Fired Up to Take Online Teaching Innovations Back to the Classroom!

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Chandler-Gilbert Community College
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S095
I have been teaching at Chandler-Gilbert Community College for 24 years and have been involved in mathematics education for 34 years! In addition to teaching students, I love the opportunity to create new, engaging, challenging, experiences that causes cognitive dissonance for teachers...with the goal that this will lead to an improved teaching and learning experience for all students!
After a year of transitioning to asynchronous, online instruction, it’s time to think about how this work can be leveraged in the return to face-to-face instruction. In this session, we will discuss the innovative, online pedagogical strategies that supported student learning that can also be effective in the face-to-face environment.
Vexing Questions...

Now that students have access to a fully developed online resource, what do I do in the classroom?

Is the classroom experience just an inferior version of what students have been experiencing in their online classes?
Vexing Questions...

We now know that much of the problem rests with an outdated mode of instruction, a lecture format in which students are reduced to scribes.

- David Bressoud (2018)
Vexing Questions...

Now that students have access to a fully developed online resource, what do I do in the classroom?

Is the classroom experience just an inferior version of what students have been experiencing in their online classes?

How do I compete with student level of comfort in staying home and learning from online resources?

What content do I really want students to learn?

How do I want them to learn it?

How do I take the best from the online resources and combine with the best from face-to-face experience?
Some things work better online!

Assumption: Students are consuming the online content as intended and with fidelity.
Reflection

We do not learn from experience...
We learn from reflecting on experience.

- John Dewey
Exam Debrief/Reflection

Suppose you are arriving at the security checkpoint at Denver International Airport. Suppose that, on average, the initial TSA official can confirm the ID of a traveler at a constant rate of 0.75 minutes per person. That is, imagine the TSA official sitting at the podium whose responsibility is to check the ID of travelers. They are able to process people in line at a constant rate of 0.75 minutes per person (on average). Keep in mind…sometimes families traveling together all go through together and sometimes the next person in line has to wait several minutes. The 0.75 minutes per person is an average rate

7. Write an integral that can be used to estimate how many people are in front of you in your particular line if it took 33 minutes for you to reach the front of the line and to show your ID to the first TSA official sitting at the podium. Hint: sketch a graph to represent the situation. (10 points)

Note: it is fully acknowledged that integral calculus is not required respond to this situation. Rather, the goal is to assess how well you understand the idea of the integral and the structure of an integral.
Anticipating Student Thinking...

\[ \int_0^P 0.75 \, dp = 33 \text{ minutes} \]

\[ \int_0^{33} \frac{4}{3} \, dt = P \text{ people} \]
<table>
<thead>
<tr>
<th>Question 5</th>
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**Exam Debrief/Reflection**

Suppose you are arriving at the security checkpoint at Denver International Airport. Suppose that, on average, the initial TSA official can confirm the ID of a traveler at a constant rate of 0.75 minutes per person. That is, imagine the TSA official sitting at the podium whose responsibility is to check the ID of travelers. They are able to process people in line at a constant rate of 0.75 minutes per person (on average). Time is valued... sometimes families traveling together all go through together and sometimes the next person in line has to wait several minutes. The 0.75 minutes per person is an average rate.

10. Write an integral that can be used to estimate how many people are in front of you in your particular line if it took 22 minutes for you to reach the front of the line and to show your ID to the first TSA official sitting at the podium.Hint: sketch a graph to represent the situation. (10 points)

Note: it is fully acknowledged that integral calculus is not required respond to this situation. Rather, the goal is to assess how well you understand the idea of the integral and the structure of an integral.
Exam Debrief/Reflection

I definitely learned that I need to analyze the problem better before jumping into any calculations. I was a victim of self-fulfilling prophecy. I expected it to be more difficult so I made it more difficult. These are all concepts that I know already. I appreciate the video and will slow down and think in the future.
Exam Debrief/Reflection

While I was watching this video I was able to learn that when we make a graph for this problem we are able to see that the 0.75 min/person is a constant rate on the graph and our x-axis would represent the number of people. The reason we have our graph like this is that when we construct an integral we get \( \int 0.75 \, dx = 33 \) which makes sense knowing that min/person * person will equal time. Once we find this integral we can solve for the number of people by finding the antiderivative of 0.75 which is 0.75x and now our integral is from 0 to x. Now we can do FOTC which would be 0.75x - 0.75(0) = 33 and once we do all the calculations we get x to equal 44 people. The video was able to show me how to efficiently think of what we needed for our graph based on what information we had.
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Reflection

Consider the following 7 questions. **Choose 1...YES...choose just 1...** and write a substantive, reflective response. Substantive and reflective does not mean long and full of stuff you made up just to make it look "substantive and reflective." Rather, it means that it contains your true ideas and is based upon the learning experience you have had so far in this course.

There is no length requirement. Just post your honest, reflective, substantive ideas about the question you chose.

https://www.francissu.com/post/7-exam-questions-for-a-pandemic-or-any-other-time
Reflection

Persistence:
Take one problem from Exam #1 that you struggled to understand and solve, and explain how the struggle itself was valuable.

Curiosity:
What mathematical ideas are you curious to know more about as a result of taking this class and/or experiencing this exam?

Imagination:
How has your mathematical imagination been enhanced as a result of taking this class and/or experiencing this exam?

https://www.francissu.com/post/7-exam-questions-for-a-pandemic-or-any-other-time
Reflection

Disposition toward beauty:
Consider one mathematical idea from the course and/or exam that you have found beautiful, and explain why it is beautiful to you.

Creativity:
Give one example of a mathematical idea from this class and/or exam that you found creative, and explain what you find creative about it.

https://www.francissu.com/post/7-exam-questions-for-a-pandemic-or-any-other-time
Reflection

**Strategization:**
For any problems you cannot solve on this exam, suggest a strategy you might try to tackle the problem, and show what happened as a result.

**Thinking for Oneself:**
Based on the experience of taking this exam, describe how you have grown in the area of "thinking for oneself" or describe how you think you may need to improve in the area of "thinking for oneself."

https://www.francissu.com/post/7-exam-questions-for-a-pandemic-or-any-other-time
Reflection

Creativity:
One mathematical idea from this class I found to be creative was based on the previous exam we took. On question 7 we were told the hint of constructing a graph to help us think of an integral that would be estimating how many people are in front of you in line knowing the average rate and the time. I thought this question was all about being creative since we as the learner had to create this graph based on our knowledge of the information we were given to help us solve the problem. I thought this question was challenging in certain ways, but also different compared to others since it made us think of what we needed to construct in order for us to solve the question that was asked. Also when watching the review video on this question I was even more sure that this question really wanted us to use our creative minds to develop a graph that could potentially help us solve what was needed. This is what I thought was creative in this class so far.
Reflection

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Reflection

Persistence:

I chose this reflection task because as I was trying to complete this problem, I was frustrated at why it didn't make sense to me. Although I know how to write an integral and what each part of it means I couldn't understand where the 33 minutes went on the integral and the graph. I know that $f(x)$ has to be a rate of change so I know 0.75 minutes per person was placed as the function $f(x)$. I knew I needed to estimate how many people were in front of me if it took 33 minutes to get to TSA, so that means the interval $[a,b]$ must be persons. Since I don't know how many people were in front of me, variable $b$ would be $x$ and variable $a$ would be 0. $dx$ is the small changes of people that are in front of me so that it sums up to 33 minutes. So the integral would look like this $\int x0.75 \, dt = 33$. Now to find how many people there was in front of me after it took 33 minutes to reach TSA we can evaluate $F(b)-F(a)=33$ minutes. 0.75x is the antiderivative so we now plug in our values: $0.75(x)-0.75(0)=33$. We now have $0.75(x)=33$ since $0.75(0)$ equals 0 and we find $x$ by dividing 0.75 on both sides which now $x$ equals 44 people.
Reflection

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Reflection

Disposition

Toward

Beauty

One mathematical idea from MAT231 that I found beautiful was the implication of real-world problems to the Fundamental Theorem of Calculus. Why this is beautiful to me is because before understanding what the Fundamental Theorem of Calculus meant, I always had the thought in my mindset of how this could be applied to any form of communication. However, Professor Adamson and with the work of his modules and videos, I was able to grasp a greater knowledge on this understanding specifically in the area of $F(b) - F(a)$ and how it translates to the definite integral of $f(x) \, dx$.

First and foremost, I was able to actively engage in class on how this function is broken apart to deeper meanings. For example, I learned that $\int_a^b f(x) \, dx$ is summing up between two points on our x-axis. We could relate a scenario to this by exemplifying "the total distance travelled between 2 seconds and 5 seconds". In this scenario of what I'm mathematically trying to explain, we can call our two points b and a, a being our starting point and b being our finishing point. We could then re-word the definite integral as "From 2(a) seconds to 5(b) seconds...the total distance($F(b) - F(a)$) travelled is...".

With this being said, we're able to relate our $\int_a^b f(x) \, dx = F(b) - F(a)$ to real world scenarios. Our $f(x)$ would be our given function (Ex. feet per second), and our $dx$ would be our change in x. (Ex. Change in Feet). To sum it all up, this is beautiful to me because it was a complex formula to me at first until I was able to imagine and connect with real world problems due to the help of the class learning environment and my own knowledge.
Reflection

Disposition
Toward
Beauty

With this being said, we're able to relate our \( \int_a^b f(x) \, dx = F(b) - F(a) \) to real world scenarios. Our \( f(x) \) would be our given function (Ex. feet per second), and our \( dx \) would be our change in \( x \). (Ex. Change in Feet). To sum it all up, this is beautiful to me because it was a complex formula to me at first until I was able to imagine and connect with real world problems due to the help of the class learning environment and my own knowledge.
Some things work better online!

Assumption: Students are consuming the online content as intended and with fidelity.
Some things work better in person!

Assumption: Students are actively engaged in thinking about mathematical ideas.
A Hero’s Journey

Source: makemathmoments.com
Kyle Pearce and Jon Orr
The Hero’s Journey
Traditional Math Class
Traditional Math Class

Source: makemathmoments.com
Kyle Pearce and Jon Orr
STUDENTS SHOULD FEEL THE NEED FOR MATH
PRODUCTIVE STRUGGLE WITH INQUIRY

Discovery, reveal of math rules, formulas, strategies
Act 1

What do you notice? What do you wonder?

Source: Jon Orr - http://mrorr-isageek.com/smartcar-smash/
Act 1

How many birds would it take?

Source: Jon Orr - http://mrorr-isageek.com/smartcar-smash/
High Ceiling

Frustrated, intimidated, unable to start

High Floor

Plan for your highest-ability students first, then figure out how to onboard your other learners.
Act 2

What information would you need to answer the question?
• What kind of bird?
• Average bird crap size?
• Strength of car?
Act 2

Smart’s tridion safety cell can withstand up to 9000lbs
10 bird craps weigh = 0.02lbs
Act 2

What if???

• 10 turkey craps weigh 0.25 lbs.
• 10 emu craps weigh 2 pounds.
• You were hit in the head? How much could your skull endure?
weight of bird crap required to damage smart’s tridion safety cell

4,500,000 pigeon craps

360,000 turkey craps

45,000 emu craps

one bird (鸾) = 10,000 craps

* smart’s tridion safety cell can withstand up to 9,000 lbs. of pressure.
† Figures are estimated and may not be exact. But they’re not totally full of crap, either.
Proportional Relationships

In this situation, is anything proportional to anything else?

What does “proportional to” mean in general?
Proportional Relationships

Proportional relationships require two covarying quantities. Those quantities must be measurable in some way, and the measures of those quantities scale in tandem. When one quantity changes by a scale factor, the other quantity also changes by the same scale factor.

Students should have ways of thinking that allow them to distinguish the two varying quantities in any proportional relationship and to explain how the quantities change by the same scale factor.

https://youtu.be/ZDvnbfSAMJQ
Important Questions:

• Who is doing the thinking?
• With whom is the thinking being done?
• Where is the thinking being done?
• How is the thinking being recorded?
1. Begin with a Problem
   - Give a problem-solving task.
   - To start:
     - Problems should be engaging
     - Problems can be curricular
     - Problems can be textbook
     - Problems promote talking
   - Later:
     - Problems should be non-curricular
     - Problems can be collaborative

2. Visibly Random Groups
   - Randomly assigned
   - Playing cards
   - Daily & in front of students
   - 2 or 3 students/group
   - Sit & Stand together

3. Vertical NonPermanent Surfaces
   - Vertical
   - Erasable
   - Whiteboard, chalkboard, window
   - 1 marker or chalk per group
   - Promotes discussion
Addition
\[
\begin{array}{c|c}
\frac{1}{3} + \frac{1}{3} & \frac{2}{3} \\
\frac{1}{4} + \frac{1}{4} & \frac{1}{2} \\
\hline
\frac{2}{5} + \frac{1}{10} & \frac{3}{10}
\end{array}
\]

Subtraction
\[
\begin{array}{c|c}
\frac{3}{4} - \frac{1}{2} & \frac{1}{4} \\
\frac{3}{12} - \frac{5}{12} & \frac{2}{12}
\end{array}
\]

Multiplication
\[
\begin{array}{c|c}
\frac{1}{5} \times \frac{1}{9} & \frac{1}{45} \\
\frac{2}{3} \times \frac{3}{6} & \frac{1}{3}
\end{array}
\]

Division
\[
\begin{array}{c|c}
\frac{2}{3} \div \frac{1}{2} & \frac{4}{3} \\
\frac{1}{8} & \frac{1}{8}
\end{array}
\]

My goal was to run \(\frac{3}{4}\) of a mile but I got a cramp and only ran \(\frac{1}{2}\) of a mile. How short was my goal? 2? I am \(\frac{1}{4}\) way to the park and \(\frac{1}{2}\) of the way my calf cramped. Did I?
STUDENTING
Behaviours students do to...

Homework
- Graded
  - Without mimicking notes
  - Did it on their own
  - Got help
  - help to finish ≠ learning understanding
- Not graded
  - Without mimicking notes
  - Did it on their own
  - Got help

You try one
- Teacher direct instruction
  - worked example
  - now you try one

Reasoning
- Not motivated
  - disinterested
  - did not attempt
- Stalling
  - found excuses to do something other than problem
- Faking
  - pretended to do problem, but didn’t
- Mimicking
  - followed patterns & rules

Teacher
- worked example
- now you try one

Student
- worked example
- now you try one
game the system

You try one

TEACHER direct instruction

worked example

now you try one

STUDENT

Reasoning
* understood the concepts & skills
* applied w/ minimal reference to examples

Not motivated
* disinterested
* did not attempt

Stalling
* found excuses to do something other than problem

Faking
* pretended to do problem, but didn’t wait on teacher’s solution for notes

Mimicking
* followed patterns & rules
Some things work better online!

Assumption: Students are consuming the online content as intended and with fidelity.
Some things work better in person!

Assumption: Students are actively engaged in thinking about mathematical ideas.
Some things work pretty good online!

Assumption: Students are consuming the online content as intended and with fidelity.
Discussion Questions – Online...

Liv Howard
@olivia_howar dd

*discussion board posts*

Student: I love bread

Me: Joe, I agree with you! I love bread too. I liked the part when you said you loved bread. Great point!

11:32 AM · Sep 19, 2018 · Twitter for iPhone

31.9K Retweets 118.2K Likes
Give Something to Discuss!

Discussion Question #3:

You have probably heard me say..."a bazillion times"...that we are summing up infinitely many, infinitesimally thin...something or stuff. What stuff? Exactly!

For this Discussion Question, you are to ponder the philosophical question:

What is an infinitesimal quantity?

Note...I say...you are to ponder the question...and to help you ponder, you will first watch this video from Numberphile. You need to watch it all! It is about 15 minutes long...watch all of it...think about it...pause it when needed...think. See more instructions below the video.
Ok...there is lots to ponder! The philosophical and historical side of mathematics can be so interesting, deep, baffling, challenging, and fun to think about! So, let's get to it...here is your task...

Part 1

Write a substantive post (more than a few sentences) that contains any or all or other than the following ideas:

- How have you specifically seen the idea of the infinitesimal in this course? Be very detailed and specific in your explanation. That is, don't just say, "I saw it in Section 8.1."
- What aspect of the idea of the infinitesimal as described in the video do you find the most interesting, deep, baffling, challenging, and/or fun to think about? Describe this aspect and explain why you find it interesting, deep, baffling, challenging, and/or fun to think about.
- *(From The Little Book of Mathematical Principles, Theories, and Things):* The whole logical foundation of calculus was suspect and was attacked by philosophers of the time. George Berkeley (1685-1753), Bishop of Cloyne, commented in his discourse The Analyst, addressed to an infidel mathematician: "And what are these Fluxions? ... They are neither finite Quantities nor Quantities infinitely small, nor yet nothing. May we not call them the Ghost of departed Quantities?" Note that "fluxion" is what Isaac Newton called the idea of the derivative. What do you think this quote means in the context of the infinitesimal? Why do you think there was such controversy among the philosophers of this era?
Help Them to Discuss

Part 2 - Respond to others

After you post, you will be able to see the posts of others. You will need to write a response to at least two others. If you read something that makes you think, "AHA!" then tell the person what that was specifically. If you read something that makes you think, "HUH?!?!" then ask the person a question. If read something that makes you think, "That's not right!" then politely and respectfully point it out to the person.
Give Them Time to Discuss

**Deadlines**

There are two due dates for this assignment:

**Due date #1:** Your initial response the explanations must be submitted by Friday, July 9 by 11:59 pm.

**Due date #2:** Your response to at least two other students as described in the assignment must be completed by Monday, July 12 at 11:59 pm.

I am hoping that in staggering the due dates, you will have plenty of opportunity to make your own post and then have time to respond to other student’s submissions in a meaningful, substantive way.
Force Student to Collaborate
Provide Students the Opportunity to Collaborate

Collaboration

After creating your own post, commenting on the posts of others, then Part 3 kicks in...engage within your Discussion Group to create one, polished, well-communicated version of a response to the question in Part 1. That is, using the Discussion Group environment, communicate with one another to choose, adapt, combine, edit, whatever...to create the best response possible.

Once this best one is determined...someone in the group take charge and send me by email this final, group response. That is...by the deadline (see below), I should have and email from each group with the final, best response that the group has collaborated to create.
Some things work better online!

Assumption: Students are consuming the online content as intended and with fidelity.
Some things work better in person!

Assumption: Students are actively engaged in thinking about mathematical ideas.
Some things work pretty good online!

Assumption: Students are consuming the online content as intended and with fidelity.
Building community can begin online!

Assumption: Students are reviewing other posts as intended.
Math is...

This assignment is intended to have you practice scanning your multi-page written work to PDF and submitting through Canvas.

• Please write, using pen and paper, a response to the following questions. When done, scan to PDF and submit here.

• Think back to your experiences as a student learning mathematics. Briefly share a positive experience you had. Perhaps it happened in elementary school? Middle school? High school? College? What made the learning experience positive?

• Again, thinking about experiences in learning mathematics, briefly share a negative experience you had? What made the learning experience negative?

• Fill in the blank with a word or short phrase. Then, write a brief explanation for why you filled in the blank the way you did.

    Math is ____________________

When done, you should have more than 1 page so that you can scan more than one page to a single PDF document and submit here.
I absolutely loved AP Calculus in high school and it was mainly because I had a wonderful teacher named Mrs. Williamson. I was in a small religious high school growing up so my math classes had about 10 students, which was extremely helpful when learning the concepts. Mrs. Williamson was always dedicated to helping us really understand and store the information, and even noticed my ADHD before I knew what I had, and helped me develop study strategies.
2. One negative math experience I had was during my second year of community college. I was in a large class with a seat in the back and the professor moved so fast that you didn't have time to take notes before he would erase the board. I ended up dropping the class in hopes that I would get a better instructor next time.
3. Math is Fascinating.

I have always loved math and in school I would always choose to do my math homework first and let other assignments go by the wayside. I knew that I wanted my degree to involve lots of math, but I'm still deciding which math degree I want to pursue. Right now I am pursuing software engineering because it has a good mix of math and engineering, but I may switch in the future. All I know is that I love math, but I'm still not sure what career to go for with that information.
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Assumption: Students are consuming the online content as intended and with fidelity.
Building community can begin online!

Assumption: Students are reviewing other posts as intended.
Online course resources are good for everyone!

Assumption: Students are consuming the online content as intended and with fidelity.
Overall Course Design

• In person class time can be focused and deep...
• Students missing class have support and resources...
• Students can pause, rewind, fast forward videos to meet their individual learning needs...
The Best of Both Worlds?

A Line Integral Example

Before clicking play, click on the notes link below and try solving the problem on your own. When needed, play the video to get some assistance. Then pause when able to continue. Go back and forth between the video and your own work as you engage in making sense of the idea of and computations involved with line integrals.

NOTES to accompany video

Assumption: Students are consuming the online content as intended and with fidelity.
Contact Information

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getrealmath.wordpress.com

TEDx Talk – Onandaga Community College

JMM Talk – Mazes, Riddles, Zombies, and Unicorns

AMATYC Blog – Rigor

MAA Blog – Rigor

Rigor Webinar - https://amatyc.org/page/TTActiveLearningvsContent