ONLINE ACTIVITIES FOR IN-PERSON OR REMOTE MULTIVARIABLE CALCULUS COURSES

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### Outline

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Overview of Project

Task: Revise the existing participation activities for Calculus III course*

Objectives:
- Increase student collaboration.
- Increase students’ conceptual understanding.
- Improve students’ ability to articulate ideas and questions.
- Improve students’ ability to visualize curves, surfaces, and volumes in three dimensions.
- Provide immediate feedback.
- Introduce students to tools for checking work (without giving solutions).
- Be more fun and engaging!

Requirements:

<table>
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<th>Modality</th>
<th>In-person</th>
<th>Remote (synchronous)</th>
<th>Online (asynchronous)</th>
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<td>Collaboration</td>
<td>Individual</td>
<td>Group</td>
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<td>Grading</td>
<td>Completeness</td>
<td>Participation Grade (low stakes)</td>
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*Original activities developed by Michael Mikucki and Debra Carney
Example: Directional Derivatives

- See Example A in Desmos Activity
Philosophy and Approach

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New Activities:
- Minimize/eliminate computations for conceptional questions. Ask students to explain thought process.
- Provide variety of 2D and 3D visualizations.
- Uses Desmos Graphing Calculator and CalcPlot3D
- Hand over control of visualizations for exploration.
- Check answers and provide option to show answer (does not show step-by-step).
- Aesthetically pleasing! Colorful!
- Accessibly limited (remains a challenge)
Student Perspective

In Breakout Rooms:

1. Go to the example in the Desmos Activity corresponding to your breakout room (modulo 5)
2. Take a couple of minutes on your own to complete (or partially complete) the page
3. Discuss with your group
4. With one person in your group screen sharing, summarize your discussion on the last page of the activity
5. If you have time, your group can pick another example to discuss

Possible discussion questions:

- How are students engaging with the activity?
- How does this problem encourage collaborating/communication?
- How does this problem deepen conceptual understanding?
- How could this problem be a jumping off point for a more in-depth class discussion?
Hey, students!

Go to student.desmos.com and type in:

**9RF C27**

You can also share this invitation link with your students:

https://student.desmos.com/join/9RFc27

Link in Chat
(Safari might have issues)

Signing in with Google or Desmos is OPTIONAL

(Safari might have issues)
Instructor Perspective

- Use Teacher Dashboard in Desmos Activity to go over the group discussions (add screenshots below)

<table>
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<th>It allows the students to be wrong without penalty.</th>
<th>Partition of labor. Allows for visualization. Students can request a better view of the picture from the person rotating the object. Connect approximation (tangent plane) with what's actually going on. Not-so-obviously above or below. Saddle points? Leads to a discussion of generalization. Natural extensions to functions of more than two variables.</th>
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<td>Activity on shared screen facilitates collaboration.</td>
<td>Students can move items around even when they're wrong, low stakes being wrong. Activity on shared screen fosters collaboration. Need to discuss which one is wrong, it doesn't tell us which one. Could be done by a single student asynchronously as well. Ask about reasoning, would help students who don't know why decisions were made.</td>
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Instructor Perspective

Teacher Dashboard Used for
- Pacing
- Sharing Student Responses (anonymized)
- Seeing who is struggling or which problems are difficult

My Observations from In-Person Class
- Students experimented beyond the questions asked
- Questions and curiosity evolved organically
- I was able to have more level-appropriate conversations with different groups
- I could identify and approach struggling students earlier
- Students enjoyed seeing their work projected onto the board
- “Ooh’s” and “Aha’s”
Student Feedback

The following feedback was taken from the online summer course.

I am confident in my ability to visualize curves, surfaces, and volumes in three dimensions.

The Desmos activities improved my ability to visualize curves, surfaces, and volumes in three dimensions.

Did you use Desmos or CalcPlot3D outside of the Desmos activities in this class (e.g., on other assignments or in other courses)? 80% Yes, 20% No
Do you prefer online interactive activities or static paper worksheets? Please elaborate on why.

“I think there are benefits [sic] to both and ideally classes would have a mix of the two. Desmos activities really helped me visualize and get a better general sense of what was going on, but I think the paper worksheets are better for me to sit down and focus on working through all the steps of a problem.”

What do you think worked well about the Desmos activities? What did not work well?

“I enjoy the Desmos activity correct answer function and including a step-by-step in the event it was wrong would be helpful.”

“The ability to visualize graphing and the 3D objects was extremely beneficial [sic] to actually understanding the math behind it.”
Building Activities

Link to Calculus III Activities:
https://teacher.desmos.com/collection/6282a6f5831b41308d27b61e?collections=6282a86708d76f089fd965ad

Links from Desmos
Teacher Account: https://teacher.desmos.com/
CL Documentation: https://teacher.desmos.com/computation-layer/documentation#

Other Useful Links
CalcPlot3D by Paul Seeburger, Monroe Community College: https://c3d.libretexts.org/CalcPlot3D/index.html
Intro to CL by Jocelyn Dagnais: https://teacher.desmos.com/collection/5cacb59a0847cb0c70183e13
Full List of Desmos functions by u/fireflame241: https://www.desmos.com/calculator/eowjrmo0mc
Templates and Emoji by Daniel Grubbs: https://teacher.desmos.com/activitybuilder/custom/5df133cc9d323b0c7c284ff0
Sirius’ Desmos Projects: https://sirius14000.wixsite.com/desmos
Reflection and Outlook

- Overall, I was very pleased with outcomes for in-class course. Engaged students at all levels. (Slightly higher than average exam scores compared to other sections that did not use the activities.)
- Still unclear how successful it was for online students. Need to analyze the data and need more data.
- Plan to implement these activities into the curriculum for in-person classes in the spring 2023.
- Desmos activities have a lot of potential for more Active and IBL courses.
- Fantasy Projects: Make activities for Calc I and II, linear algebra.
Thanks!