The Efficacy of Modeling with Technology
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In the Last Century:

We started integrating technology into our Calculus sequence

- We happened to use Maple.
- We scheduled the Calculus class in the computer lab one day a week and in the classroom three days a week.
- There was some push back from faculty but it became a department policy to use technology in the Calculus sequence.
The Labs

- We tried to create an investigative atmosphere.
- The labs were not open ended questions.
- But we encouraged experimentation with technology.
- We encouraged group work.
- We encouraged speaking Mathematics.
We kept repeating the following:

- Do not touch your partners keyboard.
- Ask your partner or your neighbor before you ask me.
- What are you trying to do?
- Does that make sense?
- Speak math!
- What do you think?
- Graph it.
- What do you think should happen?
When we found SIMIODE it was a natural next step:

- Introduce modeling into the Differential Equations course.
- Introduce technology into the Differential Equations course.
We started slowly

- Tried the M and Ms Scenario
- Tried the Spread of a Cold Scenario
- Tried the Ant Tunneling Scenario
- Tried the Oil Slick Scenario
Then COVID hit

- It would have been easier to go back to the cook book version of the course.
  - We capitalized on the breakout rooms.
  - We convinced the school to set it up so students had access to MAPLE from home.
  - We made videos showing the techniques.
  - We tweaked scenarios so that variable names aligned with the textbook and videos.
Logistics of the Virtual Lab

- Used our own videos to show techniques to solve Differential Equations! But we do not consider this to be a flipped classroom.
- The videos leave them with more time to think and discuss about how to solve a problem in the breakout rooms.
- Using technology allows them to solve "messy" differential equations, ones that would be hard or impossible to solve by the methods in the course.
- Drop in and out of the breakout rooms to listen to their thoughts.
- Have them come back from breakout sessions and have a conversation on where each group is. Encourage verbalization and conjectures.
- Have them try their solutions and see if they make sense.
Logistics of the Lab continued

- Use the computer to solve the DE.
- Use the computer to visualize. Does it make sense?
- Verbalize what the graph means in terms of the problem?

All of these items are easily transferable back to a face-to-face classroom.
Group Work

- Groups of three were randomly chosen.
- Jumped in and out of groups.
- Zoom allowed students to summon teacher for questions.
- Students actually seemed to be more vocal in online groups than in person.
- Reporter: one student to give a brief oral report at end of the class.
- Scribe: one student to submit a brief written report to Moodle. For example:
  - Construct a specific model for spread of Ebola
  - Interpret and verify the model
  - Reflect

Again, all of these items are easily transferable back to a face-to-face classroom.
Some Scenarios we Used

- M and Ms
- Spread of the Cold in English Boarding School
- Car Suspension
- Ant Tunneling
- Inner Ear Drug Delivery
- Tank Interrupt
- Spread of Ebola in East Africa
Assessment

- Group work: They worked in class on a scenario and handed in a group project.
- They were given an out of class scenario to do independently.
- This had to be written up and submitted.
- There was a question on each exam on the scenarios.
- The last scenario was part of their final assessment. Each student was interviewed to speak about how they approached and solved the scenario.
- The oral interview was part of assessment and in the time of COVID it was just wonderful to speak to each student. I would continue this in face to face.
Example of one topic

- In class scenario: Two Tank Problem A and B : Water Tanks (Brian Winkel (2016), ”1-052-T-SaltWaterTanks,” https://www.simiode.org/resources/3160.)
- Video on Using the Integrating Factor to solve first order linear DE
- Online homework on the technique
- Question on exam
- Interview
A large tank contains 30 liters of water in which 7 grams of chlorine are dissolved. Chlorine water with a concentration of 2 grams of chlorine per liter is pumped into the tank at a rate of 4 liters per minute. The well mixed solution is pumped out at the rate of 2 liters per minute. Find the amount of grams of chlorine at time t. Use C(t) for the amount of Chlorine in the tank at t minutes. ONLY set up the differential equation that you would use to solve this equation. DO NOT SOLVE Include all labels: liters, grams and minutes.
What did you think of the scenarios?
Were you better at the scenarios as the semester went on?
What did you think of the group break out sessions?
Did you prefer group work or working independently?
What we could tell from the Exams

- Students performed as well on the traditional exams as the students before who did not have the modeling approach.
What we could tell from the interviews

- The interviews indicated that the students were challenged by the scenarios.
- The students like "real life" problems with which they can identify.
- Many students felt that this was the first course where they saw mathematics really "used".
Example of Another topic

- In class scenario: Spring Mass Problem
- Video on Using the General Technique to solve second order DE
- Online homework on the technique
- Independent scenario: Car Suspension
- Question on exam
Thanks for Listening!

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