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
- Independent scenario: Inner Ear Drug Delivery : Inner Ear Drug Delivery (Jue Wang (2018), "1-138-T-InnerEarDrugDelivery," https://www.simiode.org/resources/5069.)
- Question on exam
- Interview

Exam Question

- 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.

Interview: questions to just get them talking

- 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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