Students' Voice in an Active Calculus Learning Environment: How Do Students Perceive Purposeful Design Learning Environments

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Keywords: Active Learning, Calculus, Collaborative Small Groups

Previous studies emphasized the advantages of student-centered over instructor-centered teaching and learning of Calculus (Ely, 2021). In addition, collaborative group work in calculus classrooms has been shown beneficial to meaningful student engagement with calculus problems (Hitt & Dufour, 2021) and greater students' success compared to traditional classrooms (Code et al., 2014). Yet, some studies observed students' resistance to active learning (Tharayil et al., (2018). Thus, it is important to continue investigating students' perceptions of active learning environments in Calculus courses.

This study was conducted at a four-year R1 university in the northeastern United States. Participants were students in a Calculus course, which runs in a large lecture (3 times a week) and recitation (twice a week) format. In Spring 2022, we introduced active learning into recitations and activities that focus on Scientific, Mathematical, and Metacognitive Processes (SMMPs). The students worked on SMMP activities in groups and presented their solutions in class. The recitation sections were facilitated by graduate teaching assistants and undergraduate learning assistants. At the end of the semester, we collected survey data on students' perceptions of their learning experiences in Calculus recitations. Data include surveys (n=150) with 7 Likert-scale questions and 3 open questions. We also collected students' classroom work, related home assignments and test items on the topics of SMMPs. The current analysis focuses on Students' perceptions of the active learning environment structure of the recitations and how it affected their learning experiences.

We found that 73% of the students indicated that communicating with their peers in the recitations helped them to clarify their mathematical thinking, 71% of the students stated that Calculus concepts became clearer after they heard explanations from other students in their group, 80% of the students stated that they would recommend group work for Calculus recitations to other students, and 72% of the students stated that they would like other courses to offer opportunities of group work. Student-written comments supported these results. One typical comment was: "I think that being in a group where we all have different levels of understanding or ways of understanding the class concept is helpful because it allows me to think through my thought process and explain it to my other group members."

Our results show that most students perceive small collaborative group works to provide meaningful learning experiences for them. These results echo previous studies (e.g., Hitt & Dufour, 2021) and extend them by identifying students' justifications underlying their views of the benefits of group work in Calculus recitations to their learning. These results, along with the analysis of students' achievement contribute to the growing body of knowledge on reforming the teaching of Calculus.

Acknowledgments

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NSF Transforming Undergraduate STEM Gateway Teaching and Learning by Emphasizing Core, Interdisciplinary STEM Practices (DUE # 2013427)

Background

Previous studies emphasized the advantages of student-centered over instructor-centered teaching and learning of Calculus (Hitt & Dufour, 2021). In addition, collaborative group work in calculus classrooms has been shown to be beneficial to meaningful student engagement with calculus and lead to greater students' success compared to traditional classrooms (Code et al., 2014). Yet, some studies observed students' resistance to active learning (Tharayil et al., 2018). Thus, it is important to continue investigating students' perceptions of active learning environments in Calculus courses.

Aim of the Project

We aim to support students meaningful learning experiences in Calculus via designing active learning environments. This study is focused on exploring students' perceptions of active learning environments in Calculus courses.

Research Question

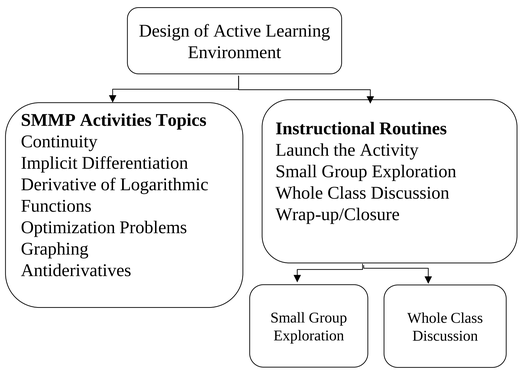
How do students perceive purposefully designed active learning environments?

Method

Research Site: This research is conducted at a four-year R1 university in the northeastern United States. Participants were students in a Calculus course, which runs in a large lecture (3 times a week) and recitation (twice a week) format.

Data Collection and Participants: Data include surveys (n=150) with 7 Likert-scale questions and 3 open questions. Participants were undergraduate students enrolled first Calculus course at the university.

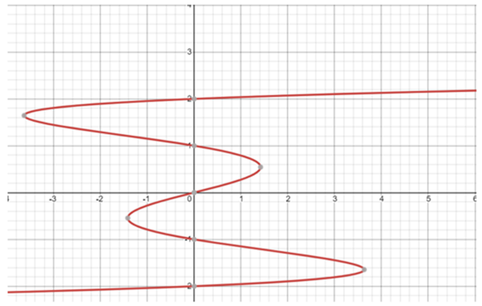
Design of the Study: We introduced active learning into recitations and activities that focus on Scientific, Mathematical, and Metacognitive Processes (SMMPs). The students worked on SMMP activities in groups and presented their solutions in class. The recitation sections were facilitated by graduate teaching assistants and undergraduate learning assistants. At the end of the semester, we collected survey data on students' perceptions of their learning experiences in Calculus recitations.



An Example of SMMP Activity

Directions: Working with the peers in your group, solve the following problems. Make sure to show and justify all your work. Next, make sure everyone in the group understands the solution and participates. Finally, be prepared to report your answers to the whole class.

Task 1: In your small group, consider the curve on the graph and the equation of the curve: $x = y^5 - 5y^3 + 4y$. With your small group, explain how you would answer the following questions using both the symbolic equation and the curve graph.



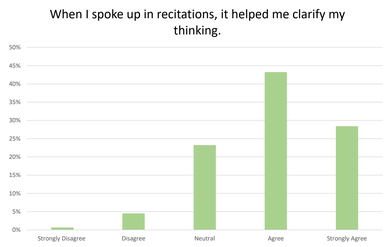
1) Is it possible to express y as an explicit function of x?

a) Explain your response using the graph.

b) Explain using the symbolic equation for the curve: $x = y^5 - 5y^3 + 4y$.

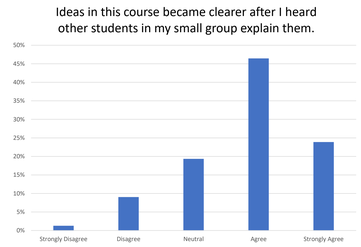
Survey Results

72% of students stated that they would agree or strongly agree with the statement: "I would recommend group work at Calculus recitation to other students."

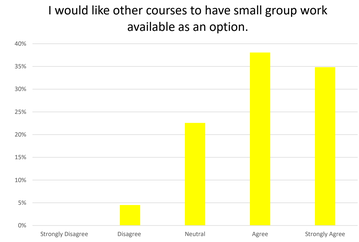


71% of students stated that they would agree or strongly agree with the statement: " When I spoke up in the recitation, it helped me to clarify my thinking."

Survey Results



70% of students stated that they would agree or strongly agree with the statement: "Ideas in this course become clear after I heard other students in my small group explain them."



73% of students stated that they would agree or strongly agree with the statement: "I would like other courses to have small group work available as an option."

Open-ended Questions and Samples from Students' Answers

Please comment on the aspects of the recitations that you think were **most** helpful for your learning	Please comment on the aspects of the recitations that you think were **least** helpful for your learning	If you were a TA **designing recitation**: What are at least two things, you would keep? Explain why these are strengths
• Direct help from the TA and LA was super helpful. I learn better by working through things with other people. **Also teaching what I knew to my classmates helped me understand the content on a deeper level**	• I think sometimes the **worksheets are very long**	• I would keep **group work** because it helps students collaborate and work through problems together.
• I think that being in a group where we all have different levels of understanding or ways of understanding the class concept is helpful because **it allows to me to think through my thought process and explain it my other group members.**	• I learn significantly more from Recitation than lecture, and don't have many complaints. Only thing I can think of would maybe **letting students design their groups at the beginning of the class**, but this also could be a downfall.	• I would also keep **the end of class where we put problems on the board to help other groups that are still struggling with an explanation on how we did it.**
	• Group work. Sometimes it can be helpful but **most of the time group members would rather work through their own work quickly versus helping other members.** Most of the help I receive in this class is from the TA or the LA.	• I would **keep the LA** because having two people to help explain things is much better than one. Especially if they have different ways of explaining things.

Summary of Justifications

- Groupwork improved students' articulation of their thoughts.
- Groupwork helped students understanding of the content on a deeper level.

Discussion

- Our results show that most students perceive that small group work provides them with meaningful learning experiences.
- These results echo previous studies (e.g., Hitt & Dufour, 2021) and extend them by identifying students' justifications underlying their views of the benefits of group work to their learning in Calculus recitations.
- These results, along with the analysis of students' achievement, contribute to the growing body of knowledge on reforming the teaching of Calculus.

References

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