

Developing Concrete Examples of Mathematics by Forming a Multidisciplinary Learning Community

Rationale: At Rose State College, we all wish to provide support to all of our students. As a two-year community college, we believe we can nurture every student who comes to us with any educational background. We observe wide variation in the preparedness and proficiency of the students in all of our mathematics courses, but this is especially true in our calculus courses. We wanted to challenge and engage calculus students of all levels of preparedness and proficiency by using a concrete example.

Pedagogical Issue: Concrete examples of mathematical applications can improve student success in any math course. The abstract nature of these courses will often frustrate and discourage students, but concrete examples can alleviate some of this frustration by linking the abstract theory directly to real world applications. The challenge: with heavy course loads, how does a single instructor effectively research a new theory or application (which may be well outside of the instructor's expertise), synthesize the theory to an appropriate level of simplicity and thoroughness, and develop a concrete example?

Idea: The concrete example chosen for this idea is the Mathematics of Unmanned Aerial Vehicles, UAV's. This idea stemmed from a project funded by the National Science Foundation (NSF). The project is a collaborative effort between Rose State College and The University of Oklahoma to increase UAV competency within our engineering and technology students. One of several goals for the NSF funded project is to integrate UAV theory into mathematics courses taken by engineering and technology students. This created another challenge; our calculus faculty were unfamiliar with the theory associated with UAV's, or drones as they are more commonly known.

To meet this challenge, Professor Steven Fowler, Principal Investigator for the NSF project, formed a multidisciplinary learning community consisting of faculty and staff from physics, math, and engineering at Rose State College. Collaborating faculty and graduate students from the University of Oklahoma's Aerospace Engineering Program were also included in the learning community. Through the efforts of the learning community, the following strategy was developed:

- 1) Identify and recruit current students who show a proficiency in Calculus to enroll in a Special Topics class: The Mathematics of Drones
- 2) Using the Special Topics course as a "sandbox", refine concrete examples to a level appropriate for calculus students of all levels of proficiency
- 3) Utilize concrete examples in future calculus courses to improve student retention, understanding, and proficiency.

Dr. Chuang Shao, a Mathematics Professor and member of the learning community, volunteered to identify and recruit a group of five students to enroll in a one-hour Special Topics course. These students had successfully completed at least 6 hours of the 12-hour calculus sequence and had shown prior proficiency in their Calculus course work. Dr. Shao also volunteered to serve as the instructor for the course.

We invited Dr. Andrea L'Afflitto and his graduate students from The University of Oklahoma's Aerospace Engineering Program to give a seminar on our campus and share their UAV based research projects with all Rose State students. After the seminar, our Special Topics students discussed their UAV interests. Based on

their discussion, we identified the following drone projects for further exploration in the hopes of developing concrete examples for use in future Calculus classes:

Topic	One Dimension	Two Dimensions	Three Dimensions
Description	Consider the straight-line flight of a drone. Students fly drones in a linear direction. Students collect data and find average velocity of the drone.	Consider the mathematics and physics involved for a drone to fly in a uniform circle. Students flew a drone in the Rose State gymnasium in a circular path. Videos were recorded for later analysis.	Consider the flight of a drone between two locations, Points A and B. Discuss the mathematics and physics involved with this flight. Students fly a drone between two points and measure data for comparison.
Result	Implemented as a Physics I laboratory exercise.	Results are being discussed and analyzed for development of a concrete example for future Calculus courses.	The semester completed before we were able to explore the three-dimension example further.

The Special Topics students were allowed to work on each topic throughout the semester with Dr. Shao and other faculty serving as mentors. Faculty from math, physics, and engineering provided short lectures as necessary to provide basic knowledge for the students to sustain progress. Students were encouraged to develop their own questions and concepts to explore. Faculty would then help refine concepts. Progress was reviewed on a weekly basis, and students submitted a project report at the end of the semester. Some students were able to use the course in conjunction with honors credit, and one project was selected to be presented in the Great Plains Honor Conference in spring 2019.

Impact on Faculty and Institutional Program: As faculty members, it was a great pleasure to have such an opportunity to enrich our students and help them to realize the beauty of science. When we were mentoring and helping the students with their projects, we were also learning from their struggles. This gave us more ideas about how to develop concrete examples for calculus and many other math, engineering, and science courses.

Impact on Students: Through this experimental practice, students experienced productive struggles. However, all of the students indicated this Special Topics course was a unique and fun college experience. It provided a deeper level of math and science understanding, and it has been a great application of the growth mindset. At the end of the semester, as they looked back, they were truly learning how to do research in math and science and how to start and accomplish their own projects. Students were able to transfer to Universities to continue their studies; one of the participants received undergraduate admission to UC Berkley.

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