AN EXAMPLE OF A VISUALLY IMPAIRED STUDENT'S LEARNING GEOMETRY

By

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ABSTRACT

Students with special needs often require additional assistance in order to learn at the university level. This article documents a professor's efforts in teaching a visually impaired prospective elementary school teacher geometry content knowledge. The goal of this article is to shed light upon the iterative process of accommodating for individual needs of students. The author highlights the persistence and creative problem solving required for helping this student, with the hope that other faculty members will provide the due help to their special needs students with the same persistence.

Keywords: Preservice Teacher Education, Geometry, Special Needs.

INTRODUCTION

A University Student Who Does not Know What a Square is?

Faculty have an academic responsibility to provide equal access to education for all students (Americans with Disabilities Act, 2000). This in turn means that faculty must make any identified accommodations in order to help students with special needs learn the content of their higher education courses. However, it is not always easy to comply especially when what is written on a student's Disability Support Services accommodations memo does not fully cover the student's needs. When a student is unable to identify what accommodations would best work for them, there are two routes for the professor to take: follow only the instructions written on the memo, or to adjust the accommodations provided in accordance with the spirit of the memo. The author chose the latter and hopes that by documenting experiences with teaching one student with special needs, other faculty members will be inspired to further adapt their instruction for those with special needs.

While teaching an undergraduate course on geometry to prospective elementary school teachers, the author noticed that one student, who will be called Tina for the purposes of this article, was unable to look anyone in the eye. It was strange because during the first class, the author asked all of the students in this class to create a concept map about their lives, and to present it in front of the class; everyone else was able to make eye contact during their short presentation. Tina approached the author at the conclusion of the first hour of class, and informed her professor that she is visually impaired. She also asked the author, "what is a square?" which was a surprising question to the author because none of the author's prior high school and college geometry students had ever asked her this question.

The course Tina was taking is the third of four mathematics courses that are required in the degree program for elementary teacher certification; prerequisites for the geometry course include a course on numbers and operations, and another course on elementary statistics and probability. Elementary geometry is inherently a visual subject. The course covers properties of triangles, quadrilaterals, interior and exterior angles of polygons, areas of polygons and circles, perimeter, surface area of prisms, and volume of prisms at an elementary level. The course is taught with the intention that students can be the discoverers of their knowledge; and it builds upon knowledge that students should have learned, in the public school curriculum in a discussion-based environment. When students are taught many carefully chosen questions posed by the instructor, and students need to analyze one another's ideas about

mathematical content, they are more likely to remember the process of gaining mathematical understandings (Choppin, 2007). The course relied drew heavily from Geometer's Sketchpad programs published in Hollenbrands & Lee's (2012) geometry textbook.

Overcoming Obstacles

Tina told the author that her career goal is to teach mathematics and all other subjects properly to visually impaired students, without omitting to teach any necessary subjects. She always acted in a professional manner, even when other students in the class were not as courteous, and even when she was frustrated with her struggles to learn geometry. She is also a self-proclaimed "hard worker," and indeed she is one.

The author learned from colleagues that Tina had already failed this geometry course once, so she was retaking this course to satisfy the degree program requirements to override her previous grade for her achievement in this course, in a prior semester. Only a few weeks later did the author understand the extent of Tina's visual impairedness; she could barely see very large font, and even then only if she used a magnifying glass and hunched over so that her eyes were close to the print. In addition, Tina said that in mathematics classes since kindergarten, her teachers gave her the impression that only visually competent people could learn mathematics, and thus continually gave her passing grades in mathematics even though her content knowledge was not accurately reflected in her mathematics course grades. As a result, Tina had a weak mathematical background by the time she finished high school. Tina only started experiencing difficulties in mathematics courses during her undergraduate program.

The author sought other faculty members' help in teaching a visual subject to a visually impaired student. Other faculty told me that it took at least two semesters and an independent study in a subsequent third semester, for Tina to pass each of her two prerequisite courses for geometry. The author wondered whether that would be an efficient way of teaching, and thought that anyone would be exhausted by the third semester of hearing the same, incomprehensible material repeated in the same manner. The author's colleagues overwhelmingly thought that, for Tina, geometry would be a harder subject that the prior two courses, since geometry requires more visualization.

Trial and error

Tina told the author that she would do anything to learn mathematics when given the chance. She also told the author that although she took many semesters repeating courses, she made sure that she eventually earned all A's. The author asked Tina to tell her of a time when she felt that she was successful in a college course and what the professor had done to help her out. The author went through the gamut of suggestions in order to help her succeed.

Getting enlarged printouts of all handouts was one of Tina's accommodation requests. While this helped Tina to see the handouts more clearly, Tina needed much more time to digest the content on the handouts. Throughout the semester, the author met Tina and received feedback to what was working and what was not. Simply providing larger versions of the handouts and providing a notetaker's notes was not enough. One of the additional accommodations was allowing Tina's university-provided personal tutor to help her with homework, however, the tutor did not take any mathematics classes in college and did not profess any knowledge of mathematics. The author provided Tina with time-and-a-half on exams, but not only did she need more time, she did not usually understand the majority of the questions posed. The author suggested that Tina work with a peer tutor provided through the university; however, while this tutor was good at solving mathematics problems, she was unfamiliar with helping people with special needs. While still searching for potential solutions, the author suggested that the handouts could be translated into Braille. However, Tina's reaction was that she had trouble in prior classes, because the diagrams could not be adequately represented in Braille; and she did not want to have her accomplishments in the class to be determined by another machine.

There were several issues involved in the beginning half of the semester. Tina was unable to catch up with the pace of the discussion, having not been able to quickly see the diagrams which the class were conversing. This made it difficult for her to participate during classroom discussions, and part of her grade was for her participation in class. Tina later resolved this situation herself by giving the author the handouts that she completed that day, for the author to grade as her participation. She also made an effort to contribute in whole group discussion when she did feel that she was able to contribute (even if she was incorrect). Tina did not raise her hand during every class period, but this token participation showed the extent of her efforts.

Another issue was Tina's inability to see the Geometer's Sketchpad software, which was heavily used in class, causing her to miss much of the discovery periods held in class and subsequently not understand the conclusions that were made in class. The university provided Tina with a university-owed laptop that had screen enlargement software installed; unfortunately, Geometer's Sketchpad software was incompatible with the screen enlargement software. Whenever possible, the author instead created paper or other hand-held manipulatives that would substitute for the concepts addressed in the software programs.

The main issue that the author observed was that Tina's poor achievement in class (during mid-semester she was on track to earn an F) was not due to lack of trying or good attitude on her part; Tina tried to her fullest extent. The very last accommodation that was made, which ultimately helped Tina the most, was to use untimed alternate assessments which Tina could complete as a take-home exam (for an example, see Appendix A). Tina had to create physical models, which the author described for her to create, and to research further or apply concepts that were included within the classroom content. Asking Tina to apply classroom content required her heavily reviewing as well as her learning new content on her own pace outside of the classroom.

Conclusion

The student who is the subject of this article earned an 'A' in the class. Even though she was fearful of maths, and more fearful of how some of her prior maths teachers dismissed her as not being able to learn maths, she had a semester-long learning experience about ways to accommodate special needs students. It was not the easiest semester for the author, but it was one of the most rewarding because Tina and the author knew that they both did their best.

Recommendations and Implications of the Study

There exists a variety of resources for those who are visually impaired. For students who are blind, resources such as braille versions of textbooks, recorded textbooks, embossed braille paper, and haptic force feedback devices could be helpful learning tools (Dick & Kubiak, 1997; Rouzier et. al., 2004). While there are potential difficulties with each resource, using a combination of resources could be more effective than only relying upon one resource.

The author recommends that other faculty keep in mind that providing equal access to content knowledge does not assume that equal amounts of time will be spent helping each student. The trial and error process of finding what best suits the student's learning needs may last the entire semester as the student provides feedback on the previously used accommodations and potential revised accommodations. This involves the students being proactive in providing feedback as to what accommodations are helpful, and the teachers' experimenting with different methods of instruction.

Appendix A: Alternate Assessment Question

Towards the end of the semester, there was a lesson focusing on the distinction between increasing area and increasing perimeter, specifically, pointing out how we can disprove the common misconception that a figure with a larger perimeter necessarily implies that the figure's area is also larger.

On Tina's alternate assessment at the conclusion of the lesson, the following question was posed:

Are either of the following possible, and explain why or why not:

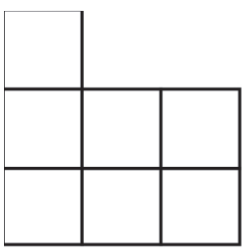
- Add one square tile such that the perimeter of the figure decreases and its area increases.
- Keeping the area constant, change the figure to get a different perimeter.

In class, it was discussed that when we change figures, our convention is to keep each tile connected on at least one side and two vertices of another tile.

Tina's solution for Part 1) is the following

As demonstrated by Figure 1, Tina cut each iteration out of graph paper and glued each cutout onto her page of solutions. As depicted above, Tina created every possible iteration by adding a squre tile to each perimeter tile. She calculated the different perimeters of those diagrams, and all of the perimeters were either the same as the original or longer. Tina correctly determined that it is impossible to add a tile and get a shorter perimeter. Although this approach was a procedural one, being able to solve this problem was a small victory for someone who had no prior successful geometry learning experience.

As one can see from Figure 2, Tina's resulting conclusion was that it was possible to use the existing square tiles from



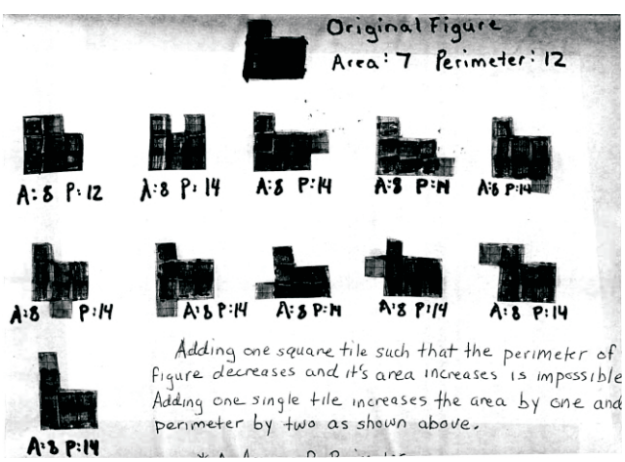


Figure 1. Part 1 Solutions

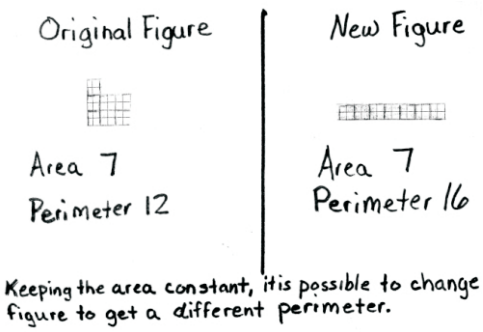


Figure 2. Part 2 Solutions

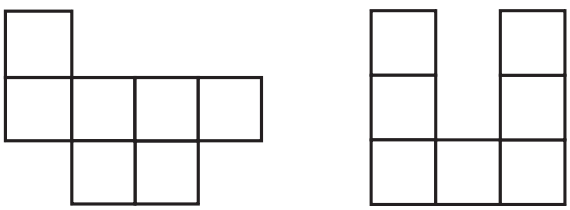


Figure 3. Examples of Potential other Figures with Different Perimeter than Original

the original figure to create another figure such that the perimeter is different. She understood that in order to keep the area constant, it is necessary to rearrange the existing tiles without adding or subtracting. There are many other rearrangements of the seven tiles that would create figures of larger perimeter than the original figure's perimeter of 12 units: possible additional perimeters include 14 units and 16 units (Figure 3, for example).

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ABOUT THE AUTHOR

Dr. Diana Cheng teaches pre-service and in-service teachers of elementary, middle, and secondary mathematics. Her research focuses on mathematics education; she is particularly interested in helping teachers learn specialized content knowledge within the mathematical knowledge for teaching framework.