How Groupwork Influences Students' Sense of Belonging in The Mathematics Classroom

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Motivation and Background

Current STEM education research has shown that a low sense of belonging in STEM leads to lower academic achievement (Stachl & Baranger, 2020). There have been several studies that have explored how shifting to an inquiry-based learning model helps increase student understanding (Connors, 1990; Coopers et al., 2015; Studies et al., 2015), but few have gone into whether this change also leads to an increased sense of student belonging (De Corte et al., 2008).

> **Belonging**
> *the extent to which the undergraduate precalculus student believes that they are accepted and included as a valuable part of the of the learning community*
> adapted from (Stachl & Baranger, 2020)

The word to stress here is **value.** The idea of value is what belonging is framed as in this study; if someone can express that they add value, it gives insight into the fact that they feel they belong. Prior studies (Stachl & Baranger, 2020) have characterized belonging through perceived peer and faculty support, class comfort in sharing ideas, social connectedness, and empathy from instructors.

The goal of this study is to begin to explore the link between groupwork and a sense of belonging.

In what ways do students report an increased sense of belonging in a precalculus course with a groupwork-based learning norm?

Setting

The University of Maine Precalculus course utilizes the *Pathways to Calculus* curriculum from Arizona State University. This curriculum focuses on introducing function types through the lens of covariation: how one quantity varies with another quantity. Forgoing a traditional textbook, students complete a workbook of problems to learn key concepts in the course.

Precalculus meets five days a week for the whole semester. In Fall 2022, the three, 75-student student sections met three days per week in active learning classrooms on "lecture" days. These rooms (example at right) help to facilitate groupwork and establish it as a class norm. The other two days of class meet in smaller breakout groups (recitations) lead by teaching assistants. All class meetings also were aided by learning assistants, undergraduates who had previously taken the course.

On "lecture" days, the instructor does very little lecturing in the traditional sense. Students are tasked with working in their groups to solve the problems assigned that often allow them to produce the mathematical idea themselves. The whiteboards around the room provide a space for students to write out their work and solutions. When in the room, you can often see other groups checking their work with that produced by other groups. Most "lecture" days often have at least one cycle of the instructor introducing a problem context, students working in groups and displaying their solutions, and a subsequent whole-class discussion of the results.

Methods

Survey

A pre- and post-survey was administered to all three lectures. The survey was given to collect initial and final student opinions concerning belongingness and mathematics. It was also utilized to source students for further interviews (below). Because of low response rates in the post-survey, only pre-survey data is shown in the results (right).

Interview

Interviews (between 20 and 45 minutes) were conducted with four students to gain more insight concerning their experience in the class.

Example questions:

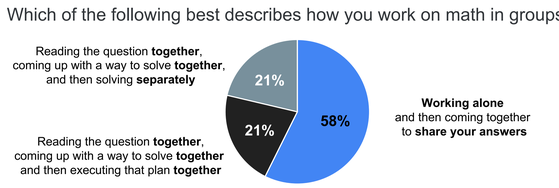
- What has your learning experience been in this class so far?
- What value do you feel you get out of groupwork?
- How comfortable do you feel sharing with your groupmates?
- How valuable is your input to the groupwork taking place?
- How do you feel about math and groupwork?

Demographics:

- 3 students solicited from survey responses, 1 volunteered
- 2 male, 2 female
- 1 student retaking the course
- 1 non-traditional student (outside 18–22-year-old demographic)

Results

Pre-survey results showed most students' conceptions of groupwork entailed only sharing answers. Less than a quarter of students believed groupwork meant working together during the entire problem solving process. (n = 136)



In the pre-survey, interviewed Students 2, 3, and 4 all expressed the view of working alone and only sharing answers. Student 1 expressed the view of preparing together and working separately. Thus the interviews showed growth in their belongingness, because all students reported working together to execute plans of action.

- All four students valued their participation in groupwork, increasing belonging.
- Students 1, 2, and 3 expressed evidence of emotional support (Student 1 example) as well as content support (Student 2 example) in increasing belonging.
- Only Student 3 expressed evidence of reinterpreting the social norms of groupwork through their own social norms as a sign of belonging.

Examples of Types of Belonging Evidence — Student Quotes and Analysis

"I like the like group dynamic and all. And it makes it a little bit **less scary** to like ask questions or give like an opinion, because you're not like sitting there in like a quiet room, with like all eyes on you. You just have the like five or six other people at your table"

"Just if someone gets it, they can explain it [to the group] in a way that the teacher hadn't. Um, so that's always **really valuable**. and then just like **emotional support in general**"

"I don't have to strain myself so hard on, what honestly is, a like simple aspect I am getting hung up on…. Uh, when I can discuss that with my group, and their like 'oh this.' I'm like 'ohhhh, okay' and then we continue on and if they hit a roadblock maybe I'm farther along then them and its that. So, its kinda like **distributed thinking**, but we are all still getting something out of it."

"Um, and there have been plenty of times where we have come to the wrong consensus and our group's…reasoning was wrong. **But we were wrong confidently together**."

Student 1 – Evidence of Emotional Support

- Lessens the pressure of sharing out
  The norm of sharing with their individual group allows the student to feel less intimidated about discussing their own thinking.
- General emotional support
  The student can lean on their group members to get a new explanation and the moral support they need to get through the problem.

The presence of emotional support implies a sense of belonging.
Being able to emotionally lean on groupmates is evidence that they feel like they belong.

Student 2 – Evidence of Content Support, Distributed Thinking

- Remembering prior concepts and fixing errors
  Completing problems together allows the student to rely on their groupmates to help them remember the 'basic' math concepts they may have forgotten. They can utilize their group members to help them catch algebraic errors so the group can focus on new concepts.
- Distributed thinking
  Mixing of ideas allows everyone to get something out of group discussion, with each member brining something to the work.
  Talking through solutions is beneficial for everyone, no matter the math background they possess.
- Group confidence
  Groupwork gives them a sense of confidence when sharing, even if it is false confidence.

The presence of content support implies a sense of belonging.
Being able to be confident together about the mathematical content means one must feel a sense of belonging within the group.

"For like chem, where [teacher] has like the whole structured lecture set up, I think it is still slightly important, but its more important in a like, in like that detail moves the story along kind of."

"We made…a little **Snapchat group chat**. And if you are struggling with one of the questions on the homework… you can like… send a picture and its like, um, someone will usually get back to you and be like 'oh this is how I did it' [and] kinda explain it a little bit, or show what they did to do it or get it correct and stuff….. I have tried, I made group chats in like **other classes that haven't really gone as well**. Like everyone usually forgets about them and all. Like I tried making like a chem chat, like a chem group chat with some people and I think like no one has ever really used it"

"As a person with like, [mental heath issues], speaking in front of the whole class…. can make me pretty anxious… But like I'm just sitting with like 4, like really nice girls… like asking questions isn't as anxious, it takes some of the pressure and anxiety off."

"[I am] **still not very [comfortable sharing]**, I'm not the most open person most of the time, so I think like I said earlier the **layout of the room really helps** me to be a little bit more open about it"

"When I'm right, its really valuable, but I kinda said it again earlier, [only] **if I have something of value** I will share it"

Student 3 – Evidence of Reinterpreting Social Norms of Groupwork

- Comparison of groupwork norms to other courses
  This student contrasted their experience in precalculus with another course they were taking concurrently (chemistry). What they shared and how they shared impacted their learning of the material between the two courses.
- Transcending classroom social norms
  Continuing the groupwork-based norms outside of class time through the Snapchat group chat allowed the student to get or provide help anytime. This shows a reinterpretation of the classroom norms of groupwork through the students' own social norms. The student unsuccessfully attempted to carry this over to another class where there is not a groupwork-based learning norm.
- Reinterpreting social norms as emotional and content support
  The group chat provided both emotional support through the relief of anxiety, and content support through students helping each other with content.

The presence of reinterpreting classroom social norms through everyday social norms (establishing an active group chat) implies a sense of belonging.
Being able to take the class-based social norms around groupwork and reinterpret them through the students' own social norms is evidence that they feel like they belong.

Student 4 – Evidence of Value of Participation

- Importance of setting for groupwork
  Being placed at tables where students are forced to look at seatmates enabled this person to share when they felt comfortable. They embraced groupwork partly because of the room they were in. This student did not enjoy the course but was still able to get something out of it

This student did share, but only when they had something they felt was valuable.
If this student had an increased sense of belonging, they would feel comfortable sharing even when they weren't sure it was the correct answer.

Conclusions

Preliminary Results

The initial finding for the survey and four unique case studies show that, by the end of the course, they felt a sense of belonging. The students interviewed were able to talk about multiple ways they **added value to the class** or to the group they worked with. Majority of the interviewees also stressed how much groupwork was utilized to further their understanding of the course material.

Further Research

More data is currently being collected (Spring 2023), as the class is offered every semester. The initial results provide a strong case for continued data collection, as the preliminary data shows evidence of increased belongingness on the class and individual levels.

- Are there other impacts on belongingness from groupwork that have yet to be observed?
- What are the mechanisms that cause in-class groupwork norms to be reinterpreted by students into their own social norms of belongingness?
- What differentiates students for whom groupwork creates an increased sense of belongingness, and for those where groupwork doesn't increase belongingness?

Belongingness in mathematics has not been widely explored in undergraduate mathematics education, but its potential effects on success and retention deserve further study.

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