At UCLA, I have taught in first year calculus classes, advanced undergraduate, graduate, and programming courses, and I was a recipient of UCLA’s 2015 Departmental Teaching Award. I have also taught in the Young Scholars program at the University of Chicago (a math program for advanced middle and high school students targeting students in Chicago Public Schools) and the engineering department’s Center for Excellence in Engineering and Diversity at UCLA (a program to help students from underrepresented groups transition into college classes). I am particularly interested in getting women and other underrepresented groups more active and interested in math.

When I teach, my primary goal is to train students to be independent thinkers and problem solvers, skills that they will carry with them beyond my class. I accomplish this using methods that I first learned through Inquiry-Based Learning (IBL) and have since refined into my own teaching style, implementing some of the fundamental ideas of IBL in a traditional lecture setting. My process is effective for working with advanced students as well as students who struggle, as the pace can be adjusted according to the students’ needs.

I first encountered IBL as an undergraduate at the University of Chicago, where I used this method as a teaching assistant for Calculus and while working in the Young Scholars Program. Inquiry-Based Learning is a student-centered approach to teaching that focuses on the process of discovering mathematics. This is in contrast to traditional lecture-based instruction, in which students learn to imitate and repeat methods that have been presented to them. In an IBL class, students are presented with problems and questions that guide their learning, and they learn mathematics by investigating these questions. The class is focused on the interaction between the students and the subject, rather than on the instructor reciting information. IBL has proven to be particularly effective at teaching thinking and problem solving, as well as increasing students’ interest and excitement in mathematics. [1] [2]

I saw how IBL teaching impacted students while working in the Young Scholars Program at the University of Chicago. In the summer program for 11th and 12th grade students, we worked through some abstract algebra and field theory, utilizing the IBL method. I volunteered to take the small group of students who had scored lowest on the diagnostic exam we gave at the beginning of the program. The first week was very difficult. My students struggled with basic computations, were intimidated by the difficult material, and were reluctant to participate or talk at all. At the beginning, I provided them with constant guidance, asking them easy questions that I knew they could answer in order to build their confidence. As they became more engaged, I asked them more difficult questions, and left more of the work and direction up to them. By the end of the program, they were running the group themselves, constantly discussing how to proceed and teaching each other the material. The following summer, everyone in that group returned to the program and tested in the top half on the diagnostic exam. One of those students recently started graduate school in math.

Since then, I have adapted the principles of IBL to a more traditional, lecture-based setting. This has been necessary since class sizes at UCLA are too large for a pure IBL class to be feasible. When giving a lecture, I imitate the structure of an IBL class. I begin with a question or a problem that we would like to solve. I work through the process of discovering the answer to that question, keeping students active and engaged by regularly asking questions. For example, in a lecture on the Intermediate Value Theorem, I start with the question “Is there a solution to $x^3 + 2x + 1 = 0$?” Then, I start to talk through the intuitive process for answering this question. First, we can’t solve it algebraically because we don’t know how to factor $x^3 + 2x + 1$. Next, we graph $f(x) = x^3 + 2x + 1$, and we see that there should be a solution, close to $x = -0.5$. How can we see that there’s a solution there? Well, plugging in values, we see there are negative outputs and positive outputs, and in order to get between those, we have to pass through the $x$-axis, so there has to be a solution. Why
do we have to pass through the $x$-axis? I have to draw the graph without lifting the chalk, since $f(x)$ is a continuous function. So we want to believe that if a function is negative at one point, positive at a second point, and continuous between them, then there is a point where the function is 0 (I draw a picture here). At this point, I state the Intermediate Value Theorem, draw a graph to illustrate it, and explain how it solves our problem. Since this is for a first year Calculus course, I do not prove the Theorem, but I explain why we should believe it’s true: our intuitive understanding of a function being continuous is that we can draw the graph without lifting the chalk. So, if we’re drawing a graph between two points, eventually we have to pass through every value in between. At this point, I note that the Intermediate Value Theorem tells us that a solution exists, but it doesn’t tell us much about what it is. So now our question is: can we at least approximate this solution? Well, we already know there is a solution to $x^3 + 2x + 1 = 0$ between $x = -1$ and $x = 0$, so that’s a start. How can we narrow that down further? I demonstrate how we can repeatedly apply the Intermediate Value Theorem using the Bisection Method in order to approximate the solution, drawing a very large graph that I gradually break up into smaller and smaller intervals. By developing the Intermediate Value Theorem and the Bisection Method in this highly motivated way, students understand the power and context of the Theorem. Because they understand the context, this approach makes the material more manageable. According to my student evaluations, I am “great at explaining the concepts” and have “made complicated calculus seem really simple and doable.”

When helping students with problems in office hours, I slowly guide them rather than just showing them how to proceed, asking them, “What do you think we should do next?” or “What does this remind you of?” This approach is closely tied to my experience with IBL, and I’ve incorporated that idea of letting students take charge in my one-on-one interactions with them. I’ll often start out guiding them very closely and carefully, intervening often. Then, as they gain confidence and understanding, I back off and allow them to take charge of solving problems. As one of my students wrote in evaluations, “she guides me to the answer instead of just showing me the answer, which greatly aids in my learning progress.”

I have found that my focus on gradually building confidence and independence is particularly effective at reaching students who have had bad experiences with math, or have otherwise been intimidated by math. This is excellent for engaging students from underrepresented groups, who might feel isolated. I maintain a friendly attitude and calm demeanor, which make them feel comfortable participating in class. I make a point of never appearing frustrated or dismissive in order to avoid shutting down students. I try to understand how the students are thinking, and use this to inform my teaching. When students are frustrated, I acknowledge their feelings and keep them engaged and working toward understanding the material. I remain open and engaged, and try to explain things in multiple ways. For students who feel insecure about math, this is very effective at building their confidence and getting them interested and even excited about the material.

By utilizing the principles of Inquiry-Based Learning and training my students to be independent problem solvers, I teach them valuable skills that benefit them beyond math. They leave my class with more confidence and a better understanding of the mathematical process, which prepares them to face future challenges. I look forward to further refining my teaching strategies and finding additional ways to teach my students to be independent thinkers.

References

Colorado University (2011).