Science and Mathematics Department
Student Learning Outcomes Assessment Report
AY 2022–2023

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Summary

In academic year 2022–23, the Assessment Committee collected and analyzed student survey data from science (SC) and science with lab (SL) classes and from the multi-section mathematics courses.

The survey developed for SC- and SL-designated courses focused on the second general science outcome, that "students should be able to discover, evaluate, and assess the credibility of general interest publications related to the scientific subjects they study." The main goal was to understand students' perceptions of what kinds of activities are most and least effective and to provide faculty information that can lead to improved teaching and learning.

The Assessment Committee, informed by students' responses to the survey, makes the following specific recommendations:

- The department may wish to consider revisiting, perhaps to revise or to reaffirm, the general outcomes statements, which were adopted in academic year 2012–13. As part of this conversation, attention should be paid to not just what we want to assess, but on what basis we assign grades.
- Continue enhancing our courses' emphasis on identifying limitations in the design of scientific studies.
- Instructors of remote classes, particularly asynchronous classes, could consider student presentations as a way to both better center students' voices and promote student-student interaction.
- Group or team learning activities are highly valued by students, effective, and should be used whenever appropriate. Groups can be particularly effective when a task requires students to stretch out of their comfort zone; for example, when asked to evaluate claims and reach their own conclusions. Students uncomfortable when the instructor refuses the mantle of scientific authority may be more comfortable with the support of a team.
- When assigning students readings, instructors should consider providing students with choices in media. While this must be balanced with other factors, including availability of quality options and learning goals, it can make access to information more equitable. Inviting students to find sources related to a topic can be a further enhancement by increasing students' agency in the learning process and by increasing the diversity of the authors of materials used in class.

Students taking Basic Math Skills, College Mathematics, Liberal Arts Mathematics, and Quantitative Reasoning were asked about their thoughts regarding some selected applications of the mathematics tools they were learning and invited to suggest additional application types. Students in those mathematics courses were also asked about their experience with the ALEKS placement system.

The Assessment Committee, informed by students' responses to the survey, makes the following specific recommendations:

- As with the science outcomes, the department may wish to consider revisiting, perhaps to revise or to reaffirm, the general outcomes statements, which were adopted in academic year 2012–13. As part of this conversation, attention should be paid to not just what we want to assess, but on what basis we assign grades.
- Coordinators should consider how scale model problems are used as an application of proportion.
- Coordinators may consider the survey results for their courses in more detail and make adjustments.
- The department should consider ways to improve the use and value of ALEKS, including investigating the creation of a course that would require students to engage with ALEKS as part of the course content.

Programs

The Science and Mathematics department's programs are as follows:

Majors:	• Environmental and Sustainability Studies, BA
Minors:	• Biology • Environmental Studies • Health and Wellness • Mathematics
Core:	• Science • Science with Lab • Mathematics

Goals for the Academic Year

The main foci for assessment in the 2022–23 academic year were:

- Science outcome 2: *Upon successful completion of science courses, students should be able to discover, evaluate, and assess the credibility of general interest publications related to the scientific subjects they study.* This outcome is common to science courses with both SC and SL designations and is rooted in the goal of helping students become more sophisticated and critical as they engaged with a variety of media forms. The committee was interested in understanding students' perceptions of their ability to understand information related to science that they may encounter in a variety of formats and how activities in science courses promote their ability to critically evaluate that information.
- Mathematics: Having collected data related to both mathematics outcomes last year, the committee was interested in hearing from students about the kinds of "applications" they find engaging and useful. It is commonly held that a student's understanding of mathematics is improved when learned in a context they find meaningful and relevant; collecting information directly from our students about their perceptions of some of the current problem contexts and inviting them to contribute ideas could support faculty efforts to make applied problems even more relevant.

Science Outcome 2

The department's three general education science outcomes have been assessed on a rotating basis, with one objective each year. Following that pattern, this year the focus returned to the second outcome, that "students should be able

to discover, evaluate, and assess the credibility of general interest publications related to the scientific subjects they study." Continuing with the practice of collecting indirect evidence via student surveys, which we began in fall 2020, the Assessment Committee again distributed a survey to students in all science classes. The main goal of the survey was to collect data about students' perceptions of the activities they participated in related to consuming and evaluating publications and what made those activities effective or could make them more effective. The goal of this data collection was to provide faculty information that can lead to improved teaching and learning.

Methods

At the start of the fall 2022 semester, the Assessment Committee developed a student survey (see appendix) in Qualtrics. This survey was largely modeled on the one used the previous year, with revisions based on our experience from the past and due to differences in the outcomes being assessed.

Introductory text explained the purpose of the survey and made clear that evaluation of faculty or classes was not the goal.

A version of the question labeled *QComfort*[1] was first used in the fall 2021 data collection. This question asks the student about their perception of their own ability to perform tasks relevant to the learning outcome. The specific items were based on the rubric faculty have used to evaluate student work as part of collecting direct evidence of learning in previous years. While results for this question may be interesting in and of themselves, the primary purpose was to help students focus on the kinds of skills they should be thinking about when answering the later questions.

Next, students were instructed to focus on the specific course mentioned in the survey. The question labeled *QFormat* asked them to identify the modality (in person, synchronous, or asynchronous) of their course. The *QActivities* question presented a list of typical activities that students may engage in during a science course. The list of provided options was refined from the previous year's survey.

The next three questions were open-ended and asked students to identify a specific activity that they recognized as related to the outcome being assessed, to explain how that activity was effective, and to suggest how it could be improved. These were slightly different from similar questions asked in the past. Previously, the survey has asked students to identify two activities—one effective and one less so—and to say why the one activity was effective and how the less effective activity could be improved. This year, the committee was cognizant that many, if not most, of our science classes include relatively few activities of this nature and that they tend to occur later in the semester. There

[1] Question labels refer to those shown in the version of the survey in the appendix; those labels were not seen by students completing the survey.

are a variety of reasons for this, not least of which is the need for students to develop a base of content knowledge within the course's subject before being able to exercise many of the component skills. The committee has consistently distributed student surveys well in advance of the launch of the college-wide student evaluations of teaching (SETs) to avoid depressing response rates for both our surveys and the department's SETs; however, in conjunction with the fact that activities involving this outcome frequently are late in the semester makes collecting informed responses a challenge.

The final question, labeled *ClassEffect* asked students to think beyond the classroom and reflect on how the course activities changed how they engage with and think about science. The committee was aware that this would be a difficult question for students to answer, but it relates directly to the outcome, as the goal is for students to apply what they learn about evaluating evidence to the media and other aspects of their lives.

Class lists for all SC- and SL-designated courses, as well as MATH 101, MATH 110, MATH 115, and MATH 120, were obtained. These were combined into a single file and students whose course status was other than "Registered" were filtered out, leaving 2103 course enrollment records, corresponding to 1955 unique students.

Most students, 1813 of 1955, appeared on only one of the class rosters. An additional 136 were taking two of the classes, and 6 in three classes. To avoid asking individual students to complete multiple surveys, students enrolled in multiple courses in the department were randomly assigned to one of the courses in which they were enrolled. Of the 1955 unique students, 672 were invited to participate in the mathematics survey and 1283 in the science survey.

All faculty in the department were given an opportunity to preview the survey with a request to promote it in their class. To accommodate instructors willing to provide extra credit for completing the survey, students were sent an automatic "thank you" email by Qualtrics which they could forward to their instructor as proof of having done the survey while keeping their responses private.

Survey invitations were sent by Qualtrics to students' email addresses on November 7, 2022, with reminders on November 15 and December 7. The email message specified the course the student was being surveyed about. Response collection ended on December 12, 2022.

Results

From the 1283 invitations sent to students in SC- or SL-designated courses, 292 students began the survey, with 5 responses marked by Qualtrics as spam and another 80 excluded because the individual began the survey but did not respond to any questions. This leaves 207 responses (a 16.1% response rate).

Note that the central goal is to obtain feedback from students that faculty can use to improve teaching and learning in future semesters. There is no pretense that these results represent statistically valid inferences about all students taking science classes, and no attempt was made to ensure the sample was representative. Moreover, demographic information was not collected from respondents so as to avoid the suggestion of representativeness. Consequently, the results here should be understood to only reflect the sample itself, subject to the self-selection bias inherent to surveys and unknown biases as well. When included, error bars representing standard error provide a sense of the results relative to the sample size but are not intended to assert statistical validity. Numbers displayed on bars represent the number of individuals giving that response. Full-sized plots are included in the appendix.

The first question, labeled *QComfort* in the version of the survey displayed in the appendix, asked students to rate their level of comfort performing tasks related to discovering, evaluating, and assessing the credibility of publications related to the scientific topics studied in their class. The specific tasks listed were based on the rubrics used by instructors to evaluate student work in previous assessment activities and includes finding and evaluating sources, identifying hypotheses, determining whether data support the hypothesis, identifying connections to class topics, identifying limitations and further questions, and arriving at a conclusion. Students rated their comfort with each on a scale of extremely, highly, somewhat, slightly, or not at all comfortable. Note that, to encourage students to separate their perception of their skills from their attitude toward their particular course, they were explicitly instructed that the question was asking about their level of comfort resulting from all the experiences they have had with science. Results are shown in Figure 1.

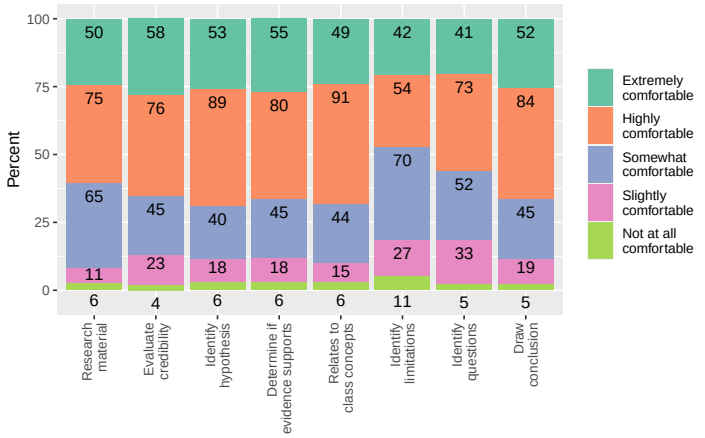

Figure 1: Responses to 'For each component below, please indicate how comfortable you are performing that task.'

Responses to the second question, *QFormat*, indicated that the majority of

respondents (76.3%) were enrolled in fully in person courses.

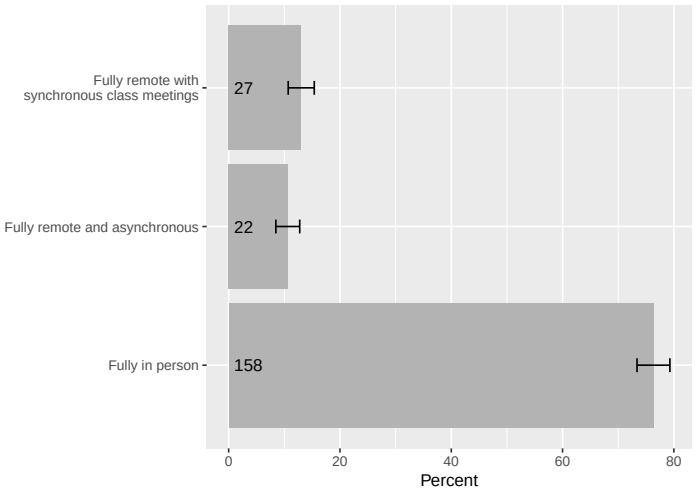

Figure 2: Responses to 'What is the class meeting format?'

The data regarding comfort with tasks were also disaggregated by modality and course designation. Figure 3 shows the percent of students with each course modality who answered that they were at least Somewhat Comfortable with the elements of the scientific process and Figure 4 shows the same percent for students in courses designated SC and SL.

Following the question about the course modality, students were asked to select from a range of options the kinds of activities they engaged in for their science class. Results are shown in Figure 5 and are disaggregated by course modality and designation in Figures 6 and 7.

In addition to the prepared choices for the multi-select question *QActivities*, students could indicate another type of activity. Only five students used that option, one of whom mentioned attending a field trip and another wrote "Strengthened my writing skills as I wrote a final paper on any Astronomer of my choice."[2] Both field trips and writing papers are worth considering as additional items for this question.

The first open-ended question asked students to describe an activity for which they engaged with a general interest publication and whether they found it effective. Overwhelmingly, the most popular kind of activity—referenced in 37 of the 106 responses—was watching videos. These included feature-length and made-for-TV documentaries (e.g., *Super Size Me* and *NOVA* episodes) and shorter pieces (e.g., TED Talks and *MythBusters* segments) shown in class or assigned for viewing outside of class. Many of the responses indicated that the video was specifically assigned, such as one student who wrote "For homework,

[2]all quotations are verbatim, except when elided and indicated by ellipses

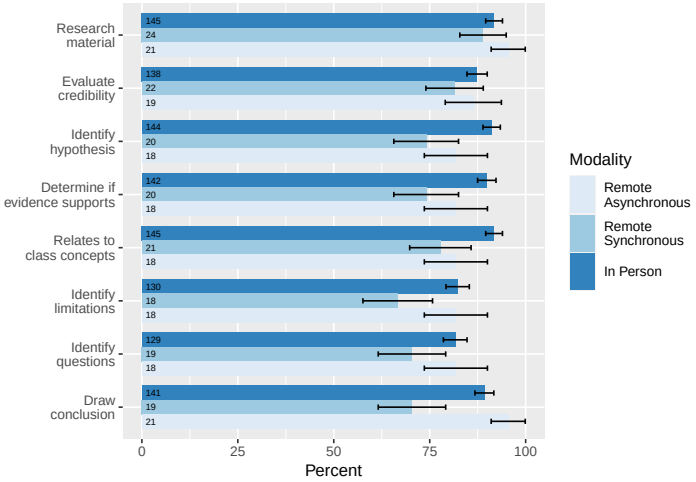

Figure 3: Percent of students indicating they are at least Somewhat Comfortable with the elements of consuming scientific information, disaggregated by course modality.

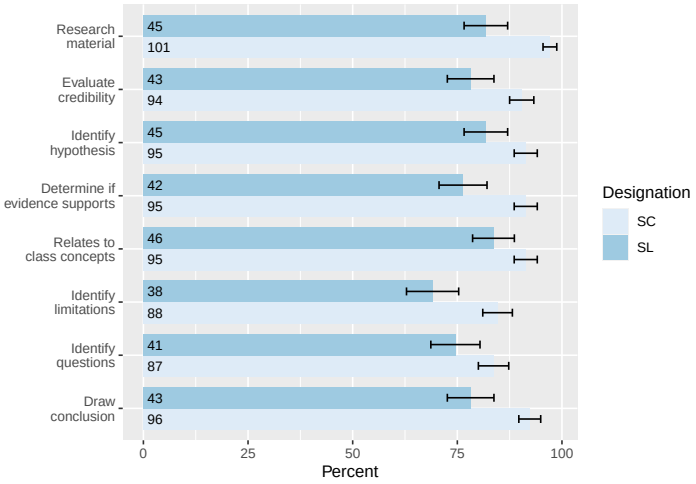

Figure 4: Percent of students indicating they are at least Somewhat Comfortable with the elements of consuming scientific information, disaggregated by course designation.

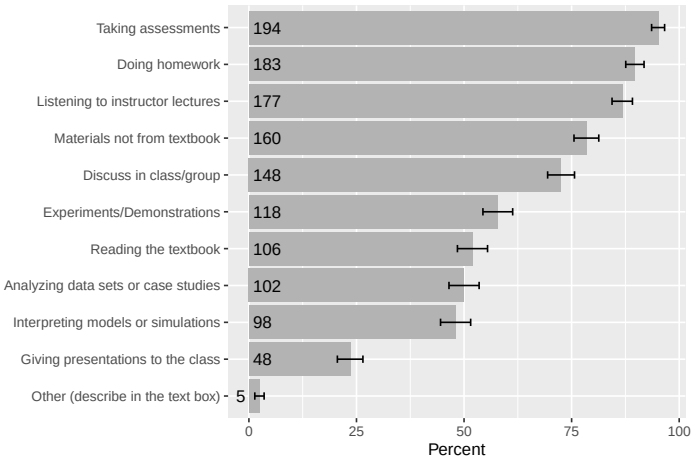

Figure 5: Responses to 'Which of the following kinds of activities have you engaged in for this science class?'

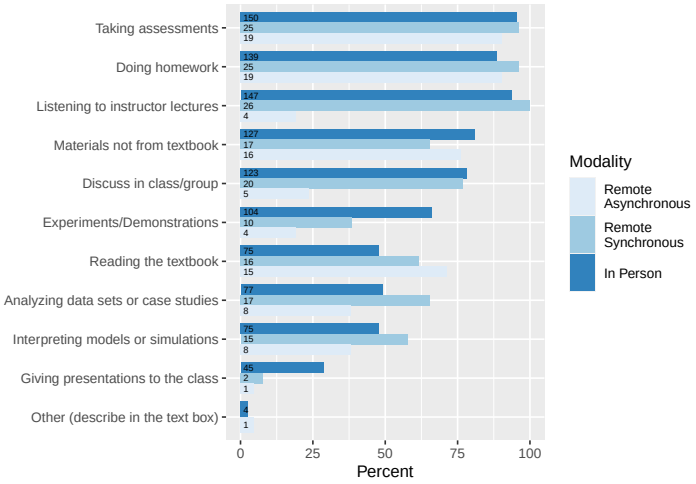

Figure 6: Responses to 'Which of the following kinds of activities have you engaged in for this science class?' disaggregated by course modality.

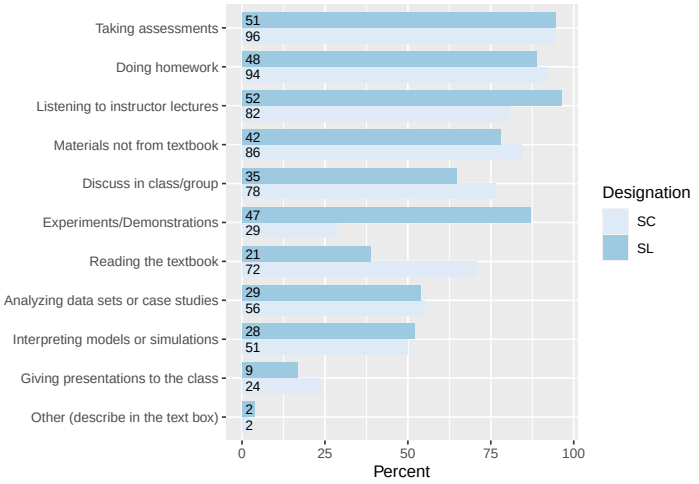

Figure 7: Responses to 'Which of the following kinds of activities have you engaged in for this science class?' disaggregated by course designation.

we would sometimes have to watch a specific video that covered a topic we went over in class in order to answer question on the homework assignment." Other responses were ambiguous about whether the specific video was chosen by the instructor or found by the student, but at least one of the responses made it clear that the class content inspired them, writing, "I was interested in art with holography so one night I watched a lot of youtube videos of people making and constructing holographic art."

Other common responses to this question included activities that are social, with 18 students mentioning class discussion or group work. One student was quite clear, saying, "we did group activities that included talking which i found fun."

Activities that were hands-on were also quite popular (14 mentions); these were mainly from SL-designated classes and frequently mentioned labs, but 4 comments from SC-designated classes also mentioned hands-on activities.

Also, 12 comments made clear that doing their own research was most beneficial. One response seemed to indicate that the student was researching topics even without it being a class requirement, but most described assignments, which varied from a daily activity ("Every day in one class, we read coverage of a topic as a small group and report out to the class") to final projects and papers. One comment describing working on a final paper: "As a i was writing my final paper on Galileo, I came across the amazing library website we have at Columbia. This site allows me to research using credible sources, including the references in them. I will now use this for any research." This comment suggests that the student has a growing awareness of how different methods of searching for sources lead to different quality results.

Many of the responses to the second open-ended question, which asked what made the activity effective, indicated that the activity helped them better understand the course content (36 of the 105 responses). A few students made comments about technical or mathematical elements. Another student wrote, "It didn't persay develop my abilities but it did enhance my understanding of genetics and how powerful a single alteration can be," suggesting that this student recognized that the activity they chose helped their understanding of the specific course content but may not have been that relevant to the skills related to evaluating sources. With a small number of clear exceptions, many of these 36 responses seem to indicate that the student was identifying an activity they enjoyed or thought helped them with specific science concepts, rather than one that developed the specific skills the committee was interested in for this survey.

Similarly, the next most common theme among responses to this question referred to the activity providing a "real world" connection (20 responses). The "real world" sometimes included the students themselves, as for one student who wrote, "From this activity, it made me think about what traits I had from both parents, having these DNA traits were nothing special of course, it was just nice to know." Another eight responses made reference to visual learning. But again, most of the responses of these kinds seemed to be focusing on how the activity helped the student understand the course content.

There were, however, some responses to this question that did make it clear the activity improved the student's skills in evaluating source material. One student acknowledged the long-term value gained, writing, "I now feel more refined as a writer, and my skill in gathering information and statistics have improved." Others indicated that the experience helped "develop my logic thinking" or "helped me do research beyond class time."

The third open-ended question asked students what could make the activity they described more effective. Many of the responses echoed those of the previous two questions, such as adding more discussion (7 mentions), making the activity more hands-on (3 mentions), and making the activity or topic more relevant or connected to the "real world" (6 mentions).

A few responses did include constructive suggestions that were not mentioned earlier, including seven that suggested follow-up activities or assignments. Once again, many of these kinds of responses—such as, "If we followed up on it or possibly dug further into the topic"—seemed to focus on understanding the content rather than the skills involved in evaluating sources. However, one student, who had described an assignment in which they were to find an article on the general topic and then write an evaluation of the article, suggested doing additional activities with a similar structure. It is certainly true that multiple opportunities for students to engage with either content or these more general skills is likely to lead to stronger outcomes.

Three students asked for some version of a "recap." For example, one student wrote, "Spending sometime talking about it in the next class because I think we

kinda glossed over what the true intended answer of the comparison was. the main answer was a bit muddled for people and I think hearing a lecture on it would've been good." This response is particularly interesting in that it reveals the student's perspective of the instructor as arbiter and dispenser of the "true intended answer."

Two other students mentioned the value of their taking more ownership of the activity and their learning. One of the students said this clearest, writing "Maybe, if we had to provide the articles ourselves." Allowing students to find their own sources is a straightforward way to make classes more inclusive of student input and can also lead to greater diversity in the media creators represented in the class.

The last question asked students how the course changed how they engage with and think about science outside of the class. The most common kind of response to this question (20 responses) described being inspired by the class. One student wrote that "I think I might be vet and not a artist. Science classes have changed me." Several described how the way they understand the world changed, with one writing, "The activities in this class have taught me to consider Chemistry as not only a science, but a language of chemicals. I think thats a beautiful yet accurate sentiment." Another student commented along similar lines, saying "This activity has made me approach life differently. Learning about human evolution is making me approach humans and other species with more care. ... I've sought out more ways to learn about my environment and have become curious to all systems of life around me."

Thirteen responses touched on the notion that the class deepened their understanding of the topic. For example, "I definitely understand more about HIV and how it functions." This echoes respondents' focus on the class topic in the previous questions.

Another twelve responses described how the course helped the student realize that "Science is everywhere!" Some students' comments in this direction were specific to their major, like an animation major who wrote that, "When I was creating an animation of a pendulum swinging this semester, it was easy knowing what I learned about in physics the day before, in terms of know what the velocity of the pendulum would be." For others, it was more personal; one response described how they connected genetics concepts to their own eye color and the more nuanced understanding they gained of how their eyes' color was related to both their parents'.

Two students gave responses to this question that clearly relate to the outcome being assessed. One wrote, "It helped me with doing research which I don't do much in my other classes," and another commented, "This changes everything about my research. Having the ability to use the academic search criteria helps find information you can rely on, using the filters set out to narrow down results that better fit your needs."

The second most common response (18 responses) was a version of "none" or "n/a"

or otherwise responded in a way that did not directly address the question (e.g., "With the science lab class, the math part of it is kind of worrying me because the last actual math class I took was in Spring 2021 so there's some adjustment for me"). It is not clear how many of these responses were actual assertions that the class had no impact on how they consume scientific information outside the class.

Interpretation and Impact

Keeping in mind that, although there are numerous potential sources of bias and responses are not known to be representative of the student population, the quantitative questions do suggest some interesting implications.

First, while the majority of students were at least highly comfortable with most of the tasks, the exception is the task "Identify limitations or suggest ways in which the research described in the publication could be strengthened." Only 47.1% of students who responded to that item indicated they were at least highly comfortable, compared to 55.9% who responded similarly to "Identify further questions inspired by the publication," the next least comfortable task and 68.9% for the task students reported being most comfortable with, "Identify the hypothesis of the study described in the publication." Identifying limitations in research has frequently been found to be difficult for students, both in self-reported data (including last year) and in instructor evaluation of student work (see, for example, the 2018–19 report). While this task is likely also the most cognitively challenging, it is worth reiterating that it should be a focus when designing and improving curriculum.

In comparison with in-person classes, responses from students in remote synchronous classes related to *QComfort* appear consistently lower, which may indicate lower student satisfaction with the course rather than an actual difference in outcomes, although instructors teaching in that modality should consider whether there may be something about the modality that is hampering student attainment. Students in remote asynchronous classes reported quite similar confidence levels as did those in in-person classes.

Comparing results by designation (SC versus SL), it appears that respondents in lab courses reported consistently less confidence than students taking SC classes. This is likely a consequence of the fact that lab courses emphasize hands-on laboratory work while classes without labs rely more on descriptions of experiments done by others. Neither course designation excludes any particular kind of activity—students in lab courses do read about others' experiments and students in non-lab courses watch demonstrations and engage in data gathering that doesn't require lab equipment—but there are differences in focus between the course types and both are important.

Comparing responses to question *QActivties* about the activities students engage in during the class by course designation are as expected, given the foci of the

courses. When disaggregated by modality, results are also generally what would be expected. One difference worth noting, however, is that student presentations appear to be used much less frequently in remote classes than in person. This seems like it may be a missed opportunity, particularly in asynchronous classes, to provide opportunities for asynchronous interaction via student creation of video or other media.

For the three open-ended questions asking about students' experiences with activities related to their skills as consumers of scientific information, the majority of respondents were not focused on the learning outcome being assessed. This may reflect the fact that the survey is asking difficult and subtle questions and is quite demanding of students' metacognition. That is particularly likely since many of the respondents who did seem aware of the outcome responded to the question about "why" the activity was effective with expressions of appreciation of the skills rather than how they were best supported in learning them.

Respondents' focus on their understanding of the course topics may also be a result of the fact that students are naturally most concerned with their course grade and a typical course grading scheme emphasizes more granular course content over these "softer" skills. Even when faculty explicitly emphasize general scientific skills over topical understanding, many students have a long history of being tested on facts and it is difficult to fully shift their perspective. That said, it is also possible that the results suggest a disconnect between the skills the department values and how students are graded.

We also must acknowledge that there may be a design flaw in the survey itself; if we continue collecting data in this manner, reflecting on the questions we ask is worthwhile.

Much of what the responses describe as effective or suggest as improvements conform to transformational teaching practices. Students have clear and strong preferences for active, hands-on, and social learning experiences. Content that connects with them personally, professionally, or culturally is highly relevant and engaging. Additionally, some comments revealed that, rather than being perceived as additional work, students may view opportunities to conduct their own research and find materials on their own as providing a sense of ownership.

Responses also suggest a very strong preference for video material and visual aids. While responses weren't explicitly denigrating written content, the preference for video over print conforms with the anecdotal experiences of faculty members. If accurate, this may be a lingering result of the COVID-19 pandemic, although it's not at all clear whether students' lack of interest in reading content is indicative of poor reading skills or is a consequence of lowered attention span.

To paraphrase one faculty member responding to these data, "students in a lot of our classes are just trying to survive." Between local and global events, family obligations, and personal financial responsibilities, students are shouldering considerable burdens. While we must take care to avoid lowering expectations, it is worth being aware of ways in which we can ease the burden for students by,

for example, providing information by video as an alternative to print. Some will certainly make the equally well-founded argument that reading is a fundamental skill and we would do students a disservice not to take opportunities to encourage development of that skill. This again raises questions about what skills faculty members and students value, how we want to spend the time with students that we have, and what skills we choose to reward.

The Assessment Committee, informed by students' responses to the survey, makes the following specific recommendations:

- The department may wish to consider revisiting, perhaps to revise or to reaffirm, the general outcomes statements, which were adopted in academic year 2012–13. As part of this conversation, attention should be paid to not just what we want to assess, but on what basis we assign grades.
- Continue enhancing our courses' emphasis on identifying limitations in the design of scientific studies.
- Instructors of remote classes, particularly asynchronous classes, could consider student presentations as a way to both better center students' voices and promote student-student interaction.
- Group or team learning activities are highly valued by students, effective, and should be used whenever appropriate. Groups can be particularly effective when a task requires students to stretch out of their comfort zone; for example, when asked to evaluate claims and reach their own conclusions. Students uncomfortable when the instructor refuses the mantle of scientific authority may be more comfortable with the support of a team.
- When assigning students readings, instructors should consider providing students with choices in media. While this must be balanced with other factors, including availability of quality options and learning goals, it can make access to information more equitable. Inviting students to find sources related to a topic can be a further enhancement by increasing students' agency in the learning process and by increasing the diversity of the authors of materials used in class.

Mathematics Outcomes

Last year, the two general education mathematics outcomes were assessed together. This year, the Assessment Committee chose to develop a survey for students in multi-section mathematics courses—namely, Basic Math Skills (MATH 101), College Mathematics (MATH 110), Liberal Arts Mathematics (MATH 115), and Quantitative Reasoning (MATH 120)—with a view towards understanding students' perception of the applications of the mathematics studied in those classes and giving students an opportunity to suggest problem domains that would help make these classes more clearly pertinent to their interests and goals.

The committee was also interested in students' experiences with placement via ALEKS, which was first fully implemented in the 2022–2023 academic year. In particular, it had been observed that the vast majority of students only attempted an ALEKS placement test once, despite being allowed five attempts. Understanding the reasons for that may help encourage students to take fuller advantage of this tool.

Methods

The Assessment Committee created a survey template at the start of the fall semester. The template included several general question stems, with each course coordinator providing details so that the questions pertain to the specific course.

Introductory text explained the purpose and made clear that evaluation of faculty or classes was not the goal.

Following the introduction, which was common to all surveys, students were presented with a list of some of the "applications" of the mathematics topics covered in the class. These applications were provided by the course coordinators and were partially intended to help the student understand what was meant by "application." The lists of applications provided can be found in the survey text in the appendix. Students were asked to rate each application as very, somewhat, or not interesting, or to make it as "Not encountered" if they did not remember completing problems of that kind.

The final question on this topic, labeled *OtherApplications* in the version of the survey in the appendix, asked students to identify any applications that should be included in the future. The intention of the question was to identify problems that students may have encountered in their major or elsewhere that they and their peers would find highly relevant and that faculty may not have thought of.

Regarding ALEKS, participants were first asked whether they had taken the ALEKS placement test. Respondents who had taken ALEKS were then asked whether they took the test once or more than once. Those who responded that they had taken the test only once were then presented with question *ALEKSwhy1* and given an opportunity to select reasons they only completed it once. An "other" option allowed for entering a reason not provided in the list. Students who responded to the first question that they did not take ALEKS or did not remember were not given the other questions and students who responded to the second question that they took ALEKS more than once or did not remember did not proceed to the last question.

As was described in the previous section, class lists for all SC- and SL-designated courses and for MATH 101, MATH 110, MATH 115, and MATH 120 were combined. For students taking more than one such class in the department, one of the classes they were registered for was randomly selected and the student was invited to complete a survey for that one class. This was to avoid asking

individuals to complete multiple surveys. Of the 1955 unique students taking a relevant class, 672 of them were invited to participate in the mathematics survey and 1283 were asked to complete the science survey.

Department faculty were given a preview of the survey and asked to promote it in their classes. Anticipating that some instructors may wish to provide extra credit for completing the survey, Qualtrics was set to automatically send a "thank you" email which the student could forward as proof of having done the survey.

On November 7, 2022, survey invitations were sent to students' email addresses, followed by automated reminders on November 15 and December 7. The email message specified the course the student was being surveyed about. Response collection ended on December 12, 2022.

Results

From the 672 invitations sent, 169 students began the survey, with 11 responses marked by Qualtrics as spam and another 65 excluded because the individual began the survey but did not respond to any questions. This leaves 93 responses (a 13.8% response rate) overall. Of these, 19 were Basic Math Skills students, 30 were students in College Mathematics, 25 were taking Liberal Arts Mathematics, and 19 were responses from Quantitative Reasoning students.

Recall that the main goal of this work was to gather feedback from students in order to provide faculty with information useful for improving course design. There was no expectation that the data produced by the survey would be sufficiently robust to draw statistical inferences about all students taking math classes. In particular, there was no attempt to ensure the sample was representative nor to achieve representativeness across demographics. The information presented here reflects only the sample itself and is subject to the self-selection bias inherent to surveys and unknown biases as well. Error bars, when present, represent standard error and are intended to provide context, but do not have statistical validity. Figures 8, 9, 10, and 11 display, for each given application, the percentages selecting the possible responses out of the number selecting Not, Somewhat, or Very Interesting. Numbers displayed on bars indicate the number of individuals giving that response. Full-sized plots are included in the appendix.

Basic Math Skills (MATH 101)

In Basic Math Skills (MATH 101), of the applications presented in the question labeled *101Interesting* in the version of the survey in the appendix, students reported greatest interest in questions having to do with sales tax, discount, and tips (see Figure 8). Problems regarding scale and monetary conversion were deemed less interesting, with monetary conversion (e.g., dollar to peso) also most frequently identified as not covered in the class.

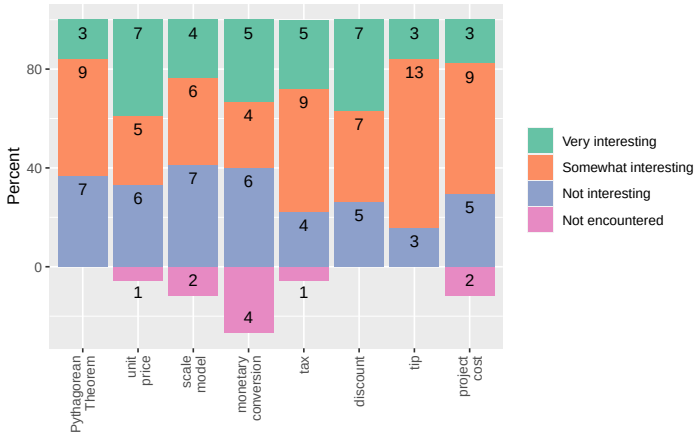

Figure 8: Responses from MATH 101 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

Of the 19 students taking Basic Math Skills who responded to the survey, 13 responded to the open-ended question asking them to describe an application they thought worth including in future classes. Of the responses, only three named something that had not been included in the previous Likert-style question. These were a generic request for "real life" problems and references to mathematics topics—one mention of equations and one of fractions and decimals—not applications of topics.

College Mathematics (MATH 110)

The high percentage of respondents who responded to the topic rating question for College Mathematics (MATH 110) indicating that they had not encountered the Pythagorean Theorem, and to a slightly lesser extent, savings/salary and project cost problems stands out (see Figure 9). This is likely due to the timing of the survey compared to when these are typically covered. However, even among those who reported having covered Pythagorean Theorem problems, nearly half rated it as not interesting. As with Basic Math, tax and discount were rated favorably.

Of the 30 College Mathematics students who responded to the survey, 13 responded to the open-ended question. Of the responses, only two named something that had not been included in the previous Likert-style question. Both referred to computations relating to personal finance and specifically interest and loans.

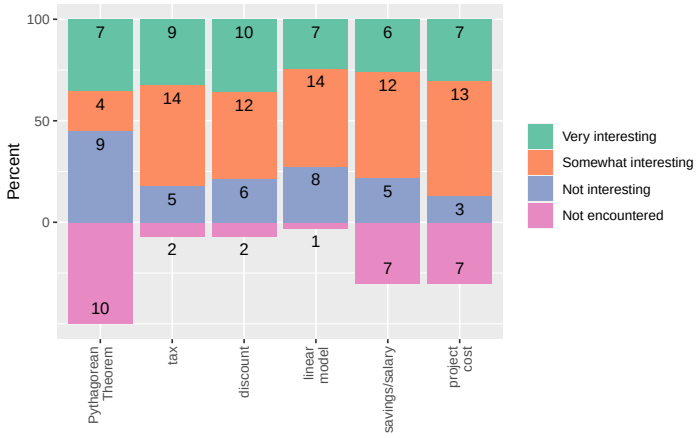

Figure 9: Responses from MATH 110 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

Liberal Arts Mathematics (MATH 115)

Among respondents who took Liberal Arts Mathematics (MATH 115), the application most frequently rated as very or somewhat interesting was to analysis of survey responses (see Figure 10). It is remarkable that "evaluate arguments" had the highest number of students indicate they had not encountered it (despite it appearing quite early in the class), the second highest percentage of "very interesting" ratings (27.3% compared to 32.0% for "survey responses") and a quite high percentage saying it is "Not interesting" (45.5%).

Of the 25 students taking Liberal Arts Mathematics who responded to the survey, 14 responded to the open-ended question inviting ideas for applications to include in the future. Two of the responses suggested a mathematical topic—probability and expected value. However, while several students listed items that were repeats of those included in the Likert-type question, no student identified a new specific application.

Quantitative Reasoning (MATH 120)

In Quantitative Reasoning (MATH 120), the problems related to sales tax and saving money on purchases were the applications rated as most interesting (see Figure 11). Scale model problems were again frequently rated as not interesting, as was revenue/cost calculations, with the related break-even problems also receiving a relatively high percentage of "Not interesting" responses and the

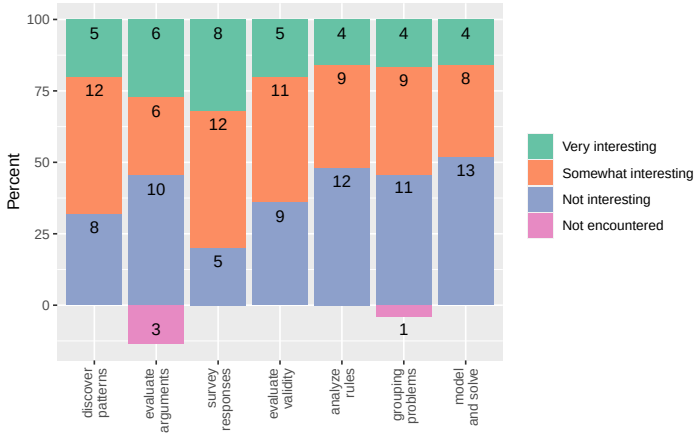

Figure 10: Responses from MATH 115 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

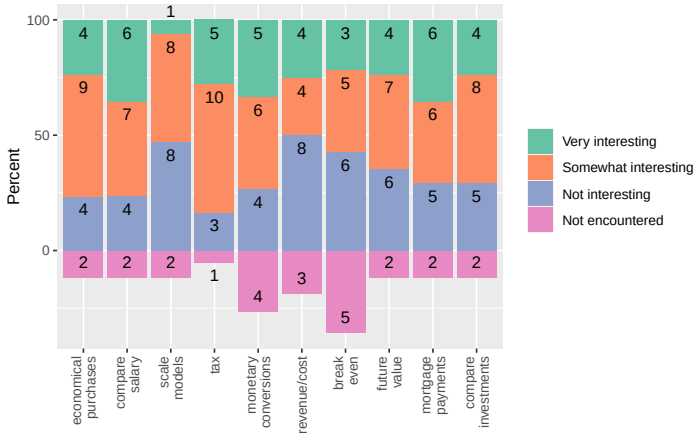

Figure 11: Responses from MATH 120 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

highest number of respondents reporting not having encountered those problems.

Of the 19 respondents taking Quantitative Reasoning, 11 responded to the open-ended question. None of the respondents named either a topic or an application that had not been included in the previous Likert-style question.

ALEKS

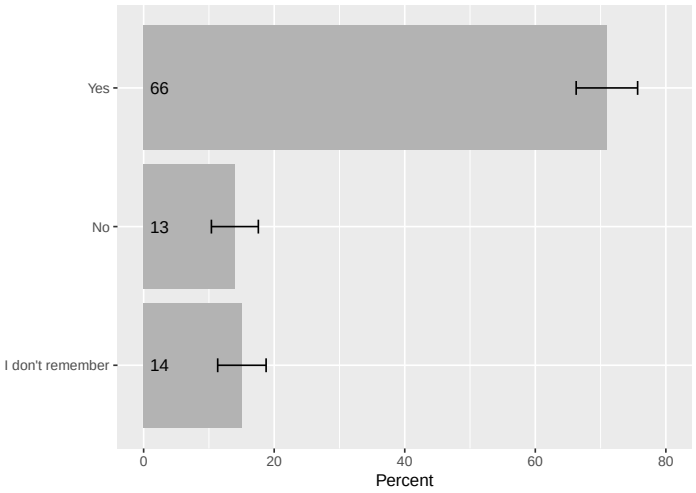

Figure 12: Responses to 'Did you take the ALEKS placement test?'

Figures 12 and 13 show the responses for questions *ALEKSever* and *ALEKS12*, which asked students whether they had taken the ALEKS PPL placement and, if so, whether they took it more than once. The majority of students (66 of 93 responses or 71.0%) who completed the survey reported having taken ALEKS PPL. Of those who reported having taken ALEKS, the vast majority (55 of 66 responses or 83.3%) indicated that they took advantage of only one attempt at the placement instrument.

Students who reported having taken the placement test only once were then asked why they made that choice. Responses from all students who responded to that question are shown in Figure 14. Only 3 respondents (5.6% of those who gave a reason) indicated they did not know how to retake the test, and 8 (14.8%) did not know they could.

Only two respondents chose "Some other reason" and provided a written response. These responses were "I took it after having not done math for a whole year (I took a gap year) Afterwards I did the Aleks course expecting I'd get a higher math class. I can name only one week where I learned something new," and "Purposely didn't do well so I could be placed in an easier class". The first reinforces the importance of improving the number of students who take the assessment more

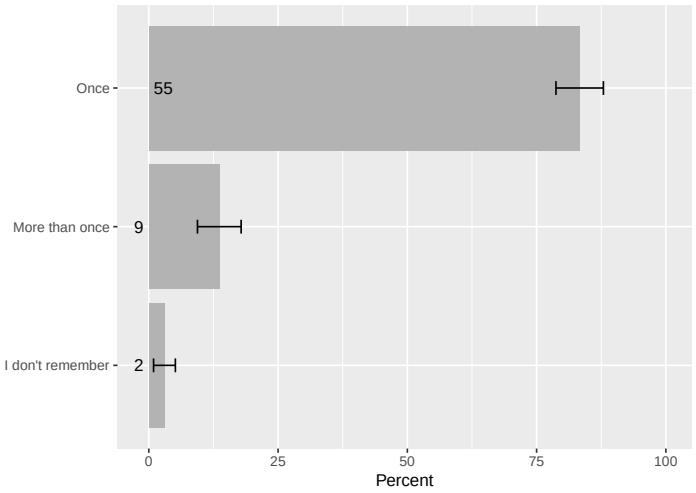

Figure 13: Responses to 'Did you complete the ALEKS placement test once or more than once?'

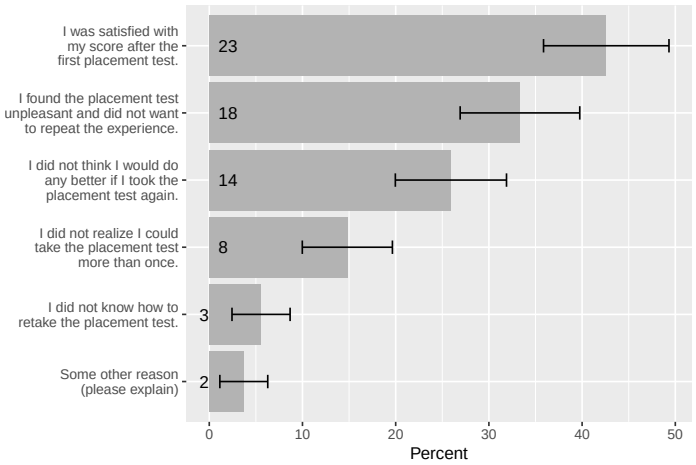

Figure 14: Responses to 'Why did you complete the ALEKS placement test only one time?'

than once but does not seem to respond to the question. The second, based on anecdotal evidence from conversations with Basic Math students, may be more common than this single student.

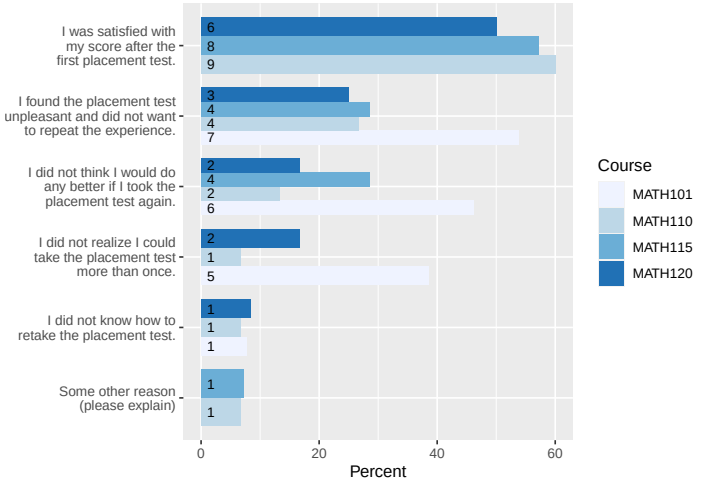

Figure 15: Responses to 'Why did you complete the ALEKS placement test only one time?' disaggregated by course.

Figure 15 shows the reported reasons for taking ALEKS only once broken down by the course the student was enrolled in at the time. Note that students who were taking MATH 110, MATH 115, or MATH 120 may have originally placed in and taken Basic Math Skills before the semester the survey was administered. The results are striking in that a majority (56.1%) of students in MATH 110, MATH 115, and MATH 120 indicated that they did not retake the placement because they were happy with their result, while none of the students taking Basic Math Skills did so.

Interpretation and Impact

As above, it is important to keep in mind that there are many possible sources of bias and that the sample is not necessarily representative.

The four courses whose students were surveyed for this report have some common topics and common applications. Across all the courses, applications related to personal finance, particularly the kinds of daily financial questions that traditional aged college students encounter—such as sales tax, tipping, and discount—were rated positively. Interest calculations, including savings interest in MATH 110 and mortgage payments in MATH 120, also were appreciated. It is surprising that the business finance applications, including revenue/cost and break-even calculations from MATH 120, were quite frequently rated as not interesting. That said, the application rated most interesting from MATH 115

had to do with understanding survey responses, which may suggest that students do appreciate topics they see as relevant to their future career, but perhaps they do not anticipate being involved in financial decisions. To some extent, this serves as a reminder that what students find interesting is not necessarily what they need.

While Pythagorean Theorem problems were rated relatively frequently as not interesting in both Basic Math Skills and College Mathematics, the essential role it plays in geometry and trigonometry makes it essential in those classes. However, scale models as an application of proportions were rated poorly in Basic Math and Quantitative Reasoning and those courses could reconsider those applications.

Similar to the Likert-type questions, in the free-response questions, across all the mathematics classes surveyed, the most common applications suggested had to do with personal financial applications, including calculating tips and tax and understanding interest. It is clear that students appreciate the relevance of mathematics to personal finance. It is disappointing, however, that respondents did not identify ways in which the mathematics topics we teach in our large-enrollment courses appear in their majors and other interests.

Perhaps one reason for that is that respondents did not fully understand the question. Many of the responses (20 of 51) did not address the question at all but instead provided praise for the course or instructor, specific complaints, or some expression of "none." Of those that did respond to the prompt, the response either mentioned one or more applications included in the Likert-style question or discussed a mathematics topic (e.g., probability) rather than an application.

It should be noted that these surveys were not designed with the intention of comparing courses and, given the relatively low response rates (13.8% overall, with 17.0% for Basic Math Skills, 11.4% for College Mathematics, 14.7% for Liberal Arts Mathematics, and 15.0% for Quantitative Reasoning), attempts at comparison would be fraught with bias.

The committee discussed several potential improvements, should we conduct a similar survey in the future. First, students may not understand what was meant by "application," and perhaps "real-world application" or another term would be clearer. Second, the word "interesting" may also have indicated something different to students than was intended. For example, students may not consider a problem "interesting" if they do not believe they will personally have use of it or if it is something they already individually know about. It may be helpful to direct their focus in the open-ended question to hypothetical future students. Third, it may help to be more direct about our goals. In the interest of balancing clarity and specificity of the purpose of the survey with respect for students' time, sending a script or otherwise asking faculty to communicate the purpose verbally in class may be helpful. Another possibility is to ask instructors to include a specific assignment in their course, perhaps as an element of exam review, in which students write their own "story problems."

Regarding the ALEKS question, while the numbers of students responding that they did not know they could retake the test or did not know how to are higher than ideal, they are not so high as to suggest that there is a major miscommunication. That Basic Math students did not want to retest and did not expect to do better is consistent with the sense faculty have that Basic Math students suffer from test anxiety and low confidence. However, the fact that no Basic Math Skills students responded that they took the exam only once because they were satisfied with their placement and a much higher proportion who reported not realizing they could retest is of great concern.

Additional efforts at communicating with Basic Math students, beyond what the course coordinator has already been doing, may help in the short term to increase awareness of the option to retake the ALEKS assessment. In the longer term, these results suggest that a large proportion of students who initially test as underprepared for MATH 110, 115, and 120 may require additional support and structure in order to best take advantage of the ALEKS system. One of the major goals and expected benefits of adopting ALEKS was to decrease the need for Basic Math Skills. By using the learning aids that are part of ALEKS in place of ALEKS, students could save time and money. A 1-credit course as an alternative to Basic Math could perhaps provide these students with the structure and support they need to take best advantage of the tools provided by ALEKS while still decreasing the credit hour burden associated with a mathematics class that does not satisfy the ELAS Core mathematics requirement.

The Assessment Committee, informed by students' responses to the survey, makes the following specific recommendations:

- As with the science outcomes, the department may wish to consider revisiting, perhaps to revise or to reaffirm, the general outcomes statements, which were adopted in academic year 2012–13. As part of this conversation, attention should be paid to not just what we want to assess, but on what basis we assign grades.
- Coordinators should consider how scale model problems are used as an application of proportion.
- Coordinators may consider the survey results for their courses in more detail and make adjustments.
- The department should consider ways to improve the use and value of ALEKS, including investigating the creation of a course that would require students to engage with ALEKS as part of the course content.

Appendix

Included here are the text of the surveys distributed to students in fall 2022 and full-sized versions of figures appearing in the report. Note that students

completing the mathematics survey saw only the questions pertaining to the course they were enrolled in.

Science Survey

Intro.

Fall 2022 Science Experience Survey

As part of our continual efforts to improve student learning in Science and Mathematics, we ask you to complete this short survey to help us better understand your experience in your science course.

One of the department's objectives for science classes is that these courses develop your ability to discover, evaluate, and assess the credibility of general interest publications related to the scientific subjects you study. By "publications," we mean any type of format, including written articles, videos, radio or podcasts, etc.

This survey is designed to help us understand what kinds of experiences in your science class this semester you feel have been most helpful in reaching that goal and inform all instructors about the most effective kinds of activities.

It is important to note that this survey is not an evaluation of your particular instructor or class. Please **be specific** in your responses about your experiences and **avoid names** of faculty and courses.

ComfortIntro.

First, we'd like to understand your experience and perception of some of the general science skills our classes are designed to enhance, specifically, your ability to discover, evaluate, and assess the credibility of general interest publications related to the scientific subjects you have studied.

Please note that we're asking you about your comfort with these tasks as a result of **all** of your experiences with science, not specifically in relation to the science course you are currently taking.

QComfort.

For each component below, please indicate how comfortable you are performing that task. Keep in mind that by "publications," we mean any type of format, including

written articles, videos, radio or podcasts, etc.

	Extremely comfortable	Highly comfortable	Somewhat comfortable	Slightly comfortable	Not at all comfortable
Research and discover material relevant to a scientific question	○	○	○	○	○
Evaluate the credibility, reliability, and relevance of a publication	○	○	○	○	○
Identify the hypothesis of the study described in the publication	○	○	○	○	○
Determine whether the evidence presented in the publication supports the hypothesis	○	○	○	○	○
Identify how the publication relates to scientific facts and concepts you have studied	○	○	○	○	○
Identify limitations or suggest ways in which the research described in the publication could be strengthened	○	○	○	○	○
Identify further questions inspired by the publication	○	○	○	○	○
Come to an informed conclusion as to the claims made in the publication	○	○	○	○	○

CourseBasicsIntro.

Next, we'd like to get some information about the ${e://Field/CName} (${e://Field/CPrefix} ${e://Field/CNum}) course you are currently taking and the activities you've engaged in for that class.

QFormat.

What is the class meeting format?

- ○ Fully in person
- ○ Fully remote with synchronous class meetings
- ○ Fully remote and asynchronous

QActivities. Which of the following kinds of activities have you engaged in for this science class? (Select all that apply.)

- ☐ Conducting experiments or watching demonstrations
- ☐ Discussing as a class or in smaller groups
- ☐ Giving presentations to the class

- [ ] Interpreting models or simulations
- [ ] Reading the textbook
- [ ] Analyzing data sets or case studies
- [ ] Taking quizzes, exams, or other assessments
- [ ] Doing homework
- [ ] Listening to instructor lectures
- [ ] Reading, listening to, or watching materials not from the textbook
- [ ] Other (describe in the text box)

FreeResponseIntro.
Science classes have many different goals and learning objectives. As mentioned earlier, one of the major objectives for all science classes in the department is that they develop your ability to discover, evaluate, and assess the credibility of general interest publications related to the scientific subjects you study. By "publications," we mean any type of format, including written articles, videos, radio or podcasts, etc.

For these questions, we ask that you reflect on the activities you've engaged with in ${e://Field/CName} (${e://Field/CPrefix} ${e://Field/CNum}) and how they have helped you develop those abilities. As a reminder, we are not asking you to evaluate your instructor—you will have the opportunity to do that as part of the college-wide process at the end of the semester.

QDescEffective.
Think about an activity in this course for which you engaged with a general interest publication (that is, media of any form that wasn't created specifically for classroom use). Please briefly describe the activity.

QWhyEffective. What about the activity you described above made it particularly effective in developing your abilities?

QWhyLessEffective. What could have made the activity you described even more effective in developing your abilities?

ClassEffect.
How did this activity, or other activities in this course, change how you engage with and think about science that you encounter outside of a science classroom?

Default Question Block

Intro.

Fall 2022 Mathematics Experience Survey

As part of our continual efforts to improve student learning in Science and Mathematics, we ask you to complete this short survey to help us better understand student experiences in mathematics courses.

This survey is specifically designed to help us understand what kinds of applications and examples you feel have been most helpful in promoting your understanding of the mathematics you've learned in ${e://Field/CName}.

It is important to note that this survey is not an evaluation of your particular instructor or class. Please **be specific** in your responses about your experiences and **avoid names** of faculty.

Block 1

101IntroInteresting. In this survey, we're asking you about applications of the mathematics you've learned, not the mathematics topics. For example, this semester you've spent some time learning about percents, a mathematics topic. As part of that lesson, you may have used percents to solve applied problems about tax.

101Interesting. Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select "not encountered."

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using the Pythagorean Theorem to compute perimeter or area	○	○	○	○

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using unit price to compare products	○	○	○	○
Using proportions to understand scale models (e.g., maps)	○	○	○	○
Using proportions to perform monetary conversion (e.g., pesos to dollars)	○	○	○	○
Using percent to compute tax	○	○	○	○
Using percent to compute discount	○	○	○	○
Using percent to compute tips	○	○	○	○
Using geometry to estimate project cost (e.g., cost to paint an area)	○	○	○	○

110IntroInteresting. In this survey, we're asking you about applications of the mathematics you've learned, not the mathematics topics. For example, this semester you've spent some time learning about percents, a mathematics topic. As part of that lesson, you may have used percents to solve applied problems about tax.

110Interesting. Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select "not encountered."

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using the Pythagorean Theorem to compute perimeter or area	○	○	○	○
Using percent to compute tax	○	○	○	○

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using percent to compute discount	○	○	○	○
Using a linear equation to solve a real world problem	○	○	○	○
Using a geometric sequence to compute savings interest and salary increases	○	○	○	○
Using geometry to estimate project cost (e.g., cost to paint an area, to pave a road)	○	○	○	○

115IntoInteresting. In this survey, we're asking you about applications of the mathematics you've learned, not the mathematics topics. For example, this semester you've spent some time learning about truth tables, a mathematical topic. As part of that conversation, you likely used what you learned from those truth tables to gain an understanding about how using symbolic statements can help to evaluate deductive reasoning arguments (syllogisms) written in words.

115Interesting. Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select "not encountered."

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using inductive reasoning to discover patterns and draw general conclusions (e.g., figuring out the formula to describe a mathematical relationship or phenomenon)	○	○	○	○
Using Euler diagrams to evaluate logical arguments	○	○	○	○

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using Venn diagrams to count groups of survey responses	○	○	○	○
Using symbolic reasoning (rules of deduction) to evaluate the validity of logical arguments	○	○	○	○
Using symbolic reasoning (rules of deduction) to analyze complex rules (e.g., interpreting road signage)	○	○	○	○
Using greatest common factors to solve grouping problems	○	○	○	○
Using linear equations and context clues to model and solve word problems	○	○	○	○

120IntroInteresting. In this survey, we're asking you about applications of the mathematics you've learned, not the mathematics topics. For example, this semester you've spent some time learning about proportions, a mathematics topic. As part of that lesson, you may have used proportions to solve applied problems about currency exchange.

120Interesting. Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select "not encountered."

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using unit prices to make more economical purchases	○	○	○	○

	Very interesting	Somewhat interesting	Not interesting	Not encountered
Using unit rates to compare different salary offers	○	○	○	○
Using proportions to understand scale models (e.g., maps)	○	○	○	○
Using percent to compute tax	○	○	○	○
Using proportions to perform monetary conversions (e.g., pesos to dollars)	○	○	○	○
Using a linear function to compute a business revenue or production cost	○	○	○	○
Using a linear function to find the production level for breaking even	○	○	○	○
Using compound interest (inflation) to compute the future worth of insurance	○	○	○	○
Using compound interest (formulas) to compute monthly mortgage payments	○	○	○	○
Using compound interest (formulas) to compare different loan/investment products	○	○	○	○

OtherApplications.

Some instructors may have included applied problems other than those mentioned above. You may also have encountered applications of the mathematics covered this semester in other mathematics classes or in your major.

Thinking about the mathematics topics covered in your ${e://Field/CName} class this semester, what applications do you think are interesting and worth including in future classes? Please be as specific as you can.

Block 3

ALEKSintro. Moving to a different topic, we'd like to ask you about the ALEKS placement test, which you may have taken as part of the admissions and enrollment process.

ALEKSever. Did you take the ALEKS placement test?

- ○ Yes
- ○ No
- ○ I don't remember

ALEKS12. Did you complete the ALEKS placement test once or more than once?

- ○ Once
- ○ More than once
- ○ I don't remember

ALEKSwhy1. Why did you complete the ALEKS placement test only one time? (Choose all that apply.)

- ☐ I was satisfied with my score after the first placement test.
- ☐ I did not realize I could take the placement test more than once.
- ☐ I found the placement test unpleasant and did not want to repeat the experience.
- ☐ I did not know how to retake the placement test.
- ☐ I did not think I would do any better if I took the placement test again.
- ☐ I had already been registered for my classes before I had the time/opportunity to retake the placement test.
- ☐ _____ Some other reason (please explain)

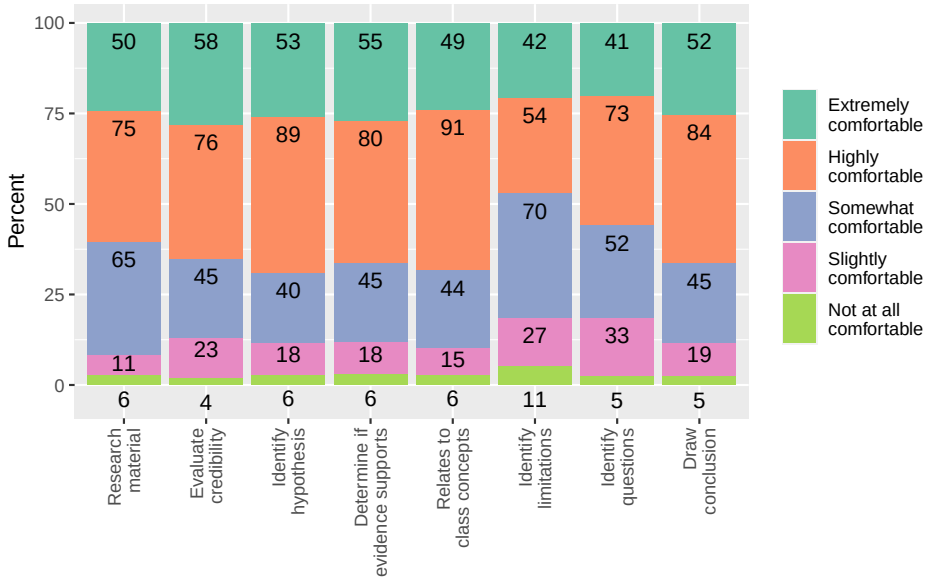

Figure 1: Responses to 'For each component below, please indicate how comfortable you are performing that task.'

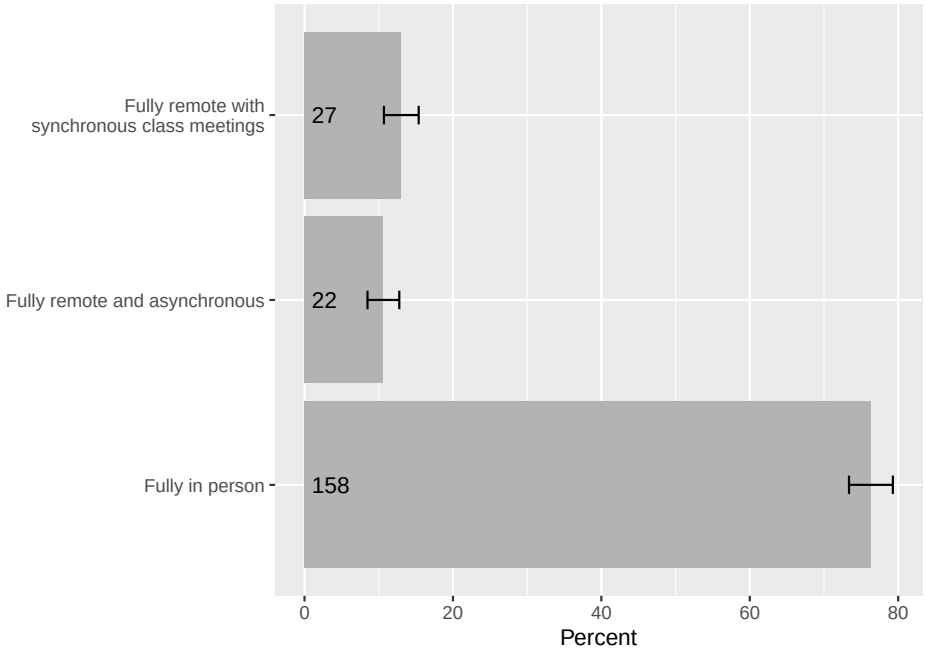

Figure 2: Responses to 'What is the class meeting format?' (for science classes)

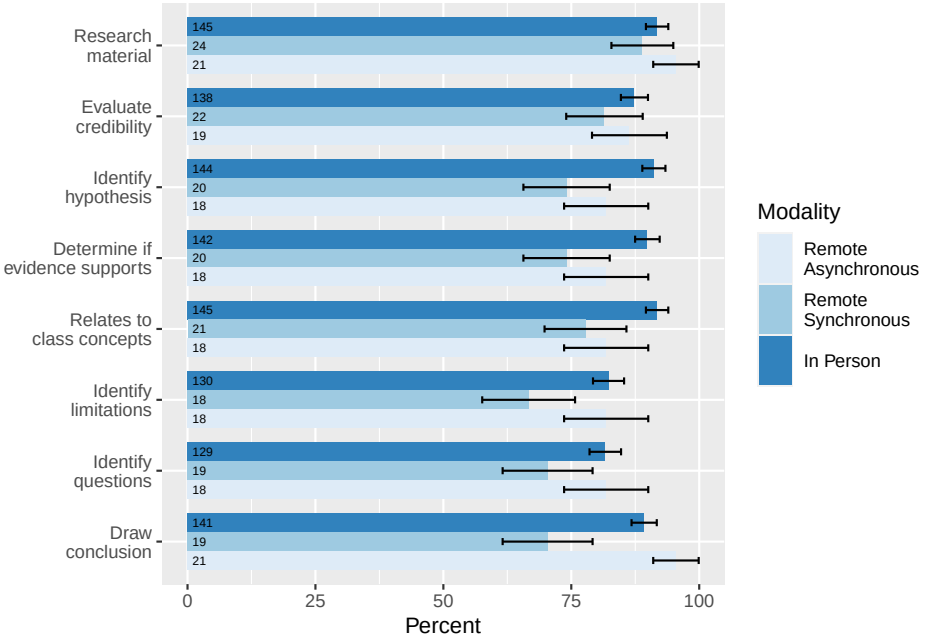

Figure 3: Percent of students indicating they are at least Somewhat Comfortable with the elements of consuming scientific information, disaggregated by course modality.

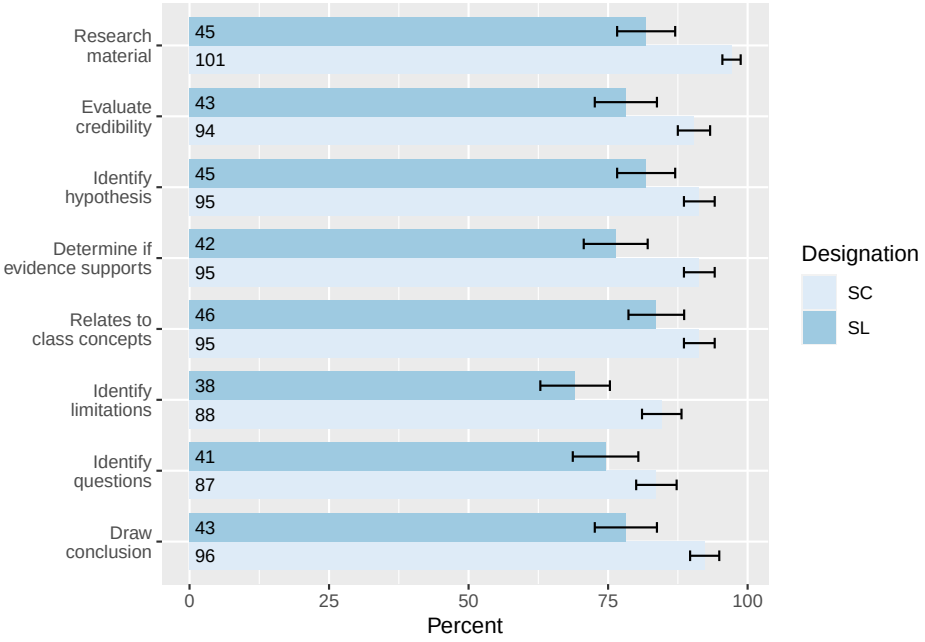

Figure 4: Percent of students indicating they are at least Somewhat Comfortable with the elements of consuming scientific information, disaggregated by course designation.

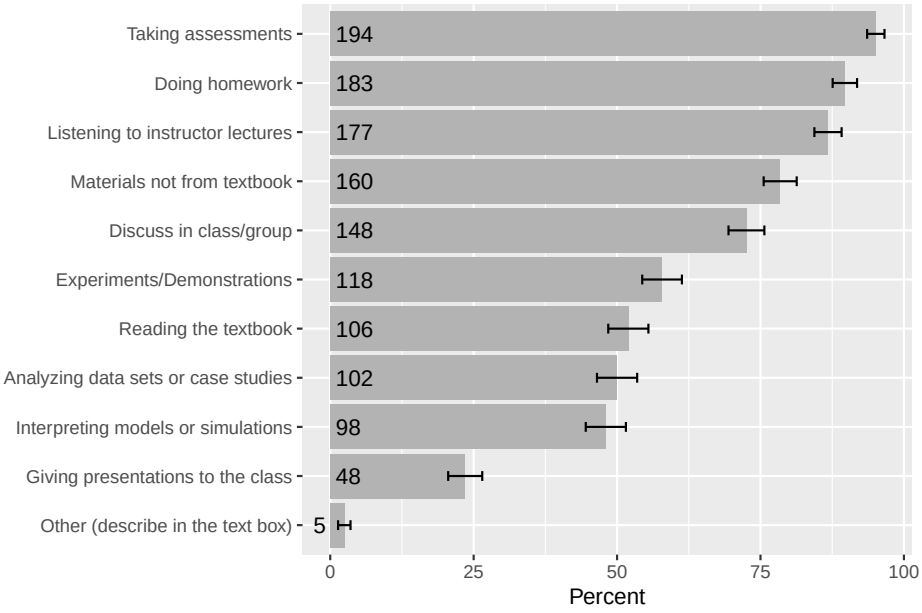

Figure 5: Responses to 'Which of the following kinds of activities have you engaged in for this science class?'

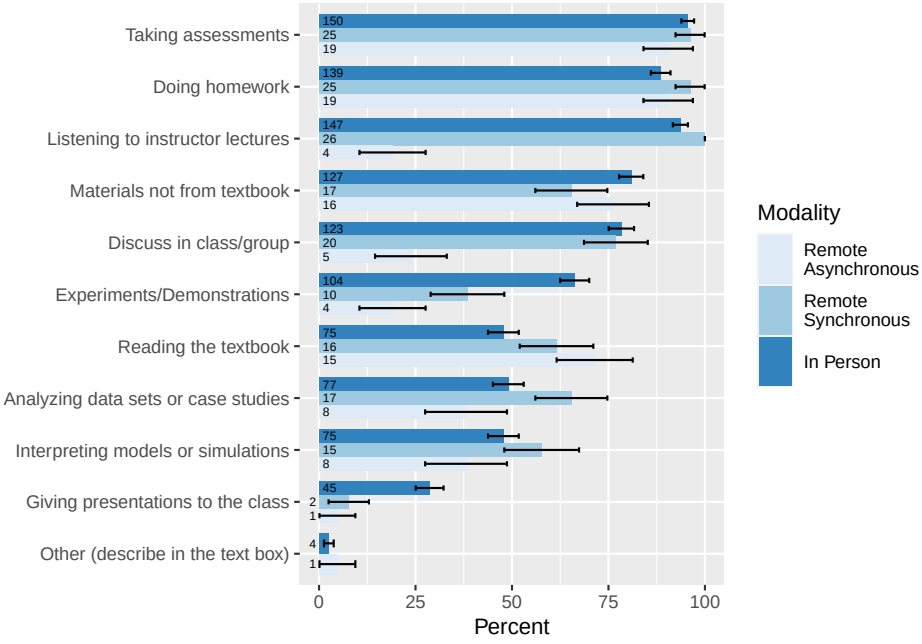

Figure 6: Responses to 'Which of the following kinds of activities have you engaged in for this science class?' disaggregated by course modality.

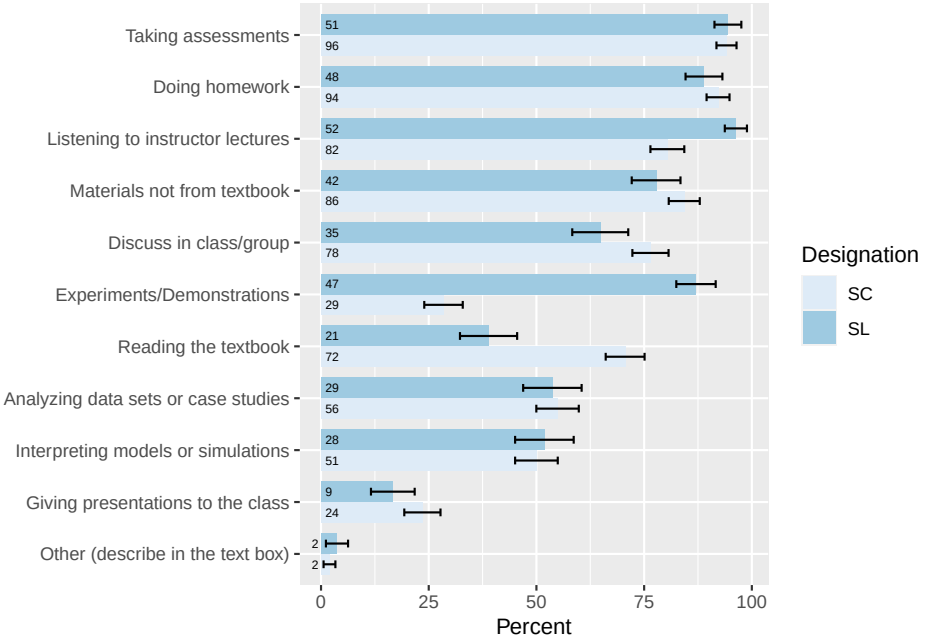

Figure 7: Responses to 'Which of the following kinds of activities have you engaged in for this science class?' disaggregated by course designation.

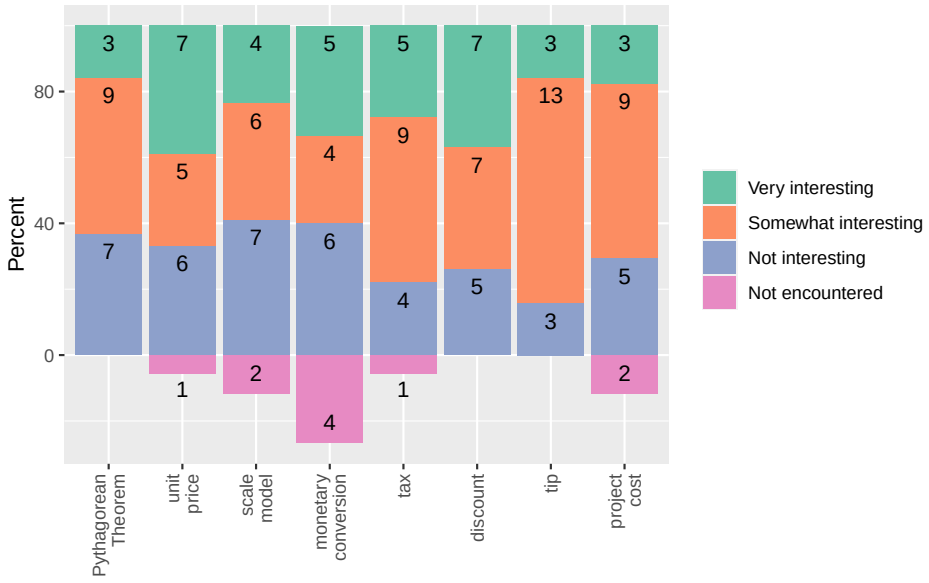

Figure 8: Responses from MATH 101 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

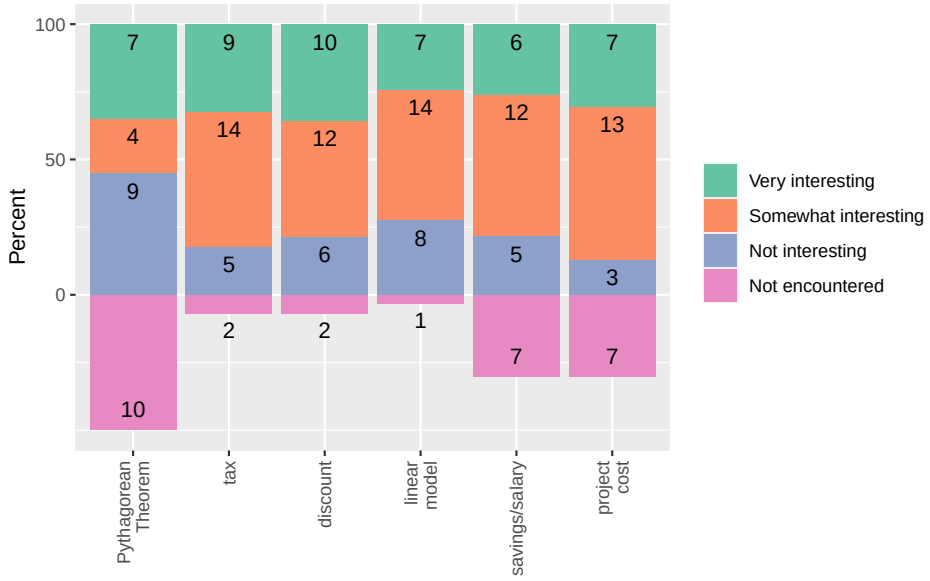

Figure 9: Responses from MATH 110 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

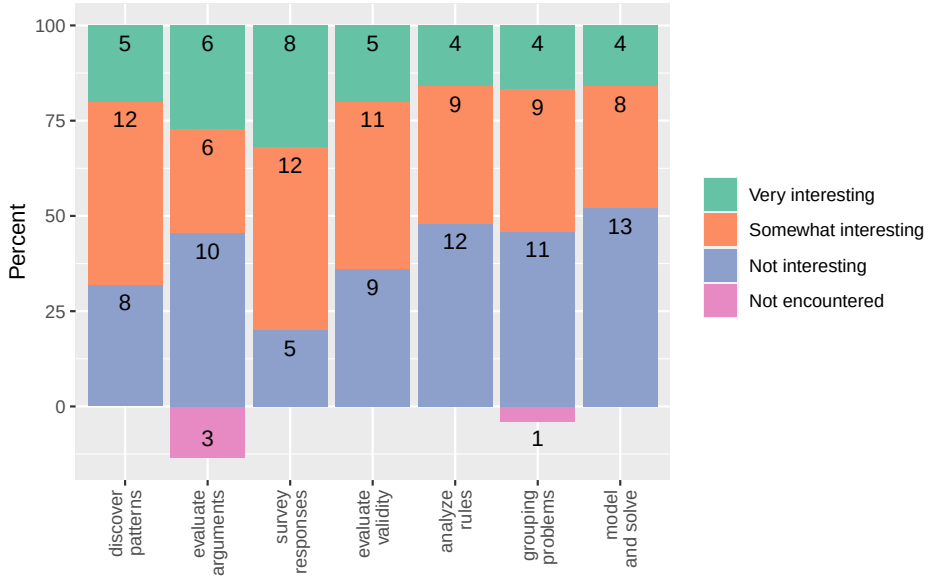

Figure 10: Responses from MATH 115 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

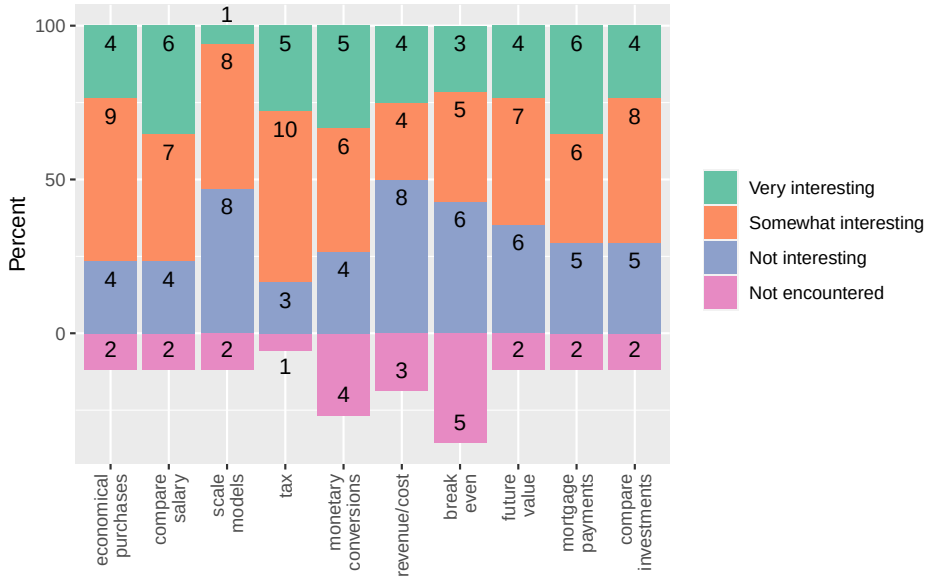

Figure 11: Responses from MATH 120 students to 'Below are some of the applications of the mathematics topics that you may have explored in this class. For each, please indicate if you found the application very interesting, somewhat interesting, or not interesting. If your class did not include or you do not remember problems related to the topic, please select 'not encountered.' '

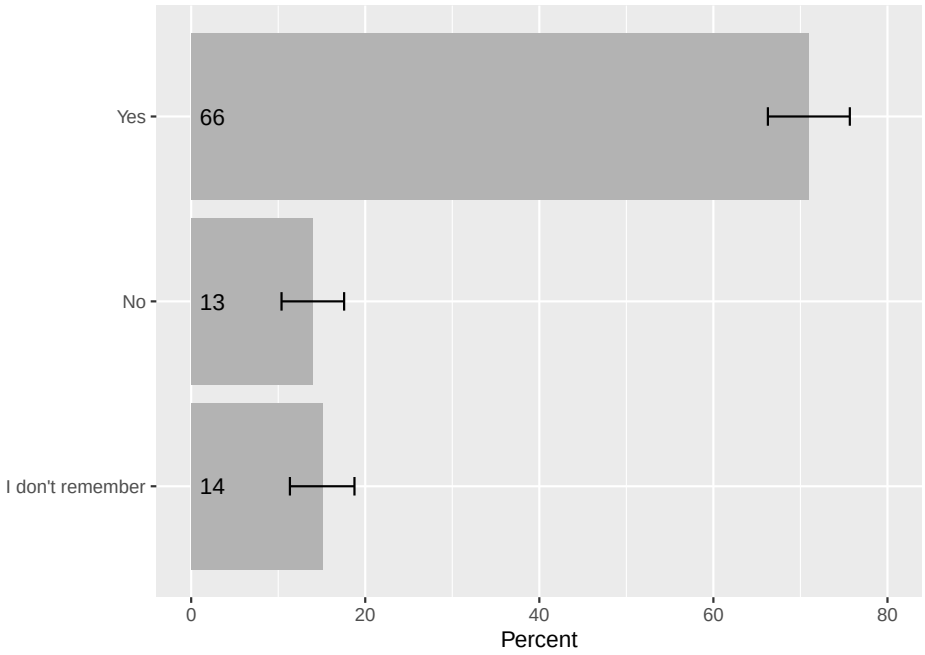

Figure 12: Responses to 'Did you take the ALEKS placement test?'

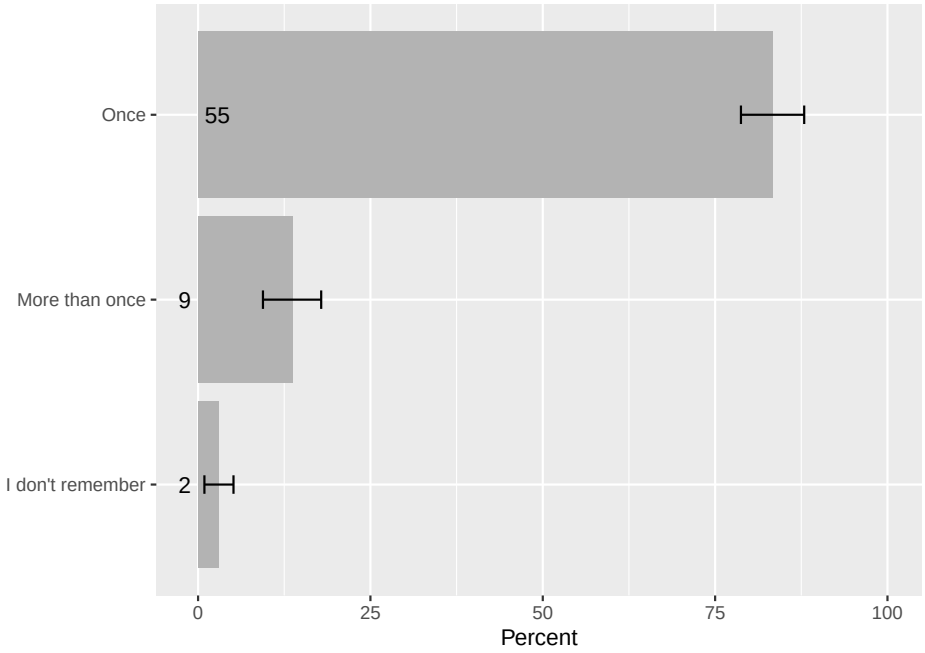

Figure 13: Responses to 'Did you complete the ALEKS placement test once or more than once?'

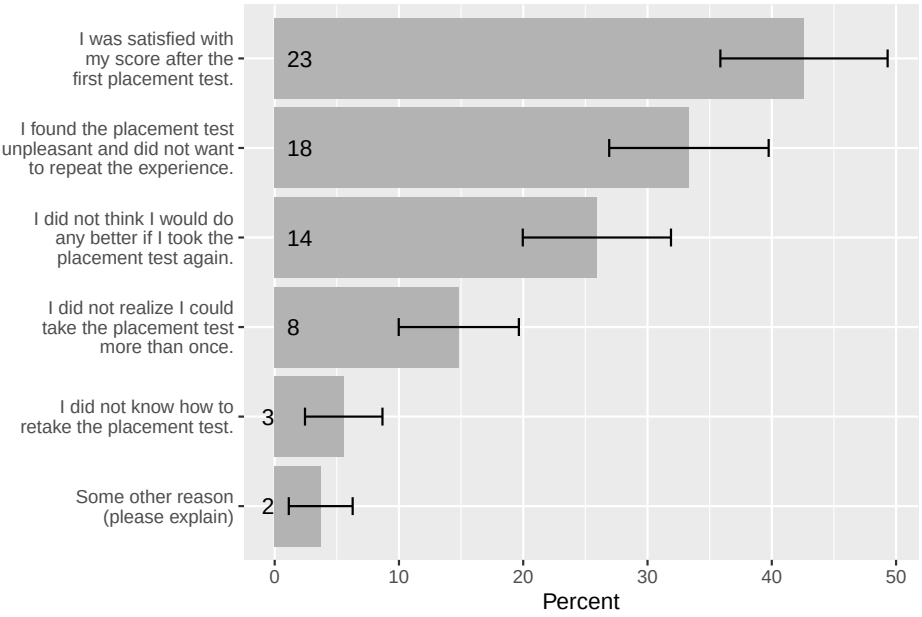

Figure 14: Responses to 'Why did you complete the ALEKS placement test only one time?'

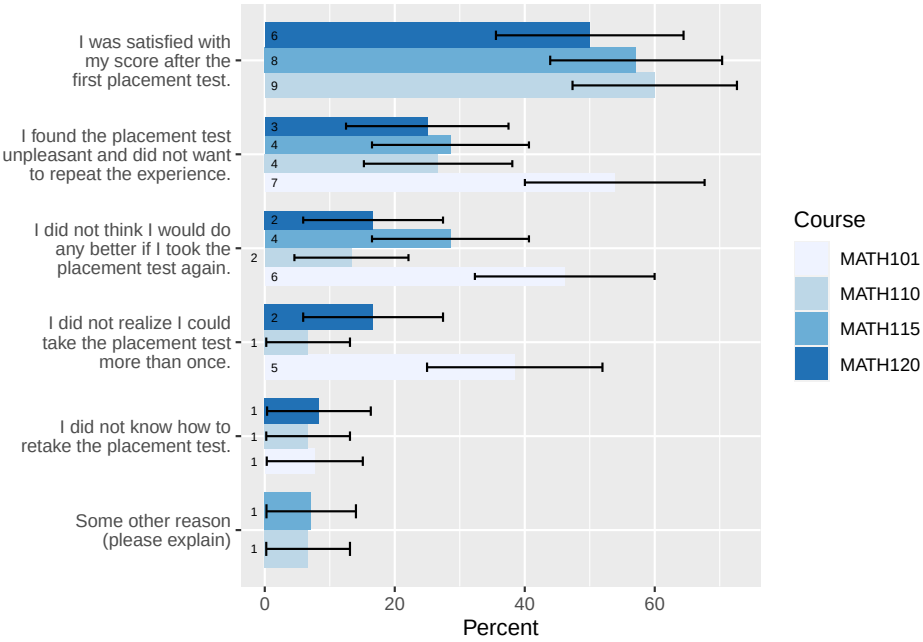

Figure 15: Responses to 'Why did you complete the ALEKS placement test only one time?' disaggregated by course.