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Review

The Use of Technology to Assist School-Aged Students with High Incidence Special Needs in Reading

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Abstract: This paper delineates some of the ways students with high incidence special needs are currently being served with technology in the United States in K–12 to learn skills or accomplish tasks related to reading. Categories examined were read aloud tools, computer applications, traditional instructional methods that utilized technology, and online instructional environments. The categories examined in online instructional environments include the prevalence of students with special needs, how Individual Education Plan requirements, such as accommodations and modifications, are being addressed, parental participation, and concerns in the online environments. Suggestions for future work at the intersection of reading technology and teachers of students with special needs are included, as well as conclusions from the current work. Future work with teachers of students with special needs is required to help better serve their unique learning requirements.

Keywords: technology; disabilities; online learning environments; reading; strategy instruction; special needs; assistive technology

1. Introduction

Reading is a crucial skill in the professional world. Without it, adults are unable to follow even simple written directions or take in new information by means of written text. Thus, reading is a crucial instructional area for children in K–12 schools today. As students progress through school, their reading becomes more crucial as teachers present new material through text [1]. Reading deficits are especially prevalent in children with special needs. Up to 80–90% of all students with special needs (SWSNs) have issues in reading [2,3]. Given that technology is increasingly more prevalent in the school classroom, or as an alternate presentation method, researchers are encouraged to examine how technology works to support SWSNs in reading. In many cases, the extra, non-judgmental, repeated drill that a computer provides can make the educational difference for the student [4] to access the general curriculum.

Indeed, access is a guaranteed right that SWSNs in the United States have provided to them by federal legislation. The legislation, called the Individuals with Disabilities Education Act, has six principles that outline how SWSNs should receive services in schools. Perhaps one of the most important provisions of the law is the Individual Education Plan (IEP). The IEP results in services that are developed from a meeting of multiple education professionals and the parents or guardians of the SWSNs who decide what best practices should be utilized to work with the student. A document developed in this meeting may include multiple strategies directing educators and schools in how best to serve the individual SWSN that the IEP concerns. The IEP requires that students have goals and objectives, as well as accommodations and/or modifications to help them access the curriculum. Often, these accommodation provide assistance in reading. The IEP also provides for parental rights in

a SWSN's learning and participation in schools. IEPs state that parents will be an important part of the IEP team that decides a course of action for SWSNs. The IEP states that parents will have a right to view their child's records with appropriate notice and initiate a due process hearing if they feel the school is not meeting their child's needs in a way they see fit [5]. Parental rights are important not only when students receive services in brick-and-mortar schools, but also when they are served in virtual schools in online environments.

How are educators following the recommendations of the IEP while utilizing this technology in their reading instruction for SWSNs? Or, in a larger schema, how are schools utilizing technology in educational methodology as a whole? How do teachers serve students using technology as a tool or a platform as seen in Online Instructional Environments (OLEs)? The following review includes read aloud tools, computer applications, traditional methods with technology, and OLEs. These areas are included to provide greater clarity about methodology and platforms of technology used with students with high incidence special needs.

2. Review Process

Articles for this review were culled from a search of the ERIC and PSYCHINFO databases using the search terms "special education", "technology" and/or "computer assisted instruction", and "reading". After this initial search, studies were then limited to the last 15 years and the instruction that was the basis for the research had to focus on work with students in the English language. Other limiters of articles after the initial search included that the researchers had to be working with school-aged children, children with high incidence disabilities, such as learning disabilities (LD), emotional disturbance, intellectual and developmental disabilities, and autism, and that the articles chosen had to be peer reviewed articles. An additional search was conducted with the terms "online learning environments", "special education", and "reading", and similarly limited with the term "school age" and the quality of peer review. It was hoped that combining these two areas would give a clearer picture of how SWSNs are being served in English-speaking schools. Technology is not just being used by SWSNs as an educational tool; it is also being used as an educational platform remote from the brick-and-mortar schools, as can be seen in OLEs. It is hoped by adding this category to the review that increased focus will be given to the current state of educating SWSNs with technology in schools in the United States.

3. Read Aloud Tools

Often students can better understand text as a whole when unfamiliar words are read to them, such as with computerized readers or text to speech devices [6,7]. Computers can use digitalized sounds, from the recorded human voice, or synthesized speech, to read unknown or new words to students because having trouble with several words in a text can slow or damage SWSNs' comprehension of the textual section. Some researchers have queried whether or not computerized readers or text to speech devices are simply compensatory and not remediative, but a recent meta-analysis found that, overall, these read aloud tools seemed to have a positive effect on the reading comprehension of SWSNs [8].

Perhaps the most promising area for continuing research includes screen readers. In fact, the National Reading Panel (NRP) (2000) pointed to hyperlinked text as one of the most promising areas for study in the combined areas of literacy and technology [9]. Further definitions of hyperlinked text boundaries, methods of using e-readers, and ways of using them in the classroom are needed to fully integrate electronic reading environments into schools [10].

Researchers investigated the Quicktionary Reading Pen II [11] which had the ability to scan and read text aloud to students with LD in upper elementary and high school grades. In a survey, students responded that they enjoyed having the pen as a tool that they could use. Overall, the students improved their scores on the Formal Reading Inventory, a comprehension measure.

Instructors [12] taught students with reading disabilities a self-questioning strategy and paired it with a text reader, the Kurzweil 3000. In comprehension quizzes after reading assignments associated with the intervention, no improvement was seen over the six weeks of intervention for the six students in the middle grades. In another study with a text-to-speech tool [13], three students with reading disabilities at the high school level used the tool while reading in seven to eleven sessions in a multiple baseline design. Though no improvement was seen in comprehension or reading fluency, students reported that the tool helped them and improved their completion time for the comprehension quizzes.

Researchers utilized another read aloud environment [14] with the TriAccess system. The system provided SWSNs with the ability to hear words when needed, as well as tools including text marking and word definitions. Each user could customize their experience. Researchers found that students improved their reading comprehension significantly when using the supports existent in the program. Additionally, subjects preferred reading with the supports in their own self-report.

4. Computer Applications

Students in K–12 increasingly have their own personal computer or tablet with them throughout the school day. There are many individual applications (apps) often downloaded to these devices that can provide learning games, as well as read aloud tools and other support, both for general education students and SWSNs. Some examples include SuperWhy Phonics Fair [15] available through public broadcasting that has literacy developing games and The Sounding Out Machine [16] that helps students struggling with their decoding skills. Through these applications, students have the extra support that they need, often making a difference in their overall reading efficacy.

In one study, fourth graders with LD utilized reading apps that included phonics instruction, timed reading, and vowel awareness on their own iPad and on pen and paper without the apps. Students preferred learning in the iPad condition and were more engaged in their tasks in such a learning environment [17]. In another study with 13 high school students with LD [18] each utilized an iPad with four apps including Flashcards, MiniMod reading for details, MiniMod reading for Inference, and BlueFire. Some of the students were able to demonstrate gains in a number of vocabulary words, but in standardized comprehension test scores showed a significant improvement over the 12-week intervention. Researchers in a third study compared iPad-assisted instruction to teacher-directed instruction for students with Autism Spectrum Disorders (ASD). Very often, students with ASD utilize iPads and the ones the students had in this study were equipped with Spacevoyager app that involved reading a passage and answering questions which enabled the student to play a game on the iPad. The contrasting condition had students receive teacher-led instruction that was measured by curriculum-based assessments. Students performed better in the teacher-led condition [19]. The program was meant to practice stand-alone skills as many apps are, but perhaps the students with ASD in this study were unable to generalize those skills to novel situations.

5. Traditional Instructional Methods with Technology

As stated in the NRP (2000) and the RAND Corporation study group (2002) [20,21] reports, instruction in comprehension strategies, such as visual imagery, advance organizers, visual imaging, visual mnemonics, summarization, main idea identification instruction, self-questioning strategies, and multiple strategy instruction improve reading comprehension in students with LD. Teaching comprehension strategies to students, especially those with LD, has assisted students in improving their comprehension [22,23]. Previously, studies had shown that work in this area of reading comprehension with adolescents was successful in assisting them with unfamiliar narratives [24,25].

Some successful computer intervention studies have paired the computer with active teacher-led instruction and feedback around many of the strategies mentioned above [26,27]. Though computer-based studies have emphasized the teacher-led intervention portion of computer learning, studies in the field of reading comprehension have also stressed passing a blueprint of strategies on to students to

assist with their reading comprehension [21]. These blueprints often involve in-depth, multi-strategy approaches to reading comprehension that may involve the use of technology.

One such strategy centers around graphic organizers [28] which pair a visual to help students organize story events to better comprehend text. Using computerized graphic organizers helped SWSNs with comprehension both in subject area instruction, as well as in reading traditional narrative writing. Gains were also seen in using computerized graphic organizers for writing. In another study, researchers completed six single-subject investigations with students with high incidence disabilities that utilized targeted online reading environments [29]. Students utilized graphic organizers and screen readers to repeatedly read a story, watch videos, highlight text, and view multiple presentations of instruction. Students performed the best in the conditions that worked with graphic organizers and screen readers.

One group of middle school students with LD who performed at least a year below their grade level in reading learned a previewing strategy and then read texts on the computer for several weeks [30]. Other students simply read the texts. At the end of the intervention, students who had received the teacher-led strategy instruction in previewing scored better on comprehension tests than the students who did not learn the strategy.

Online story mapping was the subject of another intervention [31]. Here, students with LD read a short story daily and filled out story maps online. Though their progress on these maps showed inconsistent growth, their overall comprehension, measured through comprehension scores on the Gates McGinitie Reading Test, improved significantly in seven out of nine cases over a period of six weeks.

Another strategy called the Word Identification Strategy [32] encouraged readers to find the stem of an unknown word and then attempt to better pronounce and comprehend it, as well as the root word. Though, traditionally, a paper-and-pencil strategy, the students improved not only their reading rate in four out of five cases, but also their overall passage comprehension in a computerized version.

A nine-year-old student with autism utilized the Headsprout program to improve his reading of word lists and text [33]. After 80 intervention sessions with the program, he was able to demonstrate improvement of reading of words and text. In a different study, six students with high incidence special needs (LD, emotional disturbance and attention deficit hyperactivity disorder) worked [34] in a resource room on the Headsprout program to assist with their reading comprehension, knowledge of sight words and fluency. Students completed between nine and fifteen 15–30 min sessions on the program. All six students made improvements in their comprehension of text and completion of comprehension measures. In a third study [35], three young students with autism worked on early reading activities in 52 sessions, with Headsprout. Students showed improvement not only in their ability to complete the activities, but also in their overall passage comprehension.

Twenty students with autism spectrum disorders aged 5–11 utilized the computer program ABRACADABRA to improve their reading skills [36]. The students worked on the program for 26 meetings over 13 weeks. They were able to make significant gains in reading comprehension, and accuracy both at a single word and passage level.

6. Online Learning Environments

OLEs are defined as schools where instruction takes place between student(s) and teachers where participants are disconnected from each other either by time, (i.e., students are participating in online learning activities asynchronously) or location, (i.e., students and teachers are learning together at the same time but in different physical locations) [37]. Much of the presentation in these online environments involves reading material that is presented in the course shell, especially when the course takes place asynchronously. The prevalence and enrollment of general education students in OLEs is growing, as is the incidence of SWSNs. Different states report varying rates of participation by SWSNs ranging from 0–14% of the overall OLE population, an estimated one million students overall in 2009 in 25 participating states were surveyed [38]. Researchers [39] identified the population with special needs served in the OLE system as 9.4% of the whole, slightly less than in the tradition K–12 public school system. The students with disabilities served in these programs reflect a

similar distribution to the face-to-face public school where most SWSNs have LD, but with multiple other students with disabilities represented including, but not limited to, emotional disturbance, autism, other health impairment, and hearing impairment [37]. The numbers and types of disabilities represented encompass a diverse learning corps in OLEs.

As of 2017 [40], 34 states report entire elementary or high schools functioning as OLEs, while 21 states offer only partial programs, make-up courses, enrichment, or classes too small to offer on a face-to-face basis available to students online. States report a yearly increase in the number of students served [38]. Indeed, some states are legislating that all students in their state have the option to take courses at an OLE in high school [41].

The potential appeal of an OLE for SWSNs, at least in theory, is its customizability and self-paced movement through the curriculum [42]. Often times, this type of program can increase parental involvement providing computers in the family home for the first time as part of the OLE. However, in a recent examination [43] of statewide policies about SWSNs in OLEs, researchers found that SWSNs are not being served appropriately in these environments. Many (but not all) of the learning systems that are utilized by OLEs do not have components or customizability in them to meet student needs at their reading level. This is potentially a problem for SWSNs who largely experience their disability in terms of a reading problem. Researchers [43] searched OLE websites to see if they included language about how SWSNs could access their sites and found that only 36% of all OLEs had clear language describing how students could access their site. While many of the programs offered by OLEs do not specifically cover reading, reading strategies, or reading skills, they all contain reading as one of their assumed skills because much course content is presented via text online. It is important to recognize that SWSNs often struggle with reading and do not receive the support they need to succeed in many OLEs. The inclusion in this paper of this more extensive section on OLEs attempts to bring attention to that oversight.

7. Accommodations and Modifications in OLEs

Overall, both the implementation of IEP services and utilization of accommodations and modifications in OLEs are new concepts. The Center on Online Learning and Students with Disabilities (COLSD) examined how OLEs serve SWSNs. They have identified that teachers, in some OLEs, struggle to accommodate and modify instruction in the curriculum for their students [44,45]. They go on to state that the current OLE environment is often vendor-driven in its instructional methodology, leaving it difficult for teachers to modify and accommodate appropriately for each student with an IEP. In the traditional face-to-face classroom, teachers often accommodate or modify the reading requirements to help SWSNs succeed. Reading accommodations in the face-to-face classroom might include a glossary, reading a section aloud, a peer reader, enlarged text, and/or extended time.

When the vendor-created pre-packaged programs work well, which is not always the case; they meet students at their functional level and provide online work on sequential skills. This is best for students without special needs who are on grade level and learning, but problematic for SWSNs who may be at a functional level far below their age. They may be working on the same material that they have been doing for multiple years. This can be frustrating as some SWSNs often make progress and then lose that progress as they move forward to other learning topics. Additionally, the learning modules may be written far below the interest level of the SWSN when they drop down to instruction at a grade level appropriate to their skill level. When teachers work with students face-to-face without a vendor-made program, they are able to modify and target specific skills and interest levels, thus increasing student engagement. Oftentimes, school districts buy an additional stand-alone virtual program to assist SWSNs in their online learning. Teachers also utilize open source websites to assist SWSNs. These include such readily available websites as "OER Commons (oercommons.org), Curriki (curriki.org), Ck12 (ck12.org), and Connexions (cnx.org)" [44]. However, more research on best practices in instruction, accommodations, and modifications is needed for teachers working with SWSNs in OLEs.

Modifications and accommodations are very important for SWSNs because they often have trouble accessing the general curriculum. In one study [46], SWSNs took advantage of a slower pacing option offered by an OLE. Unfortunately, length of completion time of course work corresponded with decreased final grades. Increased time on tests and assignments is an often-used accommodation for SWSNs listed in IEPs. The potential appeal of an online program for SWSNs is its self-paced movement through the curriculum [42,47] though this may be problematic for overall student outcomes, since the longer a student spends in a course, the more often it is left incomplete. Researchers examined pacing of students during their coursework finding that SWSNs took advantage of a slower pacing option when offered in an OLE. Unfortunately, in this instance, length of completion time of course work again corresponded with decreased final grades [46].

8. Parental Involvement in OLEs

OLEs can increase parental involvement in the SWSN's learning and provide computers in the family home for the first time as part of the OLE. In fact, parents become part of the learning community making sure students complete assignments and meet with the teacher [48]. This can be problematic if there is not a parent on site to ensure that students participate in the OLE. Additionally, there are potential family equity issues centering on the expense of the technology itself that may make suitable computer equipment or high-speed internet access unaffordable. It is also important to remember that parents are not trained teachers and would not necessarily be able to provide the accommodations and modifications a teacher might be able to in order to support the reading needs of a SWSN in an OLE.

Recently, researchers surveyed parents of SWSNs who had children in an OLE in grades 3–6 and found several themes. Most parents surveyed felt, to some extent, that they were both parent and teacher; in other words, the expectation was that they were responsible for making sure their student progressed through the curriculum and it was extremely time consuming for them. They knew that there were online resources for them, such as contact with the online instructor if they had questions, but they were the primary individuals driving the curriculum. In fact, they had much more direct access to their child's teacher through frequent emails, as well as occasional direct real-time contact. Perhaps, most interestingly, is that the parents pointed to the lack of ability to personalize the curriculum as hurting their children's ability to learn [49].

9. OLE Concerns

Certainly, education in an OLE has drawbacks that mirror issues found in a brick-and-mortar classroom. One such problem is student attrition with rates of some OLEs approaching anywhere from 10–70% [50]. Preceding student attrition from their OLE can be OLE student truancy, which, for SWSNs, may constitute a change in placement from that stipulated in their IEP causing legal issues [42]. In other words, if students are not attending an OLE, even by their own choice, they are changing the placement in their IEP. This attrition impacts overall graduation rates which have been found in one OLE system to be significantly lower than in a brick-and mortar-system [39].

Another problem often seen in brick-and-mortar schools that plagues OLEs for students served both in general and special education is the quality of education that is delivered to the student [51]. Part of the lack of quality consists of a move from an OLE being more of a correspondence school format to a full-time learning environment where schools are expected to meet yearly standards just as brick-and-mortar institutions are [39].

Researchers [52] examined OLEs under the umbrella of distance education. The difference these authors noted is that an OLE is an entire school that is presented online, whereas distance education may only encompass several classes. The focus of the literature review examined several different types of interventions that have taken place in distance education in rural schools in order to better educate SWSNs. The authors however, saw promise in OLEs for SWSNs. In areas of low enrollment, targeted intervention could be designed specifically for the needs of the individual student.

10. Conclusion and Future Directions

It is seemingly disappointing that there are still studies [17,19] and research syntheses [6,8] that focus on the ability of computers and apps to synthesize speech and read text. This technology has existed for decades and is a compensatory strategy that can help students with their textual comprehension but to continue to examine its effectiveness seems redundant because the technology helps many students.

Much more promising is examining areas of reading instruction that utilize traditional best practices, but either pair them with online reading work after teacher instruction [28–30] or present traditional reading strategies online [31–35]. Though the results of these studies are far from conclusive, they point to several directions moving forward to support SWSNs in their work in online reading environments around what is already known about quality reading strategies. Recently, researchers pointed to several areas as part of effective instruction of strategies in general face-to-face reading strategy instruction: explicit instruction, teaching students metacognitive strategies, cooperative learning, having both large and small group instruction, and individualizing instruction for SWSNs [53] (researchers have identified many of these areas of instruction in previous research synthesis as good points for future work [20,21]). The authors of the more current review identified these areas of good reading programs for students with LD in an attempt to contextualize their own study, but their ideas on best practices could be expanded to all SWSNs. They utilized several meta-analysis of reading strategy instruction to frame these areas. How could we include such a frame to look at ways that reading strategies or reading practice could be presented and supported for SWSNs? There are many possibilities for future research, simply looking at how we can utilize computers in these methods.

In fact, many of the studies in the review presented in this paper focus more on the technology itself [31–35], than examining how teachers utilize technology in instruction. Why do researchers and policy-makers assume that the best way to serve SWSNs is to loop the teacher and her expertise out of the equation? Indeed, this is also the case in OLEs. It is disappointing that so many SWSNs are served by OLEs with inadequate support. Technology is best used as a tool that is monitored and implemented by qualified instructors. Future work should attempt to examine how educators can use and promote better student understanding of reading strategies through use of computer programs and websites. More work should be done with utilizing the web to present learning strategies in reading.

Similarly, stakeholders working with OLEs often focus on buying prepackaged programs, but instead need to focus on how teachers can best adapt a reading-heavy learning environment for SWSNs who often struggle with reading. To assist in this effort it would benefit universities to work to train teachers about SWSNs and what accommodations can work best for them in OLEs. In OLEs, it is crucial to understand how IEPs are implemented in order to better serve SWSNs, including how special education teachers are successfully accommodating material for SWSNs in an online environment. Surveys of SWSNs need to be done to see what they perceive works.

Additionally, in OLEs it would seem that parents as instructors are the focus of most programs. It would be interesting for researchers to explore different ways, such as additional notes or plug-ins for parents of SWSNs, to work with their children in the OLE. It seems that they need more support in order oversee their student's progress in the OLE.

Perhaps in both technology used in the classroom and the online learning environment of an OLE the answer is to focus on the way we serve students in the brick-and-mortar school without technology. Good teachers of SWSNs start first with the IEP and plan their instruction accordingly, taking into account curricular standards, as well as accommodations and modifications so that SWSNs can access and learn the greatest part of the curriculum. Once we start there, the question becomes how to adapt these learning environments to best serve SWSNs.

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