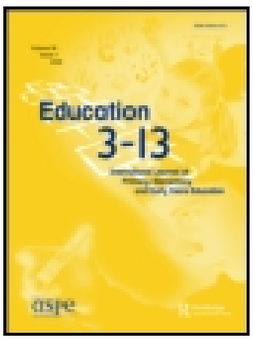

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Minttu Johler & Rune Johan Krumsvik

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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.

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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.

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