

Call on me! Undergraduates' perceptions of voluntarily asking questions in front of large-enrollment science classes

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Background

Eliciting student participation by giving students the chance to voluntarily participate by asking questions is a common way for instructors to engage students in the college science classroom. While this method is mainly used in small-enrollment discussion-based courses, it is also used upwards of 15% of the time in large-enrollment courses. Student participation in the form of voluntarily asking questions has not only been linked to student engagement but has also been associated with enhanced learning. When students themselves are not the ones voluntarily participating, but are listening to others, they can also reap the benefits; they specifically can develop a deeper understanding of the material. The science college classroom has been deemed as "chilly" by students, but when instructors give students a chance to voluntarily participate by asking questions in class, this can create a warmer and more welcoming environment, one in which students feel like the instructor cares. Generally, students who are more apprehensive and have a greater sense of fear of negative evaluation (being judged by others) about speaking will less likely voluntarily participate in class. Moreover, studies have shown that women are less likely than men to voluntarily participate in large-enrollment science courses, that non-native English speakers may be less likely to speak up in class, and that underrepresented minorities who are also first-generation students may be less likely to speak in front of their peers. To our knowledge, no studies have specifically explored student perceptions of the benefits, drawbacks, and motivators of asking questions in front of the whole class in large-enrollment college science courses and more particularly demographic differences in those perceptions.

Research questions:

1. To what extent (a) and why (b) do undergraduates perceive other students voluntarily asking questions is helpful in large-enrollment science courses?
2. How frequently (a) do undergraduates report asking questions in large-enrollment science courses during a semester and what discourages (b) students from asking questions?

Methods

This study was conducted as part of a course-based undergraduate research experience (CURE) in spring 2020 in which 19 undergraduate researchers from UCF worked collectively to develop research questions, create surveys, analyze data, and communicate findings for a novel research project. Prior to developing the survey, 50 exploratory semi-structured interviews with science undergraduate students, enrolled in at least one large enrollment course from an R1 institution were conducted in fall 2019 to understand what motivates and discourages students from asking questions in front of the whole large-enrollment courses. These data served as pilot data for the survey created in spring 2020 to further explore to what extent students perceive other students voluntarily asking questions in large-enrollment science courses to be helpful and why, and to what extent students themselves engage in asking questions in front of the whole large-enrollment science course and why. In our survey, we specifically defined large-enrollment science courses as biology, chemistry, physics, and/or geosciences courses with 100 students or more; students who have not been in classes with opportunities to voluntarily ask questions were removed. Eleven instructors from science courses of at least 50 students agreed to send our survey to their students. To address to what extent students feel it is helpful when they hear others, we used a 6-point Likert-style scale (extremely unhelpful to extremely helpful). We then followed up with open-responds questions about why they felt it is helpful. Students also were prompted to check boxes from previously identified reasons from the 50 pilot interviews. Students were then asked how often they personally volunteer to ask questions (never to fairly often) and then prompted to answer an open response question about what discourages them. After, students selected pre-determined reasons of discouragement in the form of checkboxes from the pilot interviews. Students were also given a set of demographic questions to complete (gender, race/ethnicity, college generation status, year in college, GPA, comfort speaking English, and fear of negative evaluation (FNE) or to what extent they worry they will be judged. We used binomial logistic regression to test for demographic differences in students who felt hearing others voluntarily asking questions to be helpful or not. We also used this method to address demographic differences in who voluntarily asks questions. Undergraduate researchers coded the open-ended responses.

Demographics (n=417)

Gender identity	
Woman	68% (285)
Man	31% (128)
Other	.2% (1)
Declined to state	.8% (3)
Race/ethnicity	
Black or African American	7% (28)
Hispanic, Latino, or Spanish origin	20% (85)
White/Caucasian	47% (194)
Asian	15% (64)
American Indian or Alaskan Native	1% (5)
Pacific Islander	.7% (3)
Other/multiple	6% (27)
Declined to state	3.3% (10)
Year in college	
First year	24% (99)
Second year	36% (152)
Third year	22% (93)
Fourth year or beyond	18% (73)
Frequency of fear of negative evaluation (FNE)	
All the time	12% (51)
Most of the time	21% (88)
Sometimes	37% (153)
Rarely	23% (96)
Never	7% (29)
Comfort speaking English	
Extremely comfortable	88.8% (368)
Moderately comfortable	7% (31)
Slightly comfortable	3% (13)
Slightly uncomfortable	1% (4)
Moderately uncomfortable	0% (0)
Extremely uncomfortable	.2% (1)
Average GPA	3.49
Major	
Biology	69% (286)
Chemistry	0% (0)
Geosciences	0.5% (2)
Physics	0% (0)
Double major in at least one science discipline	11% (47)
Other (business, psychology, sociology)	19.5% (82)

1. To what extent (a) and why (b) do undergraduates perceive other students voluntarily asking questions is helpful in large-enrollment science courses?

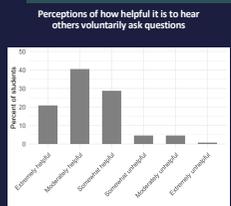


Figure 1. To what extent do students perceive hearing other students ask questions to instructors in front of large enrollment courses is helpful? Over 90% of students reported that they felt it was helpful when others voluntarily ask questions in front of the instructor, while only 9.8% said it was unhelpful. We tested whether there were demographic differences in who perceived this to be helpful or unhelpful. We found that first-generation college students were 5.1 times more likely to perceive that others voluntarily asking questions to the instructor is helpful compared to non-first-generation college students. We did not find any other demographic differences in who found it helpful or unhelpful, but we did find demographic differences in who checked off various reasons as to why it would be helpful to them when other students voluntarily ask questions.

Demographic differences in what factors students find helpful about hearing others voluntarily ask questions

Reasons students perceive other students asking questions is helpful to them	% (n)	Summary of demographic differences of which students selected each reason
I sometimes have the same question	96.0% (361)	Students with high fear of negative evaluation (FNE) were more likely to select this reason.
Other students' questions sometimes help me clarify my thinking	83.2% (313)	
I sometimes feel uncomfortable asking questions myself	77.7% (292)	Women and students with high FNE were more likely to select this reason.
Other students' questions sometimes give me a different way of thinking about the material	73.1% (275)	URM students and students with higher GPAs were more likely to select this reason.
Other students' questions sometimes break up the lecture, which keeps me engaged in class.	39.1% (158)	

Logistic regression was used to test to what extent student demographics predict whether a student would select a particular reason for why they perceived other students asking questions in large-enrollment courses is helpful. All significant findings are summarized in the last column of the table. We only included students in these analyses who reported that they felt other students asking questions is helpful (n = 376). No student reported that none of the presented factors applied to them.

Results

2. How frequently (a) do undergraduates report asking questions in large-enrollment science courses during a semester and what discourages (b) students from asking questions?

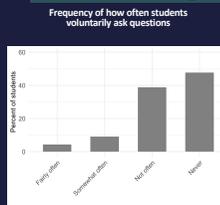


Figure 2. Students' self-reports of the average number of questions they voluntarily ask in front of whole large-enrollment science courses to their instructor per semester. Despite most students perceiving that hearing others voluntarily ask questions is helpful, nearly half of students in our sample reported never voluntarily asking a question in front of a large-enrollment science course to the instructor. This prompted us to examine demographic differences in the reasons students check off that discourage them from voluntarily asking questions in their large-enrollment science courses to the instructor in front of their peers. We found several demographic differences when we explored this. We found that women were 3.5 times more likely than men to select anxiety is what discourages them. Students were 3.9 times more likely to select anxiety discourages them for every one-point increase in FNE. Also, for every year a student has been in college, they were 1.2 times more likely to select anxiety discourages them. For every one-point increase in FNE, students were 2.6x more likely to select FNE as being the reason that discourages them. We also found that for every one-point increase in FNE, students were 1.5 times more likely to select not knowing the material well enough is what discourages them from voluntarily asking the instructor a question in large-enrollment sciences courses in front of their peers.

Demographic differences in what factors discourage students from voluntarily asking questions

Factors that discourage students from asking questions in large-enrollment science courses	% (n)	Summary of demographic differences of which students selected each factor
I feel anxious when I ask questions.	74.9% (149)	Women, students who have been in college longer, and students with high fear of negative evaluation (FNE) were more likely to select this reason.
I can look up the answer to my question myself.	66.3% (132)	
I worry others will judge me.	64.3% (128)	Students with FNE were more likely to select this reason.
I have the option of asking my questions to other students during class.	58.8% (117)	
I don't know the material well enough to ask a good question.	55.3% (110)	Students with high FNE were more likely to select this reason.
I have the option of asking the instructor my question outside of class.	53.3% (106)	
It would take away from other students' class time.	36.3% (72)	
Another student will likely ask my question.	23.1% (46)	
I don't think I will get a detailed enough answer to my question during class due to limited time.	22.1% (44)	

Logistic regression was used to test to what extent student demographics predict whether a student would select a particular reason for why they are discouraged from asking questions in large-enrollment college science courses. All significant findings are summarized in the last column of the table. We only included students in these analyses who reported on average never asking questions in large-enrollment college science courses (n = 199). No student reported that none of the reasons applied to them.

Top three themes about what discourages students from voluntarily participating and example quotes

Theme	Percent (n/196)	Description	Student example quote
Fear of negative evaluation from other students (FNE)	29.6% (58/196)	Students describe being discouraged from asking because of feeling dumb/stupid asking a question. Students worry others will judge them, that they will be perceived of as less smart, dumb, stupid, or that they will sound ignorant if they ask a bad question.	"What discourages me from asking questions is that I think other students are judging me, or if my question is stupid to ask."
Discomfort with public speaking	21.9% (43/196)	Students describe being discouraged from asking not because of having anxiety but feeling timid. Students describe not liking projecting their voice (this mostly has to do with volume). They do not want to be the center of attention. They also report that they are shy. Students state they lack self-confidence and are naturally uncomfortable speaking in class.	"I can be a shy person so I'm not very good at public speaking."
Anxiety/Insecurity	19.9% (39/196)	Students describe being discouraged from asking because of feeling nervous about speaking because of a large class size. Students also report having social anxiety and are intimidated by speaking. Additionally, they can describe that they are nervous that their question may have already been answered (but if they are worried others will judge them, this is FNE).	"I feel intimidated in room of 100 plus students more so when there is a microphone involved I prefer to let other brave students answer."

Conclusions

- Many students find it helpful when their peers voluntarily ask questions in front of the whole class in large-enrollment science courses, yet students do not want to be the ones personally volunteering themselves
- There are a number of different reasons that instructors can acknowledge as to why their students find it helpful and many reasons that have not been previously explored that they can consider as to what discourages certain demographic groups from voluntarily asking questions
- As instructors implement practices to encourage student participation in large-enrollment courses, we posit that a better understanding of what makes student participation valuable or potentially damaging, both to the student participating as well as the other students in the class, would be imperative.

Future Directions

- Exploring backchannels as another way students can share their thoughts and express their voice in large-enrollment courses without feeling "singled out" in front of their peers and without risking judgement from peers and even the instructor
- Investigating backchannels that are specifically anonymous to lower student anxiety which may already be present in large-enrollment science courses
- Understanding why instructors use these methods of participation in large-enrollment science courses and what could be enhanced to better foster inclusion and diversity

Relevant articles to check out!

- Cooper, K. M., Downing, V. R., & Brownell, S. E. (2018). The influence of active learning practices on student anxiety in large-enrollment college science classes. *International Journal of STEM Education*, 5(1), 23.
- Eddy, S. L., Brownell, S. E., & Wenderoth, M. P. (2014). Gender gaps in achievement and participation in multiple introductory biology classrooms. *CBE—Life Sciences Education*, 13(3), 478-492.