

Philosophy of Teaching

Kristin A. Camenga

Teaching and learning are different sides of the same coin for me: what I enjoy learning I want to teach, and what I teach, I learn more deeply. In passing on knowledge, I find that my own understanding is deepened as I interact with learners and consider the topic from many different perspectives. I delight in helping students to take the next step in their understanding, especially as they start asking interesting questions and start to see connections between topics. I also believe that good teaching requires continued learning, both about content matter and about pedagogy. Deeper understanding of the content one is teaching obviously enriches the course, but I also believe the process of continued learning is necessary to identify with students. If I expect my students to be learners of mathematics, I must model the process of struggling with new ideas and trying to understand them. One of the reasons that I returned to graduate school after having taught high school for two years was to challenge my own mathematical abilities and increase my mathematical knowledge base. My continued study allows me to be an authentic model for my students in their own learning process, encouraging their perseverance.

My main goal as I teach is to help students understand mathematics deeply, learning to think logically about mathematics and to work flexibly with mathematical ideas. Students should be asked to go beyond repetition of processes to think about the underlying ideas so that they can experience the power and beauty of mathematics. One of the most successful writing assignments when I taught a Freshman Writing Seminar asked each of the students to interview a mathematics faculty member. The students wrote about their perceptions of mathematics and mathematicians as compared to that of the faculty member. This caused them to think about their own view of mathematics, and I was excited to see their perspectives had expanded as a result of the new mathematical ideas they were grappling with in the course. I believe that learning mathematics deeply requires willingness on the students' part to take risks so that they grow mathematically, fluency with both concepts and computational skills, and opportunities to explore the mathematics in different ways.

Risk taking is necessary for students to stretch their ideas and abilities. Therefore, it is central to my teaching that I respect each of my students, making them comfortable in the classroom and letting them know that I believe they are capable of thinking about mathematics. To show this, I model that any mistakes I make are opportunities for learning, so that students see mistakes as a normal part of the learning process and become more willing to take risks. I also give them opportunities to express their ideas and understandings both verbally and in writing and pay careful attention to what they say to recognize insights and help correct misconceptions. I try to capitalize on their successes, building their confidence in their abilities to reason and do mathematics.

Thinking deeply about mathematics presupposes fluency in basic mathematical skills, and therefore deep understanding of concepts should not come at the expense of all computational skill. The concepts in a problem will be impeded if students spend all their time focusing on the computations necessary for it. Therefore, I believe students need enough practice with computational skills so that they become routine and they can focus on the larger concepts. I try to provide such opportunities and review pertinent material in the process of teaching, but I also believe that students need to be responsible in their learning. As an instructor I provide basic opportunities for students to practice skills and think about concepts, but I tell them that they are expected to monitor their own learning and find areas where they need extra practice or extra help. When they approach me with such needs, I try to help them or direct them to other resources where their needs can be met.

Different approaches to learning may highlight different aspects of a concept. Also, different students may find some of these avenues more helpful than others. Therefore I try to use a variety of instructional approaches for my students. In particular, I believe students need to be actively involved in their learning, not passive receptors of what I say, but interacting with the ideas and making sense of it. When I teach, I use interactive lectures, independent work in the classroom, small group work, conceptual questions that they discuss and justify with each other, traditional problem sets and conceptual writing assignments.

When I lecture, I expect students to stay engaged in what we are doing. I ask them to think about what the next step is, trying to lead them through the ideas so that later they can recognize and use the information given to them. I ask questions about why certain steps are taken, what aspects of the concept need to be examined, and how the ideas are connected to other things we have studied. I wait until these questions are answered, keeping students involved in the work at the board so that it is a whole class enterprise rather than a recitation of predetermined facts. Students are also encouraged to ask questions about what we are studying, and in my experience, have started to ask questions about the concepts as well as the process over the course of the semester. I also try to present a number of views of the ideas, using graphical, symbolic, and numerical examples so they get a deeper view of the concept. Physical models and experiences are used to connect their understanding to real life.

I use both independent work and small group work in the classroom to help them see that they are responsible for their own learning and that working with others can enrich their learning. Independent work is frequently used to help them practice skills so they can see where they struggle and get some practice before they leave the classroom. Small group work may include more difficult problems and may also lead to new ideas and concepts that we will discuss in class. These activities are ones where I believe the interactions of the group will enrich the process, providing new ideas and also providing opportunity for individual questions. Independent and small group work are used in conjunction by asking students to think about a multiple choice question and choose an answer, asking them to discuss and justify that answer to a neighbor and then revising their answer as necessary, followed by class discussion summing it up. This process is based on the Good Questions project at Cornell and is intended to encourage students to use their reasoning abilities and to learn Calculus more deeply. It is premised on the belief that students can think about mathematics deeply and want to understand the ideas, and that talking with each other can challenge their beliefs and encourage them to rethink and revise their ideas so as to deepen their understanding of the mathematical ideas.

Just as independent and small group work highlight different aspects of doing mathematics, the use of both traditional problem sets and concept writing assignments helps students to approach the ideas in multiple ways. Problem sets help students independently practice the basic skills and give them another opportunity to view concepts. Writing assignments are used to help students summarize what they have learned, practice the skills in a slightly different context or approach, and to help students learn to monitor their own learning. I believe that writing can challenge their ideas and help them revise their thinking since they have to put what they think into words and then decide if it is really true. I think that written explanations can also consolidate ideas that they have learned. I ask students to write about the main concepts of the course, explaining what they are and how they are used. I also ask them to write about concepts that students frequently confuse so they can differentiate between them. For example, Calculus I students are asked to compare the Intermediate Value Theorem and the Mean Value Theorem in order to see similarities and differences, enhancing their use of both and yet helping them to differentiate between them. This writing is frequently done in the context of solving a non-traditional problem that makes them

think more deeply about the concept or helps explain a theorem or rule, and then I ask them to write about what they noticed. Finally, I use writing to interact with students about difficulties they are having and to help them learn to monitor their own progress. On regular writing assignments, students always have the option of writing to me to let me know successes and struggles with the course. This form of communication allows students who may be too shy to talk to share with me and deepens my relationship with all students, since I also respond to their comments and concerns. As students learn to monitor their own progress by responding to prompts asking about their mathematical background, struggles they have with the course, and how they could improve their exam performance, they start to write to me voluntarily. A number have expressed growing confidence in their mathematical ability and awareness of a deeper understanding and fluency with the ideas. This has rewarded my efforts to create a classroom where students are comfortable taking risks, free to celebrate their successes and unafraid to ask questions to help with their struggles.

My use of writing grows out of my experience teaching a Freshman Writing Seminar and as a Teaching Assistant for geometry courses, as well as mathematics education research. In the Freshman Writing Seminar students were able to grapple with many new mathematical ideas in writing. They used writing both to brainstorm ideas, to record more complete ideas and to communicate these ideas to others. In the geometry classes, students' homework consisted of carefully answering thoughtful problems and revising their answers based on my comments until they had a complete answer. Students revise their thinking through written conversation with the instructor and Teaching Assistant until they achieve success with the problem. In this approach, students learn to persevere in solving problems. These experiences and the research I have done on instructional use of writing in mathematics have showed me that writing is a versatile instructional tool which does not need to be limited to the humanities. It can encourage students to take risks in their thinking by providing opportunities for revision, prompt them to think more deeply about concepts and how they are connected, and foster better relationships between instructor and student.

My development of writing as an instructional tool shows how I continue to be a learner, not just of mathematics, but also of different ways to teach it. I believe the best teachers never stop improving their teaching skills and methods. I know that I can learn something from everyone who teaches mathematics, and try to do this by sitting in on others' classes, discussing teaching ideas with colleagues, and attending sessions about teaching at conferences. Most of my teaching ideas were learned or adapted from other excellent teachers. As I have learned from others, I also have a deep desire to share what I have learned. At Cornell, I have helped to organize a seminar the last three years where we learn about teaching ideas - both practical and theoretical - from each other. I have also helped organize mentoring opportunities for new Teaching Assistants. This includes sharing ideas with them about what has worked for me and others and making myself available to brainstorm solutions to problems they encounter. Therefore my process of learning and teaching comes full circle. Teaching mathematics encourages me to learn more about mathematics, and as I learn how to teach I desire to share this knowledge with others. Learning mathematics inspires me to teach it, and in turn I learn mathematics more deeply.