ENHANCING STUDENT ENGAGEMENT AND
CULTIVATING A SENSE OF BELONGING IN
AN ONLINE MATHEMATICS COURSE at

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Background

The goal of this project was to transform the Precalculus course to improve student success and reduce DFW (drop, fail, withdraw) rates. This transformation centered on promoting student engagement through active learning strategies designed to foster a more interactive, collaborative, and supportive learning environment. By strengthening students' understanding of course content, the initiative aimed to better prepare them for subsequent coursework, enabling them to progress with confidence in their chosen STEM majors.

Our journey

Our course transformation unfolded over two distinct phases spanning a three-year period.

Phase 1

In the first phase, we redesigned the traditional lecture-based Precalculus course into a hands-on, student-centered learning experience. Funded by an Affordable Learning Georgia (ALG) grant in Spring 2022, this phase emphasized enhancing student engagement and academic performance. We adopted a blended instructional model, incorporated active learning strategies, and emphasized collaborative group work to create a dynamic and inclusive classroom environment.

As part of this effort, we developed a comprehensive instructional repository that includes video lectures, guided notes, and hands-on activities to support student learning. We also created a sample Precalculus course template tailored for departmental use. All instructional materials have been made openly available and can be accessed through the OER repository at https://alg.manifoldapp.org/projects/precalculus-ancillary-ggc.

To support active engagement, students were required to watch Edpuzzle videos before attending class, allowing them to engage with foundational content in advance. A sample Edpuzzle video is available here:

https://edpuzzle.com/media/66b7d4415f2bcb1d897 27eb4. In class, students participated in brief instructor-led mini lectures to review key concepts and clarify questions. Following these sessions, students worked collaboratively on problem-based group activities and shared their findings with the class. Instructors facilitated these sessions by guiding discussions, offering timely feedback, and providing individualized support to ensure that students remained engaged and on track with the material. During class, students participated in mini lectures where they could ask questions related to the video content. They then worked collaboratively on group activities and shared their findings at the end of class. Instructors facilitated these sessions by guiding group work, providing timely feedback, and offering support as needed to ensure student understanding and engagement.
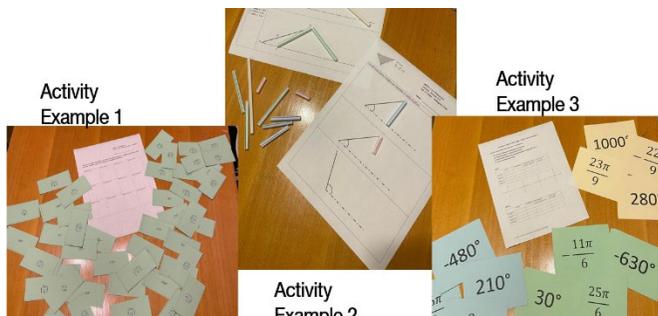

Figure 1: Sample In-Class Activities

Data were collected through pre-semester, mid-semester, and post-semester surveys to evaluate the effectiveness of course materials and instructional strategies. Students were asked to provide feedback

on the quality and usefulness of the instructional resources. The majority of respondents reported that they appreciated the Edpuzzle videos, guided notes, and in-class activities. Many students expressed a preference for the blended instruction model, noting that it allowed for more time during class to ask questions and engage with the material. One student shared, *"After learning about new material in Edpuzzle with interactive questions so you understand it, we go over it the next day in class and have a worksheet with our group. This style really helps me learn."*

Collaborative group work also received positive feedback, with students highlighting its role in enhancing peer learning. As one student noted, *"I like how we go in groups and work together to understand and teach each other how to do each problem."* However, some students expressed concerns about the time commitment required outside of class, particularly in relation to the video content. One student commented, *"Edpuzzle videos were too long,"* while another remarked, *"There was too much work."* These insights were instrumental in informing instructional adjustments and resource planning in the subsequent phase of the project.

Phase 2

Phase 2 of the project commenced in Spring 2024 with the support of a continuation grant from Affordable Learning Georgia (ALG). This phase focused on transforming the Precalculus course for

the online learning environment, building upon the active learning strategies and open educational resources developed during Phase 1. Core instructional elements—such as guided notes and Edpuzzle lecture videos—were adapted from the in-person course to suit the online modality. To ensure students remained supported in this new format, we introduced additional video resources midway through the semester in response to feedback from the mid-semester survey.

Recognizing the challenges of fostering connection in an online course, we intentionally designed this phase to strengthen two interrelated elements of student success: **engagement** and **sense of belonging**. Weekly discussion activities were introduced to encourage peer-to-peer interaction and promote consistent participation, while a collaborative group project was added to enhance student collaboration and deepen conceptual understanding.

A **sense of belonging** in an academic context refers to students' perception that they are recognized, valued, and accepted as members of a learning community (Good et al., 2012). Research shows that this sense of inclusion is positively correlated with students' mental health, academic motivation, persistence, self-efficacy, and achievement—particularly in STEM fields.

Student engagement arises from meaningful interactions with both content and peers and is particularly powerful when learning is experiential.

It encompasses four dimensions—cognitive, behavioral, emotional, and social (Wang et al., 2016)—and has been consistently linked to improved academic outcomes and greater retention in STEM disciplines.

To evaluate the impact of the course redesign, we collected data using a combination of pre-, mid-, and post-semester surveys. In addition to general course feedback, we administered a Math Sense of Belonging Survey (adapted from Good et al., 2012) and a Math Engagement Survey (based on Wang et al., 2016). Survey results indicated that a majority of students responded positively to the course structure and instructional resources. Both the weekly discussions and the group project were particularly well-received, with students reporting that these elements helped them feel more connected to their peers and more engaged in the learning process.
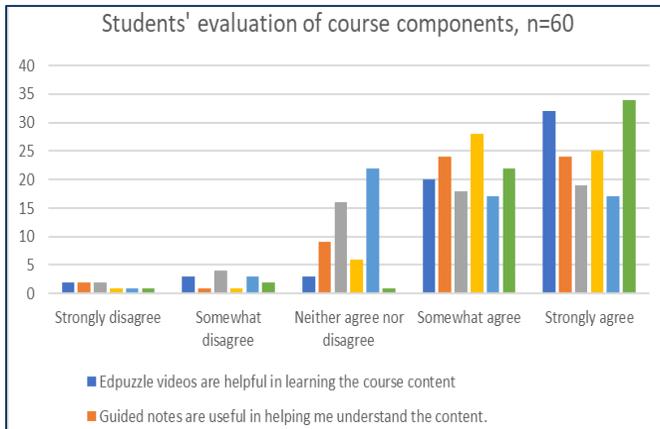

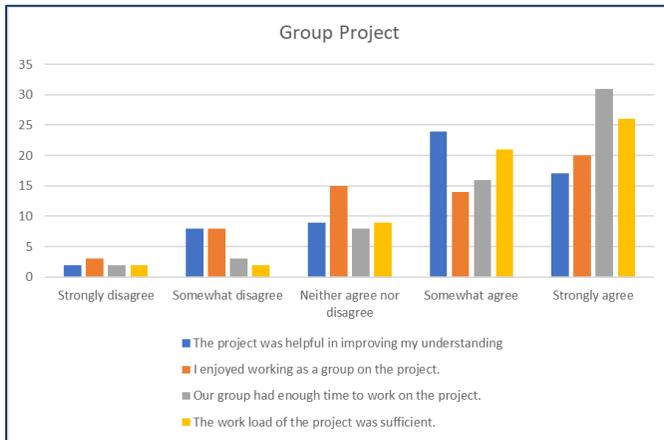Figure 2: Bar graph of students' evaluation of course components

Figure 3: Bar graph of students' evaluation of the group project

The Math Sense of Belonging Survey was scaled on 0-6 with an average pre score of 4.22 and 4.40 post score. The Math Engagement Survey was scaled at 0-5 with an average pre score of 3.38 and post score of 3.39.

Belonging		
Pre-belonging Mean Score	Post-belonging Mean Score	P-value
4.22	4.40	0.1915

Engagement		
Pre-Engagement Mean Score	Post-engagement Mean Score	P-value
3.38	3.39	0.4564

Figure 4: P-value table of pre and post belonging and engagement average scores

The scatter plot comparison between pre sense of belonging and pre-engagement versus post shows a more linear trend, which was an interesting find. It shows the correlation between improved students' engagement in the course to their sense of belonging.
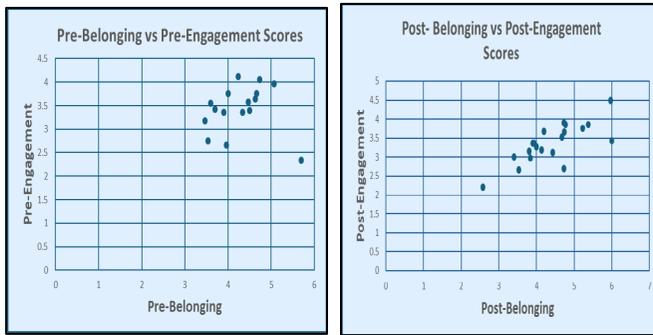

Figure 5: Scatter plot analysis of pre and post belonging versus engagement scores.

Correlation Between Belonging and Engagement Scores		
	Correlation Coefficient	P-value
Pre-belonging vs Pre-Engagement	0.03012	0.9118
Post-belonging vs Post-Engagement	0.76505	< 0.001

Figure 6: P-value table of correlation test between belonging and engagement scores

In response to the question what are some features of an online course that may positively contribute to their learning, majority of the students chose the organization of the course and the resources provided by the instructor. In alignment with this response when asked which features of an online course may not be helpful in their learning, majority of the students chose poor organization of the course and lack of interaction with the professor.

What should be kept the same or continued in the class?

1	EdPuzzle	31	51.67%
2	Homework in MyMathlab	22	36.67%
3	Collaboration /group project	7	11.67%
4	Discussions	6	10.00%
5	Notes	2	3.33%
6	Given time	2	3.33%
7	Zoom meeting	2	3.33%
8	Feedback	1	1.67%

What do you wish we had MORE of in the class?

1	More videos	17	43.59%
2	Engagement within the class/Group related activities/Discussions/Zoom meetings	7	17.95%
3	Extra credit	4	10.26%
4	Practice opportunities/Study guides	4	10.26%
5	Individual work/Busy work	2	5.13%
6	Opportunity to retake Exams	2	5.13%
7	Provide other video resources	2	5.13%
8	Provide more feedback	1	2.56%

1	Discussion	14	32.56%
2	Collaboration/Group Project	8	18.60%
3	Edpuzzle	6	13.95%
4	Time (the amount of time it takes to complete assignments)	6	13.95%
5	MML Homework	5	11.63%
6	Discussion/Responses	2	4.65%
7	The exams written work	1	2.33%
8	Quality of videos	1	2.33%

Figure 7: Students' responses from the post-survey

Key Findings

Statistically significant correlation between engagement and sense of belonging: Analysis revealed a strong, positive correlation between students' level of engagement and their sense of belonging within the course, reinforcing the critical role that social and academic connectedness plays in student success.

Effectiveness of weekly online discussions: Weekly online discussions that incorporated problem-solving and peer feedback were highly effective in promoting student engagement. These activities provided structured opportunities for students to deepen their understanding of course material while fostering peer interaction.

Student perceptions of course components:
Survey responses showed that 67% of students
viewed the weekly discussions favorably or
neutrally, while 81% had a favorable or neutral
perception of the group project. These findings
suggest that collaborative elements of the course
were generally well received, with the group
project seen as particularly beneficial.

**Collaborative project fostered peer
connections:** The group project facilitated
meaningful interactions and peer support, even
within the constraints of an online learning
environment. Students reported forming
academic and social connections that
contributed to a stronger sense of community.

**Instructor presence and responsiveness as
success factors:** High instructor visibility—
through regular announcements, timely
feedback, and availability for individual and
group meetings—was identified as a key factor
in student engagement and satisfaction. These
practices contributed to students feeling
supported and valued throughout the course.

Challenges and Successes

At the outset of the project, collaborating as a
faculty team posed significant challenges due to
differences in teaching styles, course priorities, and
scheduling constraints. Coordinating across varying
instructional approaches required considerable

effort, particularly in the early stages, as we worked to establish common ground and a shared vision for the course redesign. Over time, however, our collaboration strengthened as we developed a deeper understanding of one another's pedagogical perspectives and adapted to differing work styles. A persistent challenge throughout the project was managing the heavy workload placed on both students and instructors. Striking an appropriate balance between meaningful course activities and students' external responsibilities proved difficult, especially in an online format where boundaries between academic and personal time can blur. Additionally, aligning the most effective ways to present precalculus content and determining which topics to emphasize required ongoing dialogue and compromise. Despite these hurdles, the project yielded substantial successes. Our collective pedagogy and approach to teaching online precalculus evolved meaningfully, leading to improved instructional practices, greater responsiveness to student needs, and a more cohesive, student-centered learning experience.