The Unified English Braille Code: Examination by Science, Mathematics, and Computer Science Technical Expert Braille Readers

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Abstract: Braille-reading mathematicians, scientists, and computer scientists were asked to examine the usability of the Unified English Braille Code (UEB) for technical materials. They had little knowledge of the code prior to the study. The research included two reading tasks, a short tutorial about UEB, and a focus group. The results indicated that the participants believed that UEB could be effectively used by people who are employed in technical fields.

Since 1992, a formal effort has been under way to unite English-speaking countries with one braille code that encompasses all codes (literary, science, mathematics, and computer science) with the exception of the braille music code (Bogart, Cranmer, & Sullivan, 2000), which has been accepted internationally for several decades and was further revised in the late 1990s (Miller, 2000). The Braille Authority of North America initiated the effort to develop a unified braille code for English-speaking countries and was later supported by the International Council on English Braille. In response to this effort, a unified code was developed by braille experts, spearheaded by individuals who were braille readers, transcribers, producers of tactile materials, and other related professionals (Bogart et al., 2000). The English-speaking countries that were included in this massive project were Australia, Canada, New Zealand, Nigeria, South Africa, the United Kingdom, and the United States.

The Unified English Braille (UEB) code contains no new literary contractions; the changes to the literary code involved the elimination of nine contractions and changes in spacing. The most significant change is that the UEB code incorporates literary, mathematics, computer science, and chemistry into a single code with new UEB symbols and rules for representing math and science notation (Australian Braille Authority, n.d.).

Research on the UEB code

The original braille codes that were used in literary, mathematics, science, and computer science were developed without a strong research base. Symbols were included largely on the basis of logic and sequence, rather than on empirical evidence. Many symbols that were used in the literary code were reassigned different meanings when they were encountered in codes for mathematics or computer science. Throughout the development of the UEB code, care was taken to eliminate ambiguity that was associated with the context in which braille symbols were used. Extensive consultation was conducted to inform the decision-making process related to the meanings of symbols and the application of rules, and to garner interest in the development and implementation of a unified braille code for all English-speaking countries.

Research on the efficiency and efficacy of the UEB code has faced challenges. Randomized trials for teaching a proposed code to braille-reading youngsters presents logistical and ethical challenges. Therefore, the research conducted to date has largely been based on the opinions of consumers or professionals (Gerber & Smith, 2006; Wetzel & Knowlton, 2006a). In addition, two major studies focused on other aspects of adopting the UEB code. Knowlton and Wetzel (2006) conducted a text analysis to explore the difference in space required by the various codes in relation to the space required by the UEB code. These researchers also conducted a related study of the reading rates of adult braille readers in literary and mathematics texts (Wetzel & Knowlton, 2006b).

Implementation of the UEB code

Many English-speaking countries have considered adopting (or not adopting) UEB. Some countries (such as Australia, New Zealand, Nigeria, and South Africa) have fully adopted the UEB code, while others (Canada) have adopted but not implemented it and still others (the United States and the United Kingdom) have postponed their decisions. Australia fully implemented the UEB code beginning in 2005. This implementation included the preparation of teachers, the training of braille transcribers in the new code, and the gradual transition of textbooks for schoolchildren into the UEB code (Nobel & MacCuspie, 2009; for additional information on the Australian implementation of the UEB, see Round Table on Information Access for People with Disabilities, 2010).

One concern about implementing the UEB code has been whether it will provide appropriate access for braille readers who are employed in technical fields and for braille-reading students who are learning advanced mathematics and scientific notation. The focus of the research presented here was to examine the application of the UEB code with users of higher tactile mathematics, science, and computer braille codes. We believe that the perspectives of highly expert braille users in these fields will provide important information that may influence decisions to adopt the UEB code that are being made in Canada.

Method

In 2006, the Teaching and Learning Committee of the Canadian Braille Authority was awarded a federal research grant from the Human Resources and Skills Development: Adult Learning, Literacy and Essential Skills Program. Before the study began and in response to concerns about the threat of researcher bias related to the selection of participants, the research team formed an advisory committee to provide guidance on the selection of participants and research procedures. Members of the advisory committee were

Table 1
Demographic characteristics of the participants.

Participant	Gender	Age	Academic degree	Profession	Current job title
1	Male	39	Ph.D.	Scientist	Associate scientist
2	Female	30s	M.Ed.	Educator	Middle school mathematics teacher, residential school for students
3	Male	50	B.Sc.	Information technology (IT), computer programmer	Senior software designer
4	Male	32	B.Sc., master's degree in computer science (M.C.S.)	IT, computer programmer	Manager of XML transformation and query development
5	Male	40s	M.C.S.	Accessibility specialist	Accessibility specialist

chosen to represent different viewpoints on the adoption of the UEB code. The study was approved by the Behavioural Research Ethics Board at the University of British Columbia.

Participants

The participants in the study were experienced braille readers who were employed in high-level mathematics, science, and computer science positions. A screening was conducted to determine each person's appropriateness to be included in the study. All the screening questions were vetted through the research advisory committee. Although it was understood that participants might be familiar with the proposed UEB code and have an opinion about its adoption, they were included in the study only if they stated that they were willing to consider the research questions carefully and to be open to changing their opinions (for or against), given their exposure to the UEB code during the study.

Potential participants were asked to respond to a flyer that was widely distributed on e-mail lists. After extensive recruitment efforts, it became clear that few people met the criteria for inclusion in the study. We believe that our sample represents a high percentage of braille-reading individuals who are employed in technical fields and had limited previous involvement in UEB.

Five technical experts, three from the United States and two from Canada, participated in the study (see Table 1 for their demographic characteristics). All five participants learned braille during their school years. Four of the five had used both the literary and Nemeth codes throughout their school years. One participant, who grew up outside the United States or Canada, learned literary braille at age 11 and the Nemeth code in college, and was primarily self-taught. All the participants took mathematics and science courses in high school and majored in mathematics or science in college.

All the participants use braille in their professional and personal lives. Two of the five described themselves as "avid readers," and the other three reported using braille for reading in their personal lives. All the participants reported using braille (hard copy or via refreshable braille display on a notetaker) for professional tasks. Two participants, who work primarily in the computer field, reported that they do not currently use the Nemeth code in their professional lives. Four participants reported using the computer braille code in their work. The participants also reported their extensive use of literacy tools, including JAWS and other screen readers, embossers, braille displays, and Bluetooth technology.

The participants were not familiar with the UEB code, although all were aware of it at some level. One participant reported having been on an evaluation committee in the early 1990s but had not followed the development of the UEB code since then. All the participants were interested in learning more about UEB and were willing to provide their thoughts (pro or con) about the appropriateness of the code for use in technical fields.

Procedures

During a two-day, face-to-face meeting, the participants were asked to engage in various tasks related to the UEB code. The first three tasks were completed independently, in the presence of a member of the research team. The fourth involved a focus group with all five participants.

The first task was to read nine samples from high school science textbooks (such as physics or chemistry), mathematics (such as calculus), and computer science that had been transcribed into the UEB code. This activity was designed to give the participants experience with and information on how difficult or easy it was to read something transcribed in UEB without any instruction about the code.

During this task, the participants read the samples out loud to a researcher using the Think Aloud method (Ercikan et al., in press; van Someren, Barnard, & Sandberg, 1994), which meant that the participants read the text and spoke their thoughts as they encountered symbols that were contained in the text. The researchers did not answer questions or provide any information to the participants during the reading tasks. If a participant forgot to read aloud or did not provide his or her thoughts, the researcher would remind the participant to do so. At the completion of each passage, the participant had the opportunity to examine a list of symbols that had been compiled with the meaning of each UEB symbol included in the passage. As the participants read more passages, they often remembered what they had learned from lists of symbols in previous passages.

The second independent task was listening to a short (60-minute) UEB instructional tape and examining accompanying materials that were produced in the UEB code. The researcher was present in the room for this activity, but the participant completed the task without input from the researcher.

The third independent task was reading a work passage obtained directly from the participant's employer or a colleague prior to the face-to-face meeting. The purpose of this activity was to provide an opportunity for the participants to examine a document of familiar content that was produced in an unfamiliar code. Again, the participants were asked to read the text to a researcher using the Think Aloud method, and the session was audiotaped.

The participants met for the first time together for a focus-group discussion about the UEB code and the research tasks they had just completed. An independent focus-group leader and one project researcher asked the participants predetermined focus-group questions. The focus-group discussion was audiotaped and transcribed for analysis. The questions and discussion items for the focus group were determined somewhat by the reactions of the participants to their individual tasks; however, some general discussion questions were outlined ahead of time by the research team.

After introductions, the focus group began with a discussion of the participants' experiences with the reading tasks, including their reactions to each task. Then there was a rich discussion that focused on the participants' opinions about the use of the UEB code, the importance of having a common code for all English-speaking countries, the ease or difficulty of transition for adults who are currently using braille in their professional and personal lives if the UEB code were adopted, the suitability of the UEB code for advanced technical areas, and the participants' opinions about issues of transition from the current codes to the proposed UEB code. In addition, the participants discussed their opinions regarding the potential of adopting the UEB code on instructional issues for school-aged children.

Results

In the data analysis, three primary sources of information were used: the participants' comments that were documented on the transcripts of the participants as they were exposed to samples of both familiar and unfamiliar material that had been transcribed in the UEB code, transcripts of audiotapes of the focus group with the participants and moderator, and feedback from the participants to statements developed by the researchers to summarize the findings of the research. The two lead researchers independently made notes from multiple readings of the transcripts for each participant's response to the two reading tasks. The notes were compiled and reviewed multiple times, both independently and collaboratively, in an attempt to develop an exhaustive list of themes and categories that were associated with such things as how the participants deciphered the UEB symbols and the participants' opinions about the UEB code, responses to the list of UEB symbols at the end of each sample, responses to the activities, and code-related statements. A similar process was used to analyze the transcript of the focus group. All compiled results were sent to the participants, who were asked if they agreed with the researchers' characterization of the opinions of members of the focus group. If any participant had concerns about a statement in the results, the statement was removed. Therefore, the results presented next represent themes that were approved as accurate by all the participants.

Participants' responses

Opinions of the UEB code

The participants noted that their successes in technical fields are dependent on their use of a tactile reading system as opposed to reliance on auditory information, and that the format of brailled materials (such as the proper use of indentation and capitalization) is critical when reading technical materials. The participants said that both the current codes and the proposed UEB code are linear and that they believed that there would be little difference in the difficulty of learning and using either code for technical tasks. They thought that the issue that has not yet been addressed is the need for a tactile code (that is, a code that is designed to be read with the fingers) that fits the format of technical tasks better than do linear codes (which present material in a straight line rather than using other spatial formats that may produce material both horizontally and vertically). They stated that the UEB code could be formatted in such a way as to make it more spatial, which would enhance understanding and readability. They also noted that the UEB code is understandable and represents technical information as well as the existing codes. Because the UEB code does not rely on context as do other codes, the participants reported that it "makes sense" regardless of context.

On learning UEB in a research setting

The participants felt successful using the UEB code for individual research tasks and thought that this response was directly related to how easy it was to learn and to read the UEB code. Although the technical samples were demanding, they enjoyed this challenge. The participants commented on some aspects of the UEB code (for example, that the creators of the UEB code could have eased the transition to the new code by using some of the same features of the current code or by avoiding using symbols from the previous codes in a different way). Although the difficulty they experienced was associated with knowing the previous codes and then encountering known symbols that meant something different in the new code, they stated that this would not be a problem for someone who was learning only the UEB code. Some of the specific aspects of the UEB code that were new to the participants (such as type form indicators) were initially confusing. The participants indicated that given the opportunity to review the lists of symbols provided at the end of each sample, their level of comfort with the UEB code increased with practice, particularly as they encountered text that matched their own expertise. Overall, the participants were pleased and excited that they were able to read the UEB samples of material from various technical areas including those that were unrelated to their daily lines of work.

On the effect of ambiguity

The participants discussed how ambiguity in a braille code affected learning the code. They indicated that as experienced braille readers, they were rarely confused by symbols that represent more than one thing depending on the context. However, one participant stressed the importance of trying to eliminate symbols that represent more than one thing depending on the context. He thought that for complex technical subjects, it would be desirable to use one symbol always to represent just one item. The participants agreed that children who are learning the proposed UEB code may be helped by the fact that there is little ambiguity, especially related to punctuation. They did not believe that using upper or lower numbers had any significant effect on learning the braille codes. They also believed that children who are learning braille could just as easily learn the UEB code as the current braille codes. However, they stated that learning an additional code (like the Nemeth code) adds significant time and practice requirements.

On UEB in educational settings

The ease of translating materials from print to braille was identified by the participants as a strength of UEB. The participants all believed that having easy, accurate, automated forward and backward translation (that is, print to braille and braille to print) is critical to the successful use of any future braille code. In their opinion, teachers who do not know braille would benefit from UEB because accurate back-translation allows a student to work in braille while the teacher reads in print. The possibility of having software that would simultaneously present the student with a braille view and the teacher with a print view was also deemed significant. The participants stated that the potential exists for forward and backward translation of print and braille to increase students' access to materials in the classroom, thereby enhancing the likelihood that students will learn about technical fields. Furthermore, they suggested that using braille in technical contexts is an important experience for students.

The participants commented that given that children will use whatever they are taught and that there is not a dramatic discrepancy between the UEB code and the current codes, if adoption of the UEB code can cause 1% or 2% more teachers to expose their students to technical braille, to help their students learn it, and to incorporate technical braille into their studies, the students would benefit. If there is a group that is going to benefit from the adoption of the UEB code in Canada, the participants believed, it would be students. As technical professionals, the participants thought that they could accommodate whatever code is adopted. However, they also noted that even experienced braille users would benefit because it would eventually become easier to gain access to more materials.

On UEB and the study of math

The participants noted that using the UEB code may help "support people" (such as parents and classroom teachers) to be more engaged in math with students who use braille because math is easier with the UEB code. They stated that students who are beginning to learn math may find some characteristics of the UEB code (for instance, the way fractions are written) easier to understand, which could make a difference in a student's comfort and consequently his or her confidence and interest in going further into the study of math. In addition, they thought that because the UEB code largely follows print, the math anxiety of teachers of students who are visually impaired may be reduced, and the teachers' level of comfort with technical braille materials may increase, which could have a positive effect on the actual teaching and learning of math, science, and computer science. The participants wondered whether the teachers' level of competence in mathematics and the Nemeth code may be correlated with the poor performance in mathematics and other technical areas of students who use braille.

On implementing UEB in Canada

The participants discussed the consultation process that would need to be organized if the UEB code were to be adopted in Canada. They suggested that it would be helpful to determine the competence and comfort level of teachers of students with visual impairments in relation to the current codes and the UEB code. They noted the importance of justifying the cost of adopting a new code (for example, in training and producing new materials). One would need to be clear, they stated, that the purpose of adopting the UEB code would be to simplify the learning process by reducing or eliminating ambiguity. The participants thought that although people may recognize the benefits of UEB, they may be slow to consider using it in place of the system they are currently using because it is difficult to make changes. They also stated that what other countries decide to do in relation to adopting UEB will make a difference because UEB is supposed to unify English Braille around the world. Finally, they commented that as technical professionals, they could make it work in their day-to-day lives.

Discussion

The braille readers who participated in the study noted that the UEB code is understandable and represents technical information as well as do traditional codes. They were able to read the UEB samples from various technical areas, and their level of skill improved with practice. All five participants believed that the UEB code would provide appropriate access to high-level technical material for braille readers.

The opinions of these participants were valuable because of their professional expertise with braille materials that are used for math, science, and computer science. In addition, the participants brought valuable perspectives from their memory of learning math and science through braille.

Limitations of the study

As with all research, this study had some limitations, two of which should be noted. First, it was difficult to recruit participants. The participants were required to be braille readers who were employed in highly technical fields; had limited previous knowledge of the UEB code; and did not have a strong opinion, pro or con, about the UEB code. Thus, we had a limited pool of individuals from whom to draw. Second, although the participants were exposed to the UEB code during the study, using samples from several technical areas over two days, they obviously did not master the use of the code during that time. Therefore, their opinions were based on their experience and understanding of the code with these activities.

Implications for practice and future research

The primary implication for practice is that the data from this study can be used in the dialogue regarding the possible adoption and implementation of the UEB code. The results indicate that the UEB code supports the use of higher-level mathematics, science, and computer science. If it is decided to adopt UEB, the issues of the use of a new code by students and by individuals who will transition from the traditional codes to UEB will need to be examined by following these individuals during the transition.

The transition to the UEB code will provide a great deal of information about how braille is used in technical fields and other areas of study and work. One big benefit of a unified code is the ability to learn from the experiences of other countries.

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