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Assistive technology applications for students with reading difficulties: special education teacher's experiences and perceptions

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ABSTRACT

Purpose: Reading and writing applications (with text-to-speech, TTS and speech-to-text, STT functions), used as assistive technology (AT) for students with reading difficulties are increasingly used in education, however, research has not sufficiently enough evaluated its potential. The purpose of this study was to explore how assistive reading and writing applications were perceived to function with regard to students' possibilities to assimilate (i.e., "read") and communicate (i.e., "write") text.

Methods: Following a six-week app intervention, this follow-up survey contained 54 special education teachers' perceptions of how the use of apps impacted student motivation, learning, and its usability in special education. A total of 59 students with reading difficulties from Grade 4, Grade 8 and from high school, were assessed. Analyses included quantitative and qualitative analyses of teachers' responses and written material.

Results: The results showed individual differences in how teachers perceived app usage for text-interaction purposes, including how app usage affected student motivation and autonomy for text-based learning. Eighty-two per cent of the younger and forty-seven per cent of older students continued to use the technology after the intervention, but in various degrees.

Conclusions: Based on these findings, students with reading difficulties seem to be able to use AT in order to assimilate text (i.e., to read) and to communicate text (i.e., to write), and, thus, AT has the potential to promote participation in regular education. Future research should focus on how to customize assistive technology support in order to better utilize the potential.

➤ IMPLICATION FOR REHABILITATION

- This study found that students with reading difficulties could use reading and writing apps (with text-to-speech, TTS and speech-to-text, STT) in portable tables to be able to gain access to, and to produce text in an applied school setting.
- To use TTS and STT as assistive technology efficiently may require relative extensive support and training, but even with this support, not all students in this study benefited from the potential use of the technology, as the processes of being able to gain access to and to produce text with assistive technology seem to be a difficult process for some of the students.
- It is proposed that in order to enable all students with reading difficulties possibilities to use assistive technology efficiently, its uses need to be customized even further than was done in this extensive intervention.

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Reading difficulties; assistive technology; intervention; special education

Introduction

This study is one part of a larger Swedish project investigating the impact of assistive reading and writing apps (primarily with text-to-speech, TTS, and speech-to-text, STT functions) for students with reading difficulties in Grade 4, Grade 8 and in high school [1] [Names deleted to maintain the integrity of the review process], submitted). In this part of the project, we explored special education teachers' perceptions whether these technological functions are sufficiently beneficial to be used as assistive technology (AT), in order to bypass typical decoding and writing problems associated with reading difficulties.

In recent decades, validated special education remedies has led to a dramatic shift for students with severe reading difficulties. Based on studies that provided high-quality instructional interventions to students at risk, [2] reported that 1.6% to 6% of students could not be remediated. Other studies show that early intervention seldom have such an effect that difficulties with reading disappear, but rather, that the interventions reduces the effect of reading difficulties [3]. A large number of studies show that students with initial difficulties with learning how to read keep lagging behind in their reading development throughout school [4–6] and that many, despite special education, never develop reading abilities sufficient for fully participating in

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school activities [7]. Although, many students can improve their reading by typically used interventions like phonological awareness training [8–10] we are left in uncertainty how to meet the needs of those who do not respond adequately well to these efforts.

Al Otaiba and Fuchs [11] concludes, following a review of inadequate response to intervention (RTI) studies, that, (p. 131): "little evidence exists that even the most powerful remedial interventions make it possible to "close the gap," particularly in terms of fluency and comprehension, even in studies that have come close to doing so in terms of word reading". In this regard, some researchers, like [12] question the use of comprehensive and intense training for students who respond the least.

An alternative to intense training is to compensate for the difficulty or using other means to facilitate reading difficulties, which also Siegel suggests. Edyburn [13] writes that technology is hardly mentioned in the RTI literature, despite good potential for technologies like TTS and STT, which can be used to facilitate reading or to replace reading entirely. Mckenna and Walpole [14] and Edyburn [13] advocate to replace traditional remedies with the use of digital assistive technologies and a call to ask the needed question of remediation vs. compensation following persistent reading failure. Edyburn [13] highlights two reasons for considering AT (p. 18); "(1) failure to meet performance expectations at this point will take away time from future learning opportunities and, (2) there is overwhelming evidence that traditional instruction and remediation efforts have failed to enable the individual to perform at a satisfactory level".

In pace with technical progress, regarding the quality and availability of TTS and STT-functions provided in new technologies like tablets, including voice feedback and highlighted spoken text, many educators believe that students with reading difficulties could benefit from using these functions as AT [15–18]. This means using alternative methods to read and write, such as listening to spoken text and dictating instead of writing. Text-to-speech software uses an optical reader to transform printed text to an electronic document [19]. The speech synthesis can then convert the text to intelligible sounds, and often, one can choose among preferred voices, for example if one prefer male or female speech. While listening, the software highlights the words being voiced aloud, should the user prefer to follow along and read the text. Conversely, STT software converts a user's speech into electronic text into a word processor. Then, the speech synthesis can be used to listen to the produced text, in order for the user to get an apprehension about the structure of the text, including spelling. An imbedded spellchecker feature in the word processor can also aid the user to edit the text.

Assistive reading and writing apps have two main functions: (1) to stimulate learning of reading and writing, and (2) to function as an alternative way to access text. Apps imbedded in a portable tablet also enables the user easy access to these functions. This study focuses on reading and writing apps in tablets primarily with TTS and STT-functions, intended to support reading and writing tasks and address problems associated with impairments of reading and writing skills. This use of technology is in line with the ICF assistive technology guidelines [20,21], as this study focus on how to improve the "functions" of being able to gain access to text. Apps that are exclusively intended to practice word recognition ability (e.g., speed and fluency at word level) are not covered by this study. One definition of AT is provided by ISO (2011):

> An assistive product is any product (including devices, equipment, instruments and software), especially produced or generally available, used by or for persons with disability, for participation, to protect, support, train, measure or substitute for both functions/structures and activities, or to prevent impairments, activity limitations or participation restrictions

There has long been an interest in using AT for individuals with disabilities [22,23]. However, as several reports acknowledge [15,24,25], most research in assisting reading and writing has been conducted with small sample sizes and with limited interventions in terms of the number of training sessions provided. Since the field is under-researched, there exists no standardized methods or agreements upon of how to efficiently select, implement or to investigate effects and outcomes of AT for students with reading difficulties. The limited empirical base in this field also means, even though the usage seem logical and sound, that we do not know enough of the benefits of AT, or how interventions should be designed in an applied school setting.

A recent meta-analysis by Perelmutter et al. [26] investigated a range of different reading and writing assistive technologies, such as with TTS and STT-functions, for adolescents with learning disabilities. They reported small positive effects of using TTS and STT, but found that some participants responded unfavourably to such technology in several included studies. However, they addressed that their results are to be interpreted as rather tentative because of quality variations in included articles, and that the technology in many studies were old and inferior compared to today's range of products, which might have obscured true effects of the technologies had the studies been conducted later. While it was concluded that functions like TTS and STT had small positive effects on comprehension and text production, the authors put forth that effect sizes depended on the extent support, including technical support, and individual customization that was provided, which are in line with other papers of AT-usage in special education [27].

Therefore, following a quasi-experimental pilot study focusing on reading and writing apps in smartphones [28], a large research project was carried out in order to answer several questions associated with the use of reading and writing apps, this time in tablets, by using a randomized control trial approach in addition to explorative efforts.

Results from the previous control study [1] showed that the intervention students (whose level of reading difficulties were severe, see the method section for further details) had about equal gains in all of the measurements of reading up to a year after the intervention, compared to control students who continued with traditional special education remedies and other support (i.e., treatment as usual). It seems from this study that AT, which included a systematic six-week intervention of text interaction exercises with apps, over other special education remedies and support, did not affect the students reading development negatively. This was evaluated in comparison with control students with the same level of reading difficulties, and to standardized test norms. The study also demonstrated some aspects of the practical utility of AT, as TTS-functions substantially reduced reading speed for the younger group of students while listening to texts compared to reading the same material (i.e., in Grade 4, but not as much as for the older students) without affecting comprehension negatively.

The review by Perelmutter et al. [26] also raised the question of providing other measures of AT-evaluation than strict quantitative ones, as they argued that even if learning improves in a […] "purely numerical sense, but is uncomfortable or socially stigmatizing to use, then advocating for it might cause more harm than good." (p. 140). In addition, few studies have been able to capture the mere compensatory aspect of AT, for example, regarding the user's ability of being able to gain access to, and to produce text, investigated over and above the impact on traditional reading and writing measures.

Table 1. Teacher demographics by grade level.

Grade level	Mean age ± sd	Mean years in profession ± sd	Number of teachers*	Number of students assessed
Grade 4	51.3 ± 9.0	20.1 ± 12.5	35	38
Grade 8	48.1 ± 10.6	20.4 ± 13.8	11	13
High school	43.0 ± 10.7	13.0 ± 10.6	8	8

*Five teachers (three in Grade 4, two in Grade 8) evaluated two or more students, and two of the teachers evaluated each a Grade 4 and a Grade 8 student.

Furthermore, guidelines [29] and theoretical papers of special education research [30] also advocate for using multiple sources for evaluating this kind of interventions, over and above strict quantitative learning outcomes, in order to widen the understanding of how interventions impacts the individual, across different outcome goals.

In line with these recommendations, and from other guidelines and conclusions of AT-usage [1,16,28] (submitted), the present study explored how the students who participated in the AT-intervention were perceived to be affected, in terms of to what extent the technology enabled the user to assimilate and to communicate text using TTS and STT-functions. The study also explored how AT were perceived to impact motivation and independence for text-based learning and schoolwork in general. The concepts *assimilating* and *communicating* text were coined in the study by Authors [28] and serve as counterparts to the traditional concepts of reading, including comprehension, and text production, as the authors proclaimed that alternative concepts were needed, that were better in line with the processes of reading and writing using technology.

In order to assess these processes and functions, special education teachers who were responsible for the intervention, were asked of how they perceived the student and their use of AT, as they have been able to support and to monitor student progress in the six-week intervention and further use in regular education following the intervention.

The special education teacher's responses and supplementary written material in a survey, containing both close-end and open questions, were used to explore the utility of app usage following the intervention (see method section for details of the intervention). Using special education teachers' first-hand experiences of these complex student-technology interactions can be motivated by that the field has yet to develop research methods to investigate effects of AT-usage across a variety of outcomes [13,15]. Special education teachers' experiences of using the technology in a pedagogical setting are a valuable source of information, since the technology more and more becomes available for teachers and for students in special education.

Specifically, this study focus on special education teachers' perceptions of to what extent student interaction with reading and writing apps in tablets improves aspects of text assimilation and text communication (and also how the use affects traditional reading), including motivation and independence, in three age groups of students with reading difficulties. The groups contained students from Grade 4, (approximately ten-years-of-age), Grade 8, and in the first two years of high school (in which the students in Sweden are approximately sixteen to seventeen-years-of-age) . The complete list of questions is provided in the results section.

Aim

The aim of this explorative study is to provide the field of assistive technology better support for using reading and writing apps for students with reading difficulties, assessed through special education teacher's perceptions. Focus is on the processes of assimilating and communicating text, and how these alternative processes are perceived to affect student motivation, independence and further use of the technology to engage with text, as well as perceptions of using apps in special education teachers' practice.

Methods

The study has received ethical approval (reference number 2014/253–32) by the Ethic Review Board in Linköping, Sweden (EPN).

Participant recruitment

Fifty-four special education teachers participated in this study and were recruited to the project through special education networks from five areas in southern Sweden. The teachers were first contacted and were potentially eligible for the study if their selected students wanted to be part of the intervention, and if they met inclusion criteria (see *Participating students*). The teachers consisted of two professional groups working with special education in Sweden; special education teachers and special pedagogs and in addition, a few resource teachers in high school. Since the professions shared the same duties in their everyday work with teaching students, the teachers were compiled to one group. It proved to be very difficult to attract teachers and students to the project from Grade 8 and from high school, which resulted in a majority of Grade 4 teachers and students. Teacher demographics can be seen in Table 1.

In a review of assistive technology research, Floyd et al. [31] concluded that "studies reveal that teachers need training and technical support to infuse AT into their classrooms" (p. 98). Therefore, the teachers were trained in two group occasions three weeks before the intervention, each time involving approximately one third of the teachers as the project initiated three intervention rounds. The training was conducted by special education teachers that were experts in the field of assistive technology, and focused on how to implement the manual-based intervention. The training consisted of exercises of operating the technology, photocopying texts, using the TTS-function, produce text using the STT function, and how to edit texts using the technology. The teachers then practiced and prepared themselves for the remaining time before the coming intervention sessions. Throughout the entire intervention, the teachers had access to the experts, as well as online material, online support and tutorials of how to work with each app.

Participating students

The sample of students that were selected for inclusion by teacher participants was selected from a total of forty-two ($N = 42$) public schools. Students attended Grade 4, Grade 8 and the first two years of high school. Criteria for inclusion were documented reading difficulties and reading performance on or below the tenth percentile on word decoding tests (sight word and non-word reading), a boundary commonly found in research that

Table 2. Student demographics by grade level.

Grade level	*n*	Age in months ± sd	Percentage males
Grade 4	38	124.0 ± 4.9	63%
Grade 8	13	172.5 ± 5.7	54%
High school	8	200.5 ± 8.9	63%

examines children with dyslexia [25,32]. Students with other difficulties, such as with language impairment or Autism-spectrum disorder, were excluded from the project as well as students that had not attended the Swedish school from Grade 1.

59 out of a total of 68 students (87%) that had undergone the intervention make up the sample in this part of the project. Approximately twenty-five percent had dyslexia diagnosis and additionally four students (8%) had both dyslexia and either ADHD or ADD. There were slightly more boys than girls that entered the study.

The five regions, from which the sample was taken, represented both urban districts as well as rural areas. The student's socio-economic status, measured as parents' education, showed a diversity of the level of education in line with an expected distribution in a Swedish context. The level of education ranged between parents with no or only compulsory school graduation to parents with more than three years of university education. The most typical education was high school graduation. Student demographics can be seen in Table 2.

Study design

The data collection took place two-to-three months following the intervention because it provided an opportunity to assess student progress even after the intervention, which includes the use of apps in the students' regular education. Due to the large number of schools located in five different geographical areas, paper mail was used, followed by several reminders by e-mail.

Intervention and setting

The intervention was created based on an earlier study investigating the impact of apps in smartphones for 10–12-year-old students with reading difficulties [28] and in collaboration with representatives from The National Agency for Special Needs Education and Schools (SPSM).

The intervention was carried out as a one-to-one intervention in the students' school premises, such as in the special teachers' classroom, during or in close connection to the school day. The special education teachers followed a manual but were free to individualize some aspects of the intervention, for example, to use apps preferred by the students and by using texts, study books or other material from the students' regular education in order to get the intervention as authentic with the students' schoolwork as possible.

The sessions consisted of exercises of teaching the student how to use the apps and by carrying out other exercises, primarily of *assimilating* text by listening (TTS) and by *communicating* (STT) text by using the functions of the apps. TTS-reading with highlighted words were also used together with traditional reading (as support when reading texts).

The following overall procedure was employed

1. The student was taught by the teacher to scan a text by using a photo-based scanner and to listen to the text using a TTS-function.
2. The student then wrote down a summary of the text using a STT-function into a word processor.
3. The produced text was edited by the student, aided by a spellchecker program and the TTS-functions, for enabling the student to listen to the produced text, including receiving voice feedback regarding spelling and text disposition. The TTS-function allowed the student to listen to single sounds in a word to entire paragraphs, with highlighted words as an option.
4. The teacher encouraged the student to question the text before finishing the assignment.
5. At the end of each week, the teacher and the student compiled the texts and talked about the texts produced by the student during the week.

The tablet used was iPad 2 or 3. The following apps used in the intervention was *Legimus*, *Skolstil 2*, *Prizmo*, *SayHi* or *TableTop*, *Voice dream reader*, *Ruzzle* as well as *Pages* embedded in the iPad. The average time spent in intervention lasted for approximately 800 min, with an average of M = 21 sessions.

Materials

A survey was constructed that comprised sixteen statements divided into the three constructs outlined in the introduction; a) teacher perceptions of student motivation and b) teacher perceptions of student learning and c) how useful the technology is perceived for special education teachers' practice. The statements varied for different aspects of using AT for reading and writing purposes, including traditional reading, where the new concepts of *assimilating* (reading) and *communicating* (writing) text with the use of the apps were explicitly defined for the teachers. The scale used was a five-point scale, ranging between *in no degree, in a very small degree, in a small degree, in a fairly high degree* to *in a very high degree*. An additional question assessed if the student continued to use the technology after the intervention (i.e., two-to-three month after the intervention).

A typical statement for motivation was; *Following the intervention, do you perceive that the student's motivation for assimilating text has increased?* A typical statement for student learning was; *Following the intervention, do you perceive that the student has improved the ability to assimilate text by means of TTS?* The last construct the teachers responded to concerns general questions about perceptions of the usefulness of the technology for the teaching of students with reading difficulties and was not directed toward the project student. A typical question in this area was; *Do you perceive reading and writing app usage to enhance student's with reading difficulties learning opportunities?*

The questionnaire also included open questions for each of the 16 statements in order to receive a better understanding of how the teachers perceived the interaction between the student and the technology. These open-ended options were set immediately to the preceding structured statements, and provided opportunities for the teachers to explain the reasons to the responses they made as well as to have the opportunity to counteract any suppositions in the structured statements they felt they could not respond to.

Quantitative analysis

For the close-end questions, descriptive statistics is provided. Because the teachers of the older students were few, consequently affecting the power of statistical tests, no comparisons between groups were calculated. Recent advances in statistics has made it clear that low powered studies can lead to misleading results [33]. With low power, it is not meaningful to distinguish

significant from non-significant findings. Furthermore, this study was not designed for estimating a statistical difference between groups, but to describe the extent teachers perceived how AT functioned for the students in each group. Thus, as in the RCT-study [1] the older age groups were analysed as combined, which also was motivated by the resemblance in the organization of everyday education.

The purpose of using quantitative survey measures was to explore the perceived usability of apps from a large sample of special education teachers. The responses from the survey are presented as frequencies across the five-point scale. Scale numbers four (*in a fairly high degree)* and five (*in a very high degree*) were interpreted as being in favor of the statement and are described in the result section as a positive response. This was done to set a conservative cut-off to avoid inflated interpretation of the teachers' responses. By setting this cut-off, the ambition was that the positive responses actually reflected a positive perception of the usefulness of the technology over and above mediocre impact. This procedure was inspired by papers that aim to evaluate the clinical significance of interventions [34]. Responses that ranged between scale number one to three were interpreted as indicating no clinical impact for the student, however, in terms of transparency; all collected data are presented in Tables 3, 4 and 5 in the supplementary appendix. The question on further use of the technology in the students' regular education were also used as to signal the perceived clinical significance.

Qualitative analyses

As mentioned in the introduction, students interacting with technology constitute a complex interplay, which was difficult to examine using a quantitative survey alone. Therefore, the written comments were analyzed in order to deepen the understanding of how the teachers perceived how the intervention affected the students. A qualitative content analysis was used, by following recommendations and guidelines from Elo and Kyngäs [35]. Although the written material was explored using an inductive approach (i.e., since there are limited knowledge of AT-usage), however, the purpose of the study (evaluating how students with reading difficulties managed to use AT-functions) constituted the preunderstanding through which categorization was created. AT usage included many diverse activities (e.g., being able to listen and to comprehend texts, write text, operating the technology, etc.), and we consciously searched for how teachers perceived student interaction with the technology across different functions. Although, such functions were not stated before analyzing the data, but the analyses was of course guided by the format and content of the survey. One hundred and fifty four statements were included in the analysis.

1) First, a thorough read-through and notetaking of the material was conducted by the first author, including open coding procedures, 2) All teacher comments were analyzed as a whole regardless of grade level, however, notes were taken when grade-specific deviations occurred. 3) Open coding for each statement was mainly conducted in an inductive manner (see above). 4) After the first author's reading, the other authors contributed their comments before consensus was reached. 5) Open coding and headings was used to create general categories of the material. This was explicitly guided by evaluation purposes of how the intervention affected the student. For example, since many comments were about how students were affected by having access to TTS-functions, these narratives was organized under a general category. The specific aspects of using TTS were then presented under this category, that is, from specific content to general statements [35]. This also means that individual quotes under each category contain valuable information of AT-usage. The process generated five main categories; 1 *Variations in the ability to assimilate and to communicate text*, 2 *Written language development,* 3 *Variations in motivation and autonomy,* 4 *Need of support and practice,* and 5 *Teacher competence*.

Results

The procedure of contacting the teachers two-to-three months after the intervention resulted in that 54 out of 63 teachers in total could be re-visited. During this time, some teachers were on leave, had changed workplace, or were unavailable due to other causes, making it difficult to assess all students through the intervention teachers (59 out of 68 students could be assessed). By age level, the re-visited rate were 38 out of 44 students (86%) in Grade 4 and 21 out of 24 students (88%) for the older age groups.

Most teachers were in charge of only one student. However, seven teachers evaluated more than one student, and two of them evaluated both a Grade 4 and a Grade 8 student (but not at the same period of time since the project contained three intervention rounds). Consequently, the presentations of teacher responses (i.e., Figure 1 and the tables in the supplementary appendix) contains all responses when evaluating the students use of apps, but teachers' general evaluation of tablets and apps only contain one response for those teachers having more than one student, except for the two teachers who operated across grade levels.

First, the cut-off values (the combination of response number 4 and 5) for grade 4 and for the combined older age group can be seen in Figure 1. In the results that follows, the cut-off values were used for the determination of perceived clinical use, which are reported below. This section also reports the assessments of whether the student choose to continue using the technology in their regular education. The categories originated from the written comments are presented last.

Grade 4 special education teacher responses

In Grade 4, teacher assessments of students' further use of the technology after the intervention were approximately 82% (31 students), but this number contained students who continued with only limited use, as well as students that continued to use the technology on a day-to-day basis.

Most Grade 4 special education teachers responded positively about the impact of assistive technology app usage regarding their students' ability to assimilate text (72%), that apps could compensate for their reading difficulties (82%) and that their student's amount of text assimilated (68%) has increased because of using the apps. A lower proportion of the teachers perceived that the use has affected text comprehension (46%), and about half (54%) were perceived to have improved the motivation to assimilate texts with apps. Nearly half of the teachers perceived that traditional reading ability has improved (43%), even though the apps did not primarily train the technical side of reading, such as word recognition ability.

The responses also showed that half of the teachers (50%) perceived an improved autonomy for communicating text, but few (34%) were perceived to actually being able to produce texts with the apps.

Thus, the results indicated individual differences in how students were able to take advantage of the apps, as some teachers

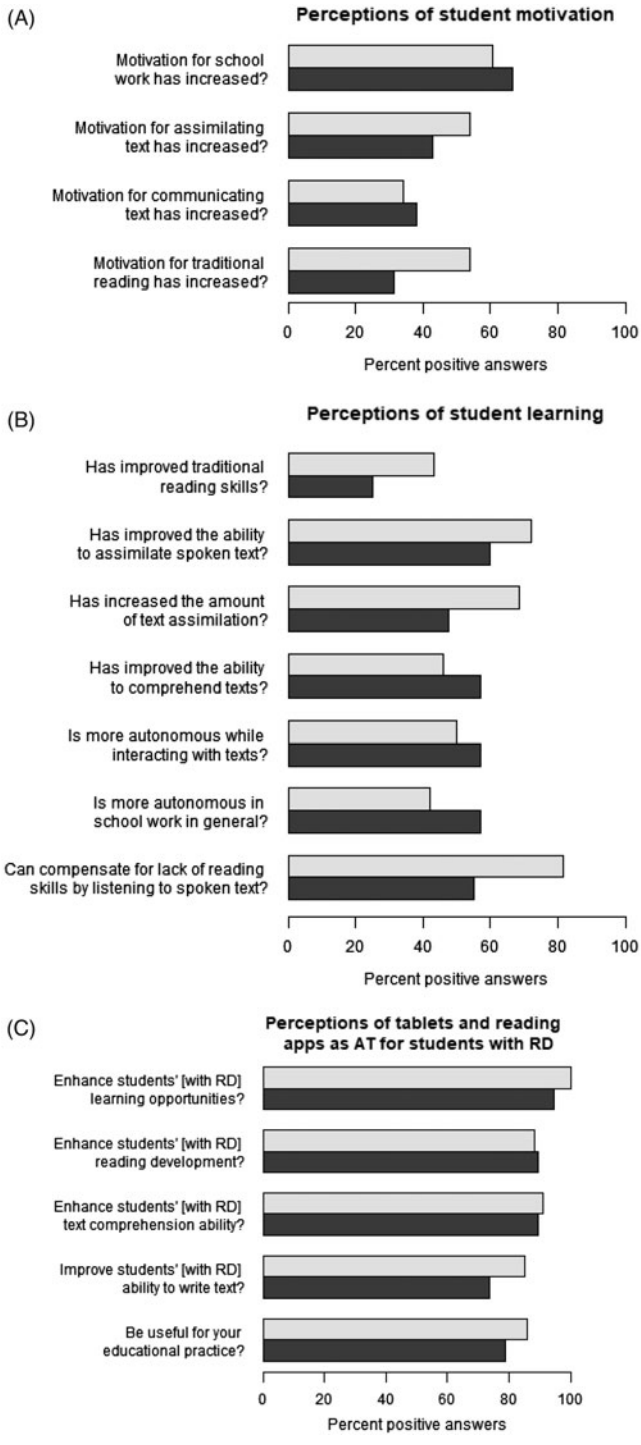

Figure 1. Percentage of teachers' positive responses (nr. 4&5). Upper bar (light grey) represent Grade 4. Lower bar (grey) represent Grade 8 and High school.

responded that none or small improvements took place (response answer 1–3 to several questions regarding motivation and learning, which can be seen in Table 3 and 4 in the supplementary appendix). There were students who were perceived to fully benefit from app usage by positively affected abilities needed for assimilating and communicating text (although, producing text with apps seemed to be more difficult than assimilating text), which also impacted autonomy for interacting with text, and for autonomy in schoolwork (42%). Other students were perceived to respond more modestly and a few students did not seem to benefit from app usage at all. Nearly all teachers evaluated the potential of this kind of assistive technology tools in special education (responses ranged between 85%–100%).

Grade 8 and high school special education teacher responses

Although, we did not carry out statistical analyses comparing answers between teachers of the two age groups, due to the older groups being much smaller, some similarities and differences could be noted in the responses.

In the combined older sample of students, teacher assessments of students further use of the technology were approximately 47% (9 out of 19 assessed on this question), which is clearly a much lower percentage than in the younger age group. Taken together, approximately 70% of all students had continued to use the technology in some form.

In relation to Grade 4, fewer teachers in the older group responded that the apps could compensate for their students reading difficulties (55%), and that, not very surprising in the older group; only a few teachers perceived that the students had become better (25%) and more motivated (32%) regarding traditional reading skills. However, more than half of the teachers responded positively regarding their students becoming more motivated toward schoolwork (67%), increased schoolwork autonomy (57%), as well as that apps could assist their students to assimilate (60%), and comprehend texts (57%).

Like some of the students in Grade 4, apps seemed to work as intended for a portion of the older students by allowing them to become autonomous when working with texts using the apps (57%), however, some teachers responded that none or small gains were perceived (response answer 1–3 to several questions regarding learning and motivation). Most teachers though, perceived the potential use of apps in special education as responses for the questions of the general usability of assistive technology apps ranged between 74%–95%, where using STT for the purpose of text production were rated the lowest.

Qualitative analysis

The content analysis of the one hundred and 54 comments resulted in five categories. Since the written material consisted of many short comments, rather than longer narratives that could be transformed to block quotes, distinguished and illustrative quotes for each category are presented in parentheses within the running text.

Variations in the ability to assimilate and to communicate text

The first category that emerged was that the teachers perceived that the intervention sessions impacted student development, in particular for learning beyond word reading performance, however, the many comments supported the results from the survey responses in that they indicated individual differences. Some students were able to fully employ the utility of the functions, whereas others only benefitted from single functions to a limited extent.

By using the supportive and compensating functions of the apps, the teachers perceived that the students had gained access to literacy, ("*The student have discovered that exciting things is happening in books*", "*Apps contribute to the students development, the assimilation of texts, reading experience and web-based texts*"), had increased the amount of text assimilated ("*The student now reads books of 200–300 pages using apps*", "*Through listening, the student has assimilated large amount of text*") and were able to

comprehend what they were listening to ("*Assimilating text has improved very much*"). No particular differences between the utility of support while reading (follow along in text while listening) with only listening (TTS) were noticed. Instead, teachers put both those functions in the foreground ("*It was easy for the student to comprehend text when the student could both see and hear the text*", "*The student easily scans a text and listens to it*"), which enabled the students to assimilate text without being stuck at struggling with reading ("*Focus now is on comprehension, instead of decoding*", "*The student use apps for presentations and are helped by being able to listen to text instead of sitting quietly and just try to read traditionally*", "*The students use the tablet to study lesson materials and to read from the tablets, because it makes it practical and helps to keep order*"). There was also support for using the apps to communicate text ("*He writes more on the iPad than by hand*", "*The student writes longer and longer texts*", "*The student has developed enormously regarding writing*").

The teachers, whose students managed to efficiently use the technology, took advantage of this by developing study skills with the students ("*We now focus on combining work with study skills – listen a bit, pause, what did you hear?*", "*Apps for this student enables; to comprehend different texts, to draw conclusions, to read between the lines and add own experiences*"). Thus, the extent students were able to use the technology varied, but it seems among teachers written material that most students could benefit from its basic functions, while some students developed the use further.

Written language development

Development of traditional reading and writing skills (e.g., improving reading speed, fluency or spelling) was never the purpose of the project, however, the second emerging category was that the teachers witnessed of an increased student awareness and knowledge of written and oral language ("*Taking part in different types of texts with repeated reading positively affects vocabulary, grammatical awareness and sentence structure, The student notice his own language by using the speech-to-text function*"). By assimilating and communicating text with apps, the teachers meant that it facilitated the skills needed for comprehension, such as an improved access to vocabulary ("*The student are now using more words automatically*") and an improved understanding of written language ("*By assimilating text through listening, the sound-letter correspondence become consolidated, which in turn should affect reading development*"), which previously was negatively affected by their impairment. However, the teachers assessed the gains to be insufficient for traditional reading to be fully functional ("*The reading ability is still causing problems despite practice, but have been improved by listening and focusing on texts*"), which supported the use of apps to facilitate and to compensate, rather than to rely on for traditional reading development.

The apps were also perceived to contribute positively to writing skills, particular regarding the structure of texts ("*It became much easier for the student to write down the text, to correct and modify the text*", "*The student scans self-produced text to be able to listen to it and to detect potential errors*").

Variations in motivation and autonomy

Based on the third category, motivation to engage with texts seemed to coincide with a perceived improvement of to be able to assimilate and to communicate text with apps ("*The tablet will be an incentive to learning as they notice that they can learn and then it becomes an upward spiral that spreads to other areas*", "*At first, the student was not so motivated to do the tasks. After the third week, motivation increased and the student was more self-going*") as apps provided autonomy for those students that were able to take advantage of the technology. These students were provided with opportunities that allowed them to follow the teaching in their classes in ways they had not experienced before ("*The student listens to books and is using the iPad with apps in the regular education in order to comprehend the books used by the peers*", "*One of the reading apps are used on a daily basis, other apps twice a week*", "*The student is reading thicker books and books the classmates read*"). By avoiding the struggles of reading and writing text, the teacher comments indicated a will of the student of wanting to assimilate and to produce text with the aid of the apps ("*The student has a greater motivation for wanting to assimilate texts. Both the use of the tablet but also to try to read traditionally*", "*The student was very proud of his texts*"). However, some teachers perceived that not all students experienced an increased performance, thus, that seemed to affect their attempts negatively to use the technology for assimilating and communicating text purposes ("*The student still has difficulties to write and is not interested in using apps*", "*During the project, the motivation was high but when the project was over, he fell through*"). Individual differences were therefore prominent regarding students' motivation and autonomy for text-based learning with the aid of the technology.

Need of support and practice

The fourth category concerned students' needs and the importance of systematic practice of apps, continuous technical and educational support ("*It took a lot of guidance from the teacher at first*", "*When the student is self-sustaining, it is a big help*"), and the importance of an implementation strategy of app usage in order for its uses to be a natural part of the teaching in the students' classrooms ("*The teachers* [i.e., the students' ordinary teachers] *must take responsibility to remind the student to use the iPad as a learning tool*", "*He never came to the situation that he could generalize it to the classroom*"). The comments concerned and especially prominent in the younger age group, that despite six weeks of practice, some students still had a need of learning how to use the apps efficiently and to change their way of learning ("*The student still need assistance with scanning texts and is unable to modify the text without assistance*", "*Difficult to use these apps on their own, I have to support him regularly to use the apps*", "*The student is still limited to work on her own, but much better than before the project*", "*The student would have needed longer one-to-one teaching to be more sure of himself*". "*It came to an abrupt end to him when we could not work together more*")

Teacher competence

The last category "Teacher competence" was related to the fourth category "Need of support and practice". The teachers wrote that they have worked intensely with sustaining the students work with apps ("*I have to support him regularly to use the apps*") but also, and more importantly, that they had become aware of the nature of the students' needs ("*We teachers have become more knowledgeable for students' needs*") and that they were using that knowledge to let the students be aware of how to use the apps to compensate for their difficulties ("*I feel safer on how to develop students' awareness of compensating for their disabilities*"). Teachers that indicated this increased awareness of what apps contribute

to, along with knowledge of how to efficiently use apps in pedagogical settings, were also positive for continued work with apps for teaching students with reading difficulties ("*I share app usage to other educators at tutoring*").

Discussion

Based on survey responses and written material, this study showed that special education teachers, after having participated in a six-week app intervention, perceived apps to have sufficient potential to compensate for reading and writing difficulties in an applied school setting. As many students in this study were perceived of having developed the abilities needed for successful use of reading and writing apps, and have gained access to literacy in new ways (and have eluded the struggles of decoding text), the potentials outlined in the introduction was supported [13,15,18]. However, not all students in this study were perceived of having developed the abilities needed for reading and writing apps to be as efficient as researchers have expected and hoped for. When emerging the survey responses and the categories together, it showed individual differences of performance patterns, and individual differences regarding how motivated and autonomous the students were of using AT, in both age groups.

Bell and Mclean [18] emphasized that when students move into secondary education, AT can serve as of allowing students with reading difficulties access to literacy in independent ways. In conjunction, they also stress the importance of students having enough skill of using AT in learning situations, in order for accomplishing these potentials. This study showed that when the students were provided with practice and opportunities, many were perceived to be able to be independent (or well on their way) in text-based learning, as well as being perceived to be motivated for assimilating and communicating text, in line with previous research [28]. This was also supported by that approximately 70% of all students continued to use the technology after the intervention, and indication of the perceived clinical significance of the intervention [34], for a majority of the students. In some cases, this meant that the students substantially increased the amount of books and texts assimilated, that they could use the same books as their peers, that they more easily could follow the general classroom teaching and that they could use apps for improving study skills.

In addition, after having taught and observed the students in text-based activities with apps, a clear majority of the teachers perceived that reading and writing apps could be part of the special education repertoire in which to enable student's with reading difficulties possibilities to take advantage of education.

Regarding app usage in relation to written language development, some students were perceived to be positively affected by continuous use of the technology, as shown in the category *Written language development*. According to the teachers, when the students no longer had to struggle to decode words, they could instead focus on how words and sentences were grammatically structured, as well as having the opportunity to practice text comprehension. One teacher of a Grade 4 student wrote that that by "*Taking part in different types of texts with repeated reading positively affects vocabulary, grammatical awareness and sentence structure*". As such, the many opportunities to interact with texts, using TTS- or STT functions, were perceived to have the desired effect on the continuation of student development of for example syntactic knowledge and vocabulary access and growth. These findings translated to the results from the main study [1] (submitted), which showed that the intervention students did not fall behind the controls on reading measures. However, although, even if these initial explorative results are promising, further studies are needed to determine if, and how AT can be used for the development of the skills needed for text comprehension and text production, as well as how to align assistive technology app usage into the general classroom teaching of written language skills.

Consistent with the literature of assistive technology, the categories *Teacher competence* and *Need of support and practice*, showed that for some students, adequate special education teacher support, which included teaching the student how to use apps to bypass specific difficulties, were crucial for many students to be able to use the technology efficiently. This was especially noted in the younger group, where some students discontinued using the technology when the one-to-one support ceased, and because of the difficulties of transferring the use from a one-to-one setting to independent use in regular education (and sometimes without the support of the class teacher). Nevertheless, 82% were perceived to continue using the technology after intervention, but many younger students were still perceived to require extensive support.

There is not much empirical research that have studied the environmental context of AT for this group of students, although, the importance of special education teacher support, practice and individualized customization have been highlighted by several researchers [15,18,27]. The variability of the teachers' responses indicated that the intervention was either not ideally designed for everyone, even though the teachers had the opportunity to individualize parts of the sessions, or that the processes of mastering app usage as aiding tools consisted of a too-high a threshold to overcome for some students.

There are three interrelated factors, substantiated from the categories, which can explain why not all students were perceived to be able to take full advantage of the app usage. First, to make efficient use of apps were lined with technical challenges of learning how to assimilate and to communicate text with TTS and STT functions, which seemed to hinder some of the students' possibilities to succeed.

Secondly, assimilating and communicating text through listening and dictating are skills that presumably takes time to master, that seemed to have added strains on the user during the learning process. Listening to written text could in some situation be more demanding compared to traditional reading, for example, that listening through a tablet decreases the user's control of the text input. Many students were also perceived of having difficulties with producing text, especially for producing and editing more complex texts using the STT function, but this could also be an indication of technological shortcomings.

The third factor consists of the challenges with bypassing the difficulties associated with their deficits in reading. Teacher comments indicated that the poor-responding students' (regarding the technology usage) difficulties with the reading and writing ability hindered them to be able to adjust to alternative ways of processing text. The comments also revealed, as reported above, that poor-responding students needed one-to-one support throughout the entire intervention and were not perceived of to be able to use the apps without the support of the special education teacher.

When taking the three factors together, it pointed to how challenging it was for some of the students' possibilities of accomplishing successful use of apps and to the importance of further research regarding individual customization and adequate teacher support of app interventions and usage.

The analysis from the special education teachers of the older students (Grade 8 and high school) is limited due to the difficulties with recruiting enough participants to the study. The results are therefore preliminary in the sense that we are more uncertain, because we did not have the opportunity to explore potentially different performance patterns. However, the apparent benefits, for example, assimilating text, being more autonomous in schoolwork and with text interaction with apps seemed to have worked as intended, but only half of the students did continue using the technology after the intervention, and a lower portion of the teachers perceived that apps could adequately compensate for their difficulties in reading. Based on these findings, it is difficult to conclude which aspects of the intervention that did not fit the older group, but some of the students seemed to benefit a lot from the intervention. The category *Variations in motivation and autonomy* most particularly demonstrated this. One of the high school teachers wrote: "*The student use apps for presentations and are helped by being able to listen to text instead of sitting quietly and just try to read traditionally*".

As some students were perceived to fulfill the potential of AT-usage, while some more modestly and a few not at all, research should focus on how to optimize the uses for every student, along with the necessary support and training. Future research is therefore needed.

At-implementation and evaluation

The level of severity of reading difficulties were in this study determined as reading scores on or below the tenth percentile on age-appropriate measures. This means that the population under investigation had not been adequately remedied by special education efforts before entering the study. Two things are of importance here; that AT-considerations can be based on how well students responds to traditional special education remedies. AT can therefore be regarded as a measure when special education fails to overcome the student's difficulties, which is the context of this study. Secondly, Edyburn [15,36] argues that AT should be introduced before students face large amount of text-based learning. By introducing AT in this way, students have the opportunity to participate in text-based learning with apps before they repeatedly fail to learn how to read and to write. This view of AT-implementation strategy can also add knowledge to the beforementioned explanations of the poor-responding students. In terms of this study, especially the older students had not been introduced to AT early in school, which might have contributed to the perceived inability or unwillingness of continuing using the technology for text-based activities.

In a wider perspective, assistive reading and writing technology have the potential to be integrated into the RTI framework as complementary support or additional solutions for non-responding students, as advocated by Edyburn [36]. Although this study did not explicitly focus on assistive technology considerations within such a framework (e.g., the timing and in which tier to implement AT), future studies could aim at investigating support for using AT as part of an overarching RTI approach, in order prevent early academic failure.

Requests of assessment practices and criteria for evaluation of assistive technology has been put forth in papers by McKenna and Walpole [14], Edyburn [15], Reid et al [16] and Melhuish and Falloon [24]. According to these papers, future assessments in this field should aim at evaluating AT as a proxy for the students possibilities of accessing a variety of text-based learning situations, with the scope of the individual students need, as well as students possibilities for reaching learning goals. This study show that such forthcoming assessments should include not only a range of different outcomes for the AT-functions, but also to measure the extent to which students manage to use such functions in an educational setting.

Limitations and strengths

We acknowledge the drawbacks with using self-reported measures from a survey not used before, as it was difficult to establish on what grounds and from which standards the teachers made their perceptions upon and potential reliability issues in the instrument. It can also be expected that the level of technology competence varied between teachers as some teachers have worked with AT for a long time, whereas others were in the starting phase of using tablets and apps, which might have impacted teachers ability to support and to make valid assessments. To guard against the subjective criterion in the instrument, all quantitative responses are available for any reader of this article, should they prefer another interpretation of the data. The results should therefore be treated with some caution, especially regarding outcomes that were more difficult to assess by means of teacher expertise only, for example, students development of written language competencies, in contrast to much easier assessments, such as how AT-usage seemed to have worked for the students. In addition to not being able to receive feedback from all intervention teachers there are also limitations regarding the results from the special education teachers of the older students, as they were few in numbers. This might limit our understanding how technology solutions contribute to different performance patterns among students in these two educational contexts.

Despite these limitations, the study contributes with knowledge in this field. In contrary to many studies that investigate how teachers use assistive technology in their practice, this study investigated the outcome of app usage from an intervention, containing both manuals that standardized the use of the technology and with provided teacher practice. In addition, although some teachers witnessed that a six-week intervention might not be sufficient for a proportion of the students, at the very least, the students were provided with practice which far exceeds what schools normally offers students when introduced to this technology. The potentials of app usage could therefore be assessed, but also some of the prerequisites of using the technology efficiently. In addition, the special education teachers assess students and tailor pedagogical work for students with reading difficulties as part of their professional lives. In this study, their expertise were used, as they were able to monitor and to assess the students' progress in a one-to-one setting over the course of six weeks and beyond.

The method of using comments not only provided results that could be difficult to collect in other ways from a large number of schools, the comments also substantiated what the teachers responded to in the quantitative measures in the survey. Although teachers' responses and comments may have had limitations of capturing student progress, it can also lead to further investigations of AT usage.

Conclusions

This study has clear practical implications for students with reading difficulties. The study demonstrated that AT can aid the users to gain access to text, and to allow students with reading difficulties to participate in classroom education and to use the same

study material as their peers. It also showed some of the prerequisites for successful use and integration of the technology in the classroom, by demonstrating that it was the teachers who made it possible for the student to use the technology efficiently. Based on the knowledge that can be drawn from this study, the take-home message for educators and researchers that wish to introduce AT for students with reading difficulties is to implement apps using a systematic, ongoing and individually designed customization. As the main result from this study was the diversity of performance patterns with app usage, future interventions could be based on how well students responds to the interventions by carefully observing progress and to conduct adjustments when students responds poorly. Today there exist no standardized way of monitoring progress over and above what can be assessed through teacher expertise, and possibly how it affects traditional reading and writing measures, therefore, research should focus on constructing means of assessing student progress that add additional measures to teacher observations, and to develop special education teacher's pedagogical knowledge of using apps in special education. This study primarily focused on students possibilities to gain access to text and to communicate text with apps. There seem to be plenty of learning situations where reading and writing apps can compensate for the difficulties associated with reading difficulties.

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References

[1] Svensson I, Nordström T, Lindeblad E, et al. Effects of assistive technology for students with reading and writing disabilities. Submitted to journal
[2] Torgesen JK. Avoiding the devastating downward spiral: The evidence that early intervention prevents reading failure. American Educ. 2004;28:6–19.
[3] Fuchs D, Fuchs LS, Compton DL. Smart RTI: A next-generation approach to multilevel prevention. Except Child. 2012;78:263–279.
[4] Bast J, Reitsma P. Mathew effects in reading: A comparison of latent growth curve models and simplex models with structured means. Multivari Behav Res. 1997;32:135–167.
[5] Francis DJ, Shaywitz SE, Stuebing KK, et al. Developmental lag versus deficit models of reading disability: A longitudinal, individual growth curves analysis. J Educ Psychol. 1996;88:3–17.
[6] Singleton C. (2009). *Intervention for Dyslexia*. Retrieved from http://www.bdadyslexia.org.uk/files/Singleton Report.pdf
[7] Wagner M, Marder C, Blackorby J, et al. The achievements of youth with disabilities during secondary school. A report from the National Longitudinal Transition Study–2 (NLTS-2). Menlo Park, CA: SRI International; 2003.
[8] Fälth L, Gustafson S, Tjus T, et al. Computer-assisted interventions targeting reading skills of children with reading disabilities–A longitudinal study. Dyslexia. 2013;19(1):37–53.
[9] Torgesen JK. The Response to Intervention Instructional Model: Some outcomes from a large-scale implementation in reading first schools. Child Develop Perspect. 2009;3:38–40.
[10] Torgesen JK, Alexander AW, Wagner RK, et al. Intensive remedial instruction for children with severe reading disabilities: immediate and long-term outcomes from two instructional approaches. J Learn Disabil. 2001;34:33–58.
[11] Al Otaiba S, Fuchs D. Characteristics of Children Who Are Unresponsive to Early Literacy Intervention. Remed Special Educ. 2002;23:300.
[12] Siegel L. (2013). Understanding dyslexia and other learning disabilities. Vancouver, BC: Pacific Educational Press.
[13] Edyburn DL. Technology-enhanced reading performance: Defining a research agenda. Read Res Quart. 2007;42:146–152.
[14] Mckenna MC, Walpole S. Assistive technology in the reading clinic: Its emerging potential. Read Res Quart. 2007;42:140–145.
[15] Edyburn, D. L. (Ed.). Efficacy of Assistive Technology Interventions (Vol. 1). Bingley: Emerald Group Publishing: 2015.
[16] Reid G, Strnadová I, Cumming T. Expanding horizons for students with dyslexia in the 21st century: Universal design and mobile technology. J Res Spec Educ Needs. 2013;13:175–181.
[17] Winters DC, Cheesman EA. Mobile instructional and assistive technology for literacy. Perspect Lang Literacy. 2013;39:42.
[18] Bell S, McLean B. Good practice in training specialist teachers and assessors of people with dyslexia. In Peer, L., & Reid, G. editors. Special Educational Needs: a guide for inclusive practice. London: SAGE. 2016: p. 157–168.
[19] Taylor P. (2009). Text-to-speech synthesis. Cambridge, MA: Cambridge University Press.
[20] ISO/IEC. ISO/IEC 13066-1:2011 Information technology — Interoperability with assistive technology (AT). Geneva, Switzerland: ISO/IEC: 2011.
[21] World Health Organisation. International classification of functioning disability and health-ICF, Geneva, WHO: 2001.
[22] Scherer MJ. Connecting to learn: Educational and assistive technology for people with disabilities. Washington, DC, US: American Psychological Association: 2004.
[23] Wise BW, Ring J, Olson RK. Individual differences in gains from computer- assisted remedial reading. J Experiment Child Psychol. 2000;77:197–235.
[24] Melhuish M, Falloon G, Melhuish K. Looking to the future: M-learning with the iPad. Comput New Zealand Schools Learning Leading Technol. 2010;22:1–16.
[25] Statens beredning för medicinsk utvärdering, SBU [Swedish Council on Health Technology Assessment]. . Dyslexi hos barn och ungdomar: tester och insatser; en systematisk översikt. No. 225/2014. Mölnycke: Elanders Sverige AB: 2014.
[26] Perelmutter B, McGregor KK, Gordon KR. Assistive technology interventions for adolescents and adults with learning

disabilities: An evidence-based systematic review and meta-analysis. Comput Educ. 2017;114:139–163.
[27] Hong CE, Lawrence SA, Mongillo G, et al. Using iPads to support K-12 struggling readers. A case study of iPad implementation in a university reading clinic. In H. An, S. Alon, & A. Fuentes editors. Tablets in K-12 Education: Integrated Experiences and Implications. Hershey, PA: IGI Global. 2015. p. 296–309.
[28] Lindeblad E, Nilsson S, Gustafson S, et al. Assistive technology as reading interventions for children with reading impairments with a one-year follow-up. Disabil Rehabil Assist Technol. 2107;12(7):713–724.
[29] National Research Council. Scientific research in education. Washington: National Academies Press; 2002.
[30] Odom SL, Brantlinger E, Gersten R, et al. Research in special education: scientific methods and evidence-based practices. Except Child. 2005;71:137–148.
[31] Floyd KK, Smith Canter LL, Jeffs T, et al. Assistive technology and emergent literacy for preschoolers: a literature review. Assist Technol Outcomes Benefits. 2008;5:92–102.
[32] Saksida A, Iannuzzi S, Bogliotti C, et al. Phonological skills, visual attention span, and visual stress in developmental dyslexia. Develop Psychol. 2016;52:1503–1516.
[33] Ioannidis JP. Why most published research findings are false. PLoS Med. 2005;2:e124.
[34] Foster SL, Mash EJ. Assessing social validity in clinical treatment research: issues and procedures. J Consult Clin Psychol. 1999;67:308–319.
[35] Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs. 2008;62:107–115.
[36] Edyburn DL. Response to intervention (RTI): Is there a role for assistive technology?; 2009. http://harvard2009group5.wikispaces.com/file/view/EdyburnHandout.pdf