An Interview with Jeff Mcguirk, College of Engineering

2017 recipient of a High Impact Teaching Practices Grant

1) In your own words, briefly describe some of the characteristics of collaborative learning. What does your collaborative learning look like in your MAE 9110 Advanced Mechetronics course?

When MAE 9110 Advanced Mechetronics was first offered, it was a combination of lectures and laboratory exercises. For a 30-lesson semester, there were approximately 18 lectures and 12 dedicated days in the lab. The lectures were done in a fairly standard academic fashion. The laboratories were designed to incorporate collaborative learning. A typical engineering lab has a number of students and either an instructor or teaching assistant (TA) that serves to answer questions and provide help to the students. Students can work either in teams or individually in these labs. In theory, this is a fine way to do things—students work on the labs, get stuck, ask the instructor/TA for help, and then continue. However, due to time constraints and growing section sizes, I found that is not what happens. What happens is rather than the students learning the lab, in many instances the instructor/TA simply shows them how to do something without allowing the students a good amount of time to struggle and figure things out on their own, which, I believe, is when the real learning happens.

The labs in MAE 9110 fell into two different categories: 1) advanced electronic filter design (four dedicated lab days) and 2) introductory robotics and robotic manipulators (eight dedicated lab days). All the students had a prerequisite electronics class, so they had some experience with the laboratory equipment and computer software (Matlab) but were certainly not experts. None of the students had any prior experience with robotic manipulators. Thus, for the labs, they were better than novices but were starting with limited knowledge of the hardware. For each lab experience, I provided a handout that gave them some basic direction and initial help on how to get started. I then left the lab, which I typically do not do; usually, I stick around and answer questions. However, I wanted to try something different. Rather than having me around as a crutch, I allowed the students to help each other. I explained this to the students, letting them know that I could help them, but I really wanted them to first try to solve the problems on their own—not individually of course, but asking each other for advice and guidance as they progressed through the lab. Only once did I get an email, asking me to come to the lab because they could not figure something out. It turns out I had provided an incorrect statement on the lab document when they were interfacing web-cameras with Matlab for the first time. Otherwise, the students were all able to collaborate and figure out how to get rather sophisticated electronics to work with only a minimum amount of initial direction from me.

2) How did you manage the collaborative activities and project? *[How did you divide students into teams? How involved were you in the activities and project? How can you evaluate teamwork?]*

Prior to the first labs, I thought I would get pushback on how the labs were run, but I did not. Of course, it helps that all students in the class were either seniors or 5th-year seniors, and at this point in their engineering education, they should be comfortable with working large problems with a minimum amount of direction. That said, the amount of help they provided each other

was amazing. Some students quickly figured out one software package and served as mentors for the other students. Other students were excellent with some of the circuit hardware, and were able to provide help on building circuits on breadboards, things all students had done previously but had likely forgotten over time. The robotic manipulators provided the largest challenge to the student—the material in lecture was new to all of them, and none had worked with an actual robotic arm. I provided almost no oversight to the students during their lab exercises. I assigned each of them a piece of hardware, and allowed them to teach themselves and each other how to program the arms to do various functions. Evaluation of teamwork is very difficult because I had no formal graded events that the students completed as teams. However, the final project and the final take-home exams were individual efforts. These two assignments focused on the robotic manipulators, and required the students to take as inputs the location and destination of an object, and using only these inputs, the robotic arms would pick up the object and place it at the exact desired location. I am happy to say all students successfully completed the project, some better than others, but all were able to get their projects working. I provided the basic theory of robotic manipulators in the lectures. The students learned how to implement the theory in the labs, of which I had little involvement. It was all student-based collaborative learning where they acquired this practical knowledge of the hardware and software.

3) What are some general strategies to keep in mind when incorporating collaborative learning into a course?

The biggest thing I had to determine when I decided I would allow the students to be responsible for their labs was the appropriate amount of work and the level of difficulty of the material I'd expect the students to accomplish collaboratively. We must be careful in that if the level of difficulty is too extreme, no amount of collaboration can help the students. Additionally, one must know the general skill and knowledge level of the students. If you have one student that is far above the others in technical expertise, then this student could default to the instructor/TA role and simply show the other students how to do everything, which would defeat the purpose of the collaborative learning efforts.

4) What was your biggest challenge from this experience?

My biggest challenge was taking myself out of the lab. I love being in the lab with the students, I love watching them work, but I have realized I do make the mistake of hovering over them and then simply showing students how to do something if something doesn't work the first time through. In some instances, this is fine—if a student does not know how something functions on a particular piece of hardware, I could show them, and they move on with the work. However, in other instances, students could have questions on how to get the software to do certain functions (e.g. the best way to move the robot). Simply showing the students the code I developed is not, in my opinion, education, nor in the students' best long-term interests. I knew if I were in the lab, my inclination would be to help the students quickly in hopes of pushing them along. By letting them struggle, letting them figure things out in pieces and then collaborating with each other on different implementations that worked best or didn't work, I believe the students learned far more than if I had quickly helped them with an instructor solution. Hearing the students, talk about their struggles was hard for me, but I held back my urge to point them in the right direction. I let them struggle.

5) What did you gain from the teaching experience?

I learned a lesson I learned as a parent—sometimes you have to let the students (your kids) struggle and even fail if you want them to really develop. I knew this before I taught this class, but I never really would let students struggle as much as I did in this course. I have always been afraid they would get frustrated and give up, which was definitely not the case. However, as I said before, a big reason for the success of this course was the maturity level of the students. I do not know if I could expect first-year engineering students to go through the number of struggles my students did in MAE 9110. Then again, I am so pleased with the results; I might have to consider how I teach my lower-level courses.

6) What do you think your students gained from the experience?

I have yet to see the FCQs for this course. However, I have received feedback from all the students. In short, they really enjoyed the course. This should not be a surprise because the course was offered as a technical elective for the students, so the students that signed up for the course did so because they were interested in the material. However, here are two unsolicited emails from the students.

This was one of the hardest classes that I have ever taken, but I really enjoyed that because I learned so much. It was hard, but not TOO hard, I just had to put a lot of work into it. It was a challenge and I love that.

Thank you for a great opportunity, I had a lot of fun with Louisa.

I must point out “Louisa” is the name this particular student gave to his robotic manipulator.

I believe these engineering students learned they can solve problems without an instructor hovering over them. They are smart kids, err, young adults, and I’m really proud of what they accomplished.