Accommodating Blind Students Taking Mathematics

By Mary Pilgrim and Paul Kennedy

I have been teaching mathematics on the postsecondary level for more than 10 years. In that time, I have worked with three blind students, two of whom took calculus. Although it is rare to have a blind student in the calculus classroom, when the occasion arises, what, as the instructor, do you do to best accommodate his or her needs?

In this article I outline the problems that many blind students in mathematics face and touch on how accommodations can be made. Then I discuss my own experience with teaching calculus successfully to a blind student, an experience that touched me deeply and helped me become a better teacher for all my students.

Obstacles and Solutions
The Americans with Disabilities Act requires that accommodations be made for students who are blind. But “accommodations” is a very broad term, and the specifics will depend on the student. Typical obstacles for blind students include exam accommodations, communication problems, inflexible instructors, and mental fatigue. In addition, the mathematics classroom poses additional challenges, as mathematics often involves visual concepts in addition to having a notation that is not coded in literary braille. A particular code of braille called the Nemeth Code is needed for most of mathematics notation.

Instruction and Accommodations
At the very least, vision-impaired students need an instructor to speak more slowly and clearly, possibly repeating phrases or sentences and avoiding using words such as “this” or “that.” As it happens, such speaking practices can also be helpful to students in the class who are not blind.

It is not uncommon to encounter a mathematical expression such as

\[ \text{equation here} \]

in a mathematics classroom. The proper placement of parentheses is important so that the student is working with the expression that the instructor intended. If the student is not told the proper placement of parentheses, then the student may be thinking of a different expression. Clear communication is a necessity.

In any classroom, regardless of subject, instructors need to be aware of their classroom presentation in relation to the student population. Instructors must have the ability and be willing to modify or possibly change their teaching style to provide a learning environment that is accommodating to all students. Utilizing various teaching styles in the classroom enhances the possibility for more students to succeed, including blind students.

Unfortunately, not all instructors are willing to make changes in their instruction—the way they speak, reduc-
ing the use of slides in lecture, having course materials in accessible formats. Instructors refusing to meet the needs of this population place these students at a disadvantage to their sighted peers and make success in a college mathematics classroom difficult to achieve.

Taking Tests
Exam accommodations must be made. For several reasons, exams (and quizzes if applicable) should be administered outside of the classroom. Often a sighted person is needed to both read the exam and write solutions down as the student dictates, or to simply clarify any questions the student may have. Thus, taking an exam can be a lengthy process for a blind student and can be quite exhausting. Dividing an exam up into parts to be taken at separate times is common.

Other needs often include a note taker or tape recorder, textbooks in braille, a braille writer, and an outside tutor. The use of manipulatives might also be useful in instruction. Mathematics is often a visual subject, and in the college mathematics classroom, the graphing of functions is a topic that comes up frequently. Manipulatives can help a blind student “see” graphs. The Picture in a Flash (P.I.A.F.) Tactile graphics maker is helpful in creating raised graphs for a blind student. However, these classroom techniques may not be enough.

Instruction for a student who is blind may require involving an outside tutor. Such a tutor must be highly knowledgeable in the mathematics subject area and be able to do more than just help with homework problems. The tutor may have to reteach concepts to the student if the classroom instruction was not sufficient. Spindler (2006) and McCallister and Kennedy (2001) realized this to be true, especially for students in higher-level courses. But as with all college students, a certain level of self-sufficiency with regard to learning the course material is expected, and a student should not become overly dependent on his or her tutor.

The Nemeth Code
One of the biggest problems, however, is that much of mathematics notation is not coded in literary braille. The braille for mathematics notation is the Nemeth code. Thus a combination of literary braille and the Nemeth code are used in mathematics textbooks.

But not all blind individuals know the Nemeth code. There is no requirement that vision-impaired students be taught Nemeth. In fact, in a survey of teachers of blind students who were randomly selected from a list of members of the Association for Education and Rehabilitation of the Blind and Visually Impaired, only about 24 percent were found to be proficient in the Nemeth code (Kapperman and Sticken, 2003). Rosenblum and Amato (2004) and Demario and Lian (2000) have conducted similar studies with such secondary teachers that resulted in a low percentage of knowledge of the Nemeth Code. The implication is that many teachers are ill prepared to teach blind students the necessary mathematics skills needed to succeed in higher-level mathematics courses. This puts these students at a severe disadvantage when it comes to gaining access to and producing mathematical work (Rosenblum and Amato, 2004, p. 484).

Not having access to the Nemeth code does not mean that blind individuals are incapable of developing higher levels of mathematical skills. It does, however, restrict their access to developing higher levels of mathematics skills. It is no wonder that “visually disabled people are so poorly represented in mathematical, scientific and technical subjects at all levels of education and employment” (Kapperman and Sticken, 2003, p. 110).

Personal Experience
During the 2008–09 school year, I was asked to teach a blind student Calculus I and Calculus II at a western land grant university. Even without circumstances that required the student’s classes be one-on-one, this type of instruction would have been needed for the calculus courses. For one, none of the Calculus I and Calculus II instructors at this institution had experience in providing instruction for the blind. Second, calculus comprises concepts that are often presented visually; therefore, proper use of language and using teaching aides specific to blind instruction needed to be employed.

I was chosen to work with this student for two reasons. First, I had experience as an exam reader for a blind student. Second, I had extensive experience in teaching calculus. I also have a master’s degree in mathematics and have taken a course to become proficient in braille. All that—and the fact that there were no other known individuals on campus with any experience in working with blind students in mathematics—made me the logical choice.

The student was fairly well prepared for tackling these
two mathematics classes. He was proficient in both braille and the Nemeth code and also had a strong background in both trigonometry and algebra. The student had purchased and installed the screen reader Jaws on a personal computer and was lent an audio calculator from the university. In addition, the student owned a Perkins Brailler, which enabled him to take notes in braille.

As the semester proceeded, we encountered two main barriers. For one, while the other students enrolled in the course had graphing calculators, the only technology to which we had access was an audio calculator. It was not user friendly. Only some of the buttons on the audio calculator were brailled, so navigating the calculator was cumbersome. Also, audio calculators do not have all the functions necessary for computing complex problems.

Our second barrier was with course materials getting accurately translated into braille and the Nemeth code. As the student and I read through and discussed particular concepts, we discovered errors in the coding. Though much time had already been spent writing materials to be converted into braille and the Nemeth code, even more time had to be spent fixing the errors. This often resulted in the student typing up additional notes using the Perkins Brailler.

**Longer Classes**

Despite the obstacles, we established effective methods of instruction. Aspects that made the instruction productive and meaningful for the student were 1.5- to 2-hour sessions three times a week, my being very careful with language, and the regular use of a P.I.A.F. (Picture in a Flash) tactile graphics machine.

Think about how long it would take to teach calculus concepts to sighted students if a chalkboard were not available. Verbally describing calculus concepts can be time consuming, and it must be done carefully and clearly, as discussed earlier. The student needs time to translate and internalize the concepts being introduced. In addition, reading and creating notes in braille takes longer than working in English. Therefore, rather than meeting for 50 minutes three or four days a week, it was more productive to have longer sessions three days a week.

**Tactile Aids**

Calculus, specifically Calculus I, is often presented in a visual way and description of these concepts can be difficult to do for a student who is blind. Several tools are available to create visual aids. But expensive, high-tech methods are not necessary for visual representations of concepts and ideas. We used the P.I.A.F. tactile graphics machine regularly to help explain visual concepts. A P.I.A.F. machine creates raised graphs using heat-sensitive paper. (A tactile gridded board with thumbtacks and yarn was also an effective way to present graphs.) This method for creating embossed visuals is not new. In fact, it is analogous to the embossed graphs created by Dick and Kubiak (1997) with Wicky Sticks (moldable strings covered with wax). These tools enable students to feel graphs so that they can explore and understand functions and their properties. Not only are these methods of creating graphs simple but they are also easy to learn and take little time to implement. This allows the instructor to present examples on the fly and not have to be constrained by a preestablished lesson plan. Though lesson plans are needed and highly useful, flexible instruction lends itself to better meet the needs of the student.

Having the tools and knowledge for creating tactile graphs easily and quickly was a must. Tactile graphs provide a physical interpretation of symbolic calculus concepts. The discussion of the derivative as a limit (i.e., means so much more when a graph, illustrating secant and tangent lines, is provided.

**A Combination of Skills**

It is not always the case that the student knows the Nemeth code or that the instructor has experience in working with blind students. But an individual who knows calculus well and has the ability to explain it to others in various ways, combined with tactile graphs, will go a long way in teaching calculus to a student who is blind.

This experience has made me a better teacher. I have become more aware of the students in my classroom and the language I use. In addition, I have learned new tools for creating tactile graphs and have become more aware of resources available for individuals who are visually impaired.

Every day I learn something new within this area of education and am always excited to share my personal experiences. Sharing educational experiences and knowledge is the only way to facilitate growth within education.

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Bibliography to come

Demario and Lian (2000)
Kapperman and Sticken, 2003, p. 110
McCallister and Kennedy (2001)
Rosenblum and Amato (2004)
Spindler (2006)