ABSTRACT: Over 5 months, the authors evaluated the efficacy of electronic assistive technology (the BrailleNote mPower BT-32 notetaker and Tiger Cub Jr. embosser) and associated software components in creating curriculum materials for a middle school Braille-reading student. The authors collected data at the beginning and end of the study from parents, teachers, paraprofessionals, and the participant through semistructured interviews. Four salient themes emerged from the interviews: efficiency, independence, technology assimilation, and technical limitations. The devices enabled teachers and paraprofessionals who had no experience with the literary Braille code to generate and emboss Braille documents with a minimum of training. Having teachers and paraprofessionals do this work allowed vision specialist teachers to concentrate on teaching their students rather than on translating literary Braille into print.

KEYWORDS: Braille-reading students, electronic assistive technology, literary Braille code

Students who are blind are typically required to use Braille instead of print as their primary literacy medium in general education settings (Koenig & Holbrook, 2000). Usually a paraprofessional or a certified vision specialist acts as the intermediary between the general education teacher and the student in teaching the student appropriate Braille formats and translating assignments completed in Braille into print for the general education teacher to
review. This process is time-consuming and may not be the most effective means of giving feedback to students on their academic performance.

Espinola and Croft (1992) suggested that telecommunications technology, to a greater degree than any other technology, has “torn down the communications wall that separates print and non-print readers” (p. 31).

**Literature Review**

Senge (n.d.) noted that access to information appears to be the largest barrier to success in science and mathematics for individuals with disabilities. Teachers often provide audiotapes as an alternative to tactual or visual reading to students with visual impairment in kindergarten through Grade 12 who are unable comfortably to read standard print. Unfortunately, the auditory sense is not capable of detecting the technical elements of spelling and punctuation. Consequently, relying on tapes results in a less effectively developed foundation in literacy skills. Ashcroft (1984) noted that the three primary technological devices available to enable computer users who are visually impaired to use basic and complex computer applications are (a) *refreshable Braille displays* (mechanical Braille cells that refresh with a new line of text after the user has tactually read a previous line, in an action similar to the cursor function on a typical computer keyboard), (b) Braille notetakers, and (c) embossers.

Boyd, Boyd, and Vanderhelden (1990) noted that because a computer program cannot translate a visual symbol or picture into meaningful Braille text, it would be difficult for people who are blind to access computer program applications through icons as sighted individuals do. (Consider the variety of symbols on any word processor toolbar that guides a sighted user to the spell-checking function. This symbol is a picture and has no text equivalent that can be translated into Braille).

Mack, Koenig, and Ashcroft (1990), recognizing that for educational success students who are visually impaired or blind need to be proficient in using access technology, formulated guidelines for teacher-training programs to use in designing training modules regarding assistive technology devices for preservice and in-service teachers. Teachers are often reluctant to adopt technological approaches because of anxiety over technological change and the relatively high cost of these devices. Because school districts may be wary of making large expenditures per individual student for assistive technology devices, it is important that
teachers skillfully present the long-term advantages that access technol-
ogy offers in educational programming for students who are visually
impaired or blind.

Edwards and Lewis (1998) surveyed 113 Florida teachers serving students
with visual impairment and found that only 4% reported teaching their
students to use refreshable Braille displays. A larger percentage of teachers
reported providing their students with instruction in word-processing and
note-taking skills with Braille notetakers, but few taught their students to
perform independent Braille translation, calendar planning, or use of e-mail.
Teachers reported widespread use of Braille embossers to produce hard-copy
Braille for their students, but few taught their students to use Braille emboss-
ers independently.

Kelly (2001) reported the use of BrailleNote notetakers with refreshable
Braille displays to assist Braille-reading students in British Columbia, Canada.
The rationale for using these devices in classrooms was based on the Braille-
Note's ability to access Windows applications such as Microsoft Word. Teach-
ers could easily, quickly, and, with a high degree of accuracy, translate elec-
tronic files from Braille to print and vice versa. In addition, students using
BrailleNote were able to read documents in uncontracted or contracted
Braille formats, send and receive e-mail, store class notes, and perform sci-
entific calculations.

The Individuals with Disabilities Education Act amendments of 2004 rec-
ognized the importance of assistive technology devices for students with
disabilities. Individual Education Plan teams must appropriately consider
the complete range of devices and services available to students with visual
impairment because the devices may affect the development of students’
self-confidence and self-esteem. Also, students trained in the skills neces-
sary to cope with their disability-specific needs by using assistive technology
devices are increasingly capable of participating fully with their nondisabled
peers in general education settings (Educating blind and visually impaired
students, 2000).

**Method**

The purpose of the present study was to (a) evaluate the efficacy of several
electronic assistive technology devices in delivering curriculum materials to a
middle school Braille-reading student and (b) determine if direct e-mail inter-
action between the student and general education teachers could reduce
the student’s need for full-time assistance from paraprofessionals or vision specialists. Specifically, we wanted to answer the following questions:

Question 1: What is the impact of electronic assistive technology devices on access to classroom content areas for a student who reads Braille?

Question 2: What are the perceptions of parent, teacher, and paraprofessional of the student’s efficiency in using the BrailleNote notetaker in comparison with using the Perkins Braillewriter with regard to exchange of homework assignments, tests, and notes?¹

Question 3: What are the perceptions of student, parent, teacher, and paraprofessional of the reliability and ease of use of the BrailleNote notetaker over the course of a school year?

**Research Genre and Theoretical Background**

We used a case study bounded by in-depth data collection of a single participant involving several sources of information that were rich in context (Creswell, 1998). A social constructivist perspective guided the investigation. Charles R. Farnsworth Jr. perceived the learner as bringing certain strengths and limitations to each task. Consequently, it was critical that Farnsworth, as the instructor–researcher, assess those characteristics and position instructional activities slightly above the learner’s ability, to engage him in Vygotsky’s (1987) “zone of proximal development” (p. 212).

**Personal Research Stance**

According to Reutzel and Cooter (2000), “Learning is not the result of development; rather learning is development. Errors are not to be avoided or minimized but are to be viewed as evidence of seeking to learn” (p. 30). This was the first author’s research stance as both observer and instructor. In the process of observing, he acted also as a participant interacting with the student, teaching staff, and parents. Before this study, as a teacher of students who were visually impaired or blind and were Braille readers, he had provided one-on-one instruction to students, often pulling them out of their general education classroom to help them use the Perkins Braillewriter to generate hard-copy Braille classroom assignments. Then, his task was to translate those assignments back into print so that the classroom teacher could grade them. As an itinerant teacher, traveling more than 500 miles per week to serve students on his caseload, he could spend only a few hours
per day with his Braille-reading students. As a result, students did not receive timely feedback from their classroom teachers on their brailed assignments or tests unless he was available or unless a paraprofessional trained in Braille could make the translations.

**Participants**

The primary participant in the present study was a male, middle school, Braille-reading student. His parents, classroom teacher, paraprofessional, and other teaching staff who regularly interacted with him, including school secretaries and administrators, participated as sources of information, giving periodic feedback about the efficacy of the assistive technology implementation.

David was a sixth-grade Braille-reading student in a remote, rural, general education setting in a Midwestern state. Approximately 150 students in kindergarten through Grade 12 attended his school. All students shared the same recreational, dining, and athletic facilities. Demographers would consider the socioeconomic status of the average student in David’s school as lower middle class. The students primarily had White, non-Hispanic family backgrounds. The principal economic activities of the region were based on agriculture, which made the population fairly stable.

David was the only student in his school with a visual impairment. His mother Joyce was a nurse in a local senior citizen’s home, with a schedule that rotated frequently. His father drove heavy equipment for a contracting firm located more than 100 miles from home, which made it possible for father and son to have time together only on weekends. David’s grandparents cared for him and his younger sister after school when both parents were still at work.

David’s class consisted of five boys and six girls. One student was identified with a learning disability. David’s full-time paraprofessional provided support for both students. The small classroom size allowed considerable interaction between each student and Mary, the general education teacher, during the 4-day school week—Tuesday through Friday. For one period of each day, Mary rotated classrooms with the science teacher who taught science to David’s class. From the beginning of the study, David had textbooks in Braille for all content areas except English. The paraprofessional used the Tiger Cub Jr. embosser (Braille printer) in conjunction with Kurzweil 3000 Software and the classroom’s flatbed scanner to produce hard-copy Braille pages of the English textbook, as needed, until a commercial Braille producer could translate David’s English text. The original text was produced in time for
David to have it at the beginning of school but unexplainably was lost in the mail and could not be located.

David was pulled out of class for 3 hr per week for vision support services from a certified vision specialist in the literary and Nemeth Braille codes and the abacus for math. Farnsworth provided direct in-class services for support in curriculum areas and training in Braille assistive technology. David had access to Perkins Braillewriters in his classroom at school, at home, and at his grandparent’s home for doing homework, taking notes, and writing tests. His typical routine involved tactually reading content material from Braille texts and participating in oral discussions in all content-area classes. For homework assignments and tests, David tactually read assigned passages or equations from his brailled texts and then produced answers on the Perkins Braillewriter at home or at school. Either he, paraprofessional Stacy, or a vision specialist —when present—translated the Braille assignments into print for Mary to review. Mary usually gave David oral feedback on assignments that had errors in spelling or sentence structure or on incorrect decimal positions in math problems.

Early in the winter holiday season, David’s mother unexpectedly underwent an emergency surgical procedure. During much of her several months of recovery, she could not supervise the completion of David’s homework on a day-to-day basis or come to school to monitor his progress from time to time, as had been her practice. In addition, the paraprofessional unexpectedly accepted an offer of employment in her hometown more than 40 miles away. The major factors in her decision appear to have been the high cost of gasoline, the long commuting distance between home and work, and the relatively low salary received by paraprofessionals. David lost two individuals on whom he relied for daily support at home and school. The school district immediately advertised for a new paraprofessional, but the replacement did not start working with David until the beginning of March. Consequently, for about 3 weeks no paraprofessional was in the classroom with Mary. To help David cope with this situation, the first author made himself available for 2 days per week as often as possible. Also, to focus on the need to keep David on task, Mary and Farnsworth made special arrangements for her to have continuous access to the BrailleNote visual display system to regularly monitor his progress on assignments throughout the day.

**Data Collection**

During the course of the 5-month study, from November 2, 2005, until March 30, 2006, the first author observed and interacted with David in the
general education classroom from 4 to 8 hr per week. We met weekly from the outset of the study to evaluate information gathered from interviews and field notes and discuss strategies to implement the assistive technology devices most efficiently. Anticipating that in the first few weeks David and his teachers would need the most support in using the BrailleNote and Tiger Cub Jr. embosser to develop proficiency in accessing e-mail, using the Kurzweil software, and using the flatbed scanner, the first author made himself available 1–2 days per week to assist in this transition. The time that the first author spent in the classroom diminished rapidly after the first few weeks because David and the teaching staff became proficient at using the assistive technology devices. Toward the latter part of the study, the first author was present in the general education classroom no more than 3–4 hr on 1 day per week. David and the teaching staff gradually began to rely on e-mail and telephone communication with the first author for assistance.

Throughout the study, the first author kept comprehensive observational notes on a weekly basis and conducted informal interviews at the beginning and end of the study with David, his parents, and the teaching staff concerning the efficacy with which they used the technology in the classroom and at home. The first author recorded the interviews electronically and later transcribed them manually.

**Data Analysis**

We each simultaneously used the constant comparison method (Glaser & Strauss, 1967) of analyzing interview transcripts and weekly field notes by categories (Bogdan & Biklen, 1992). To assess whether our perceptions of thematic analysis were aligned, we coded the first interview at the same time and in the same room. Thereafter, we performed thematic analyses separately but came together to compare the themes that each had identified. When relating the themes that we had identified individually, we had considerable discussion whenever our views appeared divergent or one of us noticed something that the other had overlooked. We continued this process of discussion and reflection until we agreed on coding of the emergent themes in each transcript. On completing the thematic analysis, the first author counted the frequency of occurrence of themes from each of the coded transcripts (Miles & Huberman, 1984). We identified the themes that occurred most frequently across all interview transcripts as the most meaningful results.
Results

The purpose of performing interviews at the beginning and the end of the study was to document changes in perceptions if they materialized by the end of the study. Perceptions were positive at the beginning and appeared to be even more positive at the end. For that reason, this section primarily contains results of data analyzed at the end of the study.

From thematic analysis, we created 12 codes from which four themes emerged. These were efficiency, technology assimilation, independence, and technology limitations.

Efficiency

Before the present study, David’s teacher Mary had observed his progress through elementary school for 3 years before he joined her sixth-grade class. She described David as having higher-than-average academic ability in comparison with his peers and had observed his progress using the Perkins Brailler during that time. When asked to comment on her first impressions of the BrailleNote, she said,

I knew it would be an improvement, in fact I was just like, get it here! We need it! . . . I thought, jeez, there has to be something out there that would have to be computerized. . . . And when it was first demonstrated to me, it actually brought tears to my eyes. . . . And I could see that it was going to move David into a more independent mode where he was not going to have to rely so much on the aide, and possibly, maybe eliminate the aide in a couple of years.

When asked to compare the technique of relying on a vision specialist to translate manually produced Braille with using e-mail attachments of print documents directly from David, Mary stated,

It’s just like going from a horse and buggy to a car. . . . It’s way more efficient. Faster, efficient, there is probably no comparison.

Mary also described, in detail, how she expected use of the BrailleNote would affect the completion of David’s coursework.

I hope that he will be able to read more efficiently. . . . And get a lot more information in the braille than he would have if someone was reading it to him. So he is going to have to read a lot more braille so his reading is going to get better. Now, as far as his grades, I think that his grades will probably stay about the same because he did well before. Now the only thing that I’m seeing that when he braillles something and you transcribe it, um, compared to when he types, and he’s brailling and it’s coming out on the computer, I think he’s going to have a lot more errors; they wouldn’t have been caught before. . . . capitals or commas, you know, that kind of thing, grammatically. I think that he is going to get a little bit of a shock. I’m going to be grading his work with a little more scrutiny than I was before.

When I asked Mary about the possible benefits of having the Tiger Cub Jr. embosser available in the classroom, she responded,
Oh, I think of course it’s going to be beneficial to him. You don’t have to have somebody brailing it out . . . it’s going to make him more independent . . . . Probably the only downside is that he won’t be able to use graphs or graphic aids as much, but as far as a test or anything, worksheets, whatever, it’ll be great.

The vision specialist teacher responsible for giving David Braille instruction in Grades 2–4 and now in Grade 6 commented on the benefit of the visual display option available on the BrailleNote:

This is wonderful because at any point in time, the teacher is moving around the classroom to see how the kids are doing, she can now see what David is doing. Before, all she could see was braille. She had absolutely no idea if he was doing it correctly or incorrectly . . . . If he is not doing it correctly, she can stop and show him right there on the spot what he is doing wrong . . . . I think it’s that instant feedback that both David and the teacher get that is very, very important.

With regard to David’s performance of homework on the BrailleNote in comparison with the Perkins Braillewriter, his mother Joyce commented,

He doesn’t care for homework, but fourth grade was really a hard year for him. He would have 4–5 hours of homework a night, and he just got so tired of homework, he did not want to do it anymore . . . . He seems to like to do homework better on the BrailleNote rather than doing it on the Perkins.

When asked in what ways she expected the BrailleNote to help David in school, Joyce replied,

Well, for one thing, it’s small and portable, and he can just do homework wherever . . . . One thing he always said was that it wasn’t fair that his sister could get her homework done on the bus and could go and play and he had to do his homework . . . . I like it where he can hook it up to the printer and print out everything so it’s in print so you can read it instead of trying to figure out the braille code off the paper on the Perkins.

With regard to doing homework on the BrailleNote as compared with the Perkins Braillewriter, David stated,

This BrailleNote has really changed how I do homework . . . . It’s different because I don’t have to worry about, well, when I am e-mailing, I don’t have to worry about losing my papers, like I did with the braillewriter.

**Technology Assimilation**

Technology assimilation emerged as a theme with regard to the ease with which David was able to transition from (a) using the Perkins Braillewriter for text generation only to (b) learning and using key-command sequences to use the BrailleNote’s software applications, such as word processing and e-mail, and to activate the visual display option. With each of these applications, he had to perform routines to navigate through menus to create electronic documents; save and retrieve them from appropriate files; gain access to the Internet; translate Braille files to Microsoft Word print files; and send, receive, and open e-mail attachments exchanged between himself and his
teachers. When asked to compare the Perkins Braillewriter with the BrailleNote, Mary commented,

Well, as I said, we are educating him in a rowboat with the Perkins and we’re educating him in a speedboat with the BrailleNote. It’s . . . wonderful! . . . Oh, it has been a life saver.

With regard to receiving assignments from David and giving him feedback, Mary stated, “it’s easier for the teacher to translate what he’s written and give him immediate feedback.”

When Internet connectivity issues occurred, David had to save electronic files on portable storage disks to give to the paraprofessional or Mary or to print those files on an ordinary printer to turn in for Mary to review. On occasions when David desired a hard-copy Braille output of his documents, he needed to choose the key-command sequences and connect the appropriate cables between the BrailleNote and the Tiger Cub Jr. embosser.

Additionally, during the study, we decided to pay close attention to the ease with which the paraprofessional and Mary adjusted to relying on the scanner, Kurzweil software, and Tiger Cub Jr. embosser for creating documents to be translated from print to Braille for David’s use. It was also important to understand how well the BrailleNote Visual Display option could be implemented for sighted persons in the classroom setting.

David commented on how he had begun to use e-mail and the portable storage devices while doing his homework assignments on the BrailleNote:

I would just . . . use the flashdisk, it’s not really a disk at all, it’s a card. What it is is a digital camera card, and you can get ‘em at your regular stores. . . . I have my own e-mail address so that I can have my homework sent by e-mail.

When asked to describe how the paraprofessional or teacher prepared his homework assignments in Braille, he stated,

Nowadays, since I have the embosser we just put, scan it in and emboss it and, we’re ready. . . . The computer, we scan it, we have an Epson scanner here, and we scan it on a Gateway laptop, and from there we change it on a Kurzweil file to a Microsoft Word file and then we emboss it.

When the first author asked the paraprofessional about her perceptions of the ease of using the Kurzweil scanner, Tiger Cub Jr. embosser, and associated software, she stated, “Once I got it figured out, it’s just natural.” She also described the responses of David’s sighted peers to the BrailleNote:

Oh, I think it fascinates them. . . . [A]ctually quite a few of them mentioned that it is a lot nicer, that it’s not quite so noisy as the brailler. . . . [W]hen he first started using it and he wasn’t using the headphones, they thought it was pretty neat that it talked back to him, and they tried to convince him to leave the headphones off while they were doing homework assignments so they could hear the answers.
Independence

We hoped to learn if implementing the electronic Braille assistive technology devices would enable David to perform at levels of independence similar to that of his sighted peers. If that were the case, then we hoped that David would be less reliant on the paraprofessional, the vision specialist, and the first author for assistance in gaining access to the school curriculum. Also, we wanted to explore to what degree David would learn to operate the devices without assistance. When the first author asked Mary what David did to compensate in case e-mail did not work, she replied,

He saves it to his BrailleNote, and then he saves it to a disk. . . . And then we just take down, and we just print it off, and we've got his assignment in hard copy. . . . I know if he does his homework at home, his grandmother is printing it off, and he is bringing a hard copy to school just like the other kids. And if he just e-mails it to me—this morning he sent three of his assignments to me by e-mail—then I just copy them off, and they are ready to go. It's wonderful.

When asked about how she expected the technology to affect David's level of independence in the classroom, the paraprofessional replied,

[R]ight now I feel, mostly what I'm doing is keeping him on task and reminding him of what he needs to do. And I think once he gains some independence, once he realizes and once others realize that he doesn't need someone there constantly to keep him on task, that he's got to take responsibility for that himself, that he . . . won't really need anybody, he'll be able to do everything on his own.

Technology Limitations

We identified some limitations to the technology devices, including items specific to certain content areas and Internet connectivity issues. When asked about these issues, Mary commented generally, “When the Internet isn’t working, it’s pretty frustrating.” The vision specialist expressed concern about David’s tendency to use auditory feedback on the BrailleNote as opposed to reading hard-copy Braille:

One concern I have is that with . . . [his] plugging in headphones, and instead of reading his braille back, he gets to hear it back using the auditory system. . . . [T]he auditory system doesn’t help me and doesn’t help him because instead of having to read his braille back, all he has to do is listen to what he wrote, and he is not getting the braille reading that I would like to see him get.

David’s mother commented on some challenges that David experienced when trying to do math assignments by using the BrailleNote at home:

Yeah, I just think that on his math papers that they don’t go down in one column. Sometimes he'll have one and then two and three and four. I mean it's not a nice column. . . . It doesn't make just one nice column as he would on the Perkins. It kind of goes wherever. . . . But if it doesn't matter to the teacher, then I guess it doesn't matter to me.
Discussion

We had asked the following research questions:

Question 1: What is the impact of electronic assistive technology devices on access to classroom content areas for a student who reads Braille?

Question 2: What are the perceptions of parent, teacher, and paraprofessional of the student’s efficiency in using the BrailleNote notetaker in comparison with using the Perkins Braillewriter with regard to exchange of homework assignments, tests and notes?

Question 3: What are the perceptions of student, parent, teacher, and paraprofessional of the reliability and ease of use of the BrailleNote notetaker over the course of a school year?

In answer to Question 1, we found considerable evidence that the BrailleNote, Tiger Cub Jr. embosser, and Kurzweil software and scanner made it possible for David to have immediate access to curriculum materials generated in hard-copy Braille on a daily basis by the paraprofessional or his teacher. Either his teachers embossed the materials in hard-copy Braille by using the Tiger Cub Jr. embosser or they sent them to David directly as e-mail attachments that he could instantaneously translate into Braille and read using the BrailleNote’s refreshable Braille display or by having the auditory feedback option read the text information back to him using synthesized speech. Immediate feedback made it possible for David to work at the same pace as his sighted peers without the delay of waiting for a vision specialist or a paraprofessional trained in Braille to translate it for him. David became increasingly efficient in accessing curriculum materials in all content areas in which literary Braille was the medium for instruction. Because the BrailleNote cannot efficiently translate print mathematical symbols into the Nemeth Braille code, that task continued to require assistance from the vision specialist or paraprofessional trained in Braille for translation purposes.

Using a refreshable Braille display built into the BrailleNote notetaker and incorporating the Tiger Cub Jr. embosser into the classroom facilitated David’s increased access to the curriculum. The use of those three components was in alignment with Ashcroft’s (1984) position that those types of devices provide computer users who are visually impaired with access to basic and complex computer applications. In addition, Internet connectivity made it possible for David to interact with his teacher by using e-mail with Microsoft Word attachments to send and receive assignments and to access text information from Web sites for research projects and other assignments.
Perhaps the most important characteristic of the BrailleNote is its flexibility. In any setting involving Ethernet or wireless Internet connections that involve complex servers for support, many issues can arise to interfere with Internet connectivity. Whenever those situations arose, David could easily use portable storage devices to download homework assignment files that teachers or paraprofessionals could retrieve by using an ordinary stand-alone or networked classroom computer. Also, the capability of sending print files directly from the BrailleNote to a standard printer made it possible for David or a member of his family to generate print documents that he could give to his teachers in the same format and at the same time as did his sighted peers.

The results indicate positive perceptions of the BrailleNote and negative perceptions of the Perkins Braillewriter (see Question 2). Mary’s comment that “It’s just like going from a horse and buggy to a car” is interesting. The fact that both David’s teacher and his vision specialist had given serious thought to electronic devices in the year before the present study indicates the apparent recognition of the need to transition David to an electronic Braille assistive technology device.

David’s mother’s observation that “he seems to like to do homework better on the BrailleNote rather than doing it on the Perkins” suggests that homework became almost an enjoyable task for David as a result of using the BrailleNote. She further expressed the value of the BrailleNote’s portability, which allowed David to take it with him wherever he went and to even do homework on the school bus. David’s mother, his teacher, and both paraprofessionals mentioned being able to monitor David both at home and at school to keep him on task. His mother found that being able to print completed assignments on a regular printer was helpful in keeping track of David’s productivity at home in comparison with the more tedious process of reading and translating Braille documents. His teacher used both hard-copy printouts and the BrailleNote’s visual display option to accomplish the same task at school.

The paraprofessional working with David during the first half of the study mentioned that the BrailleNote, Tiger Cub Jr. embosser, and Kurzweil scanner software made her job much easier in comparison with daily keeping track of and translating passages of Braille. Both she and her replacement indicated that with the technology devices in place, their tasks in the classroom changed to allow them to focus on keeping David on task during classes.

Each stakeholder shared positive perceptions of the reliability and ease of using the BrailleNote (see Question 3). From his perspective as a researcher, the first author anticipated that David might experience some difficulty in
transitioning to learning and using multiple key-command sequences within menus for the word processor and Internet applications of the BrailleNote. David had never before been exposed to an accessible Braille technology device. Considering the extensive demands on long-term memory to memorize and retain each sequence, it seemed that this process might require considerable training. In fact, this was not the case. According to his teacher, paraprofessional, and mother, David became proficient enough to produce literary Braille assignments by using the word-processing application in a matter of hours after his initial exposure and training on the BrailleNote. In addition, within weeks of being equipped with the notetaker, David elatedly told the first author that he had discovered the user’s manual on his own BrailleNote and had started using it to problem solve as he practiced with many applications on the device.

Infrequent reports about technical difficulties with the assistive technology devices from David’s teacher and paraprofessionals centered most often around the laptop computer dedicated to running the Kurzweil translation software and the Tiger Viewplus Embosser software. Late in the school year, the teacher in charge of computers at the school told us that those software applications greatly exceeded the capability of the laptop computer. Also, issues arose when this computer had to switch from stand-alone mode to network mode, which was necessary many times during the day because certain operations such as printing could be accomplished only while logged onto the network. Those issues were primarily the result of server-related complications and were rarely caused by the BrailleNote or the Tiger Cub Jr. embosser. A limitation of the BrailleNote in this regard is that it is designed to be used only in stand-alone mode. For that reason, it cannot be incorporated into any server network.

The BrailleNote visual display in the present study used a software product that we loaded onto a classroom computer. With a serial cable connecting the BrailleNote to the computer, David could easily enable the visual display mode so that his teacher could observe and monitor his work. This system proved to be completely reliable throughout the course of the present study, and Mary consistently used it during the interval in which she did not have a paraprofessional in the classroom. Its only limitation was the 6-ft-long cable to which the BrailleNote was attached.

**Limitations of the Study**

The most significant limitation of the present study is that it is confined to a single participant. David clearly has always had fairly high academic
expectations placed on him in a rural, inclusive educational setting that is familiar to him. Not all students will have had those previous experiences and would not necessarily have benefited from developing such positive rapport with teachers and other service providers in other educational settings. The high levels of cooperation with general educators and parents that we experienced in the present study may not be typical of situations in other educational settings.

We conducted the present study for only 5 months. It is difficult to rule out the novelty effect. Additional research, including longitudinal studies, is warranted.

Because the present study focused on the effect of specific assistive technology devices such as the BrailleNote notetaker, Kurzweil scanning software, the Tiger Cub Jr. embosser, and associated Tiger Suite Braille translation software, similar studies using different devices with different capabilities may arrive at slightly different conclusions.

Implications

Because this case study focused on only one student who is blind and on stakeholders in one educational setting, it would not be appropriate for researchers to assume that all children who are Braille readers could use the types of Braille assistive technology that we implemented in this study. However, the generally positive perceptions of the interviewees and the overall reliability and stability of the BrailleNote, Tiger Cub Jr. embosser, and Kurzweil scanning software appear to suggest that practitioners should consider this assistive technology approach or variations of it while doing long-range planning for their Braille-reading students. Educators in remote, rural educational settings with limited access to vision specialists and paraprofessionals with formal training in the Braille codes may find that their students with visual impairments benefit from an implementation of Braille assistive technology devices similar to those used in the present study.

Perhaps the most important finding of the present study was that the transition from reliance on the entirely manual Perkins Braillewriter technology to the BrailleNote electronic notetaker was a fairly seamless and positive experience for the student who is blind and for his teachers. There is no reason for educators and researchers to assume that transition from the Perkins Braillewriter to the BrailleNote should be made at a certain age or grade level. However, from the results of the present study, it is apparent that the sixth-grade
participant demonstrated sophisticated assimilation skills in being able to effectively use the word-processing, Internet, and e-mail applications after minimal instruction. We also observed this pattern in the general education classroom teacher. She learned quickly and effectively to use the assistive technology devices to monitor and provide immediate feedback to the student who was blind.

Educators considering the adoption of electronic assistive technology devices for students who are blind must include assessments of the quality and availability of technical support at the local level. In the present study, the frequent Internet connectivity issues were the result of lower-than-anticipated server capabilities in the hardware and software provided by the school district. Information technologists, although willing to assist in resolving problems such as Internet connectivity, e-mail, and access to applications on school servers, were in general completely unfamiliar with electronic Braille assistive technology devices capable of providing access to students who are blind. In that situation, the vision specialist becomes the liaison among information technology personnel, students who are blind, and teaching staff working with Braille assistive technology devices.

It may be possible for educators to implement electronic Braille assistive technology devices such as the BrailleNote and the Tiger Cub Jr. embosser effectively with emergent Braille readers in regular education settings. To obtain that result, educators need vision specialists with experience in using such devices to be available in preschool and kindergarten educational settings with students who are learning to become Braille readers. Future researchers will determine whether the efficacy of implementing these devices warrants educators’ doing so on a larger scale.

NOTE
1. For readers unfamiliar with Braille assistive technology, the BrailleNote mPower BT-32 notetaker (referred to in the article as the BrailleNote) is an electronic device that individuals who are blind use to access the Internet and perform word-processing, e-mail, calculator, and address book operations similar to those performed on a laptop computer. The Perkins Braillewriter, a manual device similar to a manual typewriter, is used to generate hard-copy Braille text.

REFERENCES


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