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Primary school teachers' use and perception of digital technology in early reading and writing education in inclusive settings

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ABSTRACT

Purpose: The present study aimed to investigate teachers' use and perceptions of digital technology to promote learning and participation for all young students in early reading and writing education in inclusive primary schools.

Methods: Primary school teachers [$N = 289$] in Sweden were asked to complete a survey about digital technology in reading and writing education. The data were analysed statistically and with summative content analysis.

Results: The results showed that 82% of the teachers were interested in teaching young students to read and write using digital technology. More than 50% of the teachers included digital technology to promote students' learning of phonological awareness, decoding skills, vocabulary, spelling, or text editing every week, and 74% used digital technology to support students with special needs every week. Those who perceived digital technology as a facilitator of all students' participation in early reading and writing education also reported that they used digital technology to promote different reading and writing skills more frequently. Their perceived knowledge of managing digital technology was also positively related to their perception of digital technology as a facilitator of students' participation in reading and writing education.

➤ IMPLICATIONS FOR REHABILITATION

- Teachers who are positive about digital technology perceive such technology as beneficial for all students in reading and writing education, also for those students who have special needs.
- Teachers use digital technology to compensate students with special needs in reading and writing. However, there is an unawareness of the advantages of using digital technology in inclusive education.

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Reading instruction; digital technology; primary school; participation; survey

Reading and writing are fundamental skills to learn and develop in school. Teachers in inclusive settings must therefore ensure that the reading education enables all students to practice various reading skills, such as letter knowledge, phonological awareness, and reading comprehension. There are different ways of teaching, and research shows that digital technology can promotethe students in their skill training and give opportunities to differentiate and encourage curiosity and engagement among students [1,2]. However, to our knowledge, there is little research on how teachers perceive digital technology as a tool for promoting reading and writing among young students in inclusive settings. The present study therefore focuses on teachers' use and perception of digital technology in early reading and writing education in inclusive settings.

In inclusive education, ensuring that all students are able to participate and protecting their right to an equal education is crucial [3]. Participation can be conceptualized as "attendance" and "involvement" [4]. The quality of the teaching and learning processes in inclusive education often has a lower priority than physical placement, but it is fundamental for inclusive education [5]. With more pedagogical tools and methods available to them, teachers will be better able to reach all students and increase the students' participation in their education [5]. Having the ability to differentiate, the teacher can contribute to the participation of all students in the teaching, and digital technology is generally regarded as a valuable tool in education [6]. In the last 20 years, the availability of digital technology has vastly increased, an increase which has been deemed a critical component of inclusive education [7–9]. As digital technology that facilitates reading and writing has become available for tablets and smartphones as well, the accessibility has improved [10,11].

Literature review

Reading and writing abilities are stated as necessary for every citizen to be able to participate in education, employment, and society [12]. A significant part of the activities in school is based on these abilities. In school today, these skills are required for further learning and knowledge acquisition [13,14]. Digital technology has the potential to improve education for all students, and since

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students gain knowledge in different ways, offering different kinds of digital tools can contribute to making teaching more accessible [15]. The International Reading Association [16] has called for the integration of technology in reading and writing education in schools, as research has demonstrated that digital technology is an effective tool for developing students' reading and writing abilities [for meta-analyses, see 17,42]. However, using digital technology in reading and writing instruction can, on the one hand, promote students' learning and, on the other hand, seem challenging and time-consuming for the teacher [17–22].

In the classroom, teachers are the masters of pedagogy combined with content knowledge; it is their domain of expertise [23]. They further develop their knowledge, understanding, and skills in their everyday practice of these areas. Nevertheless, for many teachers, technology is not their actual area of expertise, but they have to integrate technology into their teaching [24]. Instead of making use of the advantages offered by digital technology, teachers seem to transfer the traditional strategies associated with the use of pen and paper to computers and tablets [22]. Using technology in education requires teachers to decide when it is suitable to use (or not use) technology in the classroom [24]. According to Sparks [25], digital technology shapes the future of teaching and provides learners with additional educational opportunities. However, critical thinking is needed regarding how digital technology is used in classrooms to promote inclusive education [25]. Research shows that teachers perceive digital technology as beneficial for students' learning, but it also shows that they fail to make use of its total capacity as their knowledge of such technology is lacking [20,26]. There is uncertainty about how digital technology can be implemented in teaching [8,26,27].

Digital technology has considerable potential to promote inclusive education for the whole population, and if it is utilized to its full extent, it can offer a new context for learning and teaching [25]. Eklöf et al. [15] argue that digital technology should be introduced as early as possible to lay a foundation for using digital technology in school, especially for students at risk of developing reading difficulties. Research confirms that students' independence, motivation, and access to education are positively related to the use of digital technology [28]. However, research focussing on how teachers use and perceive digital technology in reading and writing education for young primary school students is limited. Some researchers have shown that digital technology can bridge the gap between students with special needs and their peers [29,30]. A student with reading and writing difficulties might have an increased opportunity to participate in regular teaching with the help of assistive technology such as text-to-speech and speech-to-text tools [17].

Any digital technology necessary to support an individual student achieve the goals set out by the education plan or curriculum is regarded as assistive technology [31,32]. Assistive technology allows students to increase, maintain, or improve their functional capabilities [33,34]. Hence, assistive technology is emphasized as an essential tool for enabling all students to participate in education [cf. 21,30]. Although the use of digital technology can promote participation in reading and writing activities in schools, research shows that such technology is applied within special education rather than in education for all students [35,36]. If the digital technology tools are only offered to students with disabilities in special education, the students may perceive the tool as being labelling and discriminating [37,38]. When digital tools are not a natural part of education for all students, they will probably, sooner or later, be abandoned by those who need them the most [39,40]. Digital technology should therefore be used in regular education for all students to develop their reading and writing; it can then become an assistive tool that some students continue to use. Therefore, teachers should know how to integrate digital technology when teaching all students, not only those with special needs [6]. However, there is a lack of research on the use of digital technology to enable education and learning processes for all students. Still, the digital technology itself is not the solution: an important factor is teachers' knowledge and perceptions of how digital technology can enable all students access to activities that contribute to their participation [18,41]. There are also few studies on how digital technology is used by teachers with an inclusive approach to early reading and writing education [26,27].

Aim and research questions

The present study investigated teachers' use and perceptions of digital technology to promote learning and participation for all young students in early reading and writing education in inclusive primary schools.

- What do teachers consider important when planning and teaching reading and writing lessons with digital technology?
- How frequently is digital technology used in reading and writing education to promote reading and writing skills among young students?
- How are the teachers' perceptions of digital technology as a facilitator of participation related to their perceived knowledge to manage digital technology in early reading and writing education?

Method

Participants

The study included 289 teachers (5.2% males, 94.1% females) in Sweden. All of them were in-service teachers, and they had between 1 and 45 years ($M = 15.4$, $SD = 10.4$, $Mdn = 14.5$) of experience of working with students aged 6–10. In addition, 111 (38.4%) teachers had a supplementary qualification as special education teachers. Since all Swedish schools are responsible for inclusive education, the participating teachers are required to support learning and participation among students with special needs.

Sampling procedures

Potential participants were invited to participate in the study *via* a digital newsletter by LegiLexi in February 2021.LegiLexi is a Swedish educational reading program developed pro bono and offered free of charge to schools. It is intended to help all students develop their reading abilities. The program is available for all public and private schools in Sweden. Our sample consisted of a self-selected group of teachers who got the newsletter and received no compensation for participation in the study. The teachers' participation in this study was voluntary and anonymous.

Measures

To our best knowledge, there are no previous surveys on how teachers perceive digital technology as a facilitator of learning and participation in early reading and writing education.

Therefore, an online questionnaire was developed for the current study to investigate teachers' use and perceptions of digital technology in early reading and writing education. The questionnaire is based on previous research on teachers' experiences and perceptions of using digital technology in reading and writing education [20–22,42]. The questionnaire consisted of three different parts. First, the participants responded to questions about their age, education, and years of experience of teaching students between the ages of 6 and 10. After that, they reported their use and perception of digital technology in early reading and writing education. At the end of the questionnaire, the participants were asked what they consider important when planning and teaching reading and writing with digital technology. These two last questions were open-ended.

Scale - Promotion of reading and writing

The participants were asked to rate how often digital technology had been used to promote 14 different reading and writing skills among young students in the past semester. These skills were the following: phoneme-grapheme knowledge, phonological awareness, decoding, reading fluency, reading comprehension, vocabulary, grammar, spelling, the formulation of thoughts or opinions, the editing of texts, information searches on the Internet, presentations of information, and listening comprehension regarding both fiction and non-fiction. Earlier studies have identified these 14 skills as fundamental for making reading and writing education effective [40,41]. For each of these variables, the participants reported whether they used digital technology to develop young students' reading and writing never (scored 0), 1–2 times per semester (a semester is 19 weeks long in Sweden, scored 1), 1–2 times per month (scored 2), every week (scored 3), or several times a week (scored 4). There were no missing data.

The 14 items measuring different reading and writing skills were explored with principal component analysis (PCA) [43,44] to clarify whether they could be regarded as a construct measuring the promotion of reading and writing development. Before performing PCA, the suitability of the data for component analysis was assessed, and 7 multivariate outliers were excluded. Inspection of the correlation matrix revealed the presence of many coefficients of .30 and above. The Kaiser-Meyer-Olkin value was .88, exceeding the recommended value of .60, and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. Concerning communalities, a cut-off score of .50 was applied. None of the variables had to be excluded due to a low communality value. The PCA revealed the presence of three components with an eigenvalue exceeding 1, explaining 72% of the variance. However, the first component contributed to 52% of the total variance and had a simple structure, which included all variables with strong loadings (.59–.78). Hence, the 14 variables could be regarded as a component that reflected the promotion of students' reading and writing ability by the implementation of digital technology in early reading and writing education. When all these 14 variables are summarized, a total score is obtained. This score can vary between 0 and 56, where a higher score indicates a more prevalent use. The scale's reliability was checked, and the value for Cronbach's alpha for the scale was α=.93.

Scale - Teacher's perceptions of digital technology in early reading and writing education

The participants were asked to respond to 20 statements about their perceptions of digital technology in early reading and writing education. They specified their level of agreement or disagreement on a four-point Likert scale (i.e., *strongly disagree*, *disagree*, *agree*, *strongly agree*) that was scored from 0 to 3. Negatively phrased items were revised. There were no missing data, and we used PCA [45,46] to explore whether the items could be regarded as constructs measuring the teachers' perceptions of digital technology in early reading and writing education.

At first, the suitability of the data for PCA was assessed, and 33 multivariate outliers were excluded. Also, after the inspection of the correlation matrix, we excluded 6 items due to low coefficients. The other 14 items had many coefficients of .30 and above. PCA was conducted to assess the underlying structure for the 14 items, and they loaded strongly on two components. The Kaiser-Meyer-Olkin value was .86, and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. The initial PCA revealed the presence of two components with an eigenvalue exceeding 1, explaining 60.4% of the variance. We applied .50 as a cut-off score for the communalities, and one additional variable had to be excluded. Further, a one and a two-component solution were sequentially examined using PCA with Oblimin rotation, because we assumed that the components could be correlated. The two-component solution was accepted as the most adequate alternative of the 13 items on teachers' perceptions of digital technology in early reading and writing education. The first component contributed to 41.9% and the second component to 20.5% of the total variance. The structure coefficients were between .72 and .87 without overlapping with the components.

The first component reflected the teachers' perceptions of digital technology as a facilitator of all students' participation in early reading and writing education. See Table 1 for the seven items within the scale. When summarizing the seven variables, a total score is obtained. This score can vary between 0 and 21. A higher score indicates a more positive perception of digital technology as a facilitator of all students' participation in early reading and writing education. The scale's reliability was checked, and the value for Cronbach's alpha for the scale was α=.90.

The second component reflected the teachers' perceptions of managing digital technology in reading and writing education. The subscale consisted of six items (see Table 1). When the six items are summarized, a total score is obtained. This score can vary between 0 and 18, and a higher score indicates a more positive perception of managing digital technology in early reading and writing education. A reliability analysis was performed, and the value for Cronbach's alpha for the scale was α=.86.

Data collection

Data were collected through an online questionnaire aimed at teachers working with reading and writing education for young students in primary schools. Potential participants received information about the study in a digital newsletter published by LegiLexi (www.LegiLexi.org), a digital resource for teachers in Sweden. One reminder about the study was published after four weeks, and the teachers were asked to complete the online questionnaire. The teachers approved their participation in the current study when submitting the online questionnaire.

Analytic strategies

The two open-ended questions about what the teachers considered important when planning and teaching reading and writing lessons with digital technology were analyzed with summative content analysis [for a description of the method used see [45]. The categories in the content analysis were inspired by Mishra and Koehler's [24] framework on the essential qualities of teachers' knowledge required for technology integration in teaching.

The framework is, by Mishra and Koehler, argued to be an analytic tool for exploring successful education that includes technology. The main components in the framework are the teachers' knowledge of content, pedagogy and technology, but the relationships between these three components are essential for education. These three components and their relationships represented our categories in the content analysis. Since the current study focuses on digital technology in early reading and writing education, we have formulated a description of the categories that emphasizes the key aspects of reading and writing education [40,41]. For a short description of all the categories, see Table 2.

Table 1. Two scales measuring teacher's perception of digital technology in early reading and writing education.

Scales and items
Teacher perception of digital technology as a facilitator of all students' participation in reading and writing education
Digital technology benefits all students' reading and writing development
Digital technology facilitates my reading and writing lessons
Digital technology benefits the reading and writing development of students who have reading and writing difficulties
Digital technology is a good compensatory effort for students who have reading and writing difficulties
Digital technology provides good conditions for individually adapting reading and writing education for all students in the classroom
Digital technology enables all students' participation in reading and writing education
Digital technology is easy to use for students in reading and writing education
Teachers' perception of their knowledge in managing digital technology in early reading and writing education
It is time consuming to install programs / apps (r)
I need technical support to be able to use digital technology in reading and writing education (r)
I need training in how programs / apps can be used in reading and writing education (r)
It is difficult to adapt digital technology to all students in reading and writing education (r)
It is difficult to implement digital technology in reading and writing education (r)
Extra planning time is required to use digital technology in reading and writing education (r)
More teaching time is required to use digital technology in reading and writing education (r)

Note. Teachers are asked "What do you think about the following statement regarding digital technology in reading and writing education?". Their level of agreement (strongly disagree, disagree, agree, strongly agree) is specified for each item. Revised items are marked with an (r).

One of the authors developed descriptions for each category and sorted all data. The other validated the descriptions of each category and checked how the data were sorted. When there was any disagreement on how to categorize the data, we discussed the teachers' descriptions and made a joint decision. We calculated the frequency of each category so that they reflect the teachers' descriptions of important aspects for planning and teaching reading and writing lessons with digital technology. In addition to this, we have included quotes from the participants to exemplify each category.

Variables on teachers' use and perceptions of digital technology in early reading and writing education were analysed with IBM SPSS Statistics, version 27. Associations between variables were investigated with Pearson product-moment correlation. The alpha value was set to .05.

Results

The questionnaire was answered by 289 teachers, and 238 (82.4%) of them reported that they were interested in teaching young students to read and write using digital technology. The same proportion of teachers perceived that their use of digital technology contributes to young students' reading and writing development. Similarly, 242 (83.7%) teachers believed that young students' use of digital technology contributes to the students' reading and writing development. There were 69 (23.9%) participants with no education in teaching with digital technology; 194 (67.1%) had participated in one-day in-service training courses, and 26 (9.0%) had completed a university course in teaching with digital technology. Furthermore, 190 (65.7%) teachers reported that they have a good knowledge of how to teach young students to read and write with the help of digital technology.

The importance of digital technology when planning and teaching reading and writing lessons

There were 233 (80.6%) teachers who described what they consider important for planning reading and writing lessons with digital technology (see Table 3). Among the teachers, 16 (6.9%) described the importance of planning with the aim to promote all students' learning and participation, and an additional 26 (11.2%) described the importance of thinking of adjustments to methods

Table 2. Description of categories in the content analysis focusing on teachers' reports on important aspects when planning and teaching reading and writing lessons with digital technology.

Category	Description
Digital technology knowledge	Statements about digital devices and apps, or the skills to install and remove apps, create accounts, as well as, handle internet connections and different devices and apps.
Content knowledge	Statements about what to be taught and learned in early reading and writing education. Also, statements about theoretical awareness of reading and writing development, and the importance of specific skills for acquiring good reading and writing ability.
Pedagogical knowledge	Statements about methods of teaching or learning in early education. Also, statements about how to provide instruction and tasks evaluate students' skills and understand students' need for support in the classroom to learn and participate education.
Digital technological-pedagogical knowledge	Statements about how to teach with digital technology and incorporate the technology in the classroom to promote learning and participation among young primary school students.
Digital technological-content knowledge	Statements about the relationships between digital technology and reading and writing skills, e.g., how apps can be adjusted to meet the goals of reading and writing instructions.
Pedagogical-content knowledge	Statements about how teaching methods are suitable in early reading and writing. Also, statements on how teaching supports students' development of different skills in order to gain good reading and writing ability. The teacher's knowledge about students' strategies for reading and writing is included.
Digital technological pedagogical-content knowledge	Statement about how digital technology is integrated into reading and writing education. Also, statements how digital technology can be used to promote learning and participation in reading and writing education for young primary school students.

Note: The categories are inspired by Mishra and Koehler's [24] framework on essential qualities of teachers' knowledge required for technology integration in teaching.

Table 3. Important when planning reading and writing lessons with digital technology for younger students in primary school according to teachers ($n = 233$).

Category	Planning *n* (%)	Example
Digital technology knowledge	69 (29.6)	To have access to computers or tablets for the lesson. They must be loaded and working, and there must be good installed programs. There must be headphones for everyone. (Teacher no 184) As a teacher, I need to be familiar with what we will do. Problems will occur, and then I need to be able to solve them quickly. (Teacher no 55)
Content knowledge	10 (4.2)	Work with phoneme-grapheme correspondence (Teacher no 38) It can be sound and letter learning, writing factual text, stories, practicing various sound conflicts, ortographic decoding etc. (Teacher no 130)
Pedagogical knowledge	81 (34.8)	To adapt the lesson for students with reading and writing difficulties. (Teacher no 14) Digital technology is used to complement teaching but does not replace me as a teacher. (Teacher no 41)
Digital technological-pedagogical knowledge	104 (44.6)	Use of digital technology to clarify, structure, and provide visual support during teaching and instructions. (Teacher no 88) The digital tool must be implemented. Time must be spent on how the students use the tool and not only on the writing task itself. (Teacher no 229)
Digital technological-content knowledge	21 (9.0)	That the apps correspond to what the student needs to practice. (Teacher no 36) To use apps that are linked to the curriculum. You need to know what the goal is with the apps. (Teacher no 57)
Pedagogical-content knowledge	12 (5.2)	That in letter learning it is important to write with a pen to consolidate knowledge. (Teacher no 199) Plan for feedback, i.e., when students write texts, they give each other feedback on each other's texts. This is so that the students will learn to rework their texts and understand that they are not done just because the first draft is finished. (Teacher no 39)
Digital technological-pedagogical-content knowledge	3 (1.3)	It must be clear what and how the students should practice with apps. It is also essential to consider whether digital technology is the most optimal way of learning the lesson's goal. (Teacher no 95) The digital tool should not compensate too much and exclude skill training as spelling programs do. Suppose students do not practice spelling and only trust that the computer will find errors and provide alternative spelling. In that case, the students' ability to use spelling rules and practice spelling will be affected. (Teacher no 19)

or assignments for individual students in the classroom. Further, according to the summative content analysis of the descriptions, 29.6% of the teachers mentioned their knowledge of digital technology as an important aspect when planning reading and writing lessons, whereas 44.6% stated that their digital-technological-pedagogical knowledge was important. They seldom mentioned their knowledge of content (only 4.2% did so) or pedagogical-content knowledge (only 5.2% did so). Only 1.3% of the teachers highlighted the importance of integrating knowledge related to digital technology, pedagogy, and content. For examples of the teachers' statements see Table 3.

Furthermore, 232 (80.3%) teachers mentioned what they consider important when teaching reading and writing lessons with digital technology. Nine (3.9%) of them thought all students' learning and participation were essential. Besides, 29 (12.5%) of them highlighted the importance of tailoring the reading and writing education for individual students. The content analysis showed that 53.0% of the teachers reported that their digital technological-pedagogical knowledge was important for teaching, and 22.8% mentioned their knowledge of digital technology as essential for teaching reading and writing to young primary school students. Their pedagogical knowledge was stressed by 29.3% of the teachers, whereas only 1.3% reported that content knowledge is important for reading and writing education with digital technology. Similar to the planning of reading and writing lessons including digital technology, only 1.7% stated the importance of integratingthe digital technological-pedagogical-content knowledge. See Table 4 for examples of the teachers' statements.

Using digital technology to promote young students reading and writing skills

The teachers were asked to rate how often they used digital technology to promote 14 different reading and writing skills among young students. Although most of the teachers were interested in teaching young students to read and write using digital technology, their reported use of digital technology in promoting students' reading and writing skills varied (cf. Table 5). For example, more than 50% of the teachers reported that their students practiced phonological awareness, decoding skills, vocabulary, spelling, or text editing every week using digital technology. More than 50% of the teachers also responded that they used digital technology weekly to promote students' listening abilities. On the other hand, more than 50% of the participants reported that students seldom used digital technology to develop grammar skills, search for information on the Internet, present information, or formulate thoughts and opinions.

Moreover, an inclusive approach to teaching reading and writing means giving all students the chance to use text-to-speech and speech-to-text programs in the classroom. Therefore, the teachers were asked how often they used text-to-speech and speech-to-text programs to promote all students' reading and writing development. The results showed that 88 (30.4%) teachers stated that they include text-to-speech programs in reading and writing education every week or several times a week to promote all students' reading skills. Moreover, 105 (36.3%) teachers reported that all students used speech-to-text programs once or several times a week to develop their writing skills. The frequency of text-to-speech programs in writing education is related to the use of speech-to-text programs in the classroom (r=.735, p<.001).

As digital technology is found to support students with reading and writing difficulties [17,42], we also asked the teachers how frequently they use digital technology as a support for individual students with special needs in reading and writing. According to the results, 213 (73.7%) teachers responded that they use digital technology to adjustthe reading and writing education every week or several times a week to support individual students. There were 34 (11.8%) participants who responded that they never, or only couple of times during a semester, used digital technology as an adjustment for students with special needs in reading and writing. Among

Table 4. Important when teaching reading and writing lessons with digital technology for younger students in primary school, according to teachers ($n = 232$).

Category	Teaching *n* (%)	Example
Digital technology knowledge	53 (22.8)	As a teacher, I must have knowledge about devices and Internet connections. (Teacher no 44) That teachers receive education and are not only assumed to be able to use digital technology. (Teacher no 129)
Content knowledge	3 (1.3)	Emphasize phonological awareness, decoding, and reading fluency including a communication about the text. (Teacher no 175) Practice reading fluency, vocabulary, and reading comprehension. (Teacher no 222)
Pedagogical knowledge	68 (29.3)	That I think of ALL the students. That requires a lot of work. (Teacher no 24) The extent and design; it must be short, clear assignments with immediate feedback. (Teacher no 83)
Digital technological-pedagogical knowledge	123 (53.0)	Not too large groups in the beginning. You should have time and get an overview of what the students are working on. Many activities can be performed by "click-guessing,"; for example, reading comprehension tasks. (Teacher no 8) Find routines and structures that students are well familiarized with so that digital technology becomes a natural part of teaching and a tool for learning. (Teacher no 213)
Digital technological-content knowledge	24 (10.3)	That the programs really support what I want the students to develop. (Teacher no 34) Apps or web-based pages that work well for developing reading and writing. (Teacher no 74)
Pedagogical-content knowledge	11 (4.7)	Reading, talking and writing together is very developing for everyone. Practicing individual skills as spelling with the goal to reach a "spelling driver licence". The students can practice spelling and must have a certain number of correct spelled words to get the licence. (Teacher no 87) I must know the development of reading and writing ability and have didactic skills. But, also an ability to understand students' needs. What they benefit from and when they need it. (Teacher no 229)
Digital technological- pedagogical-content knowledge	4 (1.7)	That I, as a teacher, am confident know how digital technology works. With an education in managing digital technology, it becomes natural to use the technology in teaching. One must see the possibilities with digital technology and that it facilitates and improves all students' development in their reading and writing abilities. (Teacher no 137) Text-to-speech and speech-to-text programs are great for students in their early stages of reading and writing. With the technology, students can learn to revise texts early because they do not have to erase and rewrite the text. Students who have difficulty forming letters can still write a long story digitally. However, everything is not black and white. Do not drop pen and paper entirely because you use digital technology. Eye-hand coordination should not be forgotten! (Teacher no 147)

Table 5. Teacher-reports on how often they use digital technology to promote different reading and writing skills among young students ($N = 289$).

	Never *n* (%)	1–2 times per semester *n* (%)	1–2 times per month *n* (%)	Every week *n* (%)	Several times a week *n* (%)
Students' skills					
Phoneme-grapheme knowledge	21 (7.3)	31 (10.7)	54 (18.7)	109 (37.7)	74 (25.6)
Phonological awareness	20 (6.9)	36 (12.5)	64 (22.1)	103 (35.6)	66 (22.8)
Decoding	21 (7.3)	34 (11.8)	83 (28.7)	86 (29.8)	65 (22.5)
Reading fluency	37 (12.8)	46 (15.9)	77 (26.6)	76 (26.3)	53 (18.3)
Reading comprehension	25 (8.7)	49 (17.0)	79 (27.3)	85 (29.4)	51 (17.6)
Vocabulary	28 (9.7)	37 (12.8)	79 (27.3)	95 (32.9)	50 (17.3)
Grammar	61 (21.1)	51 (17.6)	83 (28.7)	63 (21.8)	31 (10.7)
Spelling	28 (9.7)	33 (11.4)	75 (26.0)	97 (33.6)	56 (19.4)
Formulate thoughts or opinions	49 (17.0)	42 (14.5)	75 (26.0)	80 (27.7)	43 (14.9)
Edit texts	33 (11.4)	36 (12.5)	70 (24.2)	101 (34.9)	49 (17.0)
Look for information on the Internet	36 (12.5)	63 (21.8)	73 (25.3)	81 (28.0)	36 (12.5)
Present information	47 (16.3)	65 (22.5)	95 (32.9)	53 (18.3)	29 (10.0)
Listen to fictive stories	20 (6.9)	33 (11.4)	63 (21.8)	92 (31.8)	81 (28.0)
Listen to facts	27 (9.3)	42 (14.5)	65 (22.5)	93 (32.2)	62 (21.5)

the teachers, 202 (69.5%) reported that they provide special support for individual students with special needs every week or several times a week to promote these students' reading and writing development. Moreover, 43 (14.9%) teachers reported that they never, or only once or twice per semester, used digital technology when providing special support.

Teachers' perceptions of digital technology as a facilitator of participation and their perceived knowledge of managing such technology in early reading and writing education

According to the results, teachers who perceived digital technology as a facilitator of all students' participation in earlyreading and writing education also reported that they used digital technology to promote different reading and writing skills more frequently (cf. Table 6). There was also a positive correlation between the teacher's perception of their knowledge of managing digital technology in early reading and writing education and digital technology as a facilitator of participation. However, their number of years teaching younger. primary school students were neither significantly related to their perception of using digital technology as a facilitator of all students' participation in early reading and writing education nor their perception of their knowledge of managing digital technology in early reading and writing education.

Discussion

As society is digitalized, there is an increasing demand for teachers to use digital technology. Teaching using digital technology is

Table 6. Relationship between teacher use and perception of digital technology in early reading and writing education.

	n	*M (SD)*	min-max	(1)	(2)	(3)	(4)
(1) Teacher age	288	50.6 (10.2)	24–74				
(2) Teaching years	281	15.4 (10.4)	1–45	.645**			
(3) Promote reading and writing	289	32.2 (12.1)	0–56	.031	.130*		
(4) Facilitator of participation	289	15.5 (4.3)	0–21	−.064	−.039	.493**	
(5) Teacher knowledge	289	11.4 (4.2)	1–18	−.114	−.075	.306**	.316**

Note. *<.05, **<.001. (3) Scale – Promotion of students' reading and writing ability by including digital technology in early reading and writing education (4) Scale – Teacher perception of digital technology as a facilitator of all students' participation in reading and writing education. (5) Scale – Teachers' perception of their knowledge of managing digital technology in early reading and writing education.

reported to be effective, but it is sometimes perceived as complicated and demanding by the teachers [7,9]. Knowledge about teachers' use and perception of digital technology as a tool for teaching reading and writing skills to younger students will clarify what aspects are needed in the implementation of digital technology in inclusive reading and writing education. For the potential of digital technology to be utilized, the teacher must be able to relate technology to both pedagogy and content [24]. Therefore, the current study investigated teachers' use and perceptions of digital technology to promote learning and participation for all young students in early reading and writing education in inclusive primary schools.

What do teachers consider important when planning and teaching reading and writing lessons with digital technology?

Mishra and Koehler [24] have developed a framework for the essential qualities of teachers' knowledge to integrate technology into their teaching. They argue that teachers should integrate their knowledge of technology, content, and pedagogy to promote learning among their students. Using this framework, we investigated what teachers in inclusive settings considered important when planning and teaching reading and writing lessons using digital technology. The results showed that the most prevalent answer was the teachers' digital technological-pedagogical knowledge for planning (44.6%) and teaching (53.0%), whereas very few of them thought content knowledge was essential for planning (4.2%) and teaching (1.3%) reading and writing. Just above 1% of the teachers thought the integration of knowledge was essential for planning and teaching reading and writing with digital technology to young students. Hence, the teachers in the present study have not stressed the importance of integrating different types of teacher knowledge to promote students' learning to read and write through digital technology in the classroom, and these results suggest that there is more to be done to make digital technology use more optimal in reading and writing education for younger students.

A previous study on reading and writing, where the framework by Mishra and Koehler [24] was applied, showed that teachers needed extra planning time for integrating technology in reading and writing education [20]. The teachers found technology selection and planning to be challenging, and they reported that their selected technology did not suit the lesson objectives. Also, Cantú-Ballesteros et al. [48] found that many teachers perceive themselves as beginners and have difficulties integrating digital technology in their teaching. According to Mishra and Koehler [24], thinking of technology as something more than an addition to the education is crucial. Teachers might need to learn to use the tools, but they also need to be aware of how and when the digital technology is appropriate to use in the classroom. Subsequently, the fact that so few teachers in the current study emphasized the importance of applied knowledge might also reflect an unawareness of how and when digital technology can be used in early reading and writing education. They might be in need of further in-service teacher training to learn how to apply the different types of knowledge when using digital technology in early reading and writing instruction in inclusive settings.

In this study, just about 11–12% of the teachers mentioned the importance of planning for and using pedagogical adjustments when using digital technology in inclusive education to teach students reading and writing skills. However, one should keep in mind that many teachers might plan and adapt their instruction to the digital technology in order to enable all students to learn and participate in early reading and writing instruction, even if they are not reporting that they are doing so in this study. Those who mention the importance of planning for and applying adaptions in the classroom mentioned the need to differentiate assignments and use apps with individualized options to support students with special needs in their reading and writing. However, there were also teachers who did not state the importance of adaptation but who still mentioned the importance of using teaching methods and assignments suitable for all students. Whether the latter choose digital technology that adapts to the user and whether the digital technology enables individualized adaptations in the classroom is unclear. However, according to the teachers' self-reports, 6.9% described the importance of planning with the aim to promote all students' learning and participation in the classroom, whereas 3.9% of them emphasized the need to consider all students' learning and participation when teaching. These low numbers might mean that digital technology is mainly used among students with special needs rather than in education aimed at all students [cf. 35,36].

How frequently is digital technology used in reading and writing education to promote reading and writing skills among young students?

Teachers' use of digital technology to promote students' learning to read and write varies in the current study. Some teachers reported that digital technology is used several times a week to promote specific reading and writing skills among young primary school students. Others never use digital technology in early reading and writing education (cf. Table 6). The weekly use of digital technology was mainly for supporting students' learning in regards to phonological awareness, decoding, vocabulary, spelling, text editing, and listening to texts (cf. Table 5).

Digital technology, especially speech-to-text and text-to-speech programs, have been found to be supportive for students who struggle with reading and writing [17]. However, when such programs are used as individualized efforts for a few specific students in the classroom, the risk of these students feeling stigmatized and labeled as poor readers and writers is increased [9]. Digital technology as an individualized support can be regarded as a compensatory tool that helps students who struggle with reading and writing complete the same tasks as their peers. However, when a teacher uses digital technology with a more inclusive

approach, all students are provided with different pedagogical tools, including speech-to-text and text-to-speech programs. Then these programs are not just intended for students who struggle with reading and writing. In such education, individual students are not singled out, and the teaching is planned and implemented with a focus on all students' learning and participation in the classroom. In the current study, just over 30% of the teachers use speech-to-text or text-to-speech programs every week or several times a week to promote all students' acquisition of reading and writing skills. In contrast, about 74% used digital technology in the classroom every week or several times a week to adjust the reading and writing education for individual students. Consequently, the self-reports given by the teachers in the present study revealed that there is more to be done before digital technology can be claimed to be used in a more inclusive approach and not just as a compensatory support for students with special needs in reading and writing.

However, the fact that teachers so seldom report using text-to-speech programs is also a little bit surprising, since almost 60% of the teachers report that they use digital resources every week, sometimes several times a week, to promote their students' listening skills in regards to fiction; 54% also reported to use such tools for fact texts (cf. Table 4). Why it is that the teachers do not think of the text-to-speech programs as useful in promoting students' listening skills is not clear from our results. Thus, a possible explanation for the discrepancy might be alternatives other than text-to-speech programs available for listening to both fictive and fact texts. For example, Swedish schools can subscribe to audiobooks and use digital teaching aids with audio files, which might be used in the classrooms instead of text-to-speech programs. A reason for preferring such solutions may be that the reading of books is associated with a human voice that reads with empathy and emphasis, which contributes to a better reading experience and text comprehension for young students. However, this limits students who struggle with reading, as the only resources available to them are recorded files; thus, they do not learn to use text-to-speech programs, which would otherwise give them access to the texts that they want to read and listen to. Furthermore, in previous research Svensson et al. [30] suggested that the teachers' limited knowledge of digital technology might lead to such assistive tools only being used as regular books or as replacements for pen and paper, and such usage would then lead to students missing out on many of the endless possibilities of digital technology.

Systematic investigations of how speech-to-text and text-to-speech programs can assist all young students in a classroom in their reading and writing are lacking [26,27]. Hence, the results from the present study cannot be compared with previous research on an inclusive approach to the use of digital technology within early reading and writing education. Thus, a couple of studies using digital technology in reading and writing education. For example, in a survey study on special education teachers in charge of literacy instruction for students with special needs in year 7 in the US, 71% of the teachers never used text-to-speech programs, and 53% never used speech-to-text [21]. Thus, the teachers in the current study reported a more frequent use of such programs than the special education teachers in the US did. Flanagan et al. [21] suggested that these programs are used to a greater extent among teachers with more extensive teaching experiences, and maybe this could explain the more prevalent use among the teachers in the present study, as they had much experience of teaching. Our results also supported a significant relationship between teaching experiences and the use of digital technology to promote reading and writing skills among young primary school students (cf. Table 6). However, the correlation was weak (r=.13), and there are probably underlying factors such as a supportive and collegial working environment, accumulated experiences from the same grade and subject [49], and a teacher's willingness to learn and improve their practice [50].

How are the teachers' perceptions of digital technology as a facilitator of participation related to their perceived knowledge to manage digital technology in early reading and writing education?

According to UNESCO [12], digital technology has a great potential to promote inclusive education, which is essential for ensuring all students' participation and equal educational rights [3]. Still, to our knowledge, there is not a single empirical study on how digital technology is used in early reading and writing education when the intention is to ensure that all students are able to participate; neither are there any studies on the teachers' perceptions of digital technology as a valuable tool for promoting all students' participation. Therefore, our results can be regarded as a first step towards clarifying whether teachers perceive digital technology as a valuable tool for all students' participation in early reading and writing education. The results showed that those teachers who more strongly agreed that digital technology facilitates the participation of all students in early reading and writing education reported a more frequent use of digital technology in their teaching (cf. Table 6). Moreover, those teachers who had higher scores on the scale measuring teachers' perceptions of digital technology as a facilitator of students' participation in reading and writing education perceived to a higher degree that they have knowledge of managing digital technology in their reading and writing education for young students. Similarly, Lamond and Cunningham [27] found positive associations between teachers' perceptions and knowledge of digital technology and their perceived usefulness of digital technology.

In our study, about two-thirds of the teachers reported that their knowledge of how to teach young students to read and write with the help of digital technology is good. Furthermore, those teachers who perceived themselves as able to use digital technology also reported using digital technology in early reading and writing education more frequently. Still, some teachers believe digital technology is not valuable for for students' participation in early reading and writing education, and this belief is related to how they perceived their own knowledge of managing digital technology in reading and writing education. These results are in line with Cabero-Almenara et al. [5], whose findings revealed that teachers without sufficient digital skills miss out on implementing digital technology in teaching. Consequently, some classes will miss out on the advantages of including digital technology in teaching and of using the various fundamental functions available to all students [8,34]. The potential to use digital technology to promote all students' learning and participation is then lost due to the teachers' self-perceived insufficient knowledge of digital technology use. A basic precondition for digital technology to benefit all students is teachers' knowledge about how digital technology can be used optimally when teaching reading and writing [cf. 30,51]. In addition, teachers must also have a critical approach to digital technology to use it inclusively [25].

Previous research demonstrates that digital technology provides efficient support to students with special needs in reading and writing [9,30]. Similarly, the teachers in the present study

used digital technology to make adjustments in the reading and writing education. However, this is not a unique finding. Although teachers regard digital technology as a compensatory tool for students with special needs, the advantage of using digital technology in teaching inclusively is absent. Further research on the reasons that digital technology is not being used to promote all students' reading and writing is needed.

Limitations

Although the present study is an attempt to investigate teachers' use and perceptions of digital technology as a tool to promote learning and participation for all young students in early reading and writing education in primary schools, some potential limitations of this study should be recognized. As the research area is in its infancy, there is a lack of tried and valid instruments that measure teachers' perceptions and use of digital technology in early reading and writing education. Therefore, we developed a questionnaire based on previous research on teachers' use and perceptions of digital technology in reading and writing education [20–22,42]. However, there is comprehensive research on critical components in early reading and writing education [40,41] and such knowledge was considered in the development of the questionnaire. Hence, the results from the present study are based on a new instrument that has not been solidly tested. Also, our findings are based on teachers' self-reports, and their actual use of digital technology could differ from the self-reports. The teachers' responses could have been influenced by the social desirability to use digital technology, because teachers in Sweden are expected to include digital technology in education. Consequently, the teachers' answers regarding their digital technology use in early reading and writing education could be more frequent than the actual use.

Another limitation of the study is that participants were recruited though a digital newsletter from LegiLexi. We do not know the number of teachers who received the newsletter and declined participation. Sometimes, the newsletters go to school function addresses, whereas the teachers themselves have registered their email addresses in other cases. LegiLexi is available to all public and private schools in Sweden; therefore, the sampling has not targeted schools in specific areas. Thus, LegiLexi is a digital program for assessing students' reading and writing skills. Therefore, we can assume that the participating teachers are particularly interested in promoting their students' reading and writing skills as they use and receive newsletters from LegiLexi. Furthermore, the teachers probably work in schools where digital technology is a priority. Consequently, the results from the present study should not be generalized to all schools in Sweden.

Conclusions

Results from the present study showed that teachers who perceived digital technology as a facilitator of all students' participation in early reading and writing education also reported that they used digital technology to promote reading and writing development more frequently. Even though both our results and previous research show that teachers perceive digital technology as essential for supporting students within reading and writing education, the digital technology is still not being fully used. The results also showed that teachers do not integrate technology into their knowledge of pedagogy and content in reading and writingt. As digital technology continues to rapidly develop and as pedagogical approaches and understanding of participation and inclusive learning evolve, there is opportunity for further research on such technology in inclusive education.

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