Technology and Early Braille Literacy: Using the Mountbatten Pro Brailler in Primary-grade Classrooms

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Abstract: This article describes the Early Braille Readers Project, which provided a Mountbatten Pro Brailler and peripheral equipment to 20 kindergarteners, first-, and second graders in Texas. The project included training and support in the form of site visits and teacher training for both teachers of students with visual impairments and classroom teachers, group workshops, and an electronic discussion group. The project had a positive impact on the students' writing and reading skills and participation in instruction and social interaction.

Technology plays an important role in the education and daily lives of all students, and it is especially important for children who are visually impaired (that is, those who are blind or have low vision). Texas has guidelines for the curriculum in technology for students in all grades. For students in kindergarten though the second grade, the learning objectives include familiarity with appropriate keyboarding techniques; the use of a variety of input devices; and learning to create, name, and save files (Texas Education Agency, 1998). The use of alternative braille writing and technological devices is not common in the primary grades in the United States (Connell, 2003).

In addition to limited experience with technology, young children who are visually impaired often do not have braille books and materials at home or in a child care environment in the same quantity and quality as print materials. Because of this lack of exposure to braille, many of these children begin their education with a significant disadvantage compared to their peers who are print readers. Accepted educational strategies indicate that the key prerequisites to reading are mastery of oral language, construction of a conceptual framework for understanding the meaning of messages that are conveyed in text, and immersion in written language (Lamb, 1996). Because of constant exposure to written text in a variety of environments, many young sighted children are able to read and write before they begin school, but children who are potential braille readers have limited experiences with literacy in the environment and with books (Lamb, 1996). "Because of the scarcity of braille materials, children who are blind or have very low vision . . . do not automatically participate in this kind of literacy learning. Instead their 'braille immersion' must be orchestrated by teachers and parents" (Swenson, 1999, p. 11). Thus, these children "may miss out on certain experiences

and opportunities for learning that other children have available . . . incidentally as part of their everyday lives" (Wormsley & D'Andrea, 1997, p. 18).

It is because children who are visually impaired have limited reading and writing experiences that the Early Braille Readers Project was developed. This project was designed to facilitate early braille literacy by making it easier for teachers of students with visual impairments and students to engage in reading and writing activities. In addition, the project provided early exposure to braille technology for students to construct a foundation on which later technological skills could be built. Since technology can provide access to written information for people who read braille, knowledge of technology is crucial for children with visual impairments, perhaps even more so than for sighted children. Because learning tasks are less complicated in the primary grades, implementing the use of technology at this stage could help teachers of students with visual impairments to become more knowledgeable about technology and make it more likely for the teachers to use more technology at earlier ages with students who read braille.

Overview

The Texas School for the Blind and Visually Impaired (TSBVI) Outreach Program, based in Austin, provides consultative and teacher training services for children who are visually impaired throughout the state. In fall 2002, the program received a grant from the Texas Health and Human Services to fund the Early Blind Readers Project. Several electronic braille devices were reviewed before it was determined which device would be used for the project. The Braille Star (by Pulse Data), a refreshable braille display device for a computer that also functions as a stand-alone notetaking device, was considered, as were the BrailleNote (by HumanWare) and the Braille Lite (by Freedom Scientific), which were widely used at the time with students in higher grades in Texas. For beginning readers, it was decided that a paper copy of braille or a full-page display of braille was an important feature. Reading tasks, such as learning motor aspects of tracking; locating information on a page; and formatting sentences, paragraphs, and pages, are important for learning reading, writing, and math skills. Because the Mountbattten Pro Brailler (hereafter the Mountbatten) made these features easily accessible, it was selected for the project. The Mountbatten can function independently as a braillewriter and as an embosser when it is interfaced with a computer. It can be connected to a computer ink printer to produce a permanent copy of the braille. A peripheral device, called the Mimic, displays a print translation of the braille on a small screen. A user who does not know braille can produce braille by writing on a computer keyboard that is connected to the device or by translating an electronic print file with braille-translation software and sending it from the computer to the Mountbatten.

The Early Braille Readers Project also provided equipment to facilitate the use of the Mountbatten and to document its use. Each participating student's teacher of students with visual impairments received a Mountbatten and carrying case, a copy of the Duxbury Braille Translation software, cables for computer connectivity,

a Mimic visual display device, a PC keyboard, headphones, an ink printer, and a digital video camera and tripod.

Special Education Technology British Columbia (SET-BC) conducted the Emerging Braille Literacy Project (SET-BC, 2001) beginning in 2001. The Early Braille Readers Project was modeled closely on the SET-BC project (for the results of the Emerging Braille Literacy project, see Holbrook, Wadsworth, & Bartlett, 2003).

Method

Participants

An application form and checklist were developed to gather information on prospective participants. Twenty student-teacher pairs (10 in 2003–04 and an additional 10 in 2004–05) were selected through a statewide electronic discussion group and a free newsletter.

Teachers of students with visual impairments

Implementation of the use of the Mountbatten and the facilitation of high-quality interaction between print and braille readers required extra commitment from the teachers of students with visual impairments. Therefore, an application form and checklist were developed that addressed the teachers' instructional time to help select appropriate participants. Other requirements were access to an e-mail account and classrooms that had Internet connections to obtain information on support provided by the project.

Students

Learning Media Assessments and Individualized Educational Programs (IEPs) were examined to identify children who were primarily braille readers and were receiving instruction in braille. Students were selected whose academic functioning was at or near grade level according to teachers' reports and a review of their IEPs and who spent at least 60% of the day in the general education environment according to documentation supplied by the teachers. Since there were fewer qualified applicants than the project proposed to serve, children were admitted who fulfilled the age requirement but attended prekindergarten classes (see Table 1).

Table 1
Student participants in the Early Braille Readers Project.

Student	Age	Grade	Number of years participating
1	6	K	1
2	5	K	1
3	6	1	1
4	7	1	1
5	5	Pre-K	2
6	6	1	2
7	6	1	—[a]
8	6	K	2
9	5	K	1
10	7	2	1
11	5	K	2
12	7	1	2
13	6	1	2
14	6	K	1
15	5	K	2
16	5	K	1
17	5	Pre-K	1
18	4	Pre-K	1
19	7	1	2
20	7	1	2

[a]Moved during the first year.

Training and support

The project began with 10 students during the first year (the academic year 2003–04) and added 10 students the second year, with the same selection criteria for each group. The manufacturer of the Mountbatten provided training on the TSBVI

campus for teachers of students with visual impairments who were participating in the study and others who were interested in learning more about the device. The project's staff members delivered equipment to the children's schools and provided training to the classroom teachers and teachers of students with visual impairments who participated in the project. A follow-up visit was conducted later in the year. The second year, 10 additional sites were set up with two site visits each, and the first-year sites were revisited once. At the end of the first and second school years, extra funding allowed for an additional workshop for the teachers of students with visual impairments and classroom teachers to travel to TSBVI. At that time, the teachers shared strategies and provided feedback on their views and experiences with the project.

The Early Braille Readers Project included a significant amount of teacher training and technical support. In addition, timely troubleshooting and repair of the technology allowed the students and teachers of students with visual impairments to use the Mountbatten to the fullest. During site visits, both groups of teachers were trained to use many of the features of the Mountbatten and its peripherals. For support, the user's manuals were employed as guides, and a list of frequently used commands for the teachers was developed. The teachers were also given print copies of materials that were generated by the participants in the SET-BC project, including a visual guide and a teaching curriculum (Cook, 2001a; 2001b).

The arrangement of physical space was significant in promoting the effective use of technology and the integration of technology into classroom activities. The project's staff members worked with the teachers to place the participating children in general education classrooms and to minimize social and physical barriers among the students. In almost all cases, the Mountbatten was placed on a child's desk in a setting among general education students, not at a separate workstation. Because it was crucial to keep the battery charged and keep equipment accessible for frequent use, the teachers were assisted in arranging cords in a way that was the least likely to cause safety hazards in the classroom.

To support the teachers between visits, the project's staff members used a variety of distance-communication technology. An electronic discussion group was established for the project, and all the teachers were encouraged to sign up and share ideas and problems with the group. Additional attempts to use distance-communication technology included Internet-based interactive video and web conferencing. Although all the participating schools had Internet access as a condition of admission to the project, significant problems with security-protection systems were encountered in both the TSBVI's and school district's computer networks at remote sites. After numerous trials in the first year, it was decided that it was not realistic to work with Internet-based interactive video technology because it would not pass through the networks' firewalls. In the second year, a web-conferencing system was used, and there was some success in getting it to operate at a remote test site. However, the use of the web-conferencing technology was not successful until late in the second year, and because the system was confusing to users and demanded considerable preparation,

Table 2
Standardized test scores on the Texas Primary Reading Inventory (TPRI) and the Tejas LEE.

Student	First test: % Items completed correctly	Second test: % Items completed correctly	% Gain
TPRI			
A	40	80	40
B	97	93	–4
C	75	83	8
D	28	55	27
E	40	90	50
F	28	30	2
G	87	96	9
H	100	100	0
I	68	68	0
Tejas LEE			
J	72	88	16

it was discontinued. The electronic discussion group also encountered security-protection problems at some school districts, so additional e-mail messages were sent to the individual teachers' e-mail addresses to ensure reliable communication. At the end of the project, it was concluded that individual e-mail messages and telephone calls were the most effective means of distance communication.

Results

To evaluate the results of the project, the researchers used a variety of formal and informal methods. The project's staff members interviewed the teachers and requested written responses to a set of questions during the year-end workshops. The electronic discussion group and project-related e-mail messages were reviewed. Personal observations, videotapes, and work samples were used as data sources. During the second year of the project, all the participants were asked to administer a state-adopted assessment, the Texas Primary Reading Inventory (Texas Education Agency, 2001), to their students twice.

Quantitative data

The Texas Primary Reading Inventory (TPRI), an individually administered assessment for students in kindergarten to the second grade, was used to collect quantitative data (see Table 2), since it was widely administered across the state and yielded a score from which it was possible to calculate a percentage of correct responses at two times during the school year. Comparative data were not available for all the participating students because of local differences in testing procedures. Some sites administered only a portion of the test or administered the test at different times of the year than did other sites, so data from these tests are not conclusive. One student, a recent immigrant from Mexico who received educational services in a bilingual classroom, was tested in Spanish with the Tejas LEE (Texas Education Agency, 2004), a

state-adopted standardized test for primary-grade students whose main language is Spanish.

Nine sites reported scores on at least two TPRI tests, and one site reported two scores on the Tejas LEE. Of these 10 students, 7 gained percentage points on the second test, with a mean gain of 14.8; 1 had a perfect score on both tests; 1 had no change in scores; and 1 scored lower. Some students who registered large gains took the test at the beginning and end of the school year, while others took the test at the middle and end of the year. These data demonstrate that most students made gains in reading skills during the 2004–05 school year. It cannot be concluded, however, that the gains resulted from the students' involvement in the project.

Qualitative data

The researchers sought to explore the nature of the gains made by students as a result of participation in the Early Braille Readers Project. Data related to the nature of these gains consisted of portfolios of work samples, videotapes, field notes recorded during site visits, and reflections and comments by the teachers. The materials were collected by direct observation, e-mail messages, telephone and personal conversations, and queries at workshops. The data were analyzed using the constant comparative method (Bogdan & Biklen, 1998). Three significant themes emerged from this analysis: the positive effect of the use of the Mountbatten on students' progress in writing, reading, and participation in the general education experience.

Writing

By far, the most easily observable impact of the braille technology on the students' education was in the production of braille, or braille writing. Some of the youngest children in the project were 4 years old and attending prekindergarten classes when they first began to use the Mountbatten. Most students had experience with a Perkins Brailler. During instruction, prior to participation in the project, several teachers of students with visual impairments noted motor delays, especially in the youngest children. These were not motor impairments, but delays in development, such as limited hand and finger strength, limitations in the ability to use individual fingers separately, and limitations in the stamina of the students. These factors affected the amount of braille that the students produced or the time they spent brailling. The advantages of using the Mountbatten for children with fine motor problems emerged as a major theme in the project's data. The teachers stated that the Mountbatten was "easier for the student to use," "the student can use one finger per key; [she] can't do that with the Perkins." Some children were not able to use the Perkins Brailler in a functional way, but could write with the Mountbatten. Students who may not have had noticeable motor delays also benefited. The teachers made such statements as "the student wrote longer passages, and . . . [the] MB [Mountbatten] was faster to type on"; there was "less fatigue, which produces a greater quantity of writing"; "[it's] less tiring, [and the student is] more willing to stay on task longer." Most students still used the Perkins Brailler, partly to maintain a skill they had already acquired and partly as a backup device in the event of a technological breakdown. However, according to the teachers, some children who were cognitively ready to learn to write letters of the alphabet and words would not have been able to do so without the Mountbatten until later in the school year.

The classroom teachers were able to provide more immediate feedback and assume a more active role in writing instruction with the students using braille. Because the Mimic visual display showed in print what was written in braille, the teachers and paraprofessionals who could not read braille were more involved in supporting the children's writing activities. As one teacher reported, "He is able to work independently in the classroom and then get feedback from the classroom teacher, a student teacher, or a peer." The students were better able to participate in the same activities as their peers in the general education classroom and thus had more opportunities to write braille. Typical statements by the teachers included, "This has enabled him to be part of his class," and it "gives the classroom teacher immediate print if using the printer."

Using the Mountbatten was also motivating to many children. The teachers reported that the students were more interested in doing written work: "He enjoys writing on the MB," and "He LOVES it!" Some teachers believed that the students' development of skills in the area of written composition was improved because of the use of the Mountbatten, in part because the students had more experience writing and were more motivated to write, and writing was physically easier for them.

The auditory feedback of the Mountbatten was mentioned many times as having a positive effect on the students' development of writing skills. Some children liked to hear the speech and were more motivated to work because of it. Others used the speech to monitor their writing, and the teachers reported that these students' writing skills improved because the students were more consistent in remembering to add space between words, use punctuation, use correct braille characters, and discover errors in their writing as they worked. Typical comments were: "He is able to hear what he has written" and "Auditory feedback encouraged positive immediate feedback." Another teacher stated that the use of the voice-output feature "increased listening skills." Some teachers believed that using the speech was distracting to their students and did not use it, but most said that the speech enhanced the students' learning.

Some features that were mentioned less often as advantages were: having a full page of braille as opposed to a refreshable braille display, the ability to "discover" contractions, and the ease of correcting mistakes. One set of teachers reported that their student, who was a dual media user, "enjoyed reading on the Mimic what he brailled." Another teacher indicated that for her student "with behavioral problems, . . . the MB has motivated him to stay on task."

Reading

When the teachers were asked how the use of the Mountbatten had improved the students' reading skills, they were positive about the impact of the Mountbatten. By far, the most frequently mentioned aspect was that the students were reading their own work as they wrote, and because of this independent practice, they had more opportunities for reading. One teacher stated: "Our student writes stories and proofreads," and another said, "She writes books that are familiar and can 'read' them." Another widely cited feature was the benefit of the voice in teaching the children the phonetic aspects of reading. The teachers said: "Letters and sounds were reinforced by the use of the MB," and the "Student receives auditory feedback to reinforce phonetic awareness." Many

teachers of students with visual impairments discussed the importance of having more input from the classroom teacher and other students. This phenomenon was described in many different ways: "interest in what the teacher and peers have written" and the classroom "teacher is able to input lists, vocabulary, and spelling." This increased interaction with the classroom teachers gave the students many more opportunities to learn reading-related skills.

Access to the general education experience

Greater access to the general education curriculum and to the overall educational experience by the students who used braille emerged as a major theme in the teachers' comments and feedback about the effects of the Early Braille Readers Project. The teachers reported that their students who read braille were able to work on the same activities at the same time and in the same location as their peers. This participation encouraged the students to be less dependent on frequent prompting or feedback from adults. The classroom teachers were better able to monitor the students' work and to offer support or correction. One teacher said, "This has made it easier for the classroom teacher to monitor the student's writing without the [teacher of students with visual impairments] there." Another said, "[He] was able to print what he typed on the MB on paper to turn in to the classroom teacher." Another teacher reported, "Our student was able to stay in the regular education class for instruction. The teacher was able to give the student more exposure to braille."

Many teachers described both structured and spontaneous activities between the students who read braille and their classmates who read print. Some indicated that the students who read braille helped other students with spelling because of their ability to listen to the speech on the Mountbatten. One Mountbatten user was chosen to write during group activities because he could write faster than the students who used pencil and paper. Many teachers discussed ways in which the presence of the Mountbatten in the classroom raised the awareness of the sighted classmates about braille. Many sighted classmates expressed an interest in learning some braille or interacting with the visually impaired students when they watched the students using the Mountbatten. One teacher stated: "Peer interest in [the] equipment helps stimulate [the] blind student to work on it."

Technological issues

Using a new piece of technology usually presents challenges. The students and their teachers experienced some problems with malfunctions of the Mountbatten and difficulties related to the practical use of the machine in the classroom. Problems experienced by the teachers of students with visual impairments included a variety of technological malfunctions: the breakdown of the internal rechargeable battery or the failure to maintain the rechargeable battery properly; software errors, such as errors in braille translation or embossing incorrect braille characters; and malfunctioning of the embosser head. Features of the Mountbatten that caused problems for the students were the difficulty reading braille while the paper was in the Mountbatten and loading paper and the incorrect automatic division of words at the end of a line. For some teachers, the malfunctioning of the Mimic visual display or confusion about how to connect the Mimic caused frustration. The teachers also had difficulty reading from the

Mimic because the size or contrast of the print that was displayed made it difficult to see. At the time of this project, the internal rechargeable battery had some significant limitations. The battery life was estimated at about 15 pages of braille (Cook, 2001a). If the battery fully discharged, it would often fail to recharge and required replacement by an authorized dealer. During the course of the project, battery failure was the most common technical problem.

Limitations

Because the project staff's time was not funded by the grant, the time to work with the teachers and students was less than optimal. Time constraints also limited the ability to include parents in the project as active partners. The distance education and distance support component was an ongoing challenge. Although the technology functioned adequately, and the project included funding to purchase needed equipment, the computer network system's security presented an obstacle that could not be overcome. Technological problems with the Mountbatten and related equipment occurred, although the equipment was repaired or replaced in a timely manner. The lack of consistent assessments of students was an unexpected problem. The TPRI was the state-adopted assessment for students in the primary grades, but some districts chose an alternative, and some students were not retested in a consistent manner, which made a comparison of scores impossible.

Discussion

The findings of the Early Braille Readers Project closely parallel those of the project conducted by SET-BC (Holbrook et al., 2003). Virtually all the teachers reported that using the Mountbatten had a positive effect on the academic skills of the students who were learning braille, including reading, written composition, and knowledge of the braille code. They indicated that the Mountbatten helped to compensate for motor delays and to facilitate the development of motor skills, including strength and endurance. The teachers also noted that the students learned more of the braille code faster because they had more opportunities to read and write and that they became better writers sooner because they wrote more. The voice-output feature helped the students locate errors; learn the braille code and phonics; and develop listening skills, particularly listening to understand the electronic voice.

In addition, the classroom teachers were able to take a more active role in the instruction of the students who were visually impaired and expected more independence from them. The teachers of students with visual impairments who worked in locations where there was limited access to an embosser made extensive use of the Mountbatten in braille production. They downloaded and embossed braille books from Internet web sites (Iowa Braille and Sight Saving School, 2005; TSBVI, 2005). They also were able to produce more braille and adapt more materials immediately when needed, and thus the students who read braille were more likely to have class handouts at the same time as their peers. Many classroom teachers and paraprofessionals who had only limited knowledge of braille produced some braille materials for the students who read braille.

The classroom teachers, sighted students, and other staff on the school campus became more aware of braille and the needs and abilities of the students who read braille because of the presence of the

Mountbatten, which many viewed as an interesting and amazing piece of technology. One teacher reported:

> The MB has educated an entire campus that just because you're blind doesn't mean an individual can't learn, be a friend, be a teacher's helper, get in trouble, and be held accountable. The MB's presence has raised the expectations of many on the campus. It's technology, and, they ass[ume] that, "She can do that. Wow!"

Overall, the Early Braille Readers Project was a success. It contributed to an increase in the students' academic skills, supported the educational staff in learning to use braille technology, and allowed the students who read braille to have more complete access to the general education experience. The teachers of students with visual impairments were encouraged to use braille technology at earlier stages in the learning process. Further research is needed with more heterogeneous groups of students, as well as comparison studies using control groups, to determine if the use of electronic braille devices can significantly affect the acquisition of reading and writing skills and access to social experiences involving literacy for children who are visually impaired.

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