



Considerations for States Providing Materials in Braille

In November 2012, the U.S. members of the Braille Authority of North America (BANA) voted to adopt Unified English Braille Code (UEB), with implementation of the code to begin in January 2016. Prior to that, braille materials and assessments were provided through English Braille American Edition (EBAE) a "literary" code, and Nemeth Code for Mathematics & Science Notation (Nemeth). Now, math and science materials can be created in UEB only or in Nemeth that is embedded within UEB. Understanding why providing both options is important will contribute to designing appropriate school policies and procedures for braille users. The purpose of this brief is to provide information on, and recommendations for, appropriate braille materials for students.

Background

BANA is the organization that sets the braille codes and guidelines used in the U.S. and Canada. During the late 1980s, BANA and other organizations recognized that the braille codes in place at the time were confusing and repetitious. Readers had to know multiple braille symbols for the same print symbol. For example, the dollar sign symbol, \$, would be transcribed in three different ways depending on whether the material was transcribed in the “literary” code (EBAE), Nemeth, or the *Computer Braille Code*. In addition, EBAE was a true “literary” code that did not include symbols for math. If a simple phrase such as “blue + yellow = green” was transcribed into EBAE, the symbols + and = would need to be spelled out as “plus” and “equals.” This meant that the braille reader did not see the same text as the print reader, which could cause confusion in the classroom; it also made electronic transcription more difficult.

UEB was developed after more than a decade of work by an international committee, primarily by braille readers. It was designed to be a complete code that

unified literary, mathematical, and scientific symbols and rules for braille transcriptions in English-speaking countries. The goal was to create one code that could be used in any context, whether literary or technical (that is, mathematics or scientific texts), and for textbooks as well as leisure reading materials. The resulting unified code also was less ambiguous with fewer exceptions and clearer rules, and therefore more accurate for electronic translation into braille as well as for back-translation from braille into print. Table 1 provides an overview of some of the differences between EBAE and UEB.

Who is using UEB? UEB was completed in 2004. Early adopters of UEB included Australia, South Africa, and New Zealand. The U.S. has since adopted it, along with the United Kingdom, Canada, Nigeria, and Ireland. Additional countries have expressed interest in using UEB for English-language transcriptions.

What is the current status of UEB in the U.S.? BANA member organizations voted in November 2012 to adopt UEB as an official code for use in the U.S., with implementation set for January 2016. Because each state in the U.S. has a different system for procuring and producing educational materials in

Table 1. Comparison of EBAE and UEB

EBAE	UEB
Contains 189 “contractions,” or shortened words, whole word symbols, symbols that are parts of words, and abbreviations (known as “shortforms”).	Has eliminated contractions for 9 words or parts of words because they cause ambiguity in the course: <i>ble, com, dd, ally, ation, to, into, by, and o’clock</i> .
The words <i>to, by, into</i> are unspaced with the word that comes next, for example, “to my house” would have the words “to the” with no space between.	Follows word spacing of original text; the contractions for “to,” “into,” and “by” have been eliminated.
The symbols that stand for the words <i>and, for, of, the, with</i> when used together are unspaced, for example, “and the” would not have a space between the words.	Follows word spacing of original text.
Typeforms, such as italics, bold, underline, etc. were all designated the same way.	Specific typeform symbols added.
Words with accent marks designated the same way.	Specific accent mark symbols added.
Electronic addresses, such as email and URLs, enclosed in computer braille symbols with separate rules for use.	Electronic addresses, such as e-mail and URLs, presented as is without special symbols or rules needed.
No math symbols included; math symbols spelled out, for example, the = is spelled out as “equals”; otherwise, must use Nemeth code.	Includes math and science symbols as part of the code; no need to use a separate code or symbols.
	New symbols added; some changed, such as the dollar sign, ellipsis, bullet, asterisk, percent sign, etc.

braille, BANA suggested that each state create its own implementation plan; many states did so. An intense four-year period of training and outreach ensued to provide information and resources on transitioning to UEB to states and agencies that provide braille materials.

The U.S. is unique among other countries that have adopted UEB because the U.S. has maintained its previous code for mathematics. As of January 2016, the official codes used in the U.S. are Unified English Braille, Nemeth Code, Music Braille, and the International Phonetic Alphabet (IPA). The transition to UEB for literary materials has gone smoothly so far; however, the transcription of *technical materials* has been more complex.

Understanding UEB and Nemeth Code

Math and science textbooks, worksheets, and assessments can be transcribed into either UEB or Nemeth Code. Both UEB and Nemeth are equally equipped with the symbols needed to transcribe all levels of technical material. Still, with the U.S. now having two codes available for mathematics and science transcriptions, a number of misconceptions have arisen about the way the two codes work. These misconceptions have led to some students receiving textbooks, tests, and instructional materials in a code they have not learned.

Using UEB for technical materials: UEB is a complete code that can be used to transcribe any content. This is a major change, because most braille readers, educators, and producers were accustomed to using one code for literary materials and a separate code for technical materials. When using “full UEB” for math and science material, there is no need to switch into a different code; the symbols and rules are consistent

within UEB no matter what the context. The numbers in UEB are in the upper part of the cell (see Figure 1). There is no need to spell out names of the math symbols or to use a code switch device, and students do not need to learn a separate set of numbers.

Using Nemeth Code for technical materials: The Nemeth Code has been used in the U.S. for mathematics and science transcriptions since the late 1950s, although like all braille codes, it has had several revisions over time. Nemeth Code was designed specifically for mathematics and science transcriptions as a separate code from EBAE. One feature of Nemeth Code is that it uses “dropped numbers,” that is, the numerals are in the lower part of the cell (see Figure 1). The use of dropped numbers distinguishes numerals from letters, which are in the upper part of the cell. In EBAE the numbers were in the top of the cell so students learned two sets of symbols for numbers, literary and technical.

Nemeth Code itself has changed since 2016. Prior to the adoption of UEB, math textbooks in Nemeth Code used EBAE, the literary code, for the nonmathematical content of the book, such as the explanatory text around examples, captions, and other textual content. BANA recognized that once EBAE was no longer supported as an official code there would need to be a new system for using UEB for the nonmathematical content in books transcribed in Nemeth Code. To address this, BANA developed guidelines for use of the Nemeth Code embedded within UEB text available at www.brailleauthority.org/mathscience/math-science.html; the guidelines outline the use of a “code switch” symbol. This allows the text surrounding the math examples to be in UEB while the technical content—the math problems themselves—are switched into Nemeth. Therefore, Nemeth Code is used *in UEB contexts*.

Figure 1. Comparison of UEB and Nemeth Numbers

	1	2	3	4	5	6	7	8	9	0
UEB	⠠⠼	⠠⠆	⠠⠨	⠠⠲	⠠⠴	⠠⠶	⠠⠸	⠠⠺	⠠⠼	⠠⠼
Nemeth	⠠⠼	⠠⠆	⠠⠨	⠠⠲	⠠⠴	⠠⠶	⠠⠸	⠠⠺	⠠⠼	⠠⠼

The braille cell has six dots arrayed in a 3x2 pattern. In UEB, the numbers are created in the upper four dots of the braille cell, preceded by the numeric indicator. In Nemeth, the numbers are created in the bottom four dots of the cell, preceded by the numeric indicator.

There continue to be several misconceptions. These are summarized in Table 2.

Students may use UEB for all content including math and science, or they may use UEB for literary transcriptions then switch to Nemeth code within UEB contexts for technical materials. BANA's position is that "the decision to use UEB or the Nemeth Code within UEB context for technical materials should

be made based on braille readers' individual needs" (BANA, 2015). Still, the confusion about using UEB or Nemeth for braille mathematics and science has led to students who have requested textbooks and standardized tests in UEB actually receiving materials in Nemeth within UEB context, rather than in full UEB.

Table 2. Misconceptions and Facts About UEB and Nemeth Code

Misconception	Fact
UEB cannot be used for higher level math.	UEB can be used to transcribe all levels of math and science material. Seven other English-speaking countries, including Canada, use UEB exclusively for all braille transcriptions—including math and science. The U.S is the only country that has maintained its former math code in addition to adopting UEB.
States are supposed to choose one braille code to use for math and other technical materials.	BANA's position is that the decision to use UEB or the Nemeth Code within UEB context for technical materials should be made based on braille readers' individual needs. Both codes should be available for use.
Nemeth Code is going away in the United States.	Nemeth Code remains one of the official codes available for use in the U.S. in addition to UEB, Braille Music, and the International Phonetic Alphabet (IPA).
UEB is more difficult to read than Nemeth.	There is no evidence to support this claim. UEB and Nemeth are both consistent in their rules and how to apply them. They are simply different codes—structured differently and with different rules and symbols.
There is a shortage of braille transcribers for both UEB and Nemeth Code.	This is true. The National Library Service (NLS) for the Blind and Physically Handicapped (NLS) is working diligently to increase the number of certified braille transcribers in BANA approved codes. In the past two years approximately 700 transcribers have been newly certified or have gone through the process to add the letter of proficiency in UEB but many more are needed.
There is no certification course for transcribers in UEB for technical materials.	A NLS course for UEB covers basic math materials and does not go into the intricacies of high level math transcription. A second level course that covers this material is being developed and is slated to be completed by the end of 2019. Currently, the <i>Guidelines for Technical Materials</i> is available free of charge from ICEB and provides additional information and examples for transcribing math and science materials in UEB.
There are no states that provide math and science braille materials and assessments in both UEB and Nemeth codes.	A growing number of states provide materials to students in both codes. The American Printing House for the Blind (APH) is also creating new braille materials in both UEB and Nemeth.
UEB and Nemeth are the same code for math.	UEB is its own code and can be used for math and science materials. Nemeth Code is a separate code with different symbols and rules, but is embedded within UEB text, referred to as "Nemeth Code Within UEB Context." This is sometimes referred to as "UEB with Nemeth," which makes it sound as though UEB uses Nemeth symbols for math and other technical material, which is incorrect.

What the Law Says about Braille and Accommodations?

The Individuals with Disabilities Education Act (IDEA) in 1997 included language about braille instruction::

in the case of a child who is blind or visually impaired, [the Individualized Education Program (IEP) Team must] provide for instruction in Braille and the use of Braille unless the IEP Team determines, after an evaluation of the child's reading and writing skills, needs, and appropriate reading and writing media (including an evaluation of the child's future needs for instruction in Braille or the use of Braille), that instruction in Braille or the use of Braille is not appropriate for the child. (IDEA, 2004, §300.8(c) (13))

The importance of providing braille to students was reinforced in a "Dear Colleague" letter distributed June 19, 2013:

Factors, such as shortages of trained personnel to provide Braille instruction; the availability of alternative reading media (including large print materials, recorded materials, or computers with speech output); or the amount of time needed to provide a child with sufficient and regular instruction to attain proficiency in Braille, may not be used to deny Braille instruction to a child. (Musgrove & Yudin, 2013, p. 1)

Clearly, braille instruction is a critical accommodation to provide access to the general curriculum and assessments.

Accommodations for students with disabilities are decided by the IEP team based on the assessed needs of individual children. The accommodations used in the classroom for instruction generally are what are provided for statewide assessments, although allowable testing accommodations are set by each state. Every state provides assessments in braille (Smith & Amato, 2012). It is important to acknowledge that the format in which a test is currently available should not drive the decision about which form of braille a student should use for instruction and assessment.

What Should States Do?

The U.S. is now in the third year of UEB implementation. In many places the transition has gone much faster than originally predicted, and students in middle and high school around the country are already using the new code. This has increased pressure for high school graduation and college entrance tests such as the SAT and ACT to be available in UEB, including the math portions of these assessments.

Several recommendations are provided here for state departments of education about the provision of braille materials to students. These recommendations also apply to statewide materials centers that provide braille materials.

- **States should be aware that both UEB and Nemeth are official codes for use in the U.S. for transcription of technical materials.** Students should have access to the codes that they have been taught and that they use to access the curriculum.
- **Materials in EBAE should be phased out and new materials should no longer be produced in this code.** Students should have started to make the transition to UEB. Many students may have already completed that transition and are now using UEB for both literary and technical materials, or they are using UEB along with the Nemeth Code in UEB contexts.
- **States should support math instruction in UEB or in Nemeth Code based on the IEP team's decision.** It was never BANA's intention that a state should choose to implement only one code or the other for instruction in math and science. Both codes are valid and suitable for use in the U.S.
- **States should provide math and science materials in both UEB and in Nemeth within UEB contexts as needed by students.** The promise of IDEA is that students will receive braille instruction as needed, and this includes appropriate materials. Therefore, instructional and assessment materials for technical content need to be produced in both UEB and in Nemeth Code. Because providing

materials in two codes may be costly, states may want to consider sharing files and textbooks in UEB, creating databases of available books and file formats, and pooling resources to ensure that students receive materials in the formats that they need.

- **States should ensure that braille assessments are available in the codes that are being taught to students.** Students have the right to receive assessments in the formats they use for instruction. Assessment companies should be required to follow the needs of students and provide tests in the formats students request.

Resources for States

Braille transcription software is available for producing both UEB and Nemeth code materials. Two of the most popular software packages, the Duxbury Braille Translation (DBT) software program (Duxbury Systems) and the Braille Blaster (2019) available from the American Printing House for the Blind (APH), can be used to produce both UEB or Nemeth transcriptions that can be edited and embossed. Since most braille materials are originally from electronic texts, the use of this software is extremely important.

Increasingly, braille is read on portable electronic devices known as *refreshable braille displays*. UEB is built into these displays, and students can choose the code they wish to use for reading instructional materials by changing the settings on the device. However, math transcriptions are generally less accurate when done with machine translation alone, depending on how the files are formatted (Dunnam, 2016). Math instructional materials and assessments in both codes often require human transcribers to produce, especially those that are spatially presented and those with diagrams that require tactile graphics.

A number of resources are available to learn more about the use of UEB for the transcription and instruction of technical materials. Some available resources are shown in Table 3.

References

- Braille Authority of North America (April, 2018). *Guidance for transcription using Nemeth code within UEB contexts*. Retrieved from <http://www.brailleauthority.org/mathscience/math-science.html>
- Braille Authority of North America (November 18, 2015). *BANA takes action at fall meeting* [Press release]. Retrieved from <http://www.brailleauthority.org/pressreleases/pr-2015-11-18.html>
- Braille Blaster [Computer software]. (2019). Retrieved from <https://www.brailleblaster.org>
- Dunnam, J. (2016). Understanding and reducing inaccuracy in electronically generated braille. *The Journal of Blindness Innovation and Research*, 6(3). Retrieved from <https://nfb.org/images/nfb/publications/jbir/jbir16/jbir060310.html>
- Duxbury DBT: Braille Translation Software [Computer software]. (2019). Retrieved from <https://www.duxburysystems.com>
- Musgrove, M., & Yudin, M. K. (2013). "Dear colleague" [letter]. Retrieved from <https://sites.ed.gov/idea/idea-files/osep-dear-colleague-letter-on-braille/>
- National Center on Accessible Educational Materials (NCAEM) (n.d.). *What characteristics of the braille format should decision-makers think about when considering the format or a student?* Retrieved from <http://aem.cast.org/navigating/selection-faq.html#b-output>
- Smith, D. W., & Amato, S. (2012). Synthesis of available accommodations for students with visual impairments on standardized assessments. *Journal of Visual Impairment & Blindness*, 106(5), 299-304.

Key Terms

BANA: The Braille Authority of North America, the rule-setting body for the U.S. and Canada.

Contraction: A system of 180 symbols in braille that stand for words, parts of words, and abbreviated words. Contractions shorten the way words are written in braille to make text more compact. Contracted braille used to be referred to as "grade 2" braille, but this terminology is no longer used.

Table 3. Selected Resources

For more resources, visit www.brailleauthority.org

American Printing House for the Blind (APH). (n.d.). *UEB Math Tutorial* [web site]. Available from <https://uebmath.aphtech.org>.

American Printing House for the Blind (APH). (n.d.). *Nemeth Tutorial* [web site]. Available from <https://nemeth.aphtech.org>.

Banks, L. & McMillan, H. (2015). *UEB technical: A self-directed course*. Retrieved from <https://www.cnib.ca/en/sight-loss-info/braille-services-and-courses/writing-braille-courses/ueb-technical?region=gta>

Benckhuysen, W. (2015). *Using UEB in technical material: A closer look at Guidelines for Technical Materials*. Rochester, NY: National Braille Association.

International Council on English Braille (ICEB) (2013) *The Rules of Unified English Braille, Second Edition 2013*. Available from <http://www.iceb.org/ueb.html>

International Council on English Braille (ICEB) (2014). *Guidelines for Technical Materials*. Available from <http://iceb.org/ueb.html#GTM>

Region 4 Education Service Center (2015). *Assessment of Braille Literacy Skills (ABLS), 2nd Edition*. Houston, TX: Region 4 Educational Service Center.

Royal Institute for Deaf and Blind Children (RIDBC) (n.d.). *UEB Online introductory mathematics* [web site]. Available from <https://uebonline.org>

RNIB (2015). *Using UEB for Mathematics*. London, England: Royal National Institute for the Blind.

RNIB (2015). *Using UEB for Science*. London, England: Royal National Institute for the Blind.

United Kingdom Association for Accessible Formats (UKAAF) (n.d.) *UEB maths practice exercises*. Retrieved from <https://www.ukaaf.org/braille/ueb/ueb-maths-practice-exercises/>

UEB Curricula Support Writing Group (2013). *The hitchhiker's guide to UEB mathematics*. Retrieved from <http://www.banzat.org.nz/documents/HHGMaths.pdf>

Contracted braille: Braille materials that are transcribed using contractions.

EBAE: *English Braille, American Edition*, the former braille code, used in the U.S. until 2016. EBAE was a literary code only without the symbols needed for math and science transcription.

Nemeth Code: The *Nemeth Code for Mathematics & Science Notation, 1972 Revision*, one of the official codes for use in the U.S.. Nemeth code is now embedded within UEB text instead of in EBAE text.

Transcriber: A person who has been trained to “translate” print text into braille. Certified transcribers have successfully completed the training course and

received a certification from the National Library Service for the Blind and Physically Handicapped (NLS), part of the Library of Congress. Certification is available for UEB, Nemeth, Music, and braille proofreading.

UEB: *Unified English Braille*, one of the official codes for use in the U.S. and other countries that are members of the International Council on English Braille

Uncontracted braille: Transcriptions where all words are spelled out without the use of braille contractions. Uncontracted braille used to be referred to as “grade 1” braille, but this terminology is no longer used.

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