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Community Building through Technology in a Biological Systems Engineering Course

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Abstract

Building meaningful relationships with peers is crucial for student success, as these connections not only benefit students inside a classroom but may also extend beyond college life. Students who build community in a classroom will likely share other classes and could become valuable friends during college or members of a professional network after graduation. While technology sometimes distracts students from having in-person interactions, it can be strategically integrated into the classroom to help students connect, build community, and develop teamwork skills. This study used technology tools to facilitate in-person and technology-based interactions within a group of sophomore students in a Biological Systems Engineering course. A series of activities to foster community building was designed for this course. All the activities were related to the content studied in class but had an element of community building. We created two instruments to collect data: A series of open-ended questions and a survey using a 5-point Likert scale from strongly agree to strongly disagree. Results showed that a significant group of participants expressed positive perceptions of community and teamwork. Moreover, students felt encouraged to participate in all the group activities, team projects, and assignments to achieve the academic goals for the semester. Students also felt in a safe environment to ask questions and to ask for the help needed to succeed. The perceptions of students related to community building, whether negative or positive, provided feedback to improve the course. Although students value in-person interactions over technology-based interactions, technology is a good ally to foster community and aid the learning process.

Introduction

Engaging students in the classroom is always challenging for instructors, but research suggests that motivation can be sparked by appealing to students' desire to make a positive impact on the world [1], [2]. Keshwani and Curtis [2] found that sophomore students in biological engineering are motivated by the opportunity to make this world a better place, help others solve problems, and improve other people's lives. Keshwani and Keshwani [3] provided evidence that 67% of biological engineering students, who participated in a survey, placed interpersonal relationships as their biggest success during their first year at university. Moreover, students commented that good relationships and connections are good strategies for navigating college successfully. Prior studies have reported that when students work together, they stay motivated and are more likely to finish their academic programs; additionally, students participate in active learning when they discuss the course content with their peers [4]. Developing a sense of community within the classroom is a good start for students motivated by helping others while working as a team to solve the world's food, energy, and water problems. Facilitating community-building also helps students to practice interpersonal skills that will transfer to their professional interactions.

This study aims to determine if community-building activities enhance a learning environment to engage students with class content and the pursuit of their degrees. We integrated educational technology tools into some of the activities. The study will answer if students value community-building activities after experiencing isolation and limited social interactions during the COVID pandemic. The study will analyze social skills developed by community-building activities and their potential impact on student retention.

Community building and teamwork

Community building is the process of creating and fostering a sense of community among a group of people. This can involve activities such as organizing events, facilitating conversations, and creating opportunities for people to interact and connect. Being part of a community provides a sense of belonging, connection, and shared purpose among students [5]. Time in class provides a good opportunity to build community, given that students spend a consistent amount of time in a shared location [6], and all have at least one thing in common: All are enrolled in the same class.

On the other hand, teamwork is the collaborative effort of a group of individuals working together to achieve a common goal or objective. Teamwork is often used in organizations, projects, and sports to improve performance and productivity and foster a positive and supportive work environment. Literature suggests that teamwork is the first step in professional environments that aim to build a strong sense of community, which may result in better teamwork performance [7].

Building a community in the classroom

The course “Engineering Properties of Biological Materials” was designed using a blended education approach that benefits students from in-person and online activities. Combining technological resources with in-person activities may increase students’ engagement and achievement, providing more flexibility and convenience in learning [8], [9].

The course structure was designed through Canvas, a web-based learning management system, to achieve learning goals that include the development of soft skills such as teamwork and community building. Students can access instructor-produced educational videos introducing the unit content and additional educational resources through Canvas. During class, students meet to learn more about the class content and participate in discussions and other classroom activities.

Students also meet weekly in the laboratory to work in teams to solve clients' concerns by applying what they have learned in class.

Based on the findings of Keshwani and Keshwani [3], students place interpersonal relationships as one of their biggest successes during their first year of college. Students also discussed the importance of connecting with others to overcome challenges and acknowledged that acclimating to the university plays an important role in keeping themselves motivated. Students connected community with "knowing people"; hence many of the learning strategies provided spaces to get to know people in the class and the laboratory.

We avoided using the words "technology", "in-person", or "face-to-face" to label the learning activities designed for this class, which had both "in-person", and "technology based" interactions. We also avoided using these labels in the questions used to collect the data for this study to prevent any bias toward the students' answers. See Table 1 for the list of educational activities created for this course.

Table 1. Activities designed for community building.

	Name	Description	Type of interaction	Technology used
1	A video to introduce themselves in a Canvas discussion.	Students created a video introducing themselves, posted it, and commented on other students' videos.	Technology based	Canvas discussions
2	Get acquainted!	Students created a card sharing hobbies and interests. All the cards with similar hobbies were connected, creating a map of everyone in the lab. We spent a few minutes getting to know two students at the beginning of each lab session. By the end of the semester, all students knew what hobbies or interests they shared in common.	Technology based	Plectica https://www.plectica.com/
3	Final project video	Students created a video to present their final project. The video was posted on	Technology based	Flip https://info.flip.com/

	Name	Description	Type of interaction	Technology used
		Flip, a video discussion app from Microsoft Office where students can connect and build community in a safe environment.		
4	In-class activities to work in randomly assigned groups	Students work in randomly assigned groups to solve challenges related to class content. The activities usually included one or two short questions to facilitate conversations.	In-person	Students needed to submit a document with the result from their work on Canvas.
5	In-class activities to work as a team	Students work with their assigned groups from the lab to solve challenges related to class content. The activities usually included one or two brief questions to facilitate conversations.	In-person	Students needed to submit a document with the result from their work on Canvas.
6	Weekly meetings in the laboratory	Students meet every week to solve different problems presented as a real-world case. The activities usually included one or two brief questions to facilitate conversations.	In-person	Students needed to submit a document with the result from their work on Canvas.

Methodology

The participants of this study were students enrolled in the course "Engineering Properties of Biological Materials," a sophomore-level class with lectures and weekly meetings in a teaching laboratory. The students are majoring in Biological Systems Engineering or Agricultural Engineering. Students from Biological Systems Engineering are interested in pursuing careers in one of the different emphasis areas available in the program: Biomedical Engineering, Food and Bioprocess Engineering, and Environmental Engineering. As concluded by Keshwani and Curtis [2], students from these majors have expressed that motivation to pursue the degree is strongly linked to solving problems for social good.

To conduct this research, we received IRB approval # 20221022197EX. One of the co-authors of this research, who was not affiliated with the class, invited all students to participate in the research, collected the consent forms in a sealed envelope, and kept them in a file cabinet located in a building with restricted access to the other co-authors affiliated with the class. All possible efforts were made to keep the participants' information confidential. The data analysis started after submitting the grades at the end of the Fall semester of 2022.

The class had a total of 46 students, of whom 29 gave consent to participate in the study resulting in a consent rate of 63%. The participation rate is similar to previous studies in our program. We acknowledge that results could be influenced based on students' motivations in their decision to participate and may be influenced by light social desirability bias. However, we considered that embedded questions on the assignments are more likely to be answered than anonymous surveys at the end of the semester [3].

We designed two instruments to collect data: A series of open-ended questions and a survey using a 5-point Likert scale from strongly agree to strongly disagree. Questions on both instruments were designed to collect students' perceptions on different topics, including community building, teamwork, challenges, motivations, interests, and goals. All the questions were asked to all the students as part of their assignments throughout the semester; however, this study only includes data from students who provided informed consent to participate.

The open-ended questions analysis followed a hybrid approach combining deductive and inductive coding [10]. The process started with the deductive approach, where researchers read a sample of the responses, selected up to 3 keywords from the data, and then assigned a code from a set coding frame. For example, for the question "*Describe the activity that helped you the most to meet new people,"* we created the following categories: (1) Community building, (2) Teamwork, (3) In person activities, and (4) Technology based activities. When data did not fit into these categories, a new code was created, following the inductive approach. After coding all the responses, researchers reread all the data to ensure that the assigned codes matched the key ideas. In some cases, a sub-theme of pre-set codes was created, as was the case for the same question in this example, where a significant number of participants described the activity with words of enthusiasm.

In the case of the open-ended question *"How would you describe the community we have built-in class and lab over the semester?"* we first used an inductive approach by creating the code framework as we were reading the responses to later label these responses based on whether the students were communicating positive, neutral or negative perceptions.

The second instrument to collect data was a survey with a 5-point Likert scale that included the following response options: (1) Strongly agree, (2) Agree, (3) Neutral, (4) Disagree, and (5)

Strongly disagree [11]. Six participants did not submit their responses to this activity, so the participation rate went down to 50% on this survey. We also analyzed the distribution of responses and searched for indications of preferences for in-person or technology-based activities.

Results and discussions

Figure 1 shows the results from the 5-point Likert scale survey. Questions 1 to 16 cover aspects of community building, while questions 17 to 19 cover learning and class performance. Results show a significant proportion of positive perceptions of community building in the classroom and that educational needs were achieved. Students felt they could request help and get support from their classmates, and 100% felt encouraged to ask questions. Almost half of the responses indicated neutral feelings when asked if other members of this course depended on them. It is interesting how in the classroom community, students feel they can help and get help, but they also recognize the individual responsibility of each member of the community.

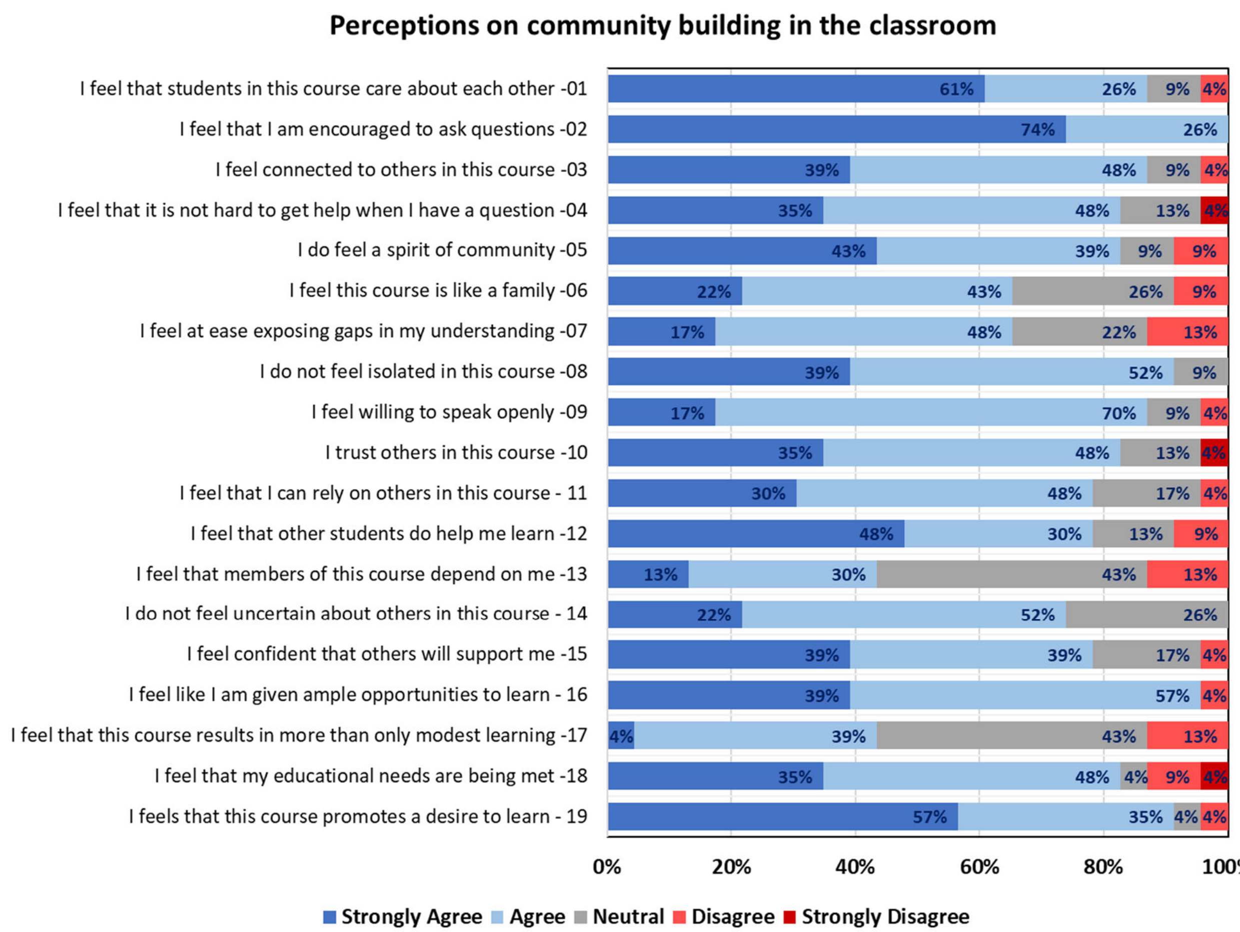

Figure 1: Survey results on a 5-point Likert scale from strongly agree to strongly disagree.

Based on the results, students perceived a sense of community in the classroom, and there is no significant evidence to conclude that students perceived community-building activities as a detrimental factor to achieving academic goals set for the course. In this regard, student comments included:

"I learned a lot even without taking tests because of the labs and their real-world applications."

"After learning more about what biological systems engineering is, I'm more excited for my future career and what I'll be able to do with my degree."

These positive comments suggest that the student is motivated to finish the degree, and this motivation may lead to improved student retention.

Figure 2 shows the results of the open-ended questions that provide more information related to the students' perceptions of community building. Figure 2.a. shows that students believe building community in the class helped them build relationships that will last beyond this course.

A student commented:

"There was a great community built throughout the entire class this semester. Now, I even have study groups with people taking other classes with me. I know I can talk to anyone in the community because we are all in the same boat. All of the activities in class and lab were very helpful to make connections with all of the people."

Students also described the community as a collaborative environment, indicating they felt comfortable working together to overcome academic challenges. The ability to work in a collaborative environment is highly valued in professional settings, making this a positive outcome that will transfer to their future career. We compared these results with the work done by Keshwani and Keshwani [3], performed before the COVID-19 pandemic, where responses described the community as "Shared time and location", "Common goal and interest", and "Knowing people". In a post-pandemic time, participants valued relationship building and efforts beyond "Sharing time and location".

In a prior study, responses also linked community with "knowing people" [3] ; thus we asked students what activities helped them to meet new people. Figure 2.b., shows that in-class activities and the laboratory helped them meet new people the most, providing in-person interactions in small groups. During the laboratory meetings, students worked with the same assigned group for the semester. In each session, one or two students used the initial three minutes of the laboratory session to share about the cards created on Plectica. The goal of this activity was to start a conversation and find common interests or common facts connecting students in the laboratory group. As a result, this activity contributed positively towards community building. See table 1 for more details about this activity. .

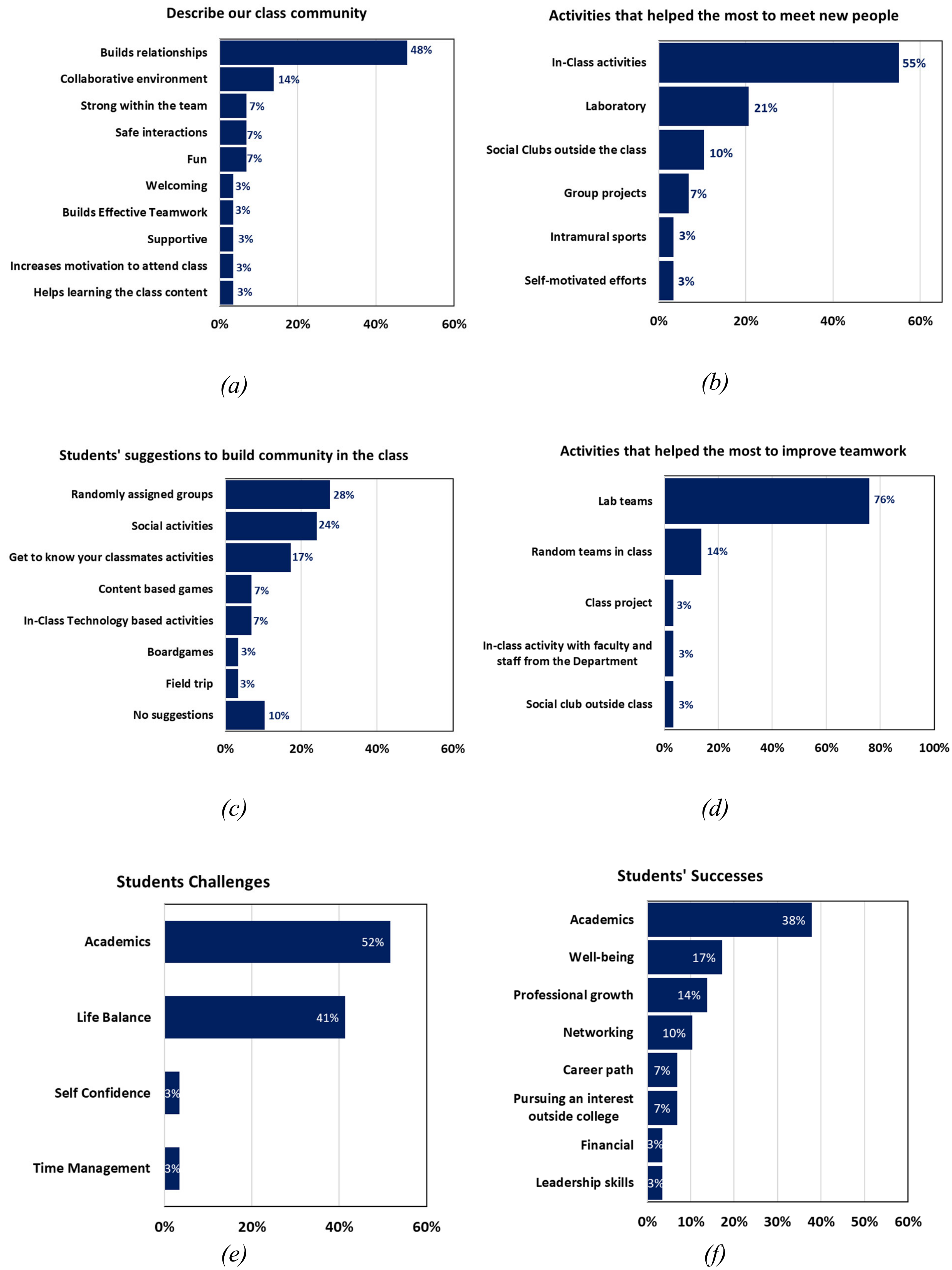

Figure 2: Responses from open-ended questions

The in-class activities usually included one question that helped students learn more about their classmates, which engage students in a conversation about themselves. See the following comment regarding this type of activities:
"What helped me the most to meet new people was the class activities. I liked the bonus questions at the end because they always asked something from each individual member, so you at least got the chance to meet someone new at each activity"

Figure 2.c. shows that randomly assigned groups, social activities, and get-to-know-your-classmates activities are the top three suggestions for building community in the class. These answers are linked to the "knowing people" aspect of the community that resonates with students.

Students were also asked what activities helped them the most to improve teamwork, a highly valued skill in the workplace. Figure 2.d. shows that students considered that working in the laboratory helped them the most to develop teamwork skills. Responses included the following comments: *"We fell into our natural group roles", "My work was valued", "I have been able to work with peers who have different strengths, and we learned to use our strengths to complete the lab."*

Figure 2.e, shows that challenges this semester were tied to academics and life balance. A significant number of responses reflected on the difficulties of developing healthy study habits. Students usually have to balance their academic load, roles in other social clubs, work, personal life, etc. However, although challenges pointed to the academic topics, figure 2.f. shows that students felt they succeeded in the academic area. Students perceived they overcame the academic challenges and made efforts to pursue well-being. Students reflected on the importance of setting aside time for exercise, doing social activities outside the class, and resting to recover from the academic demand.

Students' responses have shown the impact of in-person interactions on building community and teamwork. Although, technology-based activities were not directly mentioned in their responses, all the participants actively engaged in the online tools on Canvas, such as the creation of videos for final projects, introductions, and the creation of the mapping of lab teams using Plectica. Also, students suggested including content related games which seem to be an opportunity to include technology to enhance students' interaction for future classes. When students created the video for their final project to post on Flip, our perception as instructors was that they felt comfortable being creative and worked together without problems. Students produced interesting scripts to communicate the science behind their projects and showed an enthusiastic attitude during this activity. Students spent time in the creative process involved in producing a video, and we learned that these type of tools can be an effective way to assess the learning goals while students build community.

Based on the positive perceptions of community building and the acceptance of these activities, we see an opportunity to continue working towards this goal by sharing our findings with the next cohort of Teaching Assistants in our department. We see an opportunity to build community among the Graduate Students that will have their first teaching experience and more experienced fellows in our department.

Conclusions

Students perceived a sense of community in the classroom and the laboratory, and they perceived that building a strong community requires deliberate efforts to connect with people. As noted by the laboratory instructor, students actively engaged during the weekly meetings and made meaningful connections inside and outside their assigned teams. Students felt that class content was delivered, and communication drove the teams forward. Students expressed their motivation to work further in their degree, so these efforts may contribute to student retention.

At the start of the semester, they had a perception of community and teamwork connected to their context, and some of them went through a learning curve before they felt comfortable working in teams. By the end of the semester, many students valued the in-person activities that allowed them to expand their network and build friendships that may last beyond this classroom. Students reflected on the benefit of working with students that were from different programs within Biological Systems Engineering and learned how different perspectives could work together to solve real-world problems.

This study reveals that students in this class valued in-person interactions over technology-based interactions. However, digital tools have been a good ally for community building and teamwork activities. Students were engaged with the activities in the classroom that included guest lecture speakers, group discussions, and active participation toward a specific topic during the semester. However, data on Canvas shows that all students actively took part in creating videos, forum discussions, surveys online, and online group projects when they were asked to use digital tools. As their instructors, we could see their positive participation in digital and in-person modalities planned to increase classroom community and teamwork.

We learned that while technology often gets blamed for reducing in person interactions, it can also be used to facilitate them. For example, the video project served as a tool to bring students together, who met in person to work on the creative process, recording and production of the video, and later watched the videos posted by the other teams on the Flip community.

After experimenting with technologies that eased online interactions during the COVID pandemic, we will continue to integrate technology into the activities, but we will focus our efforts on the in-person interactions preferred by students. Students value community-building activities that allow interaction with staff and faculty from the department and give them a sense of belonging that boosts their motivation to achieve their degrees.

Knowing that technology is heavily present in the daily routine of everyone, we can't assume that instructors and students are tech experts. Therefore, we recommend running several tests before using a technology-based activity and being prepared to adjust when things do not work as expected.

In order to enhance student interaction, it is crucial for future studies to explore a wider range of apps available that could be used in the classroom to facilitate creative spaces to interact. Additionally, organizing a brief workshop with department-level teaching assistants would benefit this study's future direction. In this workshop, we would share the lessons learned from this experience and provide strategies to connect with students and other teaching assistants from our department.

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