Six Questions for Dr. John Adams, Senior Instructor
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1. **Your project description for the High Impact Teaching Practices grant was very complex and highly descriptive – can you break it down in lay terms for non-engineers to understand?**

   Many systems around us have a natural frequency. When you strike a bell or pluck a guitar string, they oscillate at their natural frequency. Mechanical and electronic systems have some similar natural frequencies. If we attempt to shake a system, we find that it can be difficult to do unless we actually shake the system at its natural frequency. But, when we do so, we find we can generate a lot of motion. This is called resonance. In electronics, when you tune your radio, you are changing its natural frequency until it resonates with the radio station you want. If a mechanical system resonates (such as a wing resonating with vibrations caused by turbulence), then a lot of damage can be caused.

   With the FRC grant, an apparatus has been created to allow students to observe and measure the motion of a simple system as the driving frequency is increased from a slow shaking to a fast shaking, with resonance somewhere in the middle. The purpose was to be able to confirm experimentally (both visually and with data) the theory covered in class.

2. **After your implementation, how successful would you say the high impact teaching practices were in your course?**

   I'd say it is mixed. Students were all very satisfied that the experiment reproduced the expected motion. Visually, students were able to confirm the theory and have a better understanding of the mechanisms through which resonance is established. Since that was a significant objective, I'm quite happy with the results. Students, on the other hand, had difficulty obtaining meaningful data and were left a little disappointed. Some modifications need to be made to the case of the system to allow it to be clamped down more firmly. The small vibrating system is able to shake the entire experiment (as well as someone sitting on it!)

   A major outcome of the project was to see if the theory presented in class could accurately describe the experimental results. To begin the collaborative learning process, first, in groups of two, the students worked together to obtain experimental results using the apparatus. They then plotted the results obtained and compared the shape of the data with theoretical results. If done correctly, their data would match the theory, and they could then go on to extract some physical parameters, such as spring constants.

The large amount of experimental and theoretical work involved in this project required students to also work collaboratively to complete the project. They were required to write a report containing not only their data, but their observations and physical interpretation of the data. It is hoped that the discussions involved in writing this report improved the students' understanding of not only the experimental methods and math involved, but also the physics and mechanisms behind the vibrations observed. In this way, the sharing of ideas through their collaboration was utilized to improve students' achievement in an area both myself and past students had identified weakness in the past.

3. What would you say is the primary learning outcome for your learners as a result of implementing this high impact teaching practice?

A clearer, physical understanding of the plot of displacement versus driving frequency for an oscillating system. I had found that students could create this plot from theory, but often lacked the physical insight to justify why the plot made sense.

4. If you had it to do over, what might you do differently the next time for this course?

Make the primary learning outcome clearer in the project instructions, and ensure instructions more clearly emphasize the need for physical interpretation of data. And, reduce the amount of data required to be taken but insist on greater time being spent on obtaining that data.

Engineering students can become fixated on crunching numbers and generating plots. The main reason for pursuing this FRC grant was to provide students with the opportunity to see a system in action and observe how its motion changed as the driving frequency changed (some qualitative data to complement all the quantitative information from class). But, once they got into the lab, the students quickly forgot to just stop and look, focusing instead on obtaining numerical data.

5. What advice do you have for your colleagues that may be considering this grant in the future?

a. Listen to your students. The idea for this grant was generated during a discussion with one of our top seniors.
b. Discuss the idea with your colleagues. Make sure your approach will not be overly complicated to implement or for the students to grasp.
c. Have a very clear, single learning objective to focus on and ensure there is a measurable outcome to determine effectiveness.

6. **Do you have anything else that you'd like to share with your colleagues about your experience?**

   I had a very small class this year (9 students, I normally have 20+). The class also has a very bimodal talent distribution. So, it has been difficult to draw meaningful conclusions from the data coming back. I will run this course again in Spring 2020 and will hopefully obtain more data. I will also try to use the apparatus in MAE3401 if I am teaching that in Fall 2019. (I am taking leave for the academic year 2018/2019).

   In general, students have provided positive feedback on the equipment in terms of being able to see the vibrations. The chance to observe a system rather than simply modelling it mathematically has been missing in courses of this nature. Students have been less enthusiastic about the data, but I shall work this summer to improve the equipment to ensure better data can be obtained more easily. I was able to obtain satisfactory data, but I don't think students allocated the time that I did.