The use of digital technology for differentiation of teaching in early school years

Gunilla Sandberg,★ Pernilla Kallberg, & Tina Hellblom-Thibblin
Mälardalen University, Sweden

Abstract

This study is interested in teachers' use of digital technology for differentiation of teaching in early school years, focusing in particular on teaching reading and writing. The study is qualitative in nature and is based on field studies in grade 2 (aged eight), along with focus groups involving teachers who work with and around pupils. Two research questions have served as a guideline for the study: 1. What characterises teachers' experiences and didactic usage of digital technology when teaching children (to read and write), and 2. How is digital technology used to promote different dimensions of reading and writing processes? The empirical material has been analysed through thematic analyses and with Luke and Freebody's four resourses model as a theoretical perspective. The results show that teachers use digital technology to differentiate teaching in various ways; by illustrating, motivating, individualising and making the didactic content accessible, for example. Digital technology is used when teaching children to read and write in order to promote both individual skills and activities promoting communication and creating meaning. Digital technology appears to provide opportunities for teachers to offer particular support within the classroom framework and offer pupils tasks at custom levels, thereby helping to provide a more inclusive didactic space. This study highlights teachers' somewhat ambivalent approach and balancing of different didactic choices in relation to digital technology.

Keywords: *differentiation; digital technology; case study; primary school; teaching reading and writing*

Introduction

In Sweden, like the rest of the western world, the use of digital technology for educational purposes is becoming increasingly prevalent at all levels. This is giving rise to greater research interest in how the technology is used and how its usage influences teachers' teaching and pupils' learning and development. The study used as a basis

---

*Correspondence: Gunilla Sandberg, e-mail: gunilla.sandberg@mdu.se

for this article uses classroom observations and focus groups involving teachers in order to examine how digital technology is used as a didactic tool in order to differentiate teaching, focusing in particular on teaching children to read and write. "Differentiated" in this regard means that teaching identifies, observes and meets pupils' different requirements, experiences and needs in a manner that does not exclude anyone (Algozzine & Anderson, 2007).

The Swedish curriculum for primary schools, Lgr11 (Swedish National Agency for Education, 2019) states that all pupils must be given opportunities to develop their digital capabilities, including a critical and responsible attitude towards digital technology, as well as creative and practical use of technology in order to translate ideas and resolve problems. For Year 3 pupils (aged nine), the course syllabi in Swedish indicate that pupils must be able to "write simple texts with legible handwriting and on a computer".

The aim of the study is to deepen the understanding of how digital technology is used in the didactic work of teachers with differentiating teaching in early school years, with particular emphasis on teaching pupils to read and write.

The aim is concretised in two questions:

– What characterises teachers' experiences and didactic usage of digital technology when teaching children (to read and write)?
– How is digital technology used to promote different dimensions of reading and writing processes?

Digital technology when teaching children to read and write

The route to mastering the written language is not the same for all pupils. Some pupils learn to read and write by taking part in reading and writing activities, while other pupils meet lots of obstacles (Adams, 2000). Research demonstrates the value of ensuring that formally teaching children to read and write early on provides good balance between activities that aim to develop the individual and the technical dimension as well as the dimension that promotes communication and creates meaning (Seidenberg, 2013; Snow & Juel, 2005; Taube et al., 2015). Digital technology can be used to promote these different dimensions of reading and writing.

Research into digital technology in relation to teaching children to read and write provides a multifaceted picture of how digital technology promotes the development of reading and writing (Maor et al., 2011; Taube et al., 2015), It appears that the composite image that emerges can be explained by the fact that research is conducted in various disciplines with different perspectives and theories, such as cognitive psychology or sociocultural theory (Wollscheild, et al., 2016). Research into writing by hand versus typing on a keyboard is one interesting example of this. A number of studies show that writing by hand is beneficial for thinking and learning, which can – for example – be explained by the fact that the brain is engaged in a different manner compared to typing on a keyboard (Mangen & Balsvik, 2016; Wollscheild, et al., 2016). The value of digital writing is emphasised from a research arena that focuses

more on sociocultural concerns. Reading and writing always take place in a social context, and digital writing takes on major significance in our contemporary digitalised landscape (Clarke & Abbott, 2016). A number of studies conclude that digital technology stimulates pupils to write in a richer, more developed, more creative manner (Dahlström & Boström, 2017; Takala, 2013).

This article is based on an empirical study conducted at a school that focused on the Writing to Reading method [Swedish: Att Skriva sig Till Läsning, ASL] from Year 1 onwards. ASL as a model for teaching pupils to read and write that has had a major impact on Swedish schools since being introduced to Sweden by Trageton (2014). This method is based on pupils working in pairs on a computer. Using the computer as a writing instrument allows pupils to focus on learning to read, which is considered to benefit many pupils. Another highlighted advantage is the fact that children write according to their personal interest, which seems to increase their motivation to write. In one of the studies that have examined that method, Hultin and Westman (2013) have shown that students wrote longer, more structurally sound texts when they used spelling programmes as support. Another finding in their study was that digitalisation seems to have influenced the didactic approaches of teachers. In another research project, Takala (2013) interviewed Finnish teachers and pupils to examine how they use ASL, and what experience they have of the method. The results of this study indicate that teachers use the method as a complement to reading and writing lessons that are more traditional in nature. The method inspired pupils to develop their own writing as it is based on their interests and levels of knowledge. According to the teachers in the study, the method was suitable for pupils in need of particular support as different settings on the computer can be adapted to meet the needs of every pupil. Another result of the study showed that pupils developed their social and communicative abilities as the method is based on cooperation between two pupils. Takala is of the opinion that ASL can be referred to as an inclusive method as it promotes individualisation and pupils do not need to leave their classroom. A slightly different picture emerges in a longitudinal intervention study (Fredriksson & Rasmusson, 2019) which shows that there are no significant differences in results between groups of pupils taught using a variant of ASL and the group offered traditional teaching on how to read and write without the use of digital tools. What emerges is that the control group scored slightly higher in tests measuring word recognition and decoding, while the members of the project group appear to have developed their writing to a greater extent.

One variant of ASL is what is normally referred to as Writing to Learning [Swedish: Skriva sig Till Lärande, STL]. This method was examined by Agélii Genlott and Grönlund (2016). The study compares results from 502 pupils in the national tests in Swedish and mathematics for Year 3 in relation to three different teaching models for the first three school years (1. teaching with STL, 2. teaching without digital technology, and 3. teaching with elements of digital technology). The study shows that pupils who worked according to STL achieved their goals in mathematics and Swedish for Year 3 to a greater extent than the pupils who worked in with digital technology a

more disorganised fashion and the pupils who worked without digital technology at all. The STL model also appears to help reduce the differences between high-performing and low-performing pupils.

Digital tools for pupils in need of support

Assistive support through digital technology is considered to be of major significance to pupils who are vulnerable in terms of reading and writing development. The digital tools can be used to offer these pupils customised working methods, tasks and technical tools that compensate for impaired ability or function; with decoding, for example (Gustafson et al., 2011; Maor et al., 2011). Research shows, for example, that the use of apps promotes learning and well-being among pupils in need of particular support (Burke & Hughes, 2018; Lindeblad, 2018). The advantage of the apps is that they can be used everywhere, thereby reducing unnecessary segregated teaching and stigmatisation and helping pupils to get more out of the teaching (Nordstöm et al., 2019). Thus it can be stated that research supports the fact that the use of digital technology leads to greater inclusion when teaching pupils to read and write, with the reservation that inclusion is a term that can be defined and understood in different ways (see, for example, Nilholm & Göransson, 2017). One way of understanding inclusion is that reflected in the study by Forsling (2019), where teachers in primary school worked on the basis of all pupils when planning and organising reading and writing situations with digital tools, and this had a positive influence on pupils in need of particular support.

Teachers' skills are a key factor when it comes to teaching children to read and write. A theoretical knowledge of the complexity of the reading and writing process is needed, along with an ability to forge relationships with empathy and respect in order to promote pupils' written language development (Alatalo, 2011; Snow & Juel, 2005). As regards digital technology, support and training are also needed for teachers if they are to achieve positive results in respect of reading and writing development in their pupils, particularly for pupils who are in need of particular support (Archer et al., 2014).

Theory

One way of defining reading is through what is known as "The Simple View of Reading" (Gough & Tunmer, 1986); that is to say, reading is regarded as a product of two interacting processes, decoding and language comprehension ($D \times L = R$). Decoding refers to the process that converts the alphabetical code, grapheme to phoneme. This is regarded as a prerequisite for development of reading to higher levels, and is a critical factor in relation to difficulties with reading and writing. Language comprehension in the model is related to how the message in the text read is processed and interpreted. This complex process involves a range of cognitive processes (working memory and phonological, syntactical and morphological awareness) that are important for reading comprehension and the skills that underpin reading

comprehension. For successful reading and writing instruction in the early years of school, both of those dimensions have to be addressed and promoted in what can be called balanced instruction or integrated instruction. (Seidenberg, 2013; Snow & Juel, 2005; Taube et al., 2015).

The model by Freebody et al. (1991) works on the basis of the fact that reading and writing are made up of different dimensions, and that reading and writing can be understood as both an individual skill and a social activity. This model describes four different resources that must be offered in teaching practice to allow pupils to develop effective reading and writing: 1) The reader as a decoder, 2) The reader as a text participant, 3) The reader as a text user, and 4) The reader as a text analyst. This model can be used to observe how working methods are used to promote these different dimensions in the development of reading and writing; in this study, highlighting digital technology when teaching pupils to read and write.

Method

The study that forms the basis for this article is part of a research project looking at digital technology in early school years. This study is designed as a case study using ethnographically inspired collection methods; participative observations, informal chats and interviews (Parker-Jenkins, 2018).

Participants

In this study, the school environment studied is a primary school in a small town. The composition of pupils at this school in terms of gender, ethnicity, class and functionality is heterogeneous. The study participants are 56 grade 2 pupils divided into two classes: class 2:1 with 28 pupils and class 2:2 with 28 pupils, four class teachers who work directly with the pupils, one head teacher, one advanced skills teacher and one special needs teacher. The observations primarily focus on the four classes' teachers and their pupils but also other adults working the classrooms, including special needs teachers, mother tongue teachers and after-school centre staff.

Before the study began, the school was visited by the researchers on two occasions. At those meetings, participating teachers were informed about the study and the ethical considerations of research studies in general. Interested teachers were personally contacted to be notified of the study's purpose, invited to participate in the larger research project on digital technology and made aware of the ethics of their participation (Swedish Research Council, 2017), which have been followed accurately and strictly in the study. This means, among other things, that it will not be possible to identify individuals, schools or municipalities when the results are reported and presented and that collected data are used only for this research project. Individually, in person the participating teachers were verbally asked about participation. They were informed initially and in connection with observations and focus groups that they could end their participation at any time without giving a reason.

After the teachers and the school management approved the study, the researchers visited the classrooms and informed the students about the research. Students were collectively asked to permit the researcher to observe their classroom, and the request was repeated for each additional observation. Written permission from the parents was awaited before the classroom observations began. The small number of pupils whose parents did not give permission have not been included in any observations or discussions.

Data collection

The empirical study was conducted during the 2019/2020 academic year. Monitoring the teaching made it possible to gain a more in-depth understanding of what happens in the specific school environment included in the study (Walford, 2008). The observations were conducted by author 1 during lessons in different subjects (Swedish, mathematics, social studies, general science) in the two classrooms, focusing in particular on digital technology relating to teaching reading and writing. Although Swedish was not on the timetable, various elements of reading and writing were included in more or less all the lessons observed. The observations were documented with field notes and photographs using digital notes software. On occasions, the observations were followed by informal chats with teachers, either individually or in a group. A total of approx. 30 hours, distributed evenly between the two classes, was spent on observing lessons (including breaks and informal chats).

Four focus groups with teachers were conducted during this study. This is a highly appropriate method for examining how teachers talk about their everyday didactic practice. As they talk not to the researcher, but to one another in the first instance, the interaction between them may lead to more in-depth reasoning in respect of the phenomenon on which the discussion is based (Wilkinson, 1998). The focus groups were conducted with slightly different compositions, see table 1. The plan was to involve four class teachers in focus group 3, but two of them were unable to participate due to an emergency at the school. Although the number of participants was less than planned, the conversation was assessed to be a valuable contribution and is therefore included in the empirical data. The focus groups were moderated by author 2, and during the conversations, the following topics were discussed: digital technology in teaching, digital skills and needs, digital technology and relationships, digital technology and professional roles. In the fourth focus group, a discussion about the impact of COVID-19 was added. The focus groups talked for 30 to 60 minutes. They were recorded and transcribed by the moderator directly afterwards. The participants in the focus groups were colleagues working closely together. Braun and Clarke (2013) noted that this can affect the findings. On one hand, an open and in-depth discussion may be hindered if participants find it inconvenient to share their opinions with colleagues, but on the other, being among people who are familiar may lead to feelings of security and, thus, to a deeper and more meaningful conversation. According to the authors, it depends to a large extent on the kind of topic discussed

in the focus groups. The issues discussed in the present focus groups involve teachers' didactic work with digital technology and, thereby, are not of a sensitive or personal nature. Therefore, the composition of the focus groups with colleagues is not considered to negatively affect the results.

Table 1. Data collection

Observations
OBS1. Observation of teaching in classes 2:1 and 2:2
OBS2. Observation of teaching in classes 2:1 and 2:2
OBS3. Observation of teaching in classes 2:1 and 2:2
OBS4. Observation of teaching in classes 2:1 and 2:2
OBS5. Observation of teaching in class 2:1
OBS6. Observation of teaching in class 2:2
Focus groups
FG1. Participants: Four class teachers, one special needs teacher, one head teacher, one advanced skills teacher
FG2. Participants: Four class teachers
FG3. Participants: Two class teachers
FG4. Participants: One head teacher, one special needs teacher, one advanced skills teacher

Data analysis

The empirical data has been processed and analysed in accordance with a thematic analysis model developed by Braun and Clarke (2006, 2019). This form of thematic analysis involves qualitative, creative and reflexive interpretation of the data collected: "a qualitative data analysis is about telling 'stories', about interpreting, and creating" (Braun & Clarke, 2019, p. 591). In the thematic analysis advocated by Braun and Clarke, a theme is understood as a pattern of collective representations or opinions in the data. Although the analysis process – which is emphasised by the authors – does not involve strictly following a linear process, it is possible to distinguish different steps as follows: 1) Becoming acquainted with the data; 2) Coding the data; 3) Creating preliminary themes; 4) Reviewing the themes; 5) Defining and naming the themes; 6) Writing a report.

The empirical material, was analysed by author 1 and, beginning with Step 4, presented to and discussed with the other authors. The empirical material, i.e. field notes from observations and transcriptions from the focus groups, was mainly analysed by author 1, who performed the coding and identification of the broader patterns, i.e., the candidate themes. These were then presented to and reviewed by authors 2 and 3 on two occasions. The review and the subsequent discussions among the three authors led to bringing together several themes, and names for the different themes were determined.

The thematic analysis generated five themes: 1) Explain, illustrate and instruct; 2) Motivate and inspire; 3) Map and individualise; 4) Make accessible and equalize; 5) Stay at the cutting edge and feel anxious. Each theme is illustrated with quotations from the focus groups and examples from field notes compiled during the observations in the classrooms.

Results

The teachers in the study work at a school that actively focuses on continuing education and creating conditions for didactic development of digital technology. So, for example, the classrooms are equipped with smartboards, a document camera and a digital clock/timekeeper. All pupils are assigned iPads, which are kept in school, when they start Year 1. Two teachers work in every class at the school. There are other members of staff as well (a special needs teacher, native language teacher, out-of-school centre staff, pupil assistants) who work in the classrooms occasionally in order to provide pupils with support.

1. Explain, illustrate and instruct

The first theme is all about how the teachers in the study use the digital technology to *explain* and *illustrate* the didactic content and to *instruct* pupils and how they should continue working in order to understand and consolidate the content independently.

The observations in the two classrooms show that digital technology is of major significance to how lessons are initiated and how didactic content and tasks are explained and instruction is given prior to pupils continuing to work. It is common for lessons to begin with a review of a task or work area by the teacher or the teachers working together. The teacher has all the material prepared on their computer, which is connected to the smartboard in the classroom: this is deemed to facilitate didactic planning and preliminary work.

One example (Ex. 1) from practice is how the classes in the study work with what is termed a "narrative curve" during a series of lessons. This can be compared to a template followed by the pupils in order to learn how a story can be built up according to a clear structure: start, problem, solution, end. The first lesson starts by showing the pupils a film version of a known picture book on the smartboard. After that, the teacher and the class retell the story of what happened in the book, while at the same time the teacher draws a narrative curve on the smartboard. The pupils then have to work in pairs and write down the sequence of events in a narrative curve on a piece of paper. In the next lesson, the pupils use their narrative curve to write down the story in words, either by hand or on their iPads.

According to the teachers in the study, the digital technology increases their chances of varying their teaching; but at the same time they observe the importance of didactic reflection on the purpose of the choice of working method and tool.

> The way we think of it is that it really gives us this mix that allows us to do things on the smartboard that gets the pupils interested, somehow. But the fact that we have to mix things up in order to reach the pupils who… it's more like we reasoned and talked about, that… that they take on board knowledge in different ways and how can we meet their needs, kind of thing. (FG2)

2. Motivate and inspire

This theme relates to how digital technology is used to *motivate* pupils in respect of the didactic content. As the teachers put it, the use of the smartboard and document camera, for example, allow teaching to be varied, thereby also motivating pupils and persuading them to focus on what they are doing. The infinite opportunities presented by downloading videos and "cool pictures", as one teacher puts it, is perceived as providing motivation and inspiration for both teachers and pupils: "the pupils don't just need to listen to somebody droning on" (FG1). According to the teachers, pupils who encounter difficulties with focusing and working with concentration benefit in particular.

There are a number of examples from the observations of how pictures and videos are used as *inspiration* for the work areas, or prior to chats and discussions. One such example (Ex. 2) is taken from UN Day on 24 October. Pictures of children from all over the world and the different ways in which they get to school – in a canoe, riding donkeys, climbing up cliff faces – were shown in order to make the pupils aware that children all over the world live under different conditions. These pictures initiated long, engaging talks in both classes about the varied conditions under which children live all over the world, and how conditions in Sweden can be compared with conditions in other countries.

One thing that emerged during these discussions is that the teachers find that their pupils are also motivated by digital technology when they have to describe or present a task to their classmates. Even pupils who are uncertain and shy are encouraged to talk using the smartboard, which helps them to forget that they might feel a bit nervous. The field notice below (Ex. 3) describes how pupils explain their solution to a mathematical problem.

> The pupils work on this task in pairs. When they have finished, two solutions are selected by the teacher and the pairs that came up with these solutions have to use the document camera to describe how they went about it. These accounts lead to a discussion on different ways of solving the problem. (OBS. 1)

3. Map and individualise

The third theme relates to the importance of digital technology in teachers' work on *mapping* every pupil's learning and development so as to be able to *individualise* their teaching as far as possible. The teachers in the study describe how they use special teaching material that includes digital tests in order to map and document the development of pupils' reading and writing abilities. As can be seen from the extract from

the focus group below, this is described as positive as it increases the chances of being able to monitor every pupil's learning and development and offering individualised teaching.

> It's so valuable, because you get that text that really tells you what the pupil needs – in the various elements, that is.
>
> Yes, maybe they understand words but need this as well – decoding, in order to maintain the flow.
>
> Oh I think it's probably this material that makes me go wow, wow! Particularly for Swedish, because that tells me how we can work with the pupils going forward and what material we should give them to work with, how we should practise – it feels absolutely brilliant! (SS 3)

For some lessons during the week, the pupils work individually towards targets that are formulated in their individual development plans [Swedish: Individuella Utevcklingsplaner, IUP]. Being able to read fluently and being able to write sentences with a capital letter and a full stop are examples of these. The pupils can choose from different working methods such as games or worksheets, but it is common for them to choose to work with one of the pedagogical apps installed on their tablets. The fact that digital technology leads to increased focus and motivation, particularly for some pupils, is emphasised during the focus groups.

The pupils' IUPs constitute a basis ahead of the appraisals that take place between teachers, pupils and guardians every term. The pupils prepare a PowerPoint presentation as a basis prior to these discussions.

> Ex 4. The lesson begins with a review on the smartboard. The pupils have to work on creating PowerPoint presentations prior to their appraisals. The pupils receive the template for the presentation on their tablets. After being given instructions, the pupils start working on their presentations. A few of them seem a bit confused, they sit and look at their tablets but don't really know what to write. They gradually get going with the help of the teachers in the classroom and write down the things they've got better at and what they need in order to learn more. (OBS 6)

4. Make accessible and equalize

One thing that is emphasised by the teachers and is also apparent in didactic practice is how digital technology can help to increase *accessibility* in teaching for more pupils, and this is at the heart of theme 4. For example, this involves being able to offer both auditory and visual support – something that many pupils benefit from – and giving some pupils alternatives without putting them at risk of being different to their friends due to special solutions.

> Hm, when it comes to accessibility I think it's a massive benefit. Because if you consider things generally, a lot of teaching is auditory – i.e. pupils sit and listen to the teacher. But suddenly we now have a vast opportunity to use image support and visualise things in a different way, which might allow more pupils to engage more, give them more opportunities to learn things. (FG1)

There are many examples, from the teaching situations in the classrooms, of how visual support is provided. One such example is the reading aloud sessions, when the pictures in the book are shown on the smartboards using a document camera. This means that all 28 pupils in the class can see them and follow the story by both listening and looking.

Another aspect of accessibility involves compensating or assisting; that is to say, when technical solutions can offer alternative working methods for pupils who encounter difficulties with fine motor skills or decoding, for example. Allowing pupils to choose between a pencil or a keyboard and reading or listening to a text are examples.

> They can listen and follow the story in the book and all that, it's really straightforward and everybody has that option. Everybody can do this, you think, the adaptations, but this is an adaptation that works out well for everybody. That's how it is. It's like a balancing act, how much. (FG2)

Pupils are often allowed to choose whether they want to write by hand or on their tablets. Some pupils are offered the option of choosing between these two options more or less all the time. In the focus groups, it emerges that the teachers perceive value in ensuring that their pupils learn to use both a pencil and a keyboard. They state that one does not need to rule out the other, but that it is important for teachers to have a purpose in mind as to why they choose one option or the other, and that the option chosen has to suit the pupil in question. One thing that is emphasised by the teachers is the fact that apps or settings that aim to provide assistive support do not work on their own. It requires both knowledge and individual guidance for it to take on genuine significance for the pupil.

Another aspect emphasised by the teachers is the fact that teaching should help to *equalize* the differences between pupils; that is to say, pupils who do not encounter all that much digital technology outside school should be offered this in school.

> And you have to show respect from the pupils' perspective as well. It might be a bit more common now for people to have equipment at home, but a couple of years ago not everybody had computers and iPads and… smartphones, and all that. I still think this set some pupils apart from others, and from that aspect, the pupils get to use these things in school even if they don't use them at home, it can – it still gives them a grounding in how to use them. (FG 1)

One aspect that is touched upon in the discussion is how pupils' differing abilities to handle options and temptations presented by their tablets lead to a balancing act between freedom and control.

> Some children are able to handle it, and some can't, and you have to know your class /…/ it's really complex, because you don't want to take away their freedom because they can handle it (no, exactly), because it can be fun for them and help them develop, and some… It's a balancing act, it's difficult. (FG 1)

In order to control this, the teachers use different ways – both collective and individual – of controlling and restricting freedom. So contracts are set up with all the pupils

and their parents on how the tablets are to be used, for example, and the teachers also use settings and apps that allow them to control and manage pupils' use of the tablets.

5. Stay at the cutting edge and feel anxious

The fifth theme is all about the ambivalence in respect of attitudes and approaches to digital technology in teaching that the teachers in the study expressed. Working on the basis of focus groups and spontaneous discussions during the observations, a composite view emerges that includes both *pride and didactics optimism* and *doubt and anxiety*. The teachers' positive attitudes towards the use of digital technology in their teaching were expressed in the focus groups and embodied clearly in the didactic space. They perceive themselves as "being at the cutting edge", and this engenders a kind of pride in them. They feel that the initiative on the part of the management at the school has "borne fruit" as it has been possible to successfully create practices where digital technology is used in a manner that is positive for the pupils. Something that can be described as didactic optimism emerges from the teachers' discussion, and this is also visible in their practices. They feel that they are helping to train their pupils for the society and labour market of the future by teaching them about programming and evaluation of sources, for example.

Provision of continued training for teachers and a certain amount of technical support at school are perceived as basic prerequisites for increased digitalisation of teaching. There are challenges that have to be overcome, such as the fact that technical development is progressing so quickly that keeping up may be difficult. Although the support is available from the top, from the school's management and the municipal administration, situations do arise occasionally such as the one described below that teachers have to resolve on their own, there and then. Concern that their own skills may not suffice or that the technology will fail creates anxiety in the teachers and may be perceived as distressing.

Another aspect brought up in the discussions is that research into digital tools in teaching and how they influence pupils' learning and development does not always provide an unambiguous response and guidance on how teaching and learning environments can be developed: "there's a debate ongoing about this business of digitalisation in schools. Is it good, or not?". (FG1)

Discussion

The purpose of this study is to deepen the understanding of how digital technology is used in teachers' didactic work in order to differentiate teaching, with particular emphasis on teaching children to read and write, and it provides a view of how digital technology is used in practical didactic work for meeting pupils' different requirements and needs in their early school years. The results are summarised and discussed below on the basis of the research questions.

What characterises teachers' experiences and didactic usage of digital technology when teaching children?

The empirical data shows the digital technology is used frequently as a tool by both the teachers and pupils included in the study, as part of the school day. The teachers say there are many benefits with the technology in terms of their didactic work and for pupils' learning and development. The technology has a major part to play in the teachers' didactic planning and supplementary work and is found to make life easier in various ways thanks to opportunities to prepare and work with others on lessons and find material that concretises and justifies the didactic content. At the same time, they also state that the rapidly changing technology can be perceived to be problematic; keeping up with development, failure of the technology so that double plans have to be in place, the fact that technology in itself may not always lead to better conditions to help pupils learn. This result comes as no surprise: it is in line with earlier classroom studies (e.g. Burkes & Hughes, 2018; Forsling; 2017; Hultin & Westman, 2013; Takala, 2013).

One key issue in respect of teaching looks at how it should be formulated in order to create equal conditions for all pupils. The teachers in the study state that digital technology helps them to meet their pupils' individual requirements and needs on different levels. On a general level, the technology gives teachers more opportunities to clarify, illustrate, vary and inspire, which greatly benefits pupils who encounter obstacles in their learning for whatever reason. On an individual level, digital technology provides teachers with good opportunities to map and document their pupils' learning, which then provides the basis for customised work schedules and selection of work forms and tools. The fact that digital technology can help to increase differentiation of teaching and so benefit pupils in need of additional support is borne out by earlier research (Agélii Genlott & Grönlund, 2016; Burkes & Hughes, 2018; Forsling, 2019; Nordström et al., 20219; Takala, 2013). So is it possible to draw conclusions from this study to indicate that digital technology helps to create an inclusive didactic space? Inclusion is an elusive and much discussed concept (Göransson & Nilholm, 2017); but from what is expressed and embodied in the study, there are nevertheless indicators showing that digital technology can help to increase inclusion in that there is a reduction in segregated teaching situations and individual pupils get more out of their teaching.

Various forms of visual support provide a specific example of how digital technology is used in teaching, highlighted by teachers as an important element in creation of accessibility and participation for all. Visual support is something that the vast majority of pupils benefit from, and it is absolutely crucial for some of them. At the same time – as one of the teachers in the focus group puts it – every choice has to be preceded by reflection and viewed in relation to what the various alternatives involve for pupils. This can be described as a balancing act where didactics questions seek an answer. What does the frequent use of visual support mean for various pupils from a contemporary and future perspective, in terms of accessibility and adaptation;

but also in respect of issues relating to text perception, creation of mental images or development of the ability to listen?

The teachers in the study emphasise that they are helping to even out pupils' different living conditions by offering their pupils new digital technology in school. Even pupils living in socioeconomically vulnerable environments must have access to new technology and learn how to use it: this aspect emerges in other studies (e.g. Forsling, 2019) and major value is attached to it. On the other hand, it can be asked whether frequent use of digital technology and expectations of digital skills in the classroom could also help to increase the gap between pupils who live in well-equipped homes (in digital terms) or homes where there is little such equipment. This is a question that requires didactic consideration of whether – and if so, how – digital technology helps to equalize pupils' requirements and how teaching can help to increase equivalence.

How is digital technology used to promote different dimensions of reading and writing processes?

The study focuses in particular on how digital technology is used in the didactic space to support different dimensions of reading and writing processes. The theoretical starting points of the study are based on the fact that the ability to read and write is a complex and multifaceted skill, including decoding as well as language understanding and that this has implications for how teaching should be formulated (Gough & Tunmer, 1986). Freebody et al. (1991) clarify this by means of their model showing four different resources that should be included when teaching pupils to read and write. The themes presented above clarify how digital technology is used within the model's four resources. Initially, work on the narrative curve (Ex. 1) represents what Freebody et al. describe as *coding* of the language – that is to say, a technical dimension – as the purpose is for pupils to acquire a technique for building up stories. The work is then gradually built up to also include *text creation*. As regards the resource that makes the most of *functional* aspects, the pupils' PowerPoint presentations prior to their appraisals (Ex. 4) are a clear example of this. The fourth of Freebody and Luke's resources all about critical *analysis* of text are not as explicit but are represented in the discussion described on how children get to school (Ex. 2). This is linked not to written text, but to images. To summarise, teaching in the two classes for promoting the development of reading and writing is characterised by a balanced and integrated approach, where digital technology is used to promote different dimensions of the development of reading and writing.

One interesting question raised in the focus groups relates to whether pupils should write with a pencil or on a keyboard, the teacher being quoted reckoning that "one won't necessarily rule out the other". This is a strategy that is clear in the observations: most pupils write by hand and on their tablets as well. As regards the research on this, it has to be viewed as a good didactic strategy as there is much to indicate that different forms of writing influence processing and learning in different ways. Some

of the pupils write only on their tablets, and this brings to the fore another didactic or special educational balancing act for the teachers. On the one hand, tablets provide great opportunities for pupils who have problems with motor skills or concentration to express themselves in writing and complete writing tasks successfully (Takala, 2013); but on the other hand, the continued learning and development of pupils appears to be influenced positively by writing by hand (Dahlström & Boström, 2017; Mangen & Bolsvik, 2016).

Limitations

The article is based on a small case study conducted using ethnographic data collection methods such as participative classroom observations and focus groups involving teachers. The study aims to provide a qualitative, in-depth understanding of how digital technology is used to differentiate teaching, with particular emphasis on teaching reading and writing. The results do not provide answers as to whether pupils' learning and development are influenced by technology, and if so how. That said, a picture of teachers' didactic work with the support of digital technology in a heterogeneous classroom, and of opportunities, challenges and – not least – direct considerations in relation to pupils' different requirements, experiences and needs, is provided on the basis of the empirical study. The pupil perspective is not present in the study. Interviews with pupils within the scope of the case study were planned prior to the study, but it was not possible to conduct these on account of the COVID-19 restrictions. It is hoped that it will be possible to conduct a complementary study of this kind after the pandemic so that the pupils' voices can be heard and we can learn from their experiences of digital technology in teaching.

Conclusions and didactic/special education implications

The results indicate that digital technology provides teachers with major didactic opportunities in their efforts to differentiate teaching under inclusive forms, provided that teachers are given good conditions in terms of continued training and technical support. Another result is that digital technology is used by the teachers in the study to support the various dimensions of development of reading and writing; both individual technical skills and communication and creation of meaning. One interesting aspect that emerges is the significance of teachers' didactic considerations and choices made when using digital technology: this is particularly evident in relation to pupils who are vulnerable in some respect. The didactic choices made influence pupils' learning and development in different ways, and teachers have to navigate and balance between different working methods and teaching strategies. What is involved in the didactic choice made between pencil and keyboard for individual pupils, for example, bearing in mind opposites such as freedom and control, present and future, practice and compensation, scope and quality, and school and outside world?

Author biographies

Gunilla Sandberg is professor in education and special needs education at the School of Education, Culture and Communication, Mälardalen University. Her research interest focuses reading and writing development and school transitions.

Pernilla Kallberg is senior lecturer in educational science, early childhood education at the School of Education, Culture and Communication, Mälardalen University. Her research interest focuses preschool education and school transitions.

Tina Hellblom-Thibblin is associate professor in special needs education at the School of Education, Culture and Communication, Mälardalen University. Her research interest focuses categorization processes and school transitions.

References

Adams, M. J. (1990). *Beginning to read. Thinking and Learning about Print.* The MIT Press.

Agelii Genlott, A., & Grönlund, Å. (2016). Closing the gaps – Improving literacy and mathematics by ict-enhanced collaboration. *Computers & Education 99*, 68–80. https://doi.org/10.1016/j.compedu.2016.04.004

Alatalo, T. (2011). *Skicklig läs- och skrivundervisning i åk 1–3. Om lärares möjligheter och hinder* [Proficient reading and writing instruction in grades 1–3: Teachers' opportunities and obstacles]. (Gothenburg Studies in Educational Sciences 311). Acta Universitatis Gothoburgensis

Algozzine, B., & Anderson, K. M. (2007). Tips for teaching: Differentiating instruction to include all students, *Preventing School Failure: Alternative Education for Children and Youth, 51*(3), 49–54. https://doi.org/10.3200/PSFL.51.3.49-54

Archer, K., Savage, R., Sanghera-Sidhu, S., Wood, E., Gottardo, A., & Chen, V. (2014). Examining the effectiveness of technology use in classrooms: A tertiary meta-analysis. *Computers & Education, 78*, 140–149. https://doi.org/10.1016/j.compedu.2014.06.001

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2013). *Successful qualitative research, a practical guide for beginners.* Sage Publications.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis, *Qualitative Research in Sport, Exercise and Health, 11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Burke, A., & Hughes, J. (2018) A shifting landscape: using tablets to support learning in students with diverse abilities. *Technology, Pedagogy and Education, 27*(2), 183–198. https://doi.org/10.1080/1475939X.2017.1396492

Clarke, L., & Abbott, L. (2016). Young pupils', their teacher's and classroom assistants' experiences of iPads in a Northern Ireland school: "Four and five years old, who would have thought they could do that?". *British Journal of Educational Technology, 47*(6), 1051–1064. https://doi.org/10.1111/bjet.12266

Dahlström, H., & Boström, L. (2017). Pros and cons: Handwriting versus digital writing. *Nordic Journal of Digital Literacy, 12*(4), 143–161. https://doi.org/10.18261/ISSN.189-943X-2017-04-04

Forsling, K. (2019). Designs for Learning: Focus on special needs. *Designs for Learning, 11*(1), 108–117. https://doi.org/10.16993/dfl.106

Fredriksson, U., & Rasmusson, M. (2019). Learning to read using computers: A longitudinal study from grade 1 to grade 3 in four Swedish schools. *Nordic Journal of Literacy Research, 5*(3), 24–48. https://doi.org/10.23865/njlr.v5.2014

Freebody, P., Luke, A., & Gilbert, P. (1991). Reading positions and practices in the classroom. *Curriculum Inquiry, 21*(4), 435–457.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*, 6–10.

Gustafson, S., Fälth, L., Svensson, I., Tjus, T., & Heimann, T. (2011). Effects of three interventions on the reading skills of children with reading disabilities in grade 2. *Journal of Learning Disabilities, 44*(2), 123–135. https://doi.org/10.1177/0022219410391187

Hultin, E., & Westman, M. (2013). Early literacy practices go digital. *Digitalization of Early Literacy Practices, 4*(2), 1096–1104. https://doi.org/10.20533/licej.2040.2589.2013.0145

Lindeblad, E. (2017). *Self-concepts and psychological health among children and adolescents with reading disabilities and the influence of assistive technology* (Doctoral thesis, Linnaeus University Dissertations No 290/2017). Linnaeus university press.

Mangen, A., & Balsvik, L. (2016). Pen or keyboard in beginning writing instruction? Some perspectives from embodied cognition. *Trends in Neuroscience and Education, 5*, 99–106. https://doi.org/10.1016/j.tine.2016.06.003

Maor, D., Currie, J., & Drewry, R. (2011). The effectiveness of assistive technologies for children with special needs: a review of research-based studies. *European Journal of Special Needs Education, 23*(3), 283–298. https://doi.org/10.1080/08856257.2011.593821

Nilholm, C., & Göransson, K. (2017). What is meant by inclusion? An analysis of European and North American journal articles with high impact. *European Journal of Special Needs Education, 32*(3), 437–451. https://doi.org/10.1080/08856257.2017.1295638

Nordström, T., Nilsson, S., Gustafson, S., & Svensson, I. (2019). Assistive technology applications for students with reading difficulties: special education teachers' experiences and perceptions. *Disability and Rehabilitation: Assistive Technology, 14*(8), 798–808, https://doi.org/10.1080/17483107.2018.1499142

Parker- Jenkins, M. (2018). Problematising ethnography and case study: reflections on using ethnographic techniques and researcher positioning, *Ethnography and Education, 13*(1), 18–33. https://doi.org/10.1080/17457823.2016.1253028

Seidenberg, Mark S. (2013). The Science of reading and its educational implications. *Language Learning and Development: The Official Journal of the Society for Language Development, 9*(4), 331–360. https://doi.org/10.1080/15475441.2013.812017.

Snow, C. E., & Juel, C. (2005). Teaching Children to Read: What do we know about how to do it? In M. J. Snowling, & C. Hulme (Eds.). *The science of reading: a handbook* (pp. 521–537). Blackwell publishing.

Swedish National Agency for Education 2011. Lgr11. *Läroplan för grundskolan, förskoleklassen och fritidshemmet: Reviderad 2019* [Curriculum for Compulsory School, Preschool-class and Leisure-time Center: Reviced 2019]. https://www.skolverket.se/undervisning/grundskolan/laroplan-och-kursplaner-for-grundskolan/laroplan-lgr11-for-grundskolan-samt-for-forskoleklassen-och-fritidshemmet

Swedish Research Council (2017). *Good Research Practice*, Vetenskapsrådet.

Takala, M. (2013). Teaching reading through writing. *Support for learning, 28*(1), 2–47. In Wiley Online library.

Taube, K., Fredriksson, U., & Olofsson, O. (2015). *Kunskapsöversikt om läs- och skrivundervisning för yngre elever* [Research overview about teaching and learning for younger students]. Vetenskapsrådets rapporter. Stockholm: Vetenskapsrådet.

Trageton, A. (2014). *Att skriva sig till läsning. IKT i förskoleklass och skola* [Writing to learn reading]. Liber.

Wilkinson, S. (1998). Focus group methodology: a review. *International Journal of Social Research Methodology, 1*(3), 181–203. https://doi.org/10.1080/13645579.1998.10846874

Wollscheid, S., Sjaastad, J., & Tømte, C. (2016). The impact of digital devices vs. Pen(cil) and paper on primary school students' writing skills – A research review. *Computers & Education 95*, 19–35. https://doi.org/10.1016/j.compedu.2015.12.001