With Our Powers Combined!

A Cross-Collaborative Approach to Tactile and Descriptive Calculus

Emily J. Helft, Ed.S., Landmark College
Michael Kerkhove, PhD, University of Richmond
Lily Dickson, University of Richmond Class of 2023
With Our Powers Combined!
A Cross-Collaborative Approach to Tactile and Descriptive Calculus

Presented for AHEAD Cleveland, July 2022

Emily J. Helft, Ed.S.
Michael Kerckhove, Ph.D.
Lily Dickson, B.A. Candidate
Introductions

Emily Helft, Ed.S., she/her
Assistant Director of Professional Development at the Landmark College Institute for Research and Training; Conceptor and board creator

Mike Kerckhove, Ph.D. he/him
Associate Professor of Mathematics at the University of Richmond; Course Instructor

Lily Dickson, B.A. cand., she/her
Student at the University of Richmond; Learning Assistant
Goals of our Presentation

1. Understand the value of creative approaches to visual math
2. Be exposed to a framework for gathering information and creating solutions for courses that are typically heavily visual
3. Understand the general approach to creating the tactile board used in our case study
4. Walk away with insight or creative starting points for working with Blind/low vision students regarding various mathematical concepts
Presentation Outline

• Background/Context
  • The student
  • Brief tactile board overview
  • The University of Richmond
  • Calc Catalog description

• Prep and Application
  • Communication/textbook accessibility

• Student Integration
  • Learn some math and use the board! (Painless—pinky promise!)

• Course Progression
  • Content and Accommodations
  • Learning Assistant
  • Assessments

*Step-by-step board creation slides at the end of the slide deck*
Think for a Moment:

What are you hoping to get out of this presentation?
https://tinyurl.com/ahead22math
Background Info: The University of Richmond

- Small, private, residential liberal arts institution
- Undergraduate student population around 3,200
- Greatly values low student-staff ratios and the concept of a “high-touch” learning experience
- Competitive admissions and internal culture with undergraduate graduation rates range in the upper 80s
- Well-endowed, highly resourced institution
- Free-standing Disability Services Office, 1 FT staff member during the case-study time period
Background Info: The Course

- Catalog Focus: Limits, continuity, derivatives, and integrals
- Chosen Textbook: Stewart, Concepts and Contexts
- Course required for Business School admission
Background Info: The Course

- Emphasis and order of topics modified
- Written HW and oral assessments for this student
- Learning Assistant funded via grader money/Student Development division
- Learning Assistant received independent study credit
Prior to the Start of the Semester

- Textbook accessibility check
- Student consultation, insight, and input
- Group consultation and brainstorming between instructor, Disability Services, the student, and the identified Learning Assistant

Based on the information gathered in the above processes, a tactile board prototype was created

- Initially, he “didn’t know what to think” about the board, but he “was pretty quickly able to realize it would help”
Background Info: Our Case Study Student

- Sighted for the majority of his K12 education, with total vision loss in his mid teens (after taking the majority of his high school math courses)
- Some exposure already to Braille (low comfort) and tactiles, with a preference for auditory engagement
- Sophomore with an interest in a business major
- Prior to the semester start, he noted that he “felt mostly prepared for class, but it had been a while [since he had taken a math course]”
Quick Board Overview
Integrating the Student into the Class

- Service Animal and Learning Assistant presence
- Discussion board for math problems in the news
- Sensory needs (cane travel to seat, audio prep)
- Work in small groups
  - “Helped me to know where I stood with respect to others’ understanding”
Let's learn some math!
And play with the board, too :)
Longitudinal Coursework

- Functions: Tables, Graphs, Formulas, Verbal Description
-Disconnected Graphs, Continuity, then Limits
- Triangles:
Slope Triangle

Trigonometry measures lengths and angles.

Calculus cares about the slope of the hypotenuse.

The slope here is:

\[
\frac{\text{rise}}{\text{run}} = \frac{m}{1} \quad \text{or} \quad \text{rise/run} = \frac{m}{1}
\]
Calculus Triangle

Horizontal change in $x$ is $dx$

Vertical change in $y$ is $dy$

The slope here is $\frac{\text{rise}}{\text{run}} = \frac{dy}{dx}$

In calculus $\frac{dy}{dx}$ is the derivative
Linear Approximation

Function is increasing at an increasing rate

Triangle is tangent to graph

New \( y \) approximately equal to \( y \) along the hypotenuse

Change in \( y \)
\[ \approx \text{slope} \cdot \text{change in } x \]
Triangles, meet Board.
Board, meet Triangles.
As the course progressed, alterations and updates to the tactile board were made.

- Derivatives: Interpretations and Applications of Linear Approximation Formula
- Recursion: Newton and Euler
- Integrals: Accumulations and Relation to Anti-Derivatives
Instructional Accommodations

- Pre-class reading: concepts and formulas
- Zoom recording of lectures
- Post-class notes: formulas in context, graphical understanding
- Office Hours: student made only occasional use
- Meetings with the Learning Assistant
Learning Assistant Focus

- Limits and Continuity
- Tangent Lines/Triangles
- Formulaic Approaches
- Concavity
- Integration/Derivatives
Assessment

- Assessments
- Homework
- Examinations: Final Exam Problem
Reflections
Student Reflections (post course interview)

● Practice with real-world examples of course work over the summer was very helpful, and advanced access to Word doc outlines prior to each class was essential
● Applicable content/scenarios made concepts much easier to understand (e.g. problems related to COVID-19)
● The board was especially helpful for parabolas, but clearer axes markers would be better
Student Reflections, cont.

- Different approaches were beneficial based on activity
  - Graphs: verbal descriptions followed by tactile clarification
  - Tables: verbal support needed; the more complex tables became, the more verbal support and repetition was needed
  - Formulas: a combination of memorization and application (especially with real-world examples)
  - Assessment: opportunity to verbally explain concepts and approach to problem solving
  - Course progression: continuous references to previous weeks for cumulative connections and deep learning
Instructor Reflections

- Awareness of student’s learning modalities/preferences
- Importance of the social aspect of learning
- What’s best for the student, but does not negatively impact those progressing to Calc 2?
- Build student interests incorporated into meaningful assessments
Learning Assistant Reflections

- Language is the most important
- Specificity and consistency
- Relationship with student is key
- Find ways for the student to use the board without the Learning Assistant
Disability Services Reflection

- More practice and interaction with the instructor and student in advance would be helpful for more detailed board tweaking.
- More one-on-one time with the student to check textbook accessibility likely would have helped things go more smoothly.
- A way to fold the board into quarters would make transportation easier, and may be possible utilizing hinges.
- The tactile board can easily be used flexibly, and is able to further evolve for additional courses with new pieces.
Audience Reflection:

Thinking back to your original expectations/hopes for this presentation, did anything we covered today resonate with you?
Board Details

Supplies and Tools
Board Creation: Tools

- Eye Protection
- Tin snips, a circular saw with a diamond-tooth/metal blade, or a kind employee at your local home improvement store who can cut your galvanized metal sheeting
- Box cutter, utility knife, or exacto-blade
- Scissors

Optional/Potential:
- Utility gloves
- Metal file or rubber mallet
- Dremel with grinder wheel
Instructions: Board

1. Cut your galvanized metal sheeting to your desired size (ours was 15x15 inches)

2. Attach the sticky-back felt to your metal sheeting from edge-to-edge, or glue thin felt directly if you cannot find adhesive felt (this step is optional, but strongly recommended to help produce the optimal level of magnetism)

3. Use your electrical or duct tape to protect the edges of the sheeting (and your hands); overlap the felt roughly ¼ inch and wrap around to the back
Instructions: Board, cont.

4. Cut your ¼ inch foam core poster board to size (recommended to have a minimum of a ¼ inch border beyond your sheeting—ours was 16x16)

5. Lay and center your felted metal sheeting on top of your poster board and attach it to your poster board with your tape of choice, wrapping to the back
Instructions: Manipulatives

- Tangent Lines: toothpicks
- Multipurpose Relational Problem-Solving Triangles: thick/sturdy non-corrugated cardboard (our triangles were two sizes at roughly 1 inch and 2 inches), magnets, glue
  - Cut cardboard to desired shape and size, then glue magnets to the back (this provides magnetic “stick” and three-dimensionality for easy grasping/moving)
Instructions: Manipulatives, cont.

- **Axis markers: Popsicle sticks, Dremel**
  - Use the Dremel to notch two popsicle sticks ½ way through in the middle to be clicked together to make an “X” (think Lincoln Logs, but with just one centered notch each)

- **Curved graph lines: Rope, tape, glue, magnets**
  - Cut two lengths of rope to roughly 10 and 14 inches; glue or tape ends to prevent fraying
  - Glue 1/8-inch magnets at roughly 4-inch intervals along rope (wrap rope with tape at each location if “stick” is a problem with direct glue-to-rope adhesion)
Contact Information

Mike:
mkercckho@richmond.edu

Emily:
emilyhelft@landmark.edu

Lily:
Lily.dickson@richmond.edu