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Evidence-Based Mathematics Education in Practice:
A Statement of Teaching Philosophy

Introduction

My primary goal in teaching mathematics is to communicate to students that math is a creative, logical field with immense importance to society. In order to do this, I work to engage students’ preexisting knowledge in order to help them better comprehend the mathematics they are learning, and I use assessments and gather student feedback to gauge and react to student learning outcomes. I promote small-group, problem-based learning and engage students on as many diverse learning modalities as possible.

Framing mathematical tools with motivating problems

At the beginning of my courses, I informally survey students on their academic and personal interests, then frame my class sessions with real-life scenarios which hew as much as possible to those interests and motivate the mathematics we will learn that day. For example, Rice has many science, technology, and engineering students who take calculus as a prerequisite, so I began my lectures by talking about planetary motion, the spread of disease, population growth, radioactive decay, and electrical circuits, among other applications. Together, the class would derive an equation which we could use to model the real-world phenomenon we had discussed, then I would pose a question about the model. I would then lecture for 10-minute intervals, broken up with student exercises and discussion, about the tools needed to analyze the model and answer the question I had posed. (Studies show that lecturing for no more than 10 minutes at a time hugely increases student retention of material, even after a year.) At the end of each class period, groups of students would use the mathematics they had learned that day to answer the motivating question. This format was highly praised by many of my students, and I found that it greatly increased student motivation to learn what before may have seemed like overly abstract mathematical concepts.

Engaging students’ preexisting schemas

Research shows that students come into a classroom with a schema of previously acquired knowledge into which they will attempt to fit the new material they will learn. When students come in with erroneous assumptions, giving specific counterexamples often provokes the student into reexamining the original assumption behind the erroneous belief and “remodeling” their schema to correct it. In general, I like to ask my students what might be a counterexample to the following statement? or when might this method fail? Teaching paradoxes (such as Zeno’s paradox of Achilles and the Tortoise when learning about limits) also pushes students to the point where their conception of reality and mathematics is challenged by a new idea. This is where learning happens. Before each class period, I consider what aspects of the material would be most challenging or confusing to my students, as well as what assumptions the students are bringing in from previous courses and their intuition, and I design problems and examples designed to target those areas.

I was, however, faced with a challenge in my abilities to scaffold knowledge when teaching an introductory linear algebra course that also served as many students’ first exposure to proof. Keeping in mind how difficult proofs had been for me when I was first learning them, I first modeled proofs myself, letting students see many examples in class. Slowly, I began asking them to fill in more and more steps in the proofs. I talked about my own past struggles with proof in class so students would know that proof-writing is a difficult process that takes a while to learn. By the end of the course, my students were much more comfortable with proof, and they were able to write basic proofs on their final exam.

Soliciting and responding to student feedback and assessment

In all of my courses, I continually solicited student feedback on course organization and structure. For instance, when I taught cryptography, I had students respond to questions about the material and their class experience in notebooks, then took up the notebooks a few times a week in order to better understand my students’ learning processes. In addition, I provide anonymous, unofficial feedback forms to students midway through my courses so that I can adjust as needed. Such mid-course feedback during my differential equations class led me to focus more on examples and to go more slowly when discussing material. Moreover, I use assessments, such as exams, quizzes, and homework, to evaluate how well students are learning so that I can tailor class time to focusing on the most confusing or difficult material. Because I view exams as tools
for student growth, I allow my students to do exam corrections, and in smaller classes, I schedule individual office hours with each of my students to discuss any confusion or uncertainty about their exams. All of my exams are cumulative, and any student who shows significant improvement and sufficient mastery on the final exam will do well in my course.

Promoting small-group learning

In my linear algebra and cryptography courses, I assigned my students to constantly-changing small groups, where each member of the group had a role (idea-generator, scribe, etc.) in the problem-solving process and groups shared materials. In my experience and in the pedagogical literature, this type of environment facilitates more equitable student interaction than might occur if students were simply told to “solve this together”. In general, I work to create a collaborative environment by setting norms of discussion together with my students at the beginning of the course, discussing with my students the research that supports group learning, and continually reiterating that questioning and confusion are necessary parts of the learning process. I follow a “think-pair-share” model, in which students are given time to consider a problem on their own before discussing it with a partner, then in groups of four, and finally having each group share their solution with the class. I found that this model greatly increased student participation and engagement.

Integrating diverse learning materials

Having the opportunity to design a problem-based, undergraduate-level cryptography course for high school-age students from the ground up has been one of my favorite teaching experiences thus far. Although the Duke TIP program targets gifted and talented 8th-10th graders, my students learned (and became comfortable with) concepts such as the extended Euclidean algorithm, modular arithmetic, and Fermat’s Little Theorem.

Working with high school-age students in the Duke TIP program challenged me greatly to integrate diverse learning materials in order to better engage students. I spent almost a month before the course designing a curriculum, creating problem sets, and integrating as many different kinds of learning experiences as possible for my students; research shows that such diversity of experience improves student learning, partially by letting students know how what they’re learning connects to other disciplines and to the world around them.

We read literature with cryptological themes, such as Edgar Allan Poe’s The Gold Bug and the Sherlock Holmes short story “The Adventure of the Dancing Men”. The students learned the history of Mary, Queen of Scots, who was executed because her code was broken. We watched a documentary on the NSA, then held a class discussion about the role of the NSA and the way that it used cryptography. Student engagement greatly increased during the discussion, as students very passionately began discussing the societal role of the mathematics they had been learning. Every evening, the students would learn to code programs in Ruby to perform the cryptanalytic techniques they had learned earlier in the day. The students’ capstone project was an independent investigation into a cryptography topic of their choice, to culminate in a presentation to the class. I am very excited to work with such highly-motivated students again, and I would love to start or participate in a high school outreach program as an assistant professor.

Future goals

I look forward to continuing to teach and develop math courses in the future, as well as to implementing some of the teaching strategies I have learned through Rice’s Center for Teaching Excellence. For example, I would like to use “backwards design”, which involves identifying desired learning outcomes before creating assignments, to design an entire course. I am very interested in teaching courses which connect undergraduates to accessible research questions, such as the research seminar on topological data analysis I helped facilitate at Rice. I am also excited by the prospect of teaching courses such as cryptography or DNA topology, which combine the austere beauty of proof-based mathematics with grounded, real-world applications essential to society. Moreover, I would like to integrate more technology into the classroom. In a moderate-to-large-sized introductory course, I would use clickers or note cards so students could simultaneously indicate their answers to questions I ask them in class. This would give me real-time feedback about students’ understanding of the material we were covering. Finally, I have performed a literature review on promoting the academic success
of underrepresented students in mathematics, and I found that there is a great disparity of studies that investigate specific teaching practices which benefit underrepresented students, including teacher-student interaction and its effects. I would like to contribute to research in this area. Overall, I am very excited to continue to grow in a university or college environment which values teaching highly, and I look forward to the challenges and rewards this will bring.
Appendix: Teaching Evaluations

Here I provide selected quotes from my teaching evaluations. See the following pages for graphs of my teaching evaluation averages for various courses. I am happy to provide copies of syllabi and/or original student evaluations forms on request. In addition, many course materials and evaluations can be found at http://math.rice.edu/~kai1/teaching.html. I provide more information about my teaching evaluations below.

Differential equations evaluations

“One of the most effective instructors I’ve had at Rice.”

“One of the best instructors I’ve had at Rice...[c]lass was really well organized, and I enjoyed how motivating problems led into the lessons, and how we revisited it after the lesson.”

“Instructor was very approachable and made the learning process fun and enjoyable.”

“Went out of his way to offer extra help if needed. Did a great job making sure everyone understood everything before moving on.”

Calculus I evaluations

"He is always there to help out and understands what it’s like to be a undergraduate student. Many students prefer Ince over the other professors."

“Kenan is a great instructor. He provides all of the resources (including himself) we need to be successful in his class and always presents real-world applications of what we’re learning so we can see how we might use the material later on in our careers.”

“Kenan is extremely enthusiastic, always happy to help his students with questions and extremely helpful in the way he explains it. He makes an effort to learn everybody’s names and creates a relaxed atmosphere in class for his students to learn. I really enjoyed my semester with him.”

“Ince was a lot of fun in class and he really related the information to you. He was also alot[sic] of help in office hours.”

"He was very enthusiastic about the topic and always made sure that no one had questions and made it clear that he was available for asking questions. He also had us work in groups to figure out problems and have students a chance to put solutions on the board, which was helpful.”
Figure 0.1: Averages from my Rice teaching evaluations. For the original evaluation sheets, see my website above.
Figure 0.2: Averages for selected questions from my Duke TIP cryptography course evaluations.