

What is my philosophy of teaching? As my students say, “it’s complicated.” Experience has convinced me that there is no magic bullet: I must tailor my teaching to each class’s unique combination of students and circumstances.

This is why active learning is a common theme running through my teaching. I believe – and it is strongly supported by research – that active involvement in the learning process solidifies knowledge and strengthens understanding. By making students the central players in the learning process, both in and out of class, I tailor my classes in ways that help each individual student learn best.

If you stopped by one of my classes, you would see this focus reflected in all of my choices. My classroom is lively: I encourage discussion and create engaging, relevant activities. Students *do* mathematics during my classes, discovering and solidifying knowledge with their peers. Students work together in groups, struggle with conceptual problems, and present ideas to each other. Class time and is tailored to the specific topics which students are struggling with. I am practical: I lecture when appropriate, especially to clarify or tie together ideas which students have developed. Through surveys and evaluations, my students describe how they enjoy my energy, enthusiasm, and genuine interest in their individual success. A final evaluation summed this up: “Genuine caring about how we do.”

A key tool in my active learning toolkit is collaborative learning. I can best explain how this came to be – and why I believe so strongly in it – by describing one of my teaching failures. As a young graduate student, I taught a summer Differential Equations class. I did my best to keep students’ attention with energetic lectures – but even interested students were simply sitting back and “soaking it up”, and most were falling asleep in the summer heat. Class dragged, students were unmotivated, and assessments were mediocre.

Although this felt like a failure, I didn’t give up: I completely restructured the next summer’s class, with the aim of actively involving my students. Each day began with a mini-lecture, followed by guided group work which helped students to immediately get their hands on new ideas. I was able to circulate and help students directly. Students met in these same groups out of class to complete authentic problems and projects. I created videos to help students confirm their understanding outside of class. The difference was stunning: students were constantly engaged, and both homework quality and attendance improved. It all came down to one thing: Students felt actively involved and invested in the success of their friends, peers, and the entire class.

Since then, I have implemented collaborative learning in many of my classes, and the results bear out the research: active involvement leads to deep learning. Each student must face exactly the new ideas which are most difficult for them, while helping others understand those which they already understand. Even in 60 or 100 student Calculus lectures, small doses of collaborative learning make a world of difference in cementing understanding of new ideas.

I have successfully used variations on active learning in many classes, with a wide range of students. I have taught Quantitative Literacy classes in which Math-phobic students create and use manipulatives in order to understand, develop confidence, and even become excited about mathematics. While teaching Calculus to talented High School students through the University of Minnesota Talented Youth Mathematics Program (UMTYMP), every one of our 2-hour class sessions includes an hour of workshop time in which students work together, struggling with new ideas and interactively solving conceptual problems. In my senior-level coding theory class, at least half of each session is

devoted to collaboratively developing proofs and solving problems, which students then present and critique in class. Students are even actively involved outside of class time: I select class topics and problems based on student responses to pre-class reading assignments. This encourages students to actively learn basic material on their own, and to take part in shaping class. This approach has worked well to inject student interaction in even traditionally lecture-based courses.

Taking this to its logical extent, I am a strong proponent of inquiry-based learning, in which students truly take responsibility for their own learning. At Michigan Tech, I taught and refined an inquiry-based senior Number Theory class. Using Mathematica and carefully crafted questions, students spend the entire class (as well as out-of-class meetings) working together to collect data, discover patterns, state conjectures, and prove theorems – including many of the fundamental results in elementary number theory. Along the way, students develop important skills in writing mathematics and presenting and critiquing new ideas. I believe that this is an essential way for students to learn about the art and practice of mathematics.

This also extends outside of the traditional classroom. Active learning is a natural fit for enrichment and outreach programs, with which I have considerable experience. As part of my current position I write curriculum and teach enrichment classes (from 1 hour through 1 week) for students at many ages and levels. One does not need to be in a room with 30 middle schoolers for long to understand the importance of active learning! I use manipulatives, hands-on activities, and games to teach topics as advanced as coding theory and abstract algebra to primary and secondary school students.

While an active classroom can lead to excellent learning, I have long been concerned that traditional assessment methods do *not* match my methods. After discussing this issue with colleagues and considering many options, I implemented a standards-based grading system in my newest Coding Theory class. Every assessment tests proficiency in one or more of the class's major learning objectives. Students pass not by obtaining a certain number of points or a high percentage, but rather by repeatedly demonstrating proficiency in those essential objectives. This encourages students to take ownership of their learning, and complements in-class work. This work in progress is the next step in ensuring that my classes are focused on active learning, and that my assessments accurately reflect the results.

So what is my philosophy? *Active learning works.* I consider each class separately and develop a tailored approach which actively involves my students. My experience with a wide variety of classes and students has demonstrated that this method is strong, flexible, and most importantly leads students to not just retain knowledge but to even enjoy mathematical discovery.