

## **Do Small Collaborative Learning Communities within a Larger Class Increase Students' Sense of Belonging and Learning?**

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## **Do small collaborative learning communities within a larger class increase students' sense of belonging and learning?**

### **Abstract**

We implemented small collaborative learning communities in 2020 during the COVID-19 pandemic to encourage connection between the students online and those who were able to come to class. We define classroom learning communities as small groups of students who sit together and are encouraged to discuss concepts together during class discussion times, such as before answering TopHat questions and during in-class problem solving sessions. Because the learning communities were so successful during the pandemic, we continued to use them in five offerings of two different classes over the past two years. We are a large department with core class sizes ranging from approximately 40-120 students. Learning communities were used in a material balances class that is the first chemical engineering class for our students. This class utilized a flipped format. Learning communities were also used in fluid mechanics, which is typically taken the semester after material balances. This class is lecture-based with active learning components. Two of these classes were mixed-mode (some students online and some in person), and three were completely in person. Surveys were administered to students in each class to answer our research questions:

1. Does the sense of belonging within the learning community, within the class, and within the department change with mixed-mode versus in-person, lecture-based versus flipped, 1<sup>st</sup> class versus 2<sup>nd</sup> class, and expected course grade?
2. Do students perceive a benefit in their learning by participating in the learning communities?
3. What are the factors that influence how the groups are formed and if they are changed throughout the semester?

Students in the current offering of the fluid mechanics course, which uses learning communities and some active learning, took one of two offerings of the material balances class: one a flipped class using learning communities and one a lecture course without learning communities. Surveys of these students reveal that learning communities of 5-7 students improve students' engagement in class, help them learn, and increase their sense of belonging. Student comments indicate that imposter syndrome is lessened: it was helpful to know that others in their learning community were having similar struggles with the material they were learning in class. Students also report that learning communities help them learn and help them break the ice in meeting new people in class. Students further report that the learning communities foster social relationships as well; they report meeting new people who they would otherwise not have met. Self-assessment shows that they feel a greater sense of belonging to learning communities than to the department. Interestingly, the sense of belonging to the learning community increases for students expecting a lower grade in the class, while sense of belonging in the department decreases with expected class grade. Students highly recommend the continuation of learning communities in the future. From instructor observation, it is noticeable that most students are participating in small group discussions with each other once they are assigned to a learning community – they physically pull closer to other students around them and start discussing the

discussion questions and/or in-class problem solving. We also notice that some of the students sitting off by themselves are getting engaged with their communities and working together.

In addition to evaluating the effectiveness of small in-class learning communities for sense of belonging and student learning, this paper describes how these learning communities are formed and how they can be used in various offerings of courses. This will include how to create the learning communities, how students assessed their peers' contribution to their learning and thoughts about making changes to the groups during the semester.

## **Introduction**

It is widely accepted that active learning and student engagement in a course helps students learn [1], [2]. Active learning can take many forms: discussion, classroom response system (clickers, TopHat), and in-class problem solving, either alone or in a co-operative environment [3]. One method of adding active learning into the course is via co-operative learning. Many studies have shown that co-operative learning helps student achievement [4], [5], [6]. Verbal interactions among group members are a large part of what makes the collaborative process successful [7].

In order to support learning, students need to see value in what they are learning, they need to feel that they are capable of learning (high efficacy), and they need a supportive environment [8]. During the Covid-19 Pandemic, our class went to mixed-mode with approximately  $\frac{1}{3}$  of students in person and  $\frac{2}{3}$  joining via zoom on any given day. To help foster support for our students, we set up what we called "in-class learning communities" within the course itself, connecting students who were in person with several classmates who were on zoom. We did this in both a lecture-based class and in a "flipped" class. Students were encouraged at least once per lecture to discuss concepts or answer short questions together in their learning communities, forming a kind of collaborative learning group. During class discussions and in-class problem solving, students connected with each other in break-out rooms on zoom, including the ones who were in class. In this manner the students all had direct contact with the instructor through their learning community. Instructors could see discussion happening within these groups via the group member present in class. In talking to students after the course, they indicated that they enjoyed participating in these learning communities and strongly advocated for continuing them in the future, even when classes were returning to fully in-person. Over the past two years we have implemented various forms of in-class learning communities in five offerings of two different classes. Learning communities were used in a material balances class that is the first chemical engineering class for our students, typically taken during the sophomore year. This class utilized a flipped format. They were also used in a fluid mechanics course, which is typically taken the semester after material balances. This class is lecture-based with active learning components. Two of these classes were mixed-mode (some students online and some in person), and three were completely in-person. We also have data from one additional material balance course that was neither flipped nor using learning communities. Surveys were administered to students in each class to answer our research questions:

1. Does the sense of belonging within the learning community, within the class, and within the department change with mixed-mode versus live, lecture based versus flipped, 1<sup>st</sup> class versus 2<sup>nd</sup> class, and expected course grade?
2. Do students perceive a benefit in their learning by participating in the learning communities?
3. What are the factors that influence how the groups are formed and if they are changed throughout the semester?

## **Background**

Extensive social psychology research has shown that collaborative learning works best when conditions foster positive interdependence among group members [5]. Positive promotive interactions occur when individuals help each other out to reach the team's goals, for example trusting each other, exchanging necessary resources, helping teammates out, and motivation for mutual benefit (such as answering TopHat questions) in low stress situations [5]. Extensive research comparing cooperative, competitive, and individualistic efforts show that cooperative efforts lead to higher achievement, more positive interpersonal relationships, and better psychological health [5]. Informal collaborative learning groups are typically short term (e.g. single class period) and might be used for a think-pair-share type of exercises. More formal cooperative learning groups are set up as a structured team with members depending on team members for success on the assigned project. The Johnson and Johnson model on social interdependence theory [5] incorporates 5 essential elements of co-operative learning: positive interdependence, individual accountability, promotive interaction, appropriate use of social skills, and team evaluation. It is generally found that more well-defined cooperative learning groups with strong positive interdependence work the best for student engagement and learning [9]. Collaborative learning refers to an active learning environment in which students collaborate in small groups towards a common goal [1], but groups are generally less structured than in co-operative learning. In our in-class learning communities, we combined think-pair-share and in-class problem solving activities with co-operative learning methods to enhancing peer interaction and increase the social interactions in the classroom to help students learn from peers and reduce stress.

Our learning communities in the lecture-based course were structured so that teams work together to answer TopHat questions posed in class for individual credit, thus fostering the necessary positive interdependence. These questions are of very low value towards student's grades; however, students perceive these questions to be of high value. Therefore, given the time to discuss among team members, they do so extensively. Without the TopHat questions (or other turn in activity) the learning community participation would probably not be as effective as there is no common goal to work towards. In the flipped format course, students work together on an in-class problem that is due at the end of the period. These in-class assignments are low-stakes formative assessments. Each student hands in their own work based on their interaction in the group.

## Methods: participants, methods, data collection

We are a large department with class sizes typically ranging from 40-120 students. After initial perceived success utilizing our in-class learning communities, we applied the concept to several other course offerings that included flipped-classroom teaching in either mixed-mode or in-person and a lecture-based course with active learning via electronic response (TopHat), learning community discussion, and in class problem solving. **Table 1** shows the various courses that were evaluated. One of the Material Balance courses over this time-period was offered as a traditional lecture-based course with some active learning components but did not use learning communities. Assessment of it was included in the Fall 2022 Fluid Mechanics course survey.

**Table 1: Course offerings over Learning Community Study Period**

Term	Course	Mode	How Learning Communities are assigned	Delivery	% Response	Class Size
Fall 2020	Fluids	Mixed Mode	Friend request option	Lecture 2 sections	40%	96
Spring 2021	Material Balance	Mixed Mode	CATME	Flipped	62%*	115
Fall 2021	Fluids	In-person	CATME with 1 friend request	Lecture	81%	112
Fall 2021	Material Balance	In-person	CATME	Flipped	80%	65
Spring 2022	Material Balance	In-person	No learning communities	Lecture	64%**	115
Fall 2022	Fluids	In-person	Assigned by seating	Lecture 2 sections	99%	99

\* Students were surveyed as part of Fall 2021 Fluids class survey

\*\* Students were surveyed as part of the Fall 2022 Fluids class survey

In the Material Balances class in Spring 2021 and Fall 2021, the students were assigned their learning communities through CATME [10] based on GPA, gender, and ethnicity. The learning communities were 4 – 5 people in size. Class time was used to complete in-class assignments that were due at the end of the class period and were submitted individually. For the mixed-mode class, the students were placed into a separate breakout room by group number. About 15% of the class were present in person and they were also in the breakout rooms with headphones. The instructor and teaching assistants traveled throughout the room and virtually throughout the breakout rooms to check on groups and answer questions. During the in-person class in Fall 2021, the students were masked and in person and sat with their learning communities in class to complete the in-class assignment. The instructor and teaching assistants traveled throughout the room to answer questions. The students provided anonymous feedback to their group members halfway through the semester provided by CATME [11]. The questions asked the students to evaluate how their group members contributed to their learning. Midsemester the communities were re-formed; however, students were allowed to stay in the group if they felt it was working for them. About half the students stayed in their original

communities. In Spring 2022, the Material Balance course was taught by a different instructor who used a lecture-based format and did not use learning communities. The students in material Balances in Spring 2021 were not given the survey during the semester. Most of these same students took Fluids in Fall 2021. The survey in the Fluids class asked about the learning communities in Material Balances. Similarly, most of the students in Material Balances in Spring 2022 were in Fluids in Fall 2022 and they were asked about their experiences in the Material Balances class in Spring 2022.

In the Fluid Mechanics (Fluids) class in Fall 2020, Fall 2021, and Fall 2022, the students were assigned to their learning communities by the instructor in various ways. Typically learning communities consisted of approximately 6 students. The fluids classes were lecture-based with active components of clicker or TopHat type questions and short in-class problems. Students were encouraged to discuss and work with their learning communities for these questions before answering them individually. The TopHat (clicker) questions were low stakes points, with most students who consistently participated receiving full credit. Interestingly, students perceived these points to be worth a lot more than they actually were. Mid-semester the learning communities were re-formed, with students in Fall 2020 and Fall 2021 having the option to opt out of reforming if communities were working for them. This option of remaining in their original community was not given in Fall 2022; all students were forced to switch. In all offerings, students participated in project work in teams of 2-3 students. These teams were formed from within their learning communities.

Assignment of learning communities in the Fluids class varied from semester to semester. The Fall 2020 Fluids class was mixed-mode and learning communities were assigned by the instructor based on having at least one member of the community in class for each class meeting. Students were allowed to pick some members of their community if they so desired and about 25% of students picked someone for their community. For the mixed-mode class, the students were placed into a separate breakout room by group number. About 15% of the class were present in person and they were also in the breakout rooms with headphones. The instructor and teaching assistants traveled throughout the room and virtually throughout the breakout rooms to check on groups and answer questions. During the in-person class in Fall 2021 learning communities were formed using CATME [10] and students were allowed to request one other person to be in their community. Students were masked and sat with their learning communities during class and turned to them for in-class discussions and problem-solving assignments. The instructors and TAs were available for questions during these discussion times. The Fall 2022 Fluids class was in person. Learning communities were formed on the first day of class based on where students were sitting in the class.

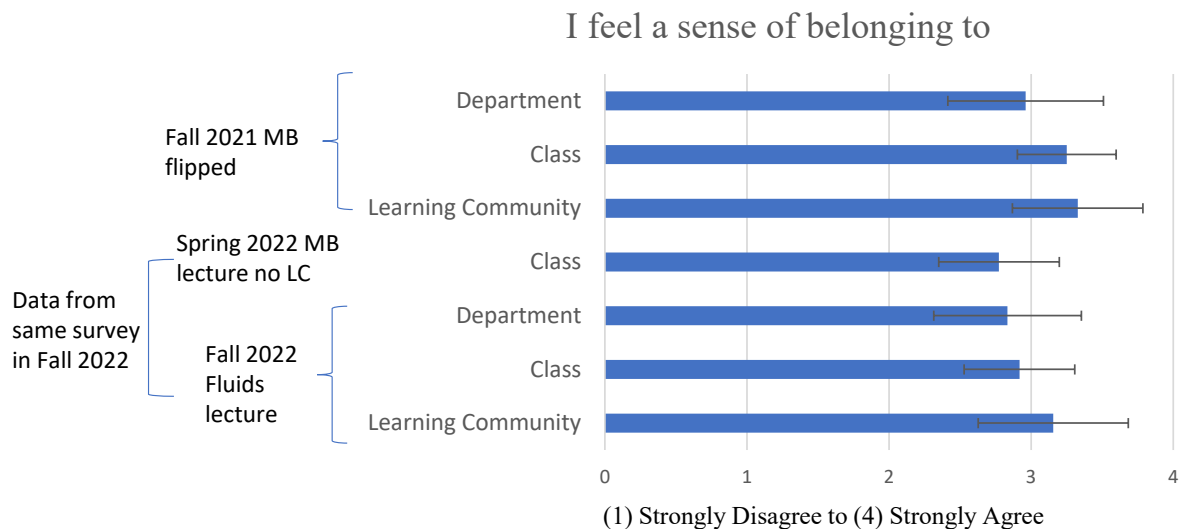
At the conclusion of the Fluids classes, students were surveyed about their experience in the class and learning communities. Surveys were anonymous google form surveys. An incentive was given to the class for achieving a minimum response rate to the survey so that response rate in Fall 2021 and Fall 2022 Fluid Mechanics courses was greater than 85%. Statistical analysis was done by one-tailed student t-test with unequal variance. For level of agreement, students were asked if they strongly disagreed (1), disagreed (2), agreed (3), or strongly agreed (4) with a

statement. The average response and variance are reported. P-values from the t-test are reported when they are below or close to 0.05. As these surveys were anonymous and no identifying characteristics were obtained, this study was IRB exempt.

## Results and Discussion

### *Sense of Belonging*

We evaluated sense of belonging in the various classes and offerings to test if the sense of belonging within the learning community, within the class, and within the department changes with mixed-mode versus in-person, lecture-based versus flipped, 1<sup>st</sup> class versus 2<sup>nd</sup> class, and expected course grade? **Figure 1** shows student Sense of Belonging for different in person courses: lecture with learning communities, flipped with learning community, and lecture without learning community. Notably students report a significantly higher sense of belonging to their learning community than to the class ( $p < 0.008$ ) for the lecture-based class than for the flipped class. This seems somewhat logical as the Learning Community is the smallest unit that they interact with in the course in the lecture based course. In the flipped course students interact with each other all the time, so the learning community and class have similar levels of belonging. The sense of belonging in the lecture class with learning communities was somewhat larger than for the lecture without learning communities MB SP 22 class ( $p < 0.08$ ) but the difference did not reach the statistical significance cutoff of  $p < 0.05$ . Interestingly, the sense of belonging in the learning community is significantly larger than that for the department



**Figure 1** Sense of Belonging to the learning community and class showing average value  $\pm$  variance. Three different in person classes are represented: flipped Material Balance (MB) with Learning Community (LC), lecture-based MB without LC, and lecture-based Fluids with LC. The data for the Spring 2022 MB without LC class was collected from the same sample as the lecture-based fluids class with LC. The sense of belonging to the learning community was significantly larger than the sense of belonging to the class for the Fall 2022 lecture-based course ( $p < 0.008$ ) as measured by student t test unequal variance. The lecture-based with LC class had a higher sense of belonging than the lecture-based without LC class ( $p < 0.08$ ), but not compared the flipped with LC class. For both classes using LC, the LC sense of belonging was significantly higher than for the department ( $p < 0.008$ )

( $p < 0.008$ ) for both classes with learning communities. This makes some intuitive sense as the smaller community provides more social safety [12] and thereby sense of belonging than does the larger department. Student free response comments indicating this social benefit include:

*I really enjoyed the learning communities! They helped me make friends within the major and meet people I would not have normally met.*

*They helped out connect with people and see peoples different view and ways of thinking for problems*

*Good strategy to engage with the class*

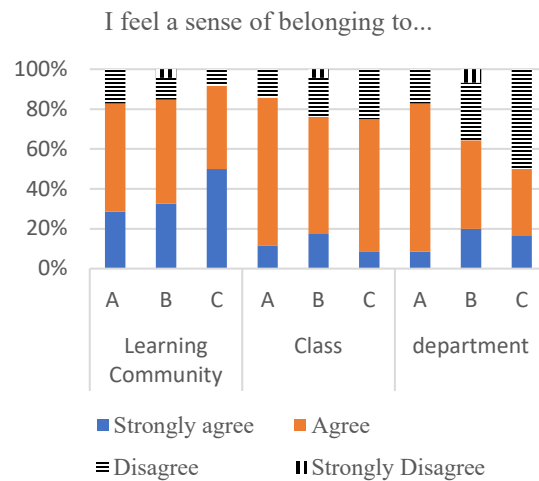
*The learning community helps me communicate my ideas and pick up on things I may have missed originally*

*It also helps to connect me to my peers that I share other ChE classes with. It allows us to talk about our common struggles/successes within all of our ChE classes.*

*They are really helpful to hear other people's thoughts and ideas that may differ from yours*

*I thought they were very helpful in gaining help in lectures and working together.*

Interestingly, there appears to be some differentiation in student's sense of belonging by expected grade in the course, as shown in **Figure 2**. Surprisingly, the sense of belonging in the learning community is higher for students who expect a lower grade in the class! However, for the department belonging, there appears to be a strong correlation with expected grade in the class. This is classic demonstration of belonging relating to technical competence in engineering communities [12]. From longitudinal studies of engineering communities, Wilson *et al.* [12] found that there were 3 main requirements for having a sense of belonging to such communities: social comfort, perceiving some technical competence, and relating to faculty. Interestingly, the perceived technical competence reason for belonging is not shown in the course learning communities. The social safety in the communities is likely high enough to overcome the lower technical competence; while within the department, the technical competence, as expressed by expected grade, has a stronger influence on the sense of belonging.



**Figure 2. Student sense of belonging in their Learning Community, Class, and Department by expected grade in the class in Fluids FA 2022.**



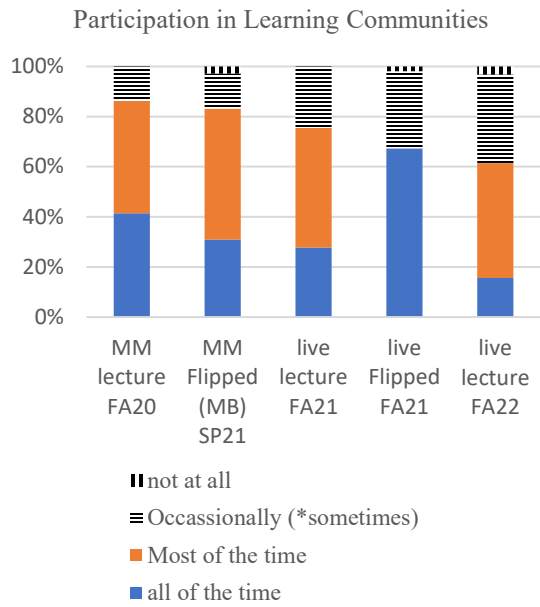
**Do students perceive a benefit in their learning by participating in the learning communities?**

As shown in **Figure 3**, student participation in learning communities is high, with a large majority of students using learning communities at least occasionally. In addition, students perceive that these communities help them succeed in the course (**Figure 4**). This is highest in the mixed-mode and flipped courses. In Fall 21 we were just emerging from the COVID-19 pandemic and this was their first in-person course. The FA22 offering of the in-person lecture course was at a time when 25% of students had already experienced an earlier flipped course with learning communities, and all students had experienced a previous in-person course in the department. Thus, it appears that the need for the learning community is not quite as high for a second offering. Because we got a lot of feedback stating that a benefit of the learning community was that students got to meet more peers who they also worked with in other courses, we asked in Fall 2022 survey specifically if they got to know new people through their learning community. This data is shown in **Figure 5**. Note that a single survey in Fall 2022 produced the data shown.

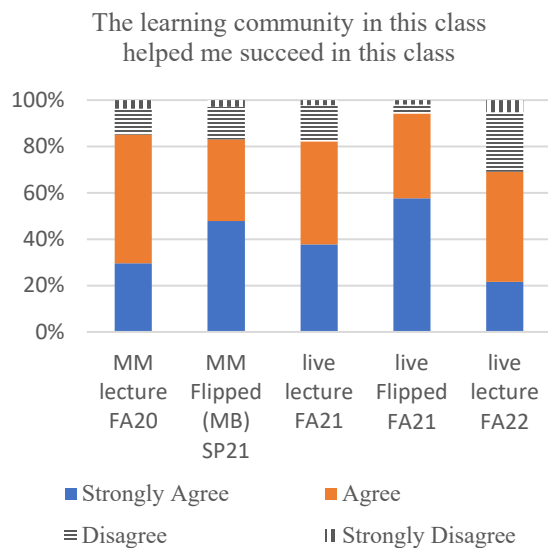
Selected comments:

*Learning communities helped for me to break the ice with people I've never met and helped me get to know people going through the same classes and struggles as I am. This was helpful to me since I have trouble meeting new people and never really force myself to make friends in my classes.*

As the above comment and **Figure 6** show, possibly the most helpful part of the learning community is in building connections with



**Figure 3. Student participation in learning communities is high, with the large majority of students participating at least some of the time.** Note that the live flipped \* course used a slightly differently worded survey that had as choices “always”, “sometimes”, and “never”. “Sometimes” was grouped with “occasionally”. MM – mixed mode



**Figure 4. Students perceive that learning communities help them succeed in the course.** This is higher in the flipped format and was higher in the MM and earlier offerings of the live lecture course, possibly due to less need for meeting new people as we move away from the pandemic.

other students and helping students see that struggling is normal and you can work through it. These learning communities help students feel socially at ease in their classroom which helps fulfill a sense of belonging and thereby eases learning. The importance of social connection to the classroom and peers has been shown in other work [12], [13]. Eryilmaz [13] studied flipped classroom learning with and without collaborative components and found that the collaborative component showed a significant reduction in social anxiety among participants. Wilson [12] showed in a longitudinal study in different engineering groupings, that feeling socially at ease goes hand in hand with a feeling of belonging in class and technical conferences.

The Fall 21 students greatly appreciated meeting new people in their course since they had just spent 2 years in isolation from their peers. The lecture-based course is also the second, or sometimes third, course in the major, so that students may not feel the need to get to know more people quite as strongly. Some report that they can get the necessary support from their friends in the class and do not need learning communities. We will continue to evaluate the learning benefit in the early major courses. We do gather from student feedback comments that learning communities are most warranted in the early courses in the major, but most students still recommend them for the Fluids course. (Figure 7). If the communities help just a few students find a student support group, the effort will be worth it.

I got to know new people in my learning community who I may otherwise not have met

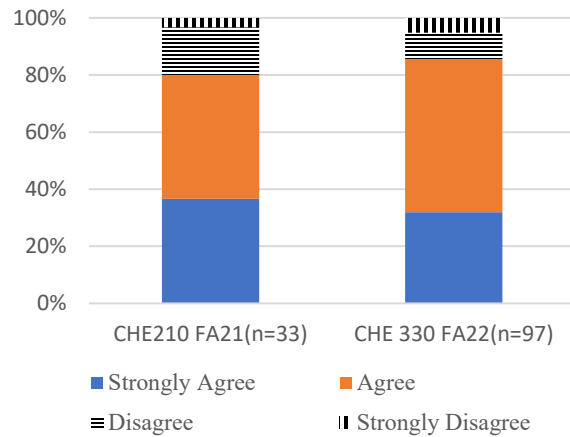


Figure 5. Students report getting to know new people through their learning communities who they otherwise would not have met. Data collected from a single survey in Fall 2022.

My learning community helped me see that I am not alone in my struggles in class

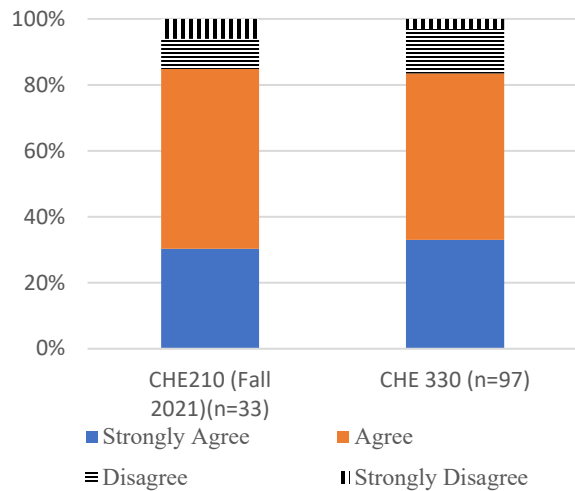


Figure 6. Learning communities help students see that they are not alone in their struggles. Data collected from a single survey in Fall 2022.

***What are the factors that influence how the groups are formed and if they are changed throughout the semester?***

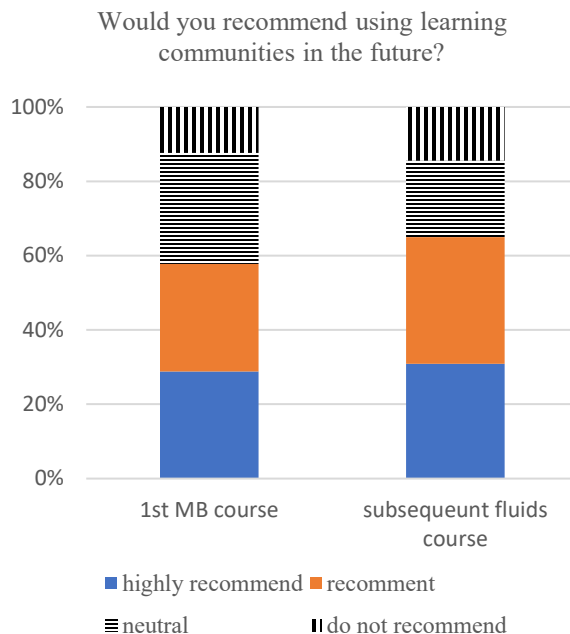
We tried various methods of forming learning communities as noted in the methods section. They ranged from using CATME [10] to form groups, using CATME with allowance to request 1 friend in the group, and using seating patterns to assign students to a community.

For the first course in the major, material balance class, using CATME to assign communities makes a lot of sense. This course is flipped format and students do not yet know others in the class. For the Fluids class, the CATME assignment was easy to use when running in mixed-mode, but was disruptive and required students to sit in areas of the classroom they would not normally have chosen when the class was in-person. For this reason we tried forming learning communities by where students were sitting on the first day of class. Students sat in their preferred location in the class. Most chose to sit near someone they already knew. This method grouped students quickly and efficiently on the first day of class. The main issue with this method was that students who sat by themselves showed resistance to moving closer (even just a few seats) to the rest of their communities until later in the semester. This method also resulted in sometimes grouping a single student with a group of 4 or 5 close friends, which may have led to the lone student feeling excluded.

All classes formed a 2<sup>nd</sup> set of learning communities. For most classes the students were given the option of remaining with the original community. About 50% of students chose to remain with their original community each semester this was an option. The last offering of Fluids in the Fall 2022 made everyone reshuffle to a new learning community. Most students hated this. The only students who did not mind were the ones who did not like their original learning community. An often stated comment in the surveys pointed to the fact that the lecture-based with active learning class required more time for communities to get to know each other than the flipped format. Thus, for the lecture-based course re-assigning learning communities should be offered only to those who request it.

**Suggestions for forming and re-forming learning communities**

We recommend using learning communities especially in the early courses in a department. For the initial course, using a team formation system like CATME [10] works very well.



***Figure 7. Student recommendation of using learning communities in future offerings of MB and Fluids courses. The recommendation remains high in both courses. Data from Fall 2022 survey in Fluids class.***

Reshuffling communities mid-semester is also recommended in a flipped format course so that students get the opportunity and encouragement to get to know more peers and interact with a more diverse set of viewpoints. For a lecture-based course, the reshuffling should be approached with a little more caution since the community level of interaction is less than for the flipped format, and a little more time may be required for bonding within the community. At the same time, giving students the opportunity to join a different community is of benefit for those who did not bond with their original community, or ended up with others who do not participate in class or dropped the class.

For a second or third class in the department sequence, students prefer knowing someone in their learning community. However, they also acknowledge the benefit of meeting new people and hearing new and different perspectives for evaluating and solving problems. Since the point of these communities is to foster communication, while encouraging all to have a group of peers to hold discussions with, we feel that allowing some choice in members of the group is warranted. From a teaching and class management perspective, grouping students by where they were sitting was much faster, easier, and more efficient than trying to assign them with CATME or other method. We recommend grouping students by where they were seated in class during the first day or week of the course. Care should be taken that a single student sitting apart is not joined with a group of students sitting close together who are likely close friends. This may make this single student the odd-one-out. Grouping students with some care by where they are seated in the classroom offers the benefit that they probably know at least one of the students in their community and they get to sit in the location they prefer in the classroom. The benefit to the instructor is that the formation process is quick and rather painless.

Getting students to use their learning communities starts on day 1 by assigning a small homework question in which they meet each other and take a picture of the group together. For the flipped course, the nature of the course encourages community participation. For the lecture-based course, it is important to foster community participation during class by repeatedly encouraging discussion within their learning community when posed with a concept question on TopHat (or similar graded question). After discussion wanes, they should individually answer the question. Note that there needs to be some benefit to the student associated with using the learning community (grade) for it to have the desired result.

Changing groupings mid-semester is a mixed bag. Students report finding this useful for the flipped format, because they work so much with each other that there is plenty of time to form connections. They also find it useful in the first department course because they need to get to know more people. In the lecture-based format, however, students generally feel that it takes longer to form connections and reshuffling teams adds stress with little benefit. Most students hated reshuffling of teams mid-semester to completely new team arrangements and a new seating chart. Only the students who did not like their first learning community (e.g. they were odd-man-out with a solid group of friends, they were grouped with students who stopped coming to class, or they simply didn't "click" with their community) liked being reshuffled. Students prefer having the option to remain in their original community and being asked if they would like to form a new one.

## Conclusion

We implemented small collaborative in class “learning communities” to help students engage in class and foster a sense of belonging. Our data shows that these learning communities do indeed foster a sense of belonging that is stronger than class belonging for a lecture-based course and stronger than department belonging. When based on expected grade, the sense of belonging to the learning community was somewhat stronger for lower expected grade than those expecting higher grades. This is reversed when expressing sense of belonging to the department. This implies that the social comfort gained from the learning community is most important for belonging, while technical competence is most important for a sense of belonging to the department. For lecture-based, flipped, mixed-mode, and in-person classes, students report that the learning communities helped them learn and they recommend continuing use of learning communities in the future. The method for forming communities depends on whether the course is first or later in the department sequence, and may also vary for flipped versus lecture-based courses. We recommend using software like CATME [10] for first courses and flipped courses, while we recommend using seating preferences in later courses and lecture-based courses. Reforming communities mid-semester depends on the need for getting to know more peers and on the type of course: flipped or lecture-based.

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