -fagkunnskap -klasseledelse -pedagogiske evner -formidlingsevne -fleksibilitet -evne til samarbeid Tror du at det er kompetanser som blir enda viktigere i fremtiden, eller kompetanser som blir mindre viktige i fremtiden? Ser du at digitalisering har noe å gjøre med det?	
Concluding notes	Har du noen andre tanker om lærerrollen eller pedagogiske praksiser som du vil gjerne dele? Tusen takk.	

Appendix 5: Observation guide

Observation guide

Date:		Time: (from – to)	
Class (grade, amount of b/g)		Teacher:	
Subject:		Lesson goal(s):	

Digital devices used during the class:

Edtech	Primary user: teacher(s)	Primary user: students
iPad		
Projector w/ Apple TV		
Headphones		
Other:		
Other:		

How does the use of ICT contribute towards (some of) the following competencies?

Collaboration and communication (student-student, student-teacher)	Notes:
Social/cultural aspects ("skolen I samfunnet"; change and development)	
ICT-related competencies (learning about ICT)	
Creativity and productivity (high-quality products, innovation, not just reproduction of knowledge)	
Differentiated instruction (pace, variation in task format and/or level)	
Problem-solving and Critical thinking	

Ethical considerations	

Teacher's role: How is the use of technology visible and/or influencing (some of the) following components in the classroom?

Relational abilities (teacher-student, student-student)	Notes:
Ability to communicate and collaborate (teacher-student, student-teacher, student – student)	
Classroom management (physical and digital learning space, leadership in digital learning processes)	
Pedagogical abilities (variation in resources & methods, flexibility, organizing teaching, leading learning processes)	
Subject knowledge	

How does the teacher/ do the students use technology during a lesson?

App, software, hardware etc.	**Teacher**	**Students**

Other notes (e.g. is EdTech being used for homework):

Appendix 6: Focus group interview guide (leader team)

Intervjuguide, skoleledere

Main research question:
How does the use of digital tools influence teachers' role and their pedagogical choices in a technology-rich primary school classroom?

Tema	**Spørsmål**	**Notater**
Personlig informasjon	Kjønn Bakgrunn (utdanning, ansiennitet som lærer / rektor)	
Strukturelle rammer	Infrastruktur: Hva slags digital teknologi bruker lærere og elevene i denne skolen for å utføre sin arbeid? Kan dere fortelle litt om hvordan de blir brukt, evt. annet relevant informasjon om infrastruktur (tilgang, nettverk etc.). Kan dere fortelle litt om de rammeverkene, dokumentene og/eller strategiene (kommune, fylkeskommune, nasjonal ol.) for bruk av IKT som på noen måte er forankret ved denne skolen?	
PfDK	Kan dere fortelle litt om hvordan lærere i denne skolen tar i bruk ulike digitale hjelpemidler? Hvordan velger de, hvordan henter de inn kompetanse osv. Hvordan forstår dere lærerens profesjonsfaglige digital kompetanse? Kan dere fortelle litt om hvordan dere opplever lærerens profesjonsfaglige digital kompetanse i denne skolen?	

Pedagogiske vurderinger	I det siste har det vært mange skeptiske og kritiske stemmer i media som omhandler bruk av IKT i barneskolen. Synes dere at det er nødvendig og/eller viktig å ha en-til-en enheter til elevene i barneskolen? Hva slags endringer har dere observert pedagogiske praksiser etter at bruk av IKT ble mer vanlig, for eksempel i form av 1:1-enheter? Er det noe dere er spesielt stolte av i denne skolen i forhold til bruk av teknologi? Finnes det noen tydelige utfordringer eller til og med ulemper? Akkurat nå forbereder skolene seg for den nye læreplanen, som har livsmestring, demokrati og medborgerskap, samt bærekraftig utvikling som kjerne-elementer. Flere andre endringer har også fått plass i fagfornyelsen. Hvordan ser dere rollen av IKT i lys av den nye læreplanen? Når det er snakk om tilpasset opplæring ser du at teknologi på noen måte kan bidra i dette området? - Dere kan snakke om konkrete eksempler eller mer generelt.	
Lærerrollen	Mange skoleledere og andre eksperter synes at lærerrollen er i endring og lærere må stadig reflektere over og utvikle sine praksiser. - Er dere enig med dette? - Ser dere noe av dette blant ansette i denne skolen? - Merker dere motstand? Med tanke på lærerrollen og ulike kompetanser, hvilke kompetanser ser du	

	som mest sentrale i nåtidens og fremtidens skole. Disse kan brukes som «prompts»: -relasjonskompetanse -fagkunnskap -klasseledelse -pedagogiske evner -formidlingsevne -fleksibilitet -evne til samarbeid Tror dere at det er kompetanser som blir enda viktigere eller mindre viktigere i fremtiden? - Ser dere at digitalisering har noe å gjøre med det? Ser dere noe endring i hvordan lærere planlegger og utfører undervisning når de (og elever) bruker IKT? Tidligere kunnskapsminister Torbjørn Røe Isaksen har sagt at vi må «være kritiske uten å stoppe utviklingen» ved bruk at IKT på skolen. Hvordan, tenker dere, kan vi klare dette?	
Oppsummerende notater	Har dere noen andre tanker om lærerrollen eller pedagogiske praksiser som du vil gjerne dele? Tusen takk.	

Appendix 7: Focus group interview guide (Grade 1)

Focus group interviews

Grade 1

Tema 1: *Lærerens kompetanser*

Klasseledelse: Dere var svært enige på intervjuene om at det er viktig med tydelig klasseledelse når en bruker teknologi med de små (for eksempel «eple opp» og hvordan læringsbrettet er satt ned på pulten). Men hvordan kan teknologi *bidra* til god klasseledelse – eller kan det?

Relasjonskompetanse: Dere var også enige om viktigheten av gode relasjoner mellom lærere og elever, og e.g. bruk av lydopptak som metode for tilbakemeldinger ble nevnt som en måte å bruke teknologi til å jobbe med relasjoner. Ser dere at teknologi ellers kan bidra positivt til lærerens relasjonskompetanse – eller motsatt vei? Hva med relasjonene mellom elever?

Pedagogiske evner: Med tanke på undervisning av fremtidens kompetanser (21st century skills) blir konstruktivistiske tilnærminger anbefalt (e.g. å jobbe i lag, problem-basert læring, utforskning og underveisvurdering; Voogt, Erstad, Dede & Mishra, 2013). Jeg har jo fått se elevene å e.g. utforske og at elever jobber i lag, men vurderingsdelen er noe jeg ikke ser så mye på timene, da dette skjer på andre tider. Kan dere fortelle litt om tilbakemeldinger og underveisvurdering her på 1. trinn?

Tema 2: *Fremtidens kompetanser*

Fremtidens kunnskaper kan deles i tre hovedkategorier (Mishra & Kereluik, 2011): grunnleggende kunnskaper (fagkunnskap, informasjon, grunnleggende ferdigheter), metakunnskap (kritisk tenkning, kommunikasjon, samarbeid og innovasjon) og humanistisk kunnskap (kulturell kompetanse, etiske vurderinger, og identitetsrelatert kunnskap). På 1. trinn har en selvsagt stor fokus på grunnleggende kunnskap og ferdigheter, fordi at annet blir senere bygget på det. Men hvordan passer de andre kunnskapene – metakunnskap og humanistisk kunnskap – inn i dette sammenheng?

Ifølge lærere er metakunnskap og humanistisk kunnskap (= 21st century skills) viktige, men uansett er det ofte stort sett bare grunnleggende kunnskaper og ferdigheter som blir undervist, mens annet per måte bare skjer, uten at elevene blir eksplisitt veiledet eller opplært i for eksempel problem-basert læring eller samarbeid. Høres dette kjent ut eller er det annerledes her på 1. trinn?

Måter å bruke teknologi kan deles i tre hovedkategorier: konsumering, der elevene konsumerer ferdiglagd innehold, reproduksjon av kunnskap, der elevene oppsummerer eller reformulerer gammelt kunnskap, og til skapning og utforskning, der elevene finner ut av eller skaper noe nytt selv. Jeg har sett alle tre i dette trinnet. Hvordan ser dere denne tredelingen på 1. trinn – er det noe som skjer mer eller mindre enn de andre? Hvorfor det? Er det noe som er vanskelig å få til på 1. trinn?

Tema 3: *Tilpasset opplæring*

Jeg har fått se hvordan dere lager tilpasset og differensiert material til elevene, for eksempel ift. prosjektet som handlet om ulike dyr. Bruker dere teknologi også til å tilpasse og differensiere lekser? Kan dere fortelle litt om det?

Lenge har folk snakket om at vi blir mer «effektive» ved bruk av teknologi, og at noen ganger teknologi kan erstatte læreren. I det siste har vi begynt å snakke heller om at læring er ikke blitt mer effektiv med teknologi, men den er blitt annerledes. Jeg har sett at elevene for eks. spiller GraphoGame på seg selv, men jeg har også sett at når elevene jobber med å produsere tekst selv så brukes det flere teknologiske hjelpemidler, og samtidig mer pedagoger er tilgjengelige. Kan dere fortelle litt om disse pedagogiske valg?

Å bruke spill i læring kan være svært motiverende, det kan tilby adaptive algoritmer for differensiering og og spesielt gutter kan ofte kobles til læring gjennom læringspill, men samtidig advarer flere psykologer om «instant gratification», altså at barna blir vant til å få belønning med en gang uten at det må jobbes langsiktig, og noen advarer om dopamin-high og at barna blir hekta på spill med øyeblikkelig belønning. Dere har valgt å bruke sånne spill-baserte læringsmåter. Kan dere fortelle litt om hvorfor og hvor mye, og hva ligger bak denne pedagogiske beslutningen?

Tema 4: *Hvordan å lykkes?*

Dere var også enige i det at det er veldig viktig at lærere holder seg oppdater ift det digitale, men mange erfarne lærere føler at det ikke finnes nok tid eller andre ressurser for å lære opp og holde seg oppdatert, da utviklingen går så fort. Lærerstudenter derimot sier at det er veldig tilfeldig om de lærer noe av det digitale, enten ved universitetet eller i praksis. I denne skolen har dere derimot kommet ganske langt. Kan jeg be hver av dere å kort presentere en ide eller en viktig faktor som gjelder hvis en vil lykkes med å bruke teknologi på en hensiktsmessig måte i barneskolen, og begrunne hvorfor du har valgt akkurat dette?

Appendix 8: Focus group interview guide (Grade 5)

Grade 5

Tema 1: *Lærerens kompetanser*

Klasseledelse: Dere var svært enige på intervjuene om at det er viktig med tydelig klasseledelse og klare regler når en bruker teknologi i såpass stor grad. Men hvordan kan teknologi også *bidra* til god klasseledelse - eller kan det? (Classroom-appen: noen bruker denne appen ganske mye, noen i svært lite grad. Kan dere fortelle litt mer om hvorfor eller hvorfor ikke dere har valgt å bruke den?)

Relasjonskompetanse: Dere var også enige om viktigheten av gode relasjoner mellom lærere og elever, og e.g. lydopptak som tilbakemelding ble nevnt som en måte å bruke teknologi til å jobbe med relasjoner. Ser dere at teknologi ellers kan bidra positivt ift. lærerens relasjonskompetanse – eller motsatt vei?

Fagkompetanse: dere var også svært enige om at behovet til fagkompetanse ift. lærerrollen har endret, da læreren ikke lenger er primær kilde til kunnskap i klasserommet, og alt kunnskap nå i hele verden er «within the reach». Kan dere fortelle litt om hvordan dere veileder elevene når de skal finne informasjon om noe selv? (Dette kan også skape et felle der «utforskning» blir googling og egentlig bare reproduksjon av kunnskap.)

Tema 2: *Fremtidens kompetanser*

Med tanke på undervisning av fremtidens kompetanser (21st century skills) blir konstruktivistiske tilnærminger anbefalt (e.g. å jobbe i lag, problem-basert læring, utforskning og underveisvurdering; Voogt, Erstad, Dede & Mishra, 2013). Jeg har jo fått se elevene på 5. trinn å «løse» problemer, utforske og at elever jobber i teams relativt mye, men vurderingsdelen er noe jeg ikke ser så mye på timene, da dette skjer på andre tider. Kan dere fortelle litt om hvordan dere bruker teknologi for vurdering og ellers til kommunikasjon mellom lærer og elev?

Fremtidens kunnskaper kan deles i tre hovedkategorier (Mishra & Kereluik, 2011): grunnleggende kunnskaper (fagkunnskap, informasjon, grunnleggende ferdigheter), metakunnskap (kritisk tenkning, kommunikasjon, samarbeid og innovasjon) og humanistisk kunnskap (kulturell kompetanse, etiske vurderinger, og identitetsrelatert kunnskap). Hvordan ser dere denne tredelingen i sammenheng med undervisning og læring? Er det noe som skiller seg fra de andre? Tror dere at ny læreplan kommer til å endre noe av dette?

Teknologi går jo sammen med disse so-called 21st century skills, og ifølge lærere er disse fremtidens kompetanser viktige, men uansett er det ofte hovedsakelig grunnleggende kunnskaper og ferdigheter som blir undervist, mens annet per måte bare skjer, uten at elevene blir eksplisitt veiledet eller opplært i for eksempel problem-basert læring eller samarbeid. Høres dette kjent ut, eller hvordan lærer deres elever om disse kompetansene, for eks. samarbeid eller kritisk tenkning? Og hvordan blir disse kompetansene vurdert?

Måter å bruke teknologi kan deles i tre hovedkategorier: konsumering, der elevene konsumerer ferdiglagd innehold (10 økter), reproduksjon av kunnskap (6 økter), der elevene oppsummerer eller reformulerer gammelt kunnskap, og til skapning og utforskning (11), der elevene finner ut og/eller skaper noe nytt selv. Jeg har sett alle tre i dette trinnet (i tillegg 4 timer som hadde elementer fra 2eller 3 kategorier, og 2 som ikke hørte til disse kategoriene i hele tatt). Kan dere fortelle litt om hvordan dere velger om elevene skal konsumere, reprodusere eller utforske og skape selv? (Er det e.g. mer typisk i et fag enn et annet, har det noe å si hvis læreren jobber alene eller i lag med de andre, om det er snakk om enkeltopplegg eller prosjekt etc.)

Tema 3: *Tilpasset opplæring*

Jeg har sett at når elever konsumerer digitalt innehold så har appen/software ofte an adaptiv algoritme. I tillegg har jeg sett at elevene har fått oppgavetyper der oppgaven i seg selv er lagd opp slik at den passer til elever på alle nivåer. Hvordan tilpasser dere lekser – kan dere fortelle litt om det?

Tema 4: *Hvordan å lykkes?*

Dere var også enige i det at det er veldig viktig at lærere holder seg oppdater ift. det digitale, men mange erfarne lærere føler at det ikke finnes nok tid eller andre ressurser for å lære opp og holde seg oppdatert, da utviklingen går så fort. Lærerstudenter derimot sier at det er veldig tilfeldig om de lærer noe av det digitale, enten ved universitetet eller i praksis. I denne skolen har dere derimot kommet ganske langt. Kan jeg be hver av dere å kort presentere en ide eller en viktig faktor som gjelder hvis en vil lykkes med å bruke teknologi på en hensiktsmessig måte i barneskolen, og begrunne hvorfor du har valgt akkurat dette?

Appendix 9: Survey

Spørreskjema
Survey

Denne spørreundersøkelsen er anonym, men jeg vil gjerne lære litt om din bakgrunn.
This survey is anonymous, but I would like to learn a little bit about your background.

Hvilke(t) klassetrinn underviser du?
Which grade level(s) do you teach?

Hvor mange års erfaring har du som lærer i grunnskolen?
How many years of teaching experience do you have in primary and lower secondary school?

Hva slags (lærer)utdanning har du?
What kind of a teacher education do you have?

Har din arbeidsgiver gitt deg mulighet til å ta videreutdanning eller etterutdanning for å utvikle din pedagogiske digitale kompetanse (f.eks. etter- og videreutdanning ved universitet/høgskole eller gjennom kommune/private aktører)? Hvis ja, hva?
Has your employer given you an opportunity for professional development in professional digital competence (e.g. tertiary education or courses arranged by the municipality or private companies). If yes, which?

Kan du nevne hvilke digitale verktøy (e.g. applikasjoner eller software) som blir brukt mest i dine undervisningstimer (av deg eller elevene dine).
Could you list digital resources (e.g. applications or software) that are used most frequently during your lessons (by you or your pupils)?

Følgende påstander og spørsmål handler om dine oppfatninger og erfaringer som lærer i en skole der bruk av digital læremidler er en del av hverdagen. Skriv gjerne ytterlige kommentarer for å utdype dine besvarelser. Dette kan være for eksempel personlige erfaringer eller konkrete eksempler. Denne spørreundersøkelsen er anonym, så ikke del personopplysninger (for eks. navn) om deg selv eller dine elever/kollegaer i dine besvarelser.
Following statements and questions map your views and experiences as a teacher in a school where use of digital resources are a part of everyday practices. Additional comments to elaborate on your answers are warmly welcomed. They can be for example personal experiences or concrete examples. This survey is anonymous, so please, do not share sensitive or personal information (e.g. names) about yourself or your pupils/colleagues.

Del 1: Klasseledelse i teknologirike omgivelser
Part 1: Classroom management in teachnology-rich environments

«Klasseledelse handler om lærerens arbeid som bidrar til elevenes faglige, sosiale og emosjonelle læring og utvikling, og spenner over et bredt praksisfelt. Det dreier seg om ledelse av grupper som lag, av den enkelte elev som aktør i en gruppe, og om lærerens tilrettelegging for læring i elevfellesskapet.» (Utdanningsdirektoratet, 2020)
«Classroom management is about teachers' work that contributes towards a wide spectrum of pupils' academic, social and emotional learning and development. It is about leading groups as teams, and

individual pupils as members of teams, and about the teachers' ability to differentiate for collective learning experiences." (The Norwegian Directorate for Education and Training, 2020)

I hvilken grad er du enig eller uenig med følgende påstander:
To what extent do you agree with the following statements:

1 – helt uenig *(strongly disagree)*
2 – litt uenig *(somewhat disagree)*
3 – verken uenig eller enig *(do not agree nor disagree)*
4 – litt enig *(somewhat agree)*
5 – helt enig *(strongly agree)*

Digital teknologi bidrar til bedre klasseledelse.
Digital technologies contribute towards better classroom management.

Digital teknologi gjør klasseledelse mer utfordrende.
Digital technologies make classroom management more challenging.

Teknologirike klasserom krever nye kompetanser av lærer ift. klasseledelse.
Technology-rich classrooms require new teacher competences in terms of classroom management.

I teknologirike klasserom er det viktig at læreren har kontroll over elevskjermene hele tiden.
It is important that the teacher has control over pupils' screens at all times in technology-rich classrooms.

I teknologirike klasserom er det mindre behov for en lærer enn i tradisjonelle klasserom.
There is a lesser need for a teacher in technology-rich classrooms than in traditional classrooms.

Overganger mellom ulike oppgaver i timen er enklere når hver elev har sin egen digitale enhet.
Transitions between tasks during a lesson are easier when each pupils has a personal digital device.

Digital teknologi kan bidra til bedre struktur i klasserommet.
Digital technologies can contribute towards a better lesson structure.

Det er særlig viktig med tydelige regler og rutiner i teknologirike klasserom.
Clear rules and good routines are particularly important in technology-rich classrooms.

Det er særlig viktig med gode relasjoner mellom lærer og elever i teknologirike klasserom.
Good teacher-pupil relationships are particularly important in technology-rich classrooms.

Det er særlig viktig med tillit mellom lærer og elever i teknologirike klasserom.
Trust between teachers and pupils is particularly important in technology-rich classrooms.

Elever skal kunne medvirke i utforming av regler og rutiner i teknologirike klasserom.
Pupils should be allowed to contribute when establishing rules and routines in technology-rich classrooms.

Lærerens rolle i teknologirike klasserom er annerledes enn lærerens tradisjonelle rolle.
Teacher's role in a technology-rich classroom is different from teacher's traditional role.

Ytterlige kommentarer:
Additional comments:

Del 2: Dine erfaringer og praksiser
Part 2: Your experiences and practices

I hvilken grad passer følgende påstander til deg og ditt arbeid som lærer.
To what extent do the following statements reflect you and your work as a teacher.

1 - i svært liten grad (to a very small extent)
2 - i liten grad (to a small extent)
3 - i noen grad (to some extent)
4 - i stor grad (to a great extent)
5 - i svært stor grad (to a very great extent)

Jeg bruker uformelle metoder for å utvikle min pedagogiske digitale kompetanse (e.g. sosiale medier, bøker, tidsskrifter, lærer av kollegaer/venner)
I use informal methods to develop my professional digital competence (e.g. social media, books, journals, learning from colleagues/friends).

Min arbeidsgiver støtter utviklingen av min pedagogiske digitale kompetanse.
My employer supports the development of my professional digital competence.

Min arbeidsgiver tilbyr meg muligheter for å utvikle min pedagogiske digitale kompetanse.
My employer offers me opportunities to develop my professional digital competence.

Jeg har endret og/eller utviklet undervisningsmetoder og -strategier pga. digitalisering i skolen.
I have changed and/or developed my teaching methods and strategies due to the digitalization of this school.

Jeg har rutiner i klasserommet der teknologi bidrar til
I have classroom routines that contribute towards

Struktur og rammer – *Structure and framings*

Kommunikasjon og samarbeid – *Communication and collaboration*

Relasjonsbygging (lærer-elev og elev-elev) – *Establishing and maintaining relationships (teacher-pupil and pupil-pupil)*

Bedre overganger – *Better transitions*

Jeg prøver gjerne ut nye digitale løsninger i mitt arbeid så lenge disse bidrar pedagogisk.
I gladly try new digital solutions at work, as long as they contribute pedagogically.

Jeg er ikke redd for å ta risiko eller feile foran elever når jeg prøver ut nye digitale teknologier.
I am not afraid of taking risks or failing in front of my pupils when experimenting with new digital technologies.

Jeg synes at elevene blir lett distrahert ved bruk av digital teknologi.
I think that pupils get easily distracted when using digital technologies.

Jeg erfarer mye utenomfaglig bruk av teknologi i undervisningstimene mine.
I find that pupils exercise a lot of non-academic use of technology during my lessons.

Ytterlige kommentarer:
Additional comments:

Del 3: Bruk av digital teknologi for ulike formål
Part 3: Using digital technologies for different purposes

I hvilken grad bruker du teknologi i følgende forbindelser:
To what extent do you use technology in the following contexts:

1 - i svært liten grad (to a very small extent)
2 - i liten grad (to a small extent)
3 - i noen grad (to some extent)
4 - i stor grad (to a great extent)
5 - i svært stor grad (to a very great extent)

Tilpasset opplæring:
Differentiated instruction:

> Adaptivt læringsverktøy (digitale ressurser som ved hjelp av algoritmer tilpasses fortløpende til hver enkelt elevs ferdighetsnivå og utvikling; e.g. applikasjoner som 99Math eller GraphoGame)
> *Adaptive learning technologies (digital resources that use adaptive algorithms to personalize each individual learning level and development; e.g. applications such as 99Math or GraphoGame)*
>
> Tilpasninger for enkeltelever (e.g. hjelpemidler ved lese- og skrivevansker)
> *Individualized instruction (e.g. resources for those with difficulties in reading and writing)*
>
> Åpne oppgavetyper som tillater elever å jobbe fra sine egne forutsetninger
> *Assignment design that allows each student to work on the same task but at the level that best suits their needs*
>
> Oppgavemengden og/eller tekstlengden blir tilpasset ved behov til enkeltelever.
> *The amount of exercises and/or length of texts is adapted to meet individual needs.*

Tverrfaglige prosjekter mellom to eller flere fag og to eller flere lærere
Cross-curricular projects between two or more subjects and two or more teachers

Relasjonsbygging
Establishing and maintaining relationships

> Mellom lærer og elever – *Between a teacher and pupils*
>
> Mellom to eller flere elever – *Between two or more pupils*

Kommunikasjon:
Communication:

> Mellom lærer og elev – *Between a teacher and a pupil*
>
> Mellom to eller flere elever – *Between to or more pupils*
>
> Mellom kollegaer – *Between colleagues*
>
> Mellom skole og hjem – *Between school and home*

Konsumering av digitalt innhold (elever bruker websider, applikasjoner etc. for å øve inn kunnskaper/ferdigheter)
Consumption of existing content (pupils use websites, applications etc. to train their skills and to gain knowledge)

Digitale læringsstrategier (elever bruker websider og digitale tekster for å finne, evaluere og bruke informasjon og eksisterende kunnskap)
Digital learning strategies (pupils use websites and digital texts to find, evaluate, and use information and existing knowledge)

Reproduksjon av kunnskap (e.g. elever lager digitale presentasjoner og andre produkter av eksisterende kunnskap)
Reproduction of knowledge (e.g. pupils make digital presentations and other products demonstrating existing knowledge)

Multimodalitet:
Multimodality:

> Jeg bruker verktøy som kombinerer tekst, lyd og/eller visuelle elementer i min undervisning.
> *When teaching, I use tools that combine text, audio, and/or visual elements.*
>
> Mine elever bruker verktøy som kombinerer tekst, lyd og/eller visuelle elementer e.g. i sine presentasjoner.
> *My pupils use tools that combine text, audio, and/or visual elements.*

Utforskende læring (utforskende metoder der prosess er viktigere enn å lage et produkt)
Exploratory learning (exploratory methods that highlight the process over product)

Skapende prosesser (e.g. anvende kunnskap for å lage noe nytt, entreprenørskap)
Creating new (e.g. processes where pupils use existing knowledge to develop something new, entrepreneurship)

Ytterlige kommentarer:
Additional comments:

Kan du gi et eksempel / eksempler om når du har brukt teknologi til utforskende og/eller skapende pedagogiske tilnærminger/praksiser:
Could you provide an example/examples of situations where you have used technology to promote practices that support exploratory learning and/or creating something new:

Ifølge dine erfaringer, hva kreves fra en lærer slik at lærer og elever lykkes med læring i teknologitette klasserom?
In your experience, what does it take to make teachers and pupils successful in learning in technology-rich classrooms?

Har økt digitalisering av skolene noen fordeler ift. ditt pedagogiske arbeid? *Ja/nei*
Hvis ja, hvilke?
Has increased digitalization of schools some advantages regarding your pedagogical work? Yes/no
If yes, which advantages?

Har økt digitalisering av skolene noen ulemper ift. ditt pedagogiske arbeid? *Ja/nei*
Hvis ja, hvilke?

Has increased digitalization of schools some disadvantages regarding your pedagogical work? Yes/no
If yes, which disadvantages?

Kan du nevne noe som du tenker er avgjørende for at lærere og elever skal lykkes i teknologirike klasserom:
Can you name something that you find absolutely essential for teachers and pupils to succeed in technology-rich classrooms:

Er det noe annet du ønsker å tilføre?
Is there something else you would like to add:

Tusen takk for dine svar!
Many thanks for your answers!

Appendix 10: Observation coding (Grade 1)

Coding lessons (observation sheets), grade 1

Categories:

Reproduction of knowledge: Digital information literacy – pupils look up, evaluate, and/or use existing information and knowledge to answer questions or to create a presentation.

Productivity (innovation/creativity): Exploratory approach, attempting to solve a problem in an original way, experimenting

Consuming content: Pupils do not create anything of their own but consume existing content online (e.g. games, e-books)

Writing practice: Pupils use apps/software for writing practice and producing simple texts

Collaboration: Digital technologies were used to collaborate on either contents, process or product (NB! More collaboration offline/unplugged)

Communication: Teacher-pupil or pupil-pupil

Classroom management: Structure, organization, intervention

Differentiated instruction: Individualized instruction, pupil participation in choice of level (NB! Many assignments were designed in a way that the design itself allowed a differentiated approach)

For what purpose were digital technologies used during the observed lessons?

Lesson	Grade level	Reproduction of knowledge	Productivity (innovation/ creativity)	Consuming content	Writing practice	Collaboration	Communication	Classroom management	Differentiated instruction	Notes
27.01. Norsk	1			Salaby (e-books), BookCr. (teachers have created activity books)	BookCreator, Kidspiration, imallesing		iThoughts, Photos	iThoughts	Salaby (also pupil participation), imallesing	Not all pupils can read, so pictures often support verbal/written communication in grade 1 in general; QR codes on iThoughts help direct pupils to where they should go
Science	1	Kidspiration		Showbie, Kidspiration (multimodal and differentiated contents created by teachers – this	Kidspiration		Showbie	Showbie	Showbie, Kidspiration (multimodality, differentiated contents)	A large, differentiated, multimodal library on Showbie, created by teachers

				repeats throughout the observation period)						(encourages also to pupil participation).
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity (innovation/ creativity)**	**Consuming content**	**Writing practice**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
28.01. Stations (Norwegian, Science, Arts and crafts – no digital elements)	1	Kidspiration		Showbie, Kidspiration	Kidspiration		iThoughts, Photos (to support verbal instruction), Showbie	iThoughts, Showbie, Photos (what should you take with you to the different stations)	Showbie, Kidspiration, Askiraski	Lots of variation in ativities and use of tech, but everything flows very effortlessly. Rules and guidelines had clearly been internalized!
30.01. Stations (Norwegian and Science)	1	Kidspiration		Showbie, Kidspiration, Salaby (e-books)	Kidspiration		iThoughts, Showbie	iThoughts, Clock	Showbie, Kidspiration, GraphoGame, Salaby	GraphoGame very game-like, adaptive algorithm, developed in JYU
03.02. Norwegian (short lesson)	1			Salaby	iMallesing			iThoughts	Salaby	
Math	1			MultiSmartØving			iThoughts, Photos	iThoughts	MultiSmartØving	
04.02. Stations (Norwegian, Science)	1	Kidspiration, STL+		Showbie	Kidspiration, STL+		iThoughts, Photos, Showbie	iThoughts	AskiRaski, STL+	2 teachers for a group of 5-6 pupils when working on more complex/new things (STL+), as AskiRaski station basically ran by itself
Math	1			NRK Super (video), MultiSmartØving			iThoughts	iThoughts	MultiSmartØving	When algorithm checks and chooses appropriate exercises a lot of teacher time is made available for helping (both grade levels)
06.02. Stations (Norwegian, Science, Soc. Studies)	1	*Eg veit* (I know) sentences on STL+	Pupils created their own multimodal math puzzles on BC	NRK Skole, Salaby	Kidspiration, STL+		iThoughts, Showbie	iThoughts, Clock	Salaby, STL+	QR codes a common way to guide pupils where they need to go – quick and easy!
07.02. Math	1			BookCr. (teachers created content)				Clock, Classroom		Multimodality practice on BC – teacher show

										how to add audio and pictures
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity (innovation/ creativity)**	**Consuming content**	**Writing practice**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
10.02. Norwegian (short lesson)	1				Kidspiration, BookCr. (Also multimodal!)		Photos (to support oral storytelling), Classroom (to share work – those who volunteered)	Classroom (to share work – those who volunteered)		Classroom app is used on several occasions but the use is non-invasive and pedagogically well justified
Math	1				BookCr. (L practice)		iThougts, BookCr. (Teacher turns storytelling into a multimodal experience)	iThouhts		Main activity playing store (analog.); Photos used a lot to support instruction, exemplify, share, play…
11.02. Music	1			YouTube – song melody and lyrics			Photos (to support oral storytelling and instruction)	Photos		Collaborative musical performance built on the YouTube song but was analogue
Stations (Norwegian, Science)	1	*Eg veit* (I know) sentences on STL+		Klassetrivsel.no (pupils answer questions about learning environment), GraphoGame	STL+, Kidspiration		iThoughts, Photos	iThoughts, Photos, Clock	GraphoGame, STL+	SplitScreen used to use two apps at the same time. STL+ is definitely not "replacing" teacher – lots of teacher support when words sound funny or showing how to use audio to support writing.
Stations (Norwegian, Science – repeat session)	1	*Eg veit* (I know) sentences on STL+		Klassetrivsel.no (pupils answer questions about learning environment), GraphoGame	STL+, Kidspiration		iThoughts, Photos	iThoughts, Photos, Clock	GraphoGame, STL+	Pupil participation – using audio was no mandatory – some tried without (but returned to audio later); "lureord" (e.g. w/ silent consonants) difficult
13.02. Stations (Norwegian, Science)	1	*Eg veit* (I know) sentences on STL+		GraphoGame	STL+, Kidspiration		iThoughts	iThoughts, Clock	GraphoGame, STL+	Teachers tell about using audiofiles often as feedback

										outside classtime, but this I do not see in class.
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity (innovation/ creativity)**	**Consuming content**	**Writing practice**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
Stations (Norwegian, Science – repeat session)	1	*Eg veit* (I know) sentences on STL+		GraphoGame	STL+, Kidspiration		iThoughts	iThoughts, Clock	GraphoGame, STL+	Role of teacher very different in 1st and 5th. Little productivity in 1st grade – still a lot of focus on thebasics.
17.02. Norwegian	1			YouTube (song), IMAL	STL+, Kidspiration, BookCr.		iThoughts (QR codes used often also today – this could be categorized here)	iThoughts	IMAL, STL+	Pupils really use iThoughts! Teacher had accidentally placed app logos in the wrong order, so pupils did the exercises in the wrong order.
Math	1			Bee-Bot app		Bee-Bot app			Bee-Bot app	Coding! Super well organized, genuine collaboration and constructive dialogue. I was impressed! Unplugged and app today,
18:02. Math	1			BookCr. (teacher created money exercises)			Photos			Main activities non-digital
Stations (Norwegian, Math)	1			Bee-Bot app, Salaby	Bluebots	Bluebots (spelling)	iThoughts	iThoughts		Unplugged, app and robots. Problem-solving
Stations (Norwegian, Math, Playtime)	1		Storytelling w/ Bluebots (maybe a stretch to place it here)	Bee-Bot app	Blue-Bots in spelling	Bluebots	Bluebots			Again well planned, constructive dialogue, problem-solving (kids enjoyed when something went wrong), lots of engagement!
Total: 22	**1**	**9**	**2**	**19**	**16**	**3**	**19**	**19**	**15**	**Collaboratio, nroductivity and experimentation more offline. IT little in pupil-pupil**

										communication but a lot in teacher-pupil (multimodality, accessibility). Collaboration, problem solving, and diologue well instructed.

Observations categorized by main themes:
For what purpose were digital technologies used during the observed lessons?

Grade level	Reproduction of knowledge	Productivity, innovation, creativity, experimenting	Consuming content	Text production/ writing practice	Collaboration	Communication	Classroom management	Differentiated instruction
Grade 1 lessons	9	2	19	16	3	19	19	15
Grade 5 lessons	5	13	21	6	15	29	30	11
Total	**14**	**15**	**40**	**22**	**18**	**48**	**49**	**26**

Appendix 11: Observation coding (Grade 5)

Coding lessons (observation sheets), grade 5

Categories:

Reproduction of knowledge: Digital information literacy – pupils look up, evaluate, and/or use existing information and knowledge to answer questions or to create a presentation.

Productivity (innovation/creativity): Exploratory approach, attempting to solve a problem in an original way, experimenting

Consuming content: Pupils do not create anything of their own but consume existing content online (e.g. games, e-books)

Text production: Pupils use text editing software to produce, edit and share linear texts.

Collaboration: Digital technologies were used to collaborate on either contents, process or product

Communication: Teacher-pupil or pupil-pupil

Classroom management: Structure, organization, intervention

Differentiated instruction: Individualized instruction, pupil participation in choice of level (NB! Many assignments were designed in a way that the design itself allowed a differentiated approach)

For what purpose were digital technologies used during the observed lessons?

Lesson	Grade level	Reproduction of knowledge	Productivity (innovation/ creativity)	Consuming content	Text production	Collaboration	Communication	Classroom management	Differentiated instruction	Notes
22.01. Math	5			99Maths, Socrative, video, MultiSmart			Showbie, iThoughts	Classroom app, iThoughts, Showbie	Different levels - pupils choose (Showbie)	Variation I
Science	5					iPad + loop in groups,	iThoughts	iThoughts, Countdown		Lab report based on own findings
Nettvett (how to be smart and safe online)	5-6									Presentation – no pupil activity
English	5			YouTube, Quest			iThoughts	iThoughts	Audio support in texts but NO captions in video	Reproduction handwritten (notes)
23.01. Norwegian	5				Podcast script, story	Podcast script	iThoughts, Showbie	iThoughts, Showbie, Clock		NRK Supernytt at lunch; inappropriate use (drawing on a shared file)
24.01. Math	5			Multismart¤ving (video)			iThoughts	Clock, iThoughts		Photos to exemplify angles around us

										(teacher), exercises analog.
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity, innovation, creativity**	**Consuming content**	**Text production**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
Music	5		Micro:bit (coding music)			Micro:bit – coding music together	iThoughts	iThoughts		Next unit full analog music – variation!
Norwegian	5			AskiRaski, Nynorskordbok, Socrative			iThoughts, Showbie	iThoughts, Showbie	Lydhør, Photos (teacher shows on a book page where they're at)	
Math (repeat session)	5			Multismartøving (video)			iThoughts	Clock, iThoughts	"Cheat seat" (terminology w/ examples available for those in need), Lydhør (silent reading at the end of class), Multismartøving	Photos to exemplify angles around us (teacher), exercises analog.
27.01. Music	5			Background music for vocals, lyrics						
Math	5		Sphero			Sphero	iThoughts	iThoughts		Experimenting!
Social competence (social studies/ religion)	5		KorArti (music videos), iMovie	Pixabay		KorArti (music videos), iMovie	iThoughts	iThoughts		Creative!
29.01. Math	5			99math, Socrative, Factor (Cap.Damm)		Pupils could solve exercises together	iThoughts, Showbie, Expl.Everything (supporting discussion), Photos (exemplify)	iThoughts, Showbie, Clock, Expl.Everything		Lots of pupil participation and variation opportunities
Social Studies	5	Notes on word (template)		Info serches online (dig. lit.)			Classroom, Zulu, BookCreator (examples to support instruction)	Classroom, Zulu, iThoughts	Siri (slow writers/weak spellers could ask Siri)	A lot of traditional reproduction
English	5			Lokus.no, Quest, learnenglish.britishcouncil.com, Showbie			iThoughts, Showbie	iThoughts, Showbie	Translation aid for those in need, Lydhør	One pupil goofing w/ the exercise on Showbie; Are the goal and content/activities of the lesson matching?
30.01. Norwegian	5		Podcasts (literacy discussion)	Socrative			iThoughts, Photos (support)	iThoughts		Listened to podcasts and gave feedback altogether – perhaps other kind of solution

										next time? Under productivity/creativity, but strictly framed by teacher – is it really that? WHY podcast not discussed.
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity, innovation, creativity**	**Consuming content**	**Text production**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
Science	5	Googling: Brine shrimp notes and text in BookCr., Expl.EDU, Keynote, iMovie				Googling: Brine shrimp notes and text in BookCr., Expl.EDU, Keynote, iMovie	iThoughts, Showbie	iThoughts, Showbie		Focus on search strategies,; Digital presentations reproducing knowledge – potential to creativity mostly not used
03.02. Arts and crafts	5-7		Scratch (creating art by coding)				Showbie, Photos (examples)	iThoughts, Showbie, Classroom (to check that all screens are black),		Experimenting w/ Scratch!; Sharing w/ airplay
Music	5		Micro:bit			Micro:bit	iThoughts, Photos (examples of code chains to support discussion)	iThoughts		Experimenting, algorithmic thinking
04.02 Interdisciplinary (Norwegian and Social Studies)	5	Googling for info, notes, presentations in iMovie, KeyNote, BookCr.	(This is the ultimate goal of the unit)		Some for the presentation	Googling for info, notes, presentations in iMovie, KeyNote, BookCr.	Showbie, iThoughts	Showbie, iThoughts		Solving a real world problem; in one hour pupils went from instructions to deciding a theme and finding info to starting the presentation – too fast?
05.02. English	5	Posters on BookCr.	(Missed potential!)	Info and pics online	Some in BookCr. (for the poster)		iThoughts	iThoughts		Lot of unused potential in creativity side again – back to repeat the same old BC model; little discussion about the purpose and topic itself
Interdisciplinary (Norwegian and Social Studies)	5		Developing solutions for real world problems:			Developing solutions for real world problems:	Showbie	Showbie		Some groups considered previously used

			iMovie, Tynker+drones, WeDo 2.0 (Lego)			iMovie, Tynker+drones, WeDo 2.0 (Lego)				tools such as Sphero, BlueBots and MicroBit. Would have been a great opportunity!; Maker Space in use (batteries, little motors etc. in use)
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity, innovation, creativity, experimenting**	**Consuming content**	**Text production**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
Math	5		Geogebra (experimenting w/ triangles)	Multismartøving			iThoughts, Clock	iThoughts	MultiSmartøving	Problem-solving and critical thinking on Geogebra through experimentation – today weigth on that and less on core cont. knowl.
06.02. Interdisciplinary (Norwegian and Social Studies)	5		Tynker+drone, Podcast studio, iMovie, BookCr., KeyNote, OneNote (variating levels!)	NRK Super (documentary)	OneNote (podcast script)	Tynker+drone, Podcast studio, iMovie, BookCr., KeyNote, OneNote				Last lesson putting together solutions for real life problems. Nest time presentations.
07.02 Music	5		Micro:bit	Skaperskolen.no (but only getting the assignment in a form of a narrative video)		Micro:bit	iThoughts	iThoughts, Clock		Teacher more confident with this now – shows in CM!
Interdisciplinary (Norwegian and Social Studies)	5		(Presenting their innovations)			Presenting together (Tynker+drone, Podcast studio, iMovie, BookCr., KeyNote)	Presenting together (Tynker+drone, Podcast studio, iMovie, BookCr., KeyNote), Showbie	Showbie		Great project but a lot of unused potential. Problems, solutions and presentations were not discussed or reflected on – no time.
Math	5			MultiSmartØving			iThoughts, Photos and Geogebra (examples)	iThoughts, Clock, MultiSmartØving	MultiSmartØving	Teacher helps a lot and checks progress every now and then on MSØ
10.2. Arts and crafts	5-7		Art through coding: Scratch, Vinyl cutter (+PC)				Photos (examples), Showbie	Showbie, iThoughts		Experimenting, creativity; Sustainability:

										use leftover pieces of vinyl
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity, innovation, creativity, experimenting**	**Consuming content**	**Text production**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
12.02. Math	5			99math, MultiSmartØving, Socrative			iThougts	iThoughts, Clock	MultiSmartØving (Several lessons: ind. up and down!)	Teachers allow lots of flexibility and pupils' own choice in how they use iPad/paper in general – not just today!
Social Studies	5	BookCreator, GreenScreen tech. (Teleprompter app + camera)	Innovative presentation format? Experimenting w/ green screen tech – ultimately still reproducing knkowledge		BookCreator, Word	BookCreator, GreenScreen tech. (Teleprompter app + camera)	iThoughts, Showbie	iThoughts, Showbie, Classroom app		Lots of reproduction but experimenting with new solutions to presenting information
English	5			Quest Audio			iThoughts, GarageBand (students record themselves reading), Showbie	iThoughts, Showbie, Classroom app	Lydhør	Lydhør during DEAR time; inappropriate use of iPad – another teacher noticed and locked it, wasn't unlocked until a discussion
13.02. Science	5			NRK (newton series), ung.no			iThoughts	iThoughts		iThoughts not only at the beginning but also before transitions (some teachers do this often!); topic of the lesson was somewhat sensitive so I left halfway through to disrupt as little as possible; reproduction done again analogically – happens often w/ reproduction
17.02. Arts and crafts	5-7		Scratch (art through coding), vinyl cutter (heat press)	Scratch (those who were ready could play coding games)				Showbie, Clock	Scratch (game adaptive)	Impressed by classroom management in a technologically complext

										environment where pupils are very active.
Lesson	**Grade level**	**Reproduction of knowledge**	**Productivity, innovation, creativity, experimenting**	**Consuming content**	**Text production**	**Collaboration**	**Communication**	**Classroom management**	**Differentiated instruction**	**Notes**
28.02. Norwegian	5		Podcast?	AskiRaski	OneNote (writing a story)	Podcast				Podcast had potential that was used, but first time using it, so teacher chose to make strict frames
Total: 34	**5**	**5**	**13**	**21**	**6**	**15**	**29**	**30**	**11**	**Differentiation often "built in" in the task. Strategies little focused on 21st century comp. and more on foundational knowledge. E.g. lots of team work but little instruction here.**

Observations categorized by main themes:
For what purpose were digital technologies used during the observed lessons?

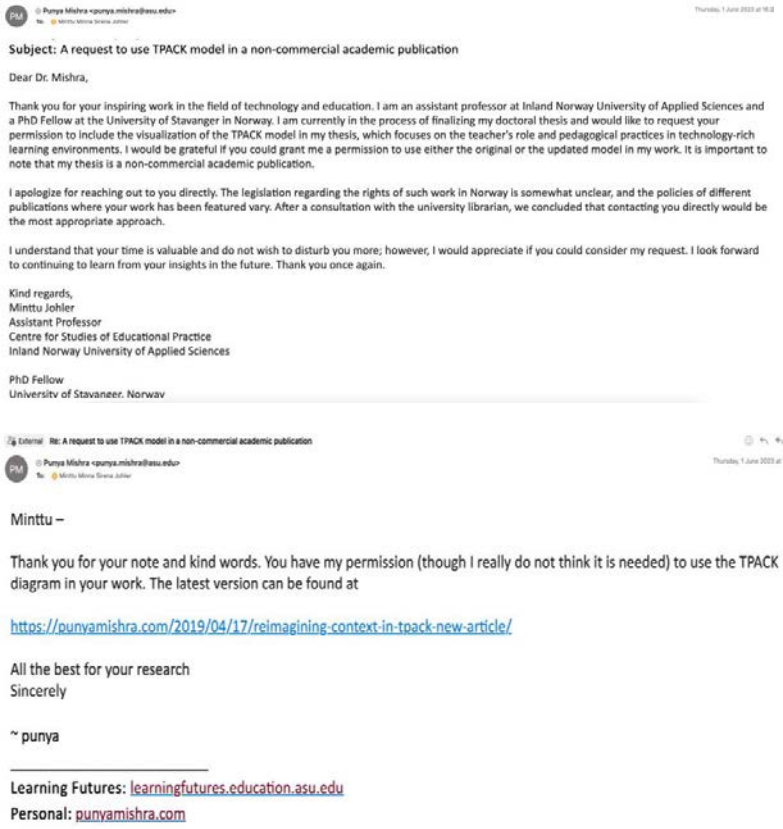
Grade level	Reproduction of knowledge	Productivity, innovation, creativity, experimenting	Consuming content	Text production/ writing practice	Collaboration	Communication	Classroom management	Differentiated instruction
Grade 1 lessons	9	2	19	16	3	19	19	15
Grade 5 lessons	5	13	21	6	15	29	30	11
Total	**14**	**15**	**40**	**22**	**18**	**48**	**49**	**26**

Appendix 12: Observation chart

Date	Time	Grade	Students (b/g)	Teacher	Subject	Theme
22/01/2020	08:15-9:15	Fifth	18 (12/6)	B	Mathematics	Quadrangles
22/01/2020	9:30-10:45	Fifth	20 (13/7)	L	Science	Lab report
22/01/2020	11:30-12:30	Fifth	37 (25/12)	B+L+R	(Visitor)	Netiquette
22/01/2020	12:40-13:45	Fifth	18 (12/6)	L	English	Dickens
23/01/2020	9:30-10:45	Fifth	17 (10/7)	R	Norwegian	Podcast, digra
24/01/2020	8:30-9:15	Fifth	17 (11/6)	R	Norwegian	Graphems, dig
24/01/2020	9:50-10:45	Fifth	18 (12/6)	B	Mathematics	Angles
24/01/2020	11:30-12:35	Fifth	17 (11/6)	B	Mathematics	Angles
24/01/2020	12:40-13:45	Fifth	13 (8/5)	L	Music	Micro:bit
27/01/2020	8:15-9:15	First	19 (7/12)	C+I	Norwegian	Letter H
27/01/2020	9:30-10:30	First	10 (4b/6g)	M	Science	Animals
27/01/2020	11:30-12:30	Fifth	20 (14/6)	B	Mathematics	Angles
27/01/2020	12:30-13:45	Fifth	37 (25/12)	L+R	Other	Prep for show
28/01/2020	8:15-9:15	First	28 (12/16)	M+C+I+T	Nor, Science	Stations
28/01/2020	9:50-10:40	Fifth	19 (11/8)	R	Norwegian	Consonants
28/01/2020	11:30-12:30	Fifth	(not rec.)	L	Soc. St. / Relig	Anti-bullying
29/01/2020	8:15-9:15	Fifth	19 (13/6)	B	Mathematics	Angles
29/01/2020	9:30-10:45	Fifth	18 (13/5)	B	Social studies	Counties
29/01/2020	12:40-13:45	Fifth	14 (9/5)	L	English	Conversation
30/01/2020	8:15-9:15	First	30 (13/17)	M+C+I+T	Nor, Science	Stations
30/01/2020	9:30-10:50	Fifth	17 (10/7)	R	Norwegian	Evaluation
30/01/2020	11:30-13:00	Fifth	20 (12/8)	L	Science	presentations
03/02/2020	8:15-9:15	First	11 (5/6)	C	Norwegian	New week /Let
03/02/2020	9:30-10:40	5th,6th,7th	16 (8/8)	B	Arts & crafts	Prog. in art
03/02/2020	11.30-12:30	First	10 (4/6)	I	Mathematics	0-20
03/02/2020	12:40-13:45	Fifth	15 (10/5)	L	Music	Micro:bit
04/02/2020	8:15-9:15	First	29 (12/17)	M+C+I+T	Nor, Science	Stations
04/02/2020	9:50-10:55	Fifth	21 (14/7)	L	Cross curr.	Global issues
04/02/2020	11:30-12:30	First	13 (5/8)	C+M	Mathematics	Tens, 0-20
05/02/2020	8:30-9:15	Fifth	20 (14/6)	B	Mathematics	Triangles
05/02/2020	9:30-10:45	Fifth	42 (x/y)	B+L	Cross curr.	Global issues
05.02.2020	12:40-13:45	Fifth	19 (13/6)	L	English	Recycle
06/02/2020	8:15-9:15	First	30 (12/18)	M+C+I	Soc. St. / Nor	Sami ppl
06/02/2020	9:30-10:35	Fifth	42 (x/y)	L+R	Cross curr.	Global issues
07/02/2020	8:30-9:15	Fifth	40 (x/y)	L+R	Cross curr.	Global issues
07/02/2020	9:50-10:50	Fifth	21 (14/7)	B	Mathematics	Missing angle
07/02/2020	11:30-12:25	First	10 (4/6)	C	Mathematics	nr story
07/02/2020	12:40-13:40	Fifth	19 (12/7)	L	Music	Micro:bit
10/02/2020	8:15-9:15	First	10 (4/6)	M	Norwegian	Letter L
10/02/2020	9:30-10:45	5th,6th,7th	15 (8/7)	B	Arts & crafts	Prog. in art
10/02/2020	11:30-12:35	First	10 (4/6)	I	Mathematics	10 to 20
11/02/2020	8:15-9:15	First	27 (11/16)	M+C+I	Nor, Science	Text
11/02/2020	9:30-10:35	First	27 (11/16)	M+C+I	Nor, Science	Text
11/02/2020	11:30-12:30	First	8 (3/5)	I	Mathematics	Music reh.
12/02/2020	8:15-9:15	Fifth	20 (14/6)	B	Mathematics	Angles
12/02/2020	9:30-10:40	Fifth	? (x/y)	B	Soc. Studies	Counties
12/02/2020	12:40-13:45	Fifth	19 (13/6)	L	English	Pronunciatior
13/02/2020	8:15-9:15	First	29 (12/17)	M+C+I	Nor, Science	Text
13/02/2020	9:30-10:30	First	29 (12/17)	M+C+I	Nor, Science	Text
13/02/2020	11:30-12:20	Fifth	20 (14/6)	L	Science	Puberty
17/02/2020	8:20-9:15	First	6 (1/5)	I	Norwegian	Letter N

Appendix 13: Permissions to use the visualizations

TPACK



Punya Mishra <punya.mishra@asu.edu>
To: Minttu Minna Sirena Johler

Thursday, 1 June 2023 at 16:3

Subject: A request to use TPACK model in a non-commercial academic publication

Dear Dr. Mishra,

Thank you for your inspiring work in the field of technology and education. I am an assistant professor at Inland Norway University of Applied Sciences and a PhD Fellow at the University of Stavanger in Norway. I am currently in the process of finalizing my doctoral thesis and would like to request your permission to include the visualization of the TPACK model in my thesis, which focuses on the teacher's role and pedagogical practices in technology-rich learning environments. I would be grateful if you could grant me a permission to use either the original or the updated model in my work. It is important to note that my thesis is a non-commercial academic publication.

I apologize for reaching out to you directly. The legislation regarding the rights of such work in Norway is somewhat unclear, and the policies of different publications where your work has been featured vary. After a consultation with the university librarian, we concluded that contacting you directly would be the most appropriate approach.

I understand that your time is valuable and do not wish to disturb you more; however, I would appreciate if you could consider my request. I look forward to continuing to learn from your insights in the future. Thank you once again.

Kind regards,
Minttu Johler
Assistant Professor
Centre for Studies of Educational Practice
Inland Norway University of Applied Sciences

PhD Fellow
University of Stavanger, Norway

External Re: A request to use TPACK model in a non-commercial academic publication

Punya Mishra <punya.mishra@asu.edu>
To: Minttu Minna Sirena Johler

Thursday, 1 June 2023 at 161

Minttu –

Thank you for your note and kind words. You have my permission (though I really do not think it is needed) to use the TPACK diagram in your work. The latest version can be found at

https://punyamishra.com/2019/04/17/reimagining-context-in-tpack-new-article/

All the best for your research
Sincerely

~ punya

Learning Futures: learningfutures.education.asu.edu
Personal: punyamishra.com

PDC / PfDK

Rights

Appendix 14: Sikt (NSD) Notification document

Meldeskjema / Using digital tools in primary education / Eksport

Meldeskjema

Referansenummer
476979

Hvilke personopplysninger skal du behandle?

- Navn (også ved signatur/samtykke)
- E-postadresse, IP-adresse eller annen nettidentifikator
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Beskriv hvilke bakgrunnsopplysninger du skal behandle

Informats job description will be revealed (principal, avdelingsleder or teacher) will be revealed. The municipality they work in might be revealed, as well as their gender, age (ballpark, not exact age) and their education and previous work experience within the field of education.

Prosjektinformasjon

Prosjekttittel

Using digital tools in primary education

Prosjektbeskrivelse

This case study aims to identify and analyse the influence of educational technology in a primary school setting. The focus is on teachers' perceptions regarding their role in the classroom and how they see the development of their role an thus, the pedagogy and methods they use in their everyday work. The data will be be collected through semi-structured interviews with teachers and school leaders, as well as through observation. Data about or from students will not be collcted, as the focus lies on teaching and pedagogy. The interviews will be executed in Norwegian and will be audio-recorded. Field notes, together with a semi-structured observation guide, will be used for the observation period. Audio-recording will not be used during the observations. The only personal data collected will be signatures for consent forms, as well as e-mail addresses for agreeing on interview and observation dates and times.

Dersom personopplysningene skal behandles til andre formål enn behandlingen for dette prosjektet, beskriv hvilke

N/A

Begrunn hvorfor det er nødvendig å behandle personopplysningene

I need teachers' and school leader's consent (signature) in the documentation, and need their contact information (e-mail address is sufficient) in order to communicate with them about times and dates, as well as to provide other information about the study. In addition to this, although this study focuses on pedagogy and teaching practices, teachers may for example name or in other ways describe colleagues or students in recorded interviews the way that could make them recognizable.

Prosjektbeskrivelse

NSD - Prosjektbeskrivelse, Johler.pdf

Ekstern finansiering
Ikke utfyllt
Type prosjekt
Forskerprosjekt

Behandlingsansvar

Behandlingsansvarlig institusjon

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)
Minttu Johler, minttu.johler@uis.no, tlf: 4679 5989

Skal behandlingsansvaret deles med andre institusjoner (felles behandlingsansvarlige)?
Nei

Utvalg 1

Beskriv utvalget

School leaders (rektor, avdelingsleder)

Beskriv hvordan rekruttering eller trekking av utvalget skjer

I have met the "pedagogisk IKT-rådgiver" of Stavanger municipality on a few occasions, as well as had e-mail contact with her. She is very positive about being the link between me and the schools in Stavanger and aiding me in finding a school that wishes to collaborate with me in this study. Should this not lead to finding a school to collaborate with, it is also possible to use my network of colleagues and "praksisskoler" of UiS, as I become acquainted with many school heads and teachers while teaching pedagogy at UiS years 2017-2018.

Alder
18 - 75

Personopplysninger for utvalg 1
- Navn (også ved signatur/samtykke)
- E-postadresse, IP-adresse eller annen nettidentifikator
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Hvordan samler du inn data fra utvalg 1?

Personlig intervju

Vedlegg

Intervjuguide, skoleleder.pdf

Grunnlag for å behandle alminnelige kategorier av personopplysninger
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Informasjon for utvalg 1

Informerer du utvalget om behandlingen av personopplysningene?
Ja

Hvordan?
Skriftlig informasjon (papir eller elektronisk)

Informasjonsskriv

Forespørsel om deltakelse 27112019.pdf

Utvalg 2

Beskriv utvalget

Teachers

Beskriv hvordan rekruttering eller trekking av utvalget skjer

I have met the "pedagogisk IKT-rådgiver" of Stavanger municipality on a few occasions, as well as had e-mail contact with her. She is very positive about being the link between me and the schools in Stavanger and aiding me in finding a school that wishes to collaborate with me in this study. Should this not lead to finding a school to collaborate with, it is also possible to use my network of colleagues and "praksisskoler" of UiS, as I become acquainted with many school heads and teachers while teaching pedagogy at UiS years 2017-2018.

Alder
18 - 75

Personopplysninger for utvalg 2
- Navn (også ved signatur/samtykke)

- E-postadresse, IP-adresse eller annen nettidentifikator
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Hvordan samler du inn data fra utvalg 2?

Personlig intervju

Vedlegg

Intervjuguide lærere.pdf

Grunnlag for å behandle alminnelige kategorier av personopplysninger
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Ikke-deltakende observasjon

Grunnlag for å behandle alminnelige kategorier av personopplysninger
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Informasjon for utvalg 2

Informerer du utvalget om behandlingen av personopplysningene?
Ja

Hvordan?
Skriftlig informasjon (papir eller elektronisk)

Informasjonsskriv

Forespørsel om deltakelse 27112019.pdf

Tredjepersoner

Skal du behandle personopplysninger om tredjepersoner?
Nei

Dokumentasjon

Hvordan dokumenteres samtykkene?
- Manuelt (papir)

Hvordan kan samtykket trekkes tilbake?

Informants can withdraw their consent by sending me an email.

Hvordan kan de registrerte få innsyn, rettet eller slettet personopplysninger om seg selv?

The informants can upon request view the transcriptions of personal interviews. No personal data will be collected during the observation period.

Totalt antall registrerte i prosjektet
1-99

Tillatelser

Skal du innhente følgende godkjenninger eller tillatelser for prosjektet?
Ikke utfyllt

Behandling

Hvor behandles personopplysningene?

- Maskinvare tilhørende behandlingsansvarlig institusjon

Hvem behandler/har tilgang til personopplysningene?
- Prosjektansvarlig
- Interne medarbeidere
- Eksterne medarbeidere/samarbeidspartnere innenfor EU/EØS

Tilgjengeliggjøres personopplysningene utenfor EU/EØS til en tredjestat eller internasjonal organisasjon?
Nei

Sikkerhet

Oppbevares personopplysningene atskilt fra øvrige data (koblingsnøkkel)?
Ja

Hvilke tekniske og fysiske tiltak sikrer personopplysningene?
- Personopplysningene anonymiseres fortløpende
- Endringslogg
- Adgangsbegrensning
- Andre sikkerhetstiltak
- Opplysningene krypteres under lagring

Hvilke

Automatic screen lock on data controller's personal computer, use of encrypted external data storage

Varighet

Prosjektperiode
01.12.2019 - 31.07.2023

Hva skjer med dataene ved prosjektslutt?
Data anonymiseres (sletter/omskriver personopplysningene)

Hvilke anonymiseringstiltak vil bli foretatt?
- Koblingsnøkkelen slettes
- Personidentifiserbare opplysninger fjernes, omskrives eller grovkategoriseres
- Lyd- eller bildeopptak slettes

Vil de registrerte kunne identifiseres (direkte eller indirekte) i oppgave/avhandling/øvrige publikasjoner fra prosjektet?
Nei

Tilleggsopplysninger

After analysing the data from interviews and observation, it has become necessary to use a survey to collect answers from all teachers in the school where the interviews and observation were carried out, in order to add validity of this study. Therefore, I wish to carry out an anonymous survey that the teachers fill out digitally (via SurveyMonkey). No personal data will be collected. The school leadership team will have access to the multiple choice results in order to develop their pedagogical practices, but they will not have access to the infromation about teachers or their written answers and comments.

A draft for the survey, as well as information for the participants can be found attached.

Due to a couple of extensions in the PhD period, the new expected end date for the project is May 4, 2022.

Due to unforeseen circumstances, the project period was extended to last until July 6, 2022, but the PhD work will not be finished by then. I will inform the informants of the study about this with an e-mail.

Andre vedlegg

Infoskriv - survey.docx

Spørreskjema 1.0.docx

Appendix 15: Sikt (NSD) approval

Meldeskjema / Using digital tools in primary education / Vurdering

Vurdering av behandling av personopplysninger

Referansenummer	Vurderingstype	Dato
476979	Standard	28.11.2019

Prosjekttittel
Using digital tools in primary education

Behandlingsansvarlig institusjon
Universitetet i Stavanger / Fakultet for utdanningsvitenskap og humaniora / Institutt for grunnskolelærerutdanning, idrett og spesialpedagogikk

Prosjektansvarlig
Minttu Johler

Prosjektperiode
01.12.2019 - 01.02.2022

Kategorier personopplysninger
Alminnelige

Lovlig grunnlag
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Behandlingen av personopplysningene er lovlig så fremt den gjennomføres som oppgitt i meldeskjemaet. Det lovlige grunnlaget gjelder til 01.02.2022.

Meldeskjema

Kommentar
Our assessment is that the processing of personal data in this project will comply with data protection legislation, so long as it is carried out in accordance with what is documented in the Notification Form and attachments, dated 28.11.2019, as well as in correspondence with NSD. Everything is in place for the processing to begin.

NOTIFY CHANGES
If you intend to make changes to the processing of personal data in this project it may be necessary to notify NSD. This is done by updating the information registered in the Notification Form. On our website we explain which changes must be notified. Wait until you receive an answer from us before you carry out the changes.

TYPE OF DATA AND DURATION
The project will be processing general categories of personal data until 01.02.2022.

LEGAL BASIS
The project will gain consent from data subjects to process their personal data. We find that consent will meet the necessary requirements under art. 4 (11) and 7, in that it will be a freely given, specific, informed and unambiguous statement or action, which will be documented and can be withdrawn. The legal basis for processing personal data is therefore consent given by the data subject, cf. the General Data Protection Regulation art. 6.1 a).

PRINCIPLES RELATING TO PROCESSING PERSONAL DATA
NSD finds that the planned processing of personal data will be in accordance with the principles under the General Data Protection Regulation regarding:

- lawfulness, fairness and transparency (art. 5.1 a), in that data subjects will receive sufficient information about the processing and will give their consent
- purpose limitation (art. 5.1 b), in that personal data will be collected for specified, explicit and legitimate purposes, and will not be processed for new, incompatible purposes
- data minimisation (art. 5.1 c), in that only personal data which are adequate, relevant and necessary for the purpose of the project will be processed

- storage limitation (art. 5.1 e), in that personal data will not be stored for longer than is necessary to fulfil the project's purpose

THE RIGHTS OF DATA SUBJECTS
Data subjects will have the following rights in this project: transparency (art. 12), information (art. 13), access (art. 15), rectification (art. 16), erasure (art. 17), restriction of processing (art. 18), notification (art. 19), data portability (art. 20). These rights apply so long as the data subject can be identified in the collected data.

NSD finds that the information that will be given to data subjects about the processing of their personal data will meet the legal requirements for form and content, cf. art. 12.1 and art. 13.

We remind you that if a data subject contacts you about their rights, the data controller has a duty to reply within a month.

FOLLOW YOUR INSTITUTION'S GUIDELINES
NSD presupposes that the project will meet the requirements of accuracy (art. 5.1 d), integrity and confidentiality (art. 5.1 f) and security (art. 32) when processing personal data.

To ensure that these requirements are met you must follow your institution's internal guidelines and/or consult with your institution (i.e. the institution responsible for the project).

FOLLOW-UP OF THE PROJECT
NSD will follow up the progress of the project at the planned end date in order to determine whether the processing of personal data has been concluded.

Good luck with the project!

Contact person at NSD: Eva J B Payne
Data Protection Services for Research: +47 55 58 21 17 (press 1)

Appendix 16: Sikt (NSD) Extension notification

Meldeskjema

Referansenummer
476979

Hvilke personopplysninger skal du behandle?

- Navn (også ved signatur/samtykke)
- E-postadresse, IP-adresse eller annen nettidentifikator
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Beskriv hvilke bakgrunnsopplysninger du skal behandle

Informats job description will be revealed (principal, avdelingsleder or teacher) will be revealed. The municipality they wo rk in might be revealed, as well as their gender, age (ballpark, not exact age) and their education and previous work experience within the field of education.

Prosjektinformasjon

Prosjekttittel

Using digital tools in primary education

Prosjektbeskrivelse

This case study aims to identify and analyse the influence of edu cational technology in a primary school setting. The focus is on teachers' perceptions regarding their role in the classroom and how they see the development of their role an thus, the peda gogy and methods they use in their everyday work. The data will be be collected through semi-structu red interviews with teachers and sch ool leaders, as well as through observation. Data about or from students will not be collcted, as the focu s lies on teaching and pedagogy. The interviews will be executed in Norwegian and will be audio-recor ded. Field notes, together with a semi-struct ured observation guide, will be used for the observation period. Audio-recording will not be used during the observations. The only personal data collected will be signatures for consent forms, as well as e-mail addresses for agreeing on interview and observation dates and times.

Dersom personopplysningene skal behandles til andr e formål enn behandlingen for dett e prosjektet, beskriv hvilke

N/A

Begrunn hvorfor det er nødvendig å behandle personopplysningene

I need teachers' and school leader's consent (signature) in the documentation, and need t heir contact information (e-mail address is sufficient) in order to communicate with them about t imes and dates, as well as to provide other inform ation about the study. In addition to this, although this study focuses on pedagogy and teaching practices, teachers may for example name or in other ways describe colleagues or students in recorded interviews the way that could make them recognizable.

Prosjektbeskrivelse

NSD - Prosjektbeskrivelse, Johler.pdf

Ekstern finansiering
Ikke utfyllt
Type prosjekt
Forskerprosjekt

Behandlingsansvar

Behandlingsansvarlig institusjon

Prosjektansvarlig (vitenskapelig ansatt/ veileder eller stipendiat)
Minttu Johler, minttu.johler@uis.no, tlf: 4679 5989

Skal behandlingsansvaret deles med andre institusjoner (felles behandlingsansv arlige)?
Nei

Utvalg 1

Beskriv utvalget

School leaders (rektor, avdelingsleder)

Beskriv hvordan rekruttering eller trekking av utvalget skjer

I have met the "pedagogisk IKT-rådgiver" of Stavanger municipality on a few occasions, as well as had e-mail contact with her. She is very positive about being the link between me and the schools in Stavanger and aiding me in finding a school that wishes to collaborate with me in this study. Should this not lead to finding a school to collaborate with, it is also possible to use my network of colleagues and "praksisskoler" of UiS, as I become acquainted with many school heads and teachers while teaching pedagogy at UiS years 2017-2018.

Alder
18 - 75

Personopplysninger for utvalg 1
- Navn (også ved signatur/samtykke)
- E-postadresse, IP-adresse eller annen nettidentifikator
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Hvordan samler du inn data fra utvalg 1?

Personlig intervju

Vedlegg

Intervjuguide, skoleleder.pdf

Grunnlag for å behandle alminnelige kategorier av personopplysninger
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Informasjon for utvalg 1

Informerer du utvalget om behandlingen av personopplysningene?
Ja

Hvordan?
Skriftlig informasjon (papir eller elektronisk)

Informasjonsskriv

Forespørsel om deltakelse 27112019.pdf

Utvalg 2

Beskriv utvalget

Teachers

Beskriv hvordan rekruttering eller trekking av utvalget skjer

I have met the "pedagogisk IKT-rådgiver" of Stavanger municipality on a few occasions, as well as had e-mail contact with her. She is very positive about being the link between me and the schools in Stavanger and aiding me in finding a school that wishes to collaborate with me in this study. Should this not lead to finding a school to collaborate with, it is also possible to use my network of colleagues and "praksisskoler" of UiS, as I become acquainted with many school heads and teachers while teaching pedagogy at UiS years 2017-2018.

Alder
18 - 75

Personopplysninger for utvalg 2
- Navn (også ved signatur/samtykke)

- E-postadresse, IP-adresse eller annen nettidentifikator
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Hvordan samler du inn data fra utvalg 2?

Personlig intervju

Vedlegg

Intervjuguide lærere.pdf

Grunnlag for å behandle alminnelige kategorier av personopplysninger
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Ikke-deltakende observasjon

Grunnlag for å behandle alminnelige kategorier av personopplysninger
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Informasjon for utvalg 2

Informerer du utvalget om behandlingen av personopplysningene?
Ja

Hvordan?
Skriftlig informasjon (papir eller elektronisk)

Informasjonsskriv

Forespørsel om deltakelse 27112019.pdf

Tredjepersoner

Skal du behandle personopplysninger om tredjepersoner?
Nei

Dokumentasjon

Hvordan dokumenteres samtykkene?
- Manuelt (papir)

Hvordan kan samtykket trekkes tilbake?

Informants can withdraw their consent by sending me an email.

Hvordan kan de registrerte få innsyn, rettet eller slettet personopplysninger om seg selv?

The informants can upon request view the transcriptions of personal interviews. No personal data will be collected during the observation period.

Totalt antall registrerte i prosjektet
1-99

Tillatelser

Skal du innhente følgende godkjenninger eller tillatelser for prosjektet?
Ikke utfyllt

Behandling

Hvor behandles personopplysningene?

- Maskinvare tilhørende behandlingsansvarlig institusjon

Hvem behandler/har tilgang til personopplysningene?
- Prosjektansvarlig
- Interne medarbeidere
- Eksterne medarbeidere/samarbeidspartnere innenfor EU/EØS

Tilgjengeliggjøres personopplysningene utenfor EU/EØS til en tredjestat eller internasjonal organisasjon?
Nei

Sikkerhet

Oppbevares personopplysningene atskilt fra øvrige data (koblingsnøkkel)?
Ja

Hvilke tekniske og fysiske tiltak sikrer personopplysningene?
- Personopplysningene anonymiseres fortløpende
- Endringslogg
- Adgangsbegrensning
- Andre sikkerhetstiltak
- Opplysningene krypteres under lagring

Hvilke

Automatic screen lock on data controller's personal computer, use of encrypted external data storage

Varighet

Prosjektperiode
01.12.2019 - 31.07.2023

Hva skjer med dataene ved prosjektslutt?
Data anonymiseres (sletter/omskriver personopplysningene)

Hvilke anonymiseringstiltak vil bli foretatt?
- Koblingsnøkkelen slettes
- Personidentifiserbare opplysninger fjernes, omskrives eller grovkategoriseres
- Lyd- eller bildeopptak slettes

Vil de registrerte kunne identifiseres (direkte eller indirekte) i oppgave/avhandling/øvrige publikasjoner fra prosjektet?
Nei

Tilleggsopplysninger

After analysing the data from interviews and observation, it has become necessary to use a survey to collect answers from all teachers in the school where the interviews and observation were carried out, in order to add validity of this study. Therefore, I wish to carry out an anonymous survey that the teachers fill out digitally (via SurveyMonkey). No personal data will be collected. The school leadership team will have access to the multiple choice results in order to develop their pedagogical practices, but they will not have access to the infromation about teachers or their written answers and comments.

A draft for the survey, as well as information for the participants can be found attached.

Due to a couple of extensions in the PhD period, the new expected end date for the project is May 4, 2022.

Due to unforeseen circumstances, the project period was extended to last until July 6, 2022, but the PhD work will not be finished by then. I will inform the informants of the study about this with an e-mail.

Andre vedlegg

Infoskriv - survey.docx

University of Stavanger

4036 Stavanger
Tel: +47 51 83 10 00
E-mail: post@uis.no
www.uis.no

ISBN: 978-82-8439-197-7
ISSN: 1890-1387