Allowing students to ask and answer questions is a common practice employed by college science instructors. However, recent literature has identified that women participate in whole-class discussions less often than men. One hypothesized reason for this gender gap is that women may be less comfortable participating. However, no studies have examined students’ comfort with asking and answering questions in large-enrollment science courses, identified what about these practices might make students uncomfortable, or explored whether there are gender differences with regard to student comfort. To answer these questions, we surveyed 417 undergraduates at an R1 institution about their experiences asking and answering questions in large-enrollment college science courses. Students answered questions about the extent to which they felt comfortable both asking and answering questions and selected possible factors that could make them uncomfortable participating. Using binary logistic regression, we tested whether student demographics predicted their opinions about these practices. Over half of students reported feeling uncomfortable both asking and answering questions in front of college science classes, and women were significantly less comfortable than men both asking and answering questions. Furthermore, we identified student confidence regarding their knowledge of the material and a concern that other students would judge them as some of the primary factors that could cause students to feel uncomfortable asking and answering questions in front of the whole class. This work highlights factors that instructors can target in hopes of maximizing student comfort participating in large-enrollment college science courses.

KEYWORDS comfort, gender, participation, asking questions, answering questions, active learning, comfort

INTRODUCTION

Presenting students with the opportunity to voluntarily ask and answer questions is a common practice employed by college science instructors of both small- and large-enrollment courses (1–5). Having students ask and answer questions in front of the whole class can give the instructor an idea of whether students are grasping the content and can help indicate whether the instructor should move on to the next concept or spend more time helping students learn the current content (6, 7). Asking and answering questions have been shown to specifically benefit college students by enhancing their learning and critical thinking (8) and by creating a welcoming classroom climate (9, 10).

One common critique of these practices is that they can result in inequities with regard to whose voices are heard in the
classroom. Specifically, studies have shown that in college science classrooms, women’s voices are heard less frequently than men’s voices (11), even when there are more women in the class than men (4). This gap has been shown to be magnified in large-enrollment courses (2). Men participating more frequently than women in class has been demonstrated across the sciences (12), and a study of over 500 students, which disaggregated students asking and answering questions, showed that men both asked and answered more questions than women (1). However, other studies have shown that men and women ask questions at equal rates, but that men tend to answer questions more frequently (4, 13).

One potential explanation for this gender gap in participation is students’ comfort voluntarily participating in college science classes (2, 14, 15). Increasing student comfort with in-class activities has been shown to enhance students’ willingness to engage in such activities (14, 16, 17). Specifically, students’ comfort has been shown to be an important predictor of students’ willingness to make contributions to whole-class discussions (2, 10, 14). Additionally, Eddy and colleagues measured biology students’ comfort being oneself in small groups and in whole-class discussion (18). They found that students were significantly more comfortable in small groups compared to whole-class discussion and that this was particularly true for women (18). However, this study only measured students’ comfort in the context of whole-class discussion generally and did not distinguish their comfort levels voluntarily asking and answering questions. Another study conducted in large-enrollment introductory biology courses showed that volunteering to answer a question can cause students significant anxiety (15), which may discourage students from participating in these practices (19, 20). However, this study did not find any gender differences with regard to the level of anxiety students reported having about asking questions (15).

To our knowledge, no studies have examined students’ comfort voluntarily asking and answering questions in the context of large-enrollment college science courses or the factors that contribute to students’ comfort levels when asking or answering questions.

In this study, we examined students’ comfort voluntarily asking and answering questions in the context of large-enrollment college science courses and probed what factors might make students uncomfortable in each of these situations. Furthermore, we assessed not only whether student demographics predict student comfort, but also the factors students identify that may make them uncomfortable participating in class. Based on the extant literature, we hypothesized that women may be less comfortable than men both asking and answering questions, particularly in the context of large-enrollment college science courses. We also hypothesize that certain factors, such as students’ fear of being judged or their confidence in their knowledge of the material, may disproportionately discourage women from asking and answering questions.

Our research questions were:

- To what extent do students feel comfortable asking and answering questions to instructors of large-enrollment college science courses in front of the whole class? To what extent do student demographics predict student comfort asking and answering questions?
- What are the most common reasons students feel uncomfortable asking and answering questions to instructors of large-enrollment college science courses in front of the whole class? To what extent do student demographics predict the factors that make students uncomfortable asking and answering questions?

**METHODS**

This study was done with approved Institutional Review Board protocols 1519 from the University of Central Florida and 11614 from Arizona State University.

This research was conducted as part of a science education course-based undergraduate research experience (CURE) taught by K. M. Cooper in spring 2020 at the University of Central Florida. In a CURE, students conduct authentic research in the context of a course (21, 22). This CURE was backward-designed to involve students in a science education research project with the intent to develop their science process and quantitative reasoning skills (22–24). Nineteen students were enrolled in the CURE: collectively with the instructor; they were responsible for developing the research questions, collecting the data, analyzing the data, and communicating their findings. All data for this study were collected prior to universities delivering courses online due to COVID-19.

**Survey development**

We developed a survey to answer our research questions. At the beginning of the survey, students were asked if they had ever been enrolled in at least one large-enrollment college science course (defined as a biology, chemistry, geosciences, or physics course with 100 students or more) that allowed them to voluntarily ask questions of the instructor in front of the whole class. We also asked whether they had ever been enrolled in a large-enrollment college science course that allowed them to voluntarily answer instructor questions in front of the whole class. Only students who answered “yes” to both questions were invited to complete the rest of the survey.

On the survey, students were asked to think about their experience, on average, in large-enrollment college science courses. We asked students to what extent they felt comfortable voluntarily asking questions of instructors of large-enrollment college science courses in front of the whole class, which they answered using a Likert scale: 1, extremely uncomfortable; 2, moderately uncomfortable; 3, somewhat uncomfortable; 4, somewhat comfortable; 5, moderately comfortable; 6, extremely comfortable. Then, students were presented with a set of previously determined factors that may affect their comfort asking questions. (The development of these factors is described below.) Students were asked to select all factors that may cause them to feel uncomfortable voluntarily asking questions of instructors of large-enrollment college science
courses in front of the whole class. Students then answered a set of identical questions that were focused on answering questions as opposed to asking questions.

(i) Development of previously determined factors

Nineteen researchers collected preliminary data about factors that may influence student comfort asking and answering questions that informed the closed-ended choices presented to students on the survey. To collect the preliminary data, each researcher interviewed five undergraduate science students at a research-intensive institution asking the following questions: (i) “What makes you feel uncomfortable asking questions to an instructor in front of the whole class in your large-enrollment college science courses?” (ii) “What makes you feel uncomfortable answering questions from an instructor in front of the whole class in your large-enrollment college science courses?” The researcher then wrote down a summary of each student’s response to each question. In total, the researchers collected 95 responses to each question. Then, the researchers pooled all students’ responses and iteratively reviewed them to identify common factors that affect student comfort asking questions and common factors that affect student comfort answering questions (25). Specifically, the researchers used constant comparison methods by continuously comparing student responses that were coded as a particular factor to ensure that each response adequately represented the factor and was not different enough from other responses to warrant the creation of a separate factor (25). Most students’ interview responses included multiple factors. In total, the researchers identified 12 common factors that may affect students’ comfort asking questions and 10 common factors that may affect students’ comfort answering questions.

To establish the cognitive validity of the survey, 21 of the researchers (19 student researchers in the CURE and two additional researchers) reviewed and modified the survey questions using criteria developed to assess each question (e.g., “Is the meaning of this question clear?”) (26). Then, all 19 student researchers in the CURE conducted two rounds of think-aloud interviews with a total of 38 undergraduate science students to ensure that students understood what each question was asking (27) and revised the survey iteratively based on their responses. Twenty-one researchers (19 student researchers in the CURE and two additional researchers) then reviewed the revised survey and provided a final set of recommended revisions before the survey was revised a final time. The survey was revised a total of four times based on 78 instances of individual feedback. The survey was then piloted with 30 undergraduate science students, and it was determined that no further revision was needed because students were answering the questions in ways that implied that they understood what each question was asking. A copy of the survey questions that were analyzed is provided in Text S1 in the supplemental material.

(ii) Survey distribution

We emailed instructors at a large research-intensive university in the southwestern United States who were teaching an in-person biology, chemistry, physics, or geosciences class and asked if they would be willing to distribute our survey to their students. Of the 48 instructors who were contacted, 11 agreed to send out the survey to their students. In exchange for participating in the survey, students were given a small amount of extra credit in the course they were recruited from. In cases where the instructor was not able to offer extra credit, students were incentivized to participate by being entered into a drawing to win one of two $100 gift cards. Students were given 1 week to complete the survey. A total of 417 students completed the survey and were included in the analyses.

Analyses. (i) To what extent do students feel comfortable asking and answering questions in large-enrollment science courses?

We calculated the percentage of students who reported each level of comfort asking and answering questions ranging from “extremely uncomfortable” to “extremely comfortable.” Then, we used binary logistic regression to assess to what extent students’ demographics predicted whether they were comfortable or uncomfortable asking questions. All students who answered “extremely uncomfortable,” “moderately uncomfortable,” or “somewhat uncomfortable” were coded as “uncomfortable,” and all students who answered “extremely comfortable,” “moderately comfortable,” or “somewhat comfortable” were coded as “comfortable.” We included demographics in our model that we hypothesized could influence student comfort, including gender (woman or man), race/ethnicity (Asian, white, or BLPA [Black, Latinx, Pacific Islander, and American Indian or Alaska Native]), college generation status (first generation or continuing generation), year in school (first, second, third, or fourth year or more), and grade point average (GPA [0.0 to 4.0]). We recognize that not all students identify as gender binary (woman or man) (28); however, there were too few students who identified as non-gender binary to include this category in the analysis. We grouped students who identified as Black, Latinx, Pacific Islander, and American Indian or Alaska Native into one category (BLPA). These students share the experience of being underserved by institutions of higher education (29). We recognize that the experiences of these students are different, but the small sample sizes of students who identified as Black or African-American, Pacific Islander, and American Indian or Alaska Native necessitated that we pool them with students who identify as Hispanic, Latinx, or Spanish in order to retain all identities in our analyses. We did not nest students within the courses they were recruited from because we asked students to answer questions based on their collective experiences in large-enrollment college science courses. We repeated this exact process to analyze the data about students’ comfort answering questions. The following is an example model: comfortable asking questions
(yes/no) ~ gender + race/ethnicity + college generation + year in school + GPA.

(ii) What factors make students feel uncomfortable asking and answering instructor questions?

To identify which factors students most commonly reported can make them feel uncomfortable asking instructors questions, we only analyzed data from the students who indicated that they felt uncomfortable asking instructors questions. First, we calculated the percentage of students who selected each factor. Then, we used binary logistic regression to assess to what extent student demographics predicted whether a student indicated that a particular factor affected their comfort. For each factor, we ran the following model: student-selected factor (yes/no) ~ gender + race/ethnicity + college generation + year in school + GPA. We repeated this process to analyze the question about what factors make students uncomfortable when answering questions.

(iii) Data interpretation

There are several ways to interpret model coefficients from logistic regression; the most accessible way is to interpret the natural exponential of the estimated coefficient, which is the ratio of the odds that one demographic group (e.g., women) will report a particular factor (e.g., that their confidence in the material affects their comfort) compared against the odds that another group (e.g., men) will report the same factor, also referred to as the "odds ratio." As such, we use odds ratios when summarizing and reporting our findings.

RESULTS

Participants

Of the students who completed the survey, 68.3% identified as women, 46.5% identified as white, and 57.8% identified as continuing-generation college students. All student demographics are reported in Table 1.

Finding 1. Over half of students report that they feel uncomfortable voluntarily asking questions to instructors of large-enrollment college science courses in front of the whole class.

Sixty-four percent of students reported that they were uncomfortable voluntarily asking questions to instructors of large-enrollment college science courses in front of the whole class, while 36.5% of students reported that they were comfortable (Fig. 1). Specifically, students were most likely to report that they were moderately uncomfortable asking questions (26.4%) and least likely to report that they were extremely comfortable asking questions (4.6%).

Finding 1a. Women are more uncomfortable than men asking questions.

We found that women were 2.9× more likely to feel uncomfortable asking questions compared to men while controlling for the other demographic factors (Table 2 and Fig. 2).

Finding 1b. Students' lack of confidence in the course material and fear of judgement can make them uncomfortable voluntarily asking questions.

We examined what factors students most commonly reported affected their comfort asking questions and whether disproportionately likely to be selected by women. Students most frequently reported that they felt uncomfortable voluntarily asking instructors questions in front of the whole class if they do not feel confident about the course material (72.5%) and if they feel that other students will judge them (67.5%). Over half of students also selected that they felt uncomfortable if they feel like there are too many people in the class

TABLE 1
Demographics of survey participants

| Demographic                          | Result (n = 417) |
|--------------------------------------|-----------------|
| Gender identity, % (n)               |                 |
| Woman                                | 68.3 (285)      |
| Man                                  | 30.7 (128)      |
| Other                                | 0.2 (1)         |
| Declined to state                    | 0.7 (3)         |
| Race/ethnicity, % (n)                |                 |
| Black or African-American            | 6.7 (28)        |
| Hispanic, Latinx, or Spanish origin  | 20.4 (85)       |
| White/Caucasian                      | 46.5 (194)      |
| Asian                                | 15.3 (64)       |
| American Indian or Alaskan Native    | 1.2 (5)         |
| Pacific Islander                     | 0.7 (3)         |
| Other/multiple                       | 6.7 (28)        |
| Declined to state                    | 2.4 (10)        |
| College generation status, % (n)     |                 |
| 1st generation                       | 39.1 (163)      |
| Continuing generation                | 57.8 (241)      |
| Declined to state                    | 3.1 (13)        |
| Yr in college, % (n)                 |                 |
| 1st                                  | 23.7 (99)       |
| 2nd                                  | 36.5 (152)      |
| 3rd                                  | 22.3 (93)       |
| 4th or more                          | 17.5 (73)       |
| Declined to state                    | 0.0 (0)         |
| GPA, avg ± SD                        | 3.49 ± 0.45     |
and if the instructor responds negatively to other students’ questions (52.5%). See Table 3 for the percentage of students who selected each factor. We conducted binary logistic regressions to test whether women were disproportionately likely to select particular factors and controlled for other demographic variables, including race/ethnicity, college generation status, year in school, and GPA. The results of the full logistic regressions can be found in Text S1. Only the gender differences are presented in Table 3. Women are significantly more likely than men to select that they feel uncomfortable asking questions if the instructor does not designate class time for students to ask questions, which was selected by 25.3% of students.

TABLE 2
Results of logistic regression testing to what extent student demographics predict whether students are comfortable or uncomfortable voluntarily asking questions in front of the whole class to instructors of large-enrollment college science courses

| Model                          | B ± SE  | z value | P value |
|--------------------------------|---------|---------|---------|
| Intercept                      | 0.51 ± 1.15 | 0.44 | 0.66 |
| Gender (men)                   |         |         |         |
| Women                          | -1.07 ± 0.25 | -4.28 | <0.001 |
| Race (white)                   |         |         |         |
| Asian                          | 0.06 ± 0.32 | 0.32 | 0.86 |
| BLPA                           | 0.38 ± 0.27 | 1.40 | 0.16 |
| Generation status (continuing generation) |         |         |         |
| 1st generation                 | -0.33 ± 0.25 | -1.35 | 0.18 |
| Yr in school                   | -0.22 ± 0.12 | -1.84 | 0.07 |
| GPA                            | -0.04 ± 0.28 | 0.13 | 0.90 |

B, estimated model coefficient; SE, standard error; z value = B/SE.

The P values shown are two-sided P values based on the standard normal distribution. Reference groups are in parentheses.

FIG 1. Results of a Likert scale question asking students how comfortable they are on average asking questions in front of the whole class to instructors of large-enrollment college science courses.

FIG 2. Violin plot summary of student comfort asking questions by gender measured on a Likert scale ranging from 1 (extremely uncomfortable) to 6 (extremely comfortable). Box limits indicate the 25th and 75th percentiles. The polygons represent density estimates of the data and extend to extreme values. Black circles indicate the means.
TABLE 3
Percentages of students and differences in gender who selected each factor that would make them feel uncomfortable asking questions of instructors of large-enrollment college science coursesa

| What makes students feel uncomfortable asking questions | % (n) | Odds ratio of gender difference | P value for gender in respective model |
|--------------------------------------------------------|-------|---------------------------------|---------------------------------------|
| If I do not feel confident in the course material       | 72.5 (192) | Women are 1.4× more likely to select this factor | 0.299 |
| If I feel that other students will judge me             | 67.5 (179) | Women are 2.0× more likely to select this factor | 0.052 |
| If I feel like there are too many people in class       | 55.8 (148) | Women are 1.5× more likely to select this factor | 0.244 |
| If the instructor responds negatively to other students’ questions | 52.5 (139) | Men are 1.2× more likely to select this factor | 0.668 |
| If asking a question might make me feel less smart     | 49.4 (131) | Women are 1.9× more likely to select this factor | 0.060 |
| If other students are not asking questions during class | 47.2 (125) | Women are 1.1× more likely to select this factor | 0.824 |
| If the instructor does not seem to welcome students’ questions | 44.9 (119) | Women are 1.1× more likely to select this factor | 0.803 |
| If it is hard to ask a question from where I sit in class | 36.2 (96) | Men are 1.0× more likely to select this factor | 0.932 |
| If it is obvious to other students in class that I am the one asking the question | 29.4 (78) | Women are 1.1× more likely to select this factor | 0.744 |
| If I have not had the opportunity to discuss my questions with other students in class | 29.4 (78) | Men are 1.1× more likely to select this factor | 0.944 |
| If the instructor does not designate class time for students to ask questions | 25.3 (67) | Women are 2.6× more likely to select this factor* | 0.040 |
| If other students are talking while I’m asking a question | 22.6 (60) | Women are 1.3× more likely to select this factor | 0.547 |
| None of these apply to me                               | 2.6 (7) | NA                             | NA                                    |

*aFor this analysis, we included the total n = 265 students who reported that they were uncomfortable asking questions. For each factor, we used binomial logistic regression to test whether a woman or man is more likely to select it, controlling for race/ethnicity, college generation status, year in school, and GPA. The results of each regression can be found in Text S1. In this table, we include the odds ratios that a woman or man is more likely to select a particular factor, and we indicate with an asterisk which odds ratio is significant at the significance level of 0.05. We also include the P values for gender in the regression model in the last column. NA, not applicable, because we did not test whether there were differences with regard to who selected “none of these apply to me,” since so few students selected this category.

Finding 2. Over half of students report that they feel uncomfortable voluntarily answering instructors’ questions in large-enrollment college science courses in front of the whole class.

Sixty-four percent of students reported that they were uncomfortable voluntarily answering questions from instructors of large-enrollment college science courses in front of the whole class, while 36.2% of students reported that they were comfortable (Fig. 3). Specifically, students were most likely to say they were moderately uncomfortable (22.5%) and least likely to say that they were extremely comfortable (4.1%) answering instructors’ questions in front of the whole class.

Finding 2a. Women are more uncomfortable than men answering instructors’ questions.

We found that women are 2.9× more likely to feel uncomfortable answering questions compared to men while controlling for the other demographic factors. (Table 4 and Fig. 4)

Finding 2b. Students’ lack of confidence about their answer and lack of clarity of the material can make them uncomfortable voluntarily answering questions.

We examined what factors most commonly affected a student’s comfort answering questions. Students most frequently selected that they felt uncomfortable voluntarily answering instructors’ questions in front of the whole class if they do not feel confident about their answer (91.4%). Students were also likely to select that they felt uncomfortable if the material is not clear to them (82.3%). Additionally, 68.0% of students highlighted that they felt uncomfortable if they are afraid of speaking in front of the whole class. More than half of students also highlighted that they felt uncomfortable if they feel other students will judge them (63.2%) or if they feel like there are too many people in the classroom (54.5%). See Table 5 for the percentage of students who selected each factor. We conducted binary logistic regressions to test whether women were disproportionately likely to select each factor. In each regression, we controlled for other demographic variables, including race/ethnicity,
college generation status, year in school, and GPA. The results of the full logistic regressions can be found in Text S1. Only the gender differences are presented in Table 5. Women are significantly more likely than men to report that they do not feel comfortable answering questions if they do not feel confident in their answer.

**DISCUSSION**

In this study, we examined students’ reported comfort with two common classroom engagement practices: asking

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**TABLE 4**

Results of logistic regression testing to what extent student demographics predict how comfortable students are voluntarily answering questions from instructors of large-enrollment college science courses in front of the whole classa

| Model                          | B ± SE   | z value | P value |
|--------------------------------|---------|---------|---------|
| Intercept                      | 0.34 ± 1.15 | 0.29    | 0.78    |
| Gender (men)                   |         |         |         |
| Women                          | −1.08 ± 0.25 | −4.35   | <0.001  |
| Race (white)                   |         |         |         |
| Asian                          | 0.00 ± 0.32 | 0.01    | 0.99    |
| BLPA                           | −0.18 ± 0.27 | −0.64   | 0.52    |
| Generation status (continuing generation) |         |         |         |
| 1st generation                 | −0.10 ± 0.25 | −0.42   | 0.68    |
| Yr in school                   | −0.07 ± 0.12 | −0.57   | 0.57    |
| GPA                            | 0.00 ± 0.28 | 0.02    | 0.99    |

*aB, estimated model coefficient; SE, standard error; z value = B/SE. The P values shown are two-sided P values based on the standard normal distribution. Reference groups are in parentheses.

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FIG 3. Results of a Likert scale question asking students how comfortable they are on average answering questions from instructors in front of the whole class in large-enrollment science courses.

FIG 4. Violin plot summary of student comfort answering questions by gender measured on a Likert scale ranging from 1 (extremely uncomfortable) to 6 (extremely comfortable). Box limits indicate the 25th and 75th percentiles. The polygons represent density estimates of the data and extend to extreme values. Black circles indicate the means.
As we hypothesized, we also found that women are disproportionately more likely to feel uncomfortable asking and answering questions compared to men. While Eddy, Brownell, and colleagues found that students were significantly more comfortable in small groups compared to whole-class discussion, and this was particularly true for women, they did not identify any significant difference between men’s and women’s overall comfort in whole-class discussion (12). Our findings align with another study of students across different college courses showing that women were less comfortable contributing to whole-class discussion and subsequently reported participating less than the men in class (14). To our knowledge, our study is the first to reveal a gender gap with regard to different types of participation in large-enrollment science courses: asking instructor questions and answering instructor questions in front of others in the classroom.

Helping students become more comfortable asking and answering questions is not only integral to enhancing the experiences of many students in college science courses, but it may also help close the gender participation gap. Instructors can help students feel more comfortable in class by increasing instructor immediacy, which has been described as lessening the psychological distance between students and their instructors in the classroom setting (31–33). Instructors can practice immediate behaviors, such as using student names (34, 35), walking around the classroom (36), making eye contact with students (36), and using humor cautiously (37–39). Instructors can also use instructor talk, defined as language used by the instructor that is not solely based on the course.

**TABLE 5**

The percentages of students and gender differences in who selected each factor that would make them feel uncomfortable answering questions in front of the whole class to instructors of large-enrollment college science courses

| What makes students feel uncomfortable answering questions | % (n) | Odds ratio of gender difference | P value for gender in respective model |
|-----------------------------------------------------------|-------|-------------------------------|-------------------------------------|
| If I do not feel confident about my answer                 | 91.4 (243) | Women are 3.3× more likely to select this factor | 0.027 |
| If the material is not clear to me                        | 82.3 (219) | Women are 1.9× more likely to select this factor | 0.130 |
| If I am afraid of speaking in front of the whole class    | 68.0 (181) | Women are 1.8× more likely to select this factor | 0.079 |
| If I feel that other students will judge me               | 63.2 (168) | Women are 1.8× more likely to select this factor | 0.082 |
| If I feel like there are too many people in the classroom | 54.5 (145) | Women are 1.2× more likely to select this factor | 0.607 |
| If the instructor responds negatively when other students answer questions | 48.1 (128) | Men are 1.0× more likely to select this factor | 0.926 |
| If I am unable to discuss my answer with other students before answering in front of the class | 40.2 (107) | Men are 1.2× more likely to select this factor | 0.575 |
| If other students are not answering questions             | 37.2 (99) | Men are 1.0× more likely to select this factor | 0.899 |
| If it is hard to answer a question from where I sit in class | 33.8 (90) | Men are 1.1× more likely to select this factor | 0.835 |
| If it is obvious to others in class that I am the one answering the question | 27.1 (72) | Women are 1.5× more likely to select this factor | 0.314 |
| None of these apply to me                                 | 1.5 (4) | NA                            | NA |

*For this analysis, we only included the total n = 266 students who reported that they were uncomfortable answering questions. For each factor, we used binomial logistic regression to test whether a woman or man is more likely select it, controlling for race/ethnicity, college generation status, year in school, and GPA. The results of each regression can be found in Text S1. In this table, we include the odds ratios that a woman or man is more likely to select a particular factor, and we indicate with an asterisk which odds ratio is significant at the significance level of 0.05. We also include the P values for gender in the regression model in the last column. NA, we did not test whether there were differences with regard to who selected “none of these apply to me,” since so few students selected this category.
content (40, 41), to help students build confidence and lessen potential judgement, two factors that students in this study reported affected their comfort participating. Using instructor talk, instructors can highlight that the purpose of asking questions is to garner new knowledge and that asking questions highlights that students are intelligent and curious as opposed to indicating a lack of knowledge. Instructors can also explain the reasons why they allow students to voluntarily ask and answer questions and be clear that they hope that all students will participate in these opportunities. When students perceive that their instructors are transparent about what is expected of them, then they are more willing to meet those classroom expectations (42–44). Presenting students with data at the beginning of the semester is another approach to increase their comfort participating. Studies have shown that students who participate more in class are perceived as more knowledgeable than their peers (45, 46); presenting these findings may help students who are uncomfortable because they are worried their peers will judge them realize that their peers are more likely to perceive they are smart (not less smart) when they participate in class. Additionally, instructors may want to set aside specific times for students to ask questions. Our findings show that this may be particularly important for women, since they were more likely to report that they feel uncomfortable asking questions if instructors do not set aside a specific time for this practice. Instructors can also moderate whose voices are heard and when; one study showed that when a man was the first to ask a question, women asked proportionately fewer questions in academic seminars (47). In sum, this study has revealed a variety of potential factors that instructors can target to increase student comfort asking and answering questions in class.

Limitations

Students in this study were asked to consider their collective experience in large-enrollment college science courses when reporting their comfort asking and answering questions. Who instructors are, including their gender (14, 32, 48), their approach to inviting students to voluntarily ask and answer questions (10), and their ability to establish a positive classroom climate (48, 49) likely affect student comfort. As such, students’ comfort levels would likely vary if they were asked to think about one course compared to another. Additionally, this study was conducted at a large research-intensive institution, and students were asked specifically about their experiences in large-enrollment college science courses. Therefore, these findings are not generalizable to other institution types or other class sizes. Finally, the students who participated in this study had significantly higher GPAs (3.5) than the average GPA at this institution (3.3); therefore, these findings may be more reflective of the opinions of higher-performing students. Since students’ grasp of the material was a factor that affected their comfort, we hypothesize that these findings may overestimate the comfort of students with average GPAs with regard to asking and answering questions.

Conclusions

In this study, we examined student comfort voluntarily asking and answering questions in large-enrollment college science courses. We found that over half of students report that they are uncomfortable voluntarily asking and answering questions in front of the whole class in large-enrollment college science courses. Furthermore, women are less comfortable than men both asking and answering questions in class. Common reasons for why students may feel uncomfortable asking and answering questions are that they are not confident in their knowledge of the material and that they are concerned they will be judged by other students. Improving student comfort asking and answering questions may be a key step in improving the experience of many college science students and might be helpful in reducing the well-established gender gap in student participation in college science classes.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, DOCX file, 0.03 MB.

ACKNOWLEDGMENTS

We thank the students who participated in our survey and the instructors of the courses from which they were recruited, as well as RachelScott and Sara Brownell for their thoughtful feedback on earlier versions of the manuscript. Conflicts of interest do not exist for this work.

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