## A Perpetual Student

By the end of seventh grade, I knew I was going to be a teacher. I'm not sure when I figured out that meant I would also be a perpetual student, but that didn't really bother me much. I liked school. And while there were always assignments or instructors I didn't care for, I continued to like school all the way through my undergraduate studies. There were always new things to learn, to practice, and to master. I fell in love with mathematics and physics, the way ideas and facts I had known from the time I was little connected to each other and explained the "interior machinery" that made things work. I just had to figure out how to help my future students to make those connections and build the beautifully simple ideas into a complex masterpiece.

It's not an easy thing to do. Many students come in, looking to be given the algorithm that will always work for each sort of problem, or for lists of facts to memorize and parrot back. It's difficult to motivate them to go further and figure out why the algorithm works or how those facts lead us to create a models and laws and theories. Technology helps, sometimes, if used the right way. It can take care of the monotonous work of creating graphs and tables of values, allowing us to spend time on the interpretation. It allows us to set up situations that we can't easily set up in the classroom, and collect data. The hard part is knowing how to incorporate into the curriculum so that it supports and extends student learning, rather than distracting and frustrating the students.

And so I had three main struggles in my teaching: helping students understand mathematics, helping students understand physics and learning to use technology to expand student learning, not hinder it. I made use of professional development opportunities and tried different techniques in my classroom. Sometimes it helped, sometimes it didn't. After four years of teaching, I had to return to school. I needed to earn my Master's degree to get my professional teaching certificate. When I explored Michigan State's online Master of Arts in Education (MAED) program, I found that it had the perfect concentrations for me: Science and Mathematics Education, and Technology and Learning. From the titles and descriptions of the courses within each concentration, I built a plan for my Master's program that would help me to improve my teaching for understanding and appreciation in both math and physics, and show me how to evaluate and incorporate technology into my classroom.

My first course in the MAED program, TE 861A: Teaching Science for Understanding, laid a solid foundation for my future work in leading students to a deep understanding and appreciation of science. By asking the hard question, "What does 'understanding' really mean?" and giving me the resources to read about several different viewpoints, I was able to coherently and concisely verbalize what I mean when I say "Do you understand?" Before this course, I would have said something along the lines of "You know: Do you get it?" Now, I can tell you that I am asking first if a specific concept is connected to other ideas that give it more meaning than just a phrase they've memorized, and second if they can apply and extend the idea to new situations. And because there's so much loaded into that three word question, I've stopped using it. Instead, I write specific questions to allow my students to show me the mental connections they've made. I design my lessons to facilitate the creation of concept webs and then provide practice in applying new and old ideas in novel situations. I was reminded of the purpose of asking about preconceptions and quick reviews: to bring to the surface the concepts the new material should be connected to and determine if that previous material was understood properly.

Viewing understanding as having a dual nature, active and representational, provided an excellent base on which to build when I took TE 861B: Inquiry, Nature of Science and Science Teaching. Moving between fitting facts into what is already known and then extending that knowledge to new situations matches the Observations-Patterns-Models framework. Weaving together facts into a larger picture moves students from observations to patterns to models, which is the inquiry part of science. Application happens when students use models and patterns to explain why new observations make sense. There was a moment of epiphany, an "aha!" moment, when I realized we use "science" the same way we use "understanding". "Science" is both the body of work, the theories and laws and models, and the process of building and extending that body of work. I knew that I had used the word both ways, and described it to my students both ways, but I had never been able to verbalize it quite that way before. Students will understand science by doing science.

With this epiphany came the recognition that I had been focusing more on the body of work than the process in my classroom. It's no wonder that my students believed science could prove things to be true if I was just introducing them to the current theories and models. They wouldn't have a conception of how the theories had been slowly built after laws and models had been revised and reworked so that they consistently predict the observations we make. Their experiences in the lab consisted mainly of "Collect the data. See how it fits the theory?" I needed to bring real inquiry into my classroom. At the time, I was teaching our freshman Scientific Literacy course, which was designed to review the processes of science and introduce our students to the high school lab procedures. It was an excellent opportunity to practice teaching inquiry without having to fret about covering all of the content I needed to. The content was inquiry itself! It was fun to see my students explore buoyancy and the best way to design cargo boats. And while there were many things I realized I should do differently the next time, it gave me the confidence to start reworking my physics curriculum to include more inquiry opportunities. I think more of my students (all young women) will learn to love the collaborative and creative nature of scientific inquiry, and choose to pursue scientific careers. I recently discovered the American Modeling Teachers Association, and I'm excited for the potential this holds for my classroom!

In my calculus courses, I was struggling to help students look beyond the algorithms to the meaning of it all: why the algorithms worked and what that meant about their results. Before I started the MAED program, I had introduced what I called a "research log", where I posed questions they didn't know how to solve, and asked them to "play around" until they came up with a solution. (There were some guidelines for how to "play around" with the mathematical ideas.) The first year I tried it, my students loved it. They had brilliant discussions that really chased down what it means to be tangent to a curve and how to find the slope of a tangent line. But in the following years, my students struggled to do anything with the questions. They weren't interested in figuring it out for themselves. I thought it might be because they weren't as strong of problem solvers as that first class had been. So when we were introduced to action research in TE 855: Teaching School Mathematics, it was natural for me to explore how my open ended questions were helping my students improve their problem solving skills. The results were not what I had hoped they would be, as my students seemed to be getting worse over time. By the end of the action research project, and the class, I decided that I needed to restructure the questions and provide better scaffolding to my students. The next year, I cut back on the questions, and focused on just a few. I used heavily guided inquiry instead of open inquiry, and while my students were more successful in answering the questions, it still wasn't what I was looking for.

Oddly enough, this is where CEP 820: Teaching Students Online really helped me. When I was asked to choose a unit to reimagine as part of a hybrid course, I chose the one that had included the most difficult open-ended questions. Each week, as we moved through different aspects of good online course design, I slowly figured out how I might use online journals coupled with class discussion to ease students into exploring those important questions in a way where the stakes didn't feel as high as they had to students in the past. By the time the hybrid unit was finished, we'd already moved past it in my classroom, but I'm excited to use it in the coming year. I want to see what works well and what doesn't, so that I can both improve that unit for the year after and expand what I've created into an entire hybrid course. I have a lot more confidence in using Moodle (or any learning management system, really) to support my work in the classroom. There was so much to designing an online course that aligned with what I knew about designing a face-to-face course that I don't know why I was so scared to try it before. I hadn't even considered Moodle as a possible solution to my trouble with using open ended questions because of that fear. Now I can see it as an important extension of my classroom.

Learning to incorporate Moodle is only a small part of what I learned about incorporating technology into my teaching. Moodle extends my classroom, but by itself, it doesn't expand my curriculum. When I started grad school, I knew that I needed to learn to use technology to give my students more and, more importantly, better opportunities to learn. I really didn't want to use the newest Web 2.0 tool just because it was new and shiny. I needed to have a real reason to use it in my classroom, and I needed to learn how to evaluate tools like that for their usefulness to the curriculum. CEP 805: Learning Mathematics with Technology was extremely helpful with that. I might have been frustrated that the example tools we explored in class were for lower levels of mathematics, but I learned a lot about what questions I needed to ask myself when evaluating those tools and what answers meant that it was a meaningful tool to be using. Building my own resource library allowed me to evaluate on- and offline tools I had been using, as well as making me find new, and sometimes better, alternatives. It's great to have the options, because I can go through my library again when we're getting stuck in class to find a tool that can help us. I'm proud of what I've put together, because I know I was looking for something like this library when I first started teaching calculus. I hope somebody out there has found it and can make use of what's there.

All in all, I've come a long way in the past three years. I have concrete ideas for how to achieve my goals. I will be incorporating more inquiry projects and labs into my physics courses, possibly by pursuing modeling instruction. Using Moodle in a hybrid course setting will provide a way to better support my students' mathematical explorations, so that they can see where the algorithms we use come from. I know how to evaluate technology tools for use in my classroom. And for all that I want to do, I have research that backs me up. I've gained an appreciation for all of the articles and texts I've read, and I've started a list of what to read next. I've performed action research in my classroom and written case studies of students, and while I may not formally do either ever again, the habits of thought are there to be developed and practiced when I evaluate my teaching and my students' learning. Like I said before, there is always more to learn, more practice to be done and more things to master. I am a perpetual student.

-Katrina Hamilton