Student Motivations and Barriers toward Online and In-Person Office Hours in STEM Courses

Jeremy L. Hsu,* Melissa Rowland-Goldsmith, and Elaine Benaksas Schwartz
Schmid College of Science and Technology, Chapman University, Orange, CA 92866

ABSTRACT

Office hours are one of the most common support mechanisms found in courses. Despite the prevalence of office hours in life sciences classes, there has been little investigation of how science, technology, engineering, and math (STEM) students perceive office hours, particularly at non–research intensive universities or other institutions where a majority of students attend office hours. We surveyed more than 500 students, representing most life sciences majors at a comprehensive university, to investigate their motivations and barriers for attending office hours. We then compared instructors' perceptions to students' conceptions of office hours. We identified key themes in student and instructor comments using inductive, grounded theory, finding that students view a more limited range of benefits for office hours than instructors. Students likewise cited a larger number of barriers for attending than instructors perceived. In addition, while there were minimal differences in rates of office hours attendance and perception of office hours based on key demographic factors, we identify areas where students of different class years and gender perceive differences, suggesting areas of future research. Finally, we explored students' views of in-person versus online office hours, providing insight for instructors to better reach all students.

INTRODUCTION

Office hours—defined here as any nonstructured instructional time set aside outside class for students to interact with the instructor of a course and receive help in the course—are a key component of college and university science, technology, engineering, and math (STEM) classes, with nearly all STEM courses offering office hours. For example, multiple universities mandate in their faculty manuals or equivalent handbooks that instructors provide office hours (e.g., *Chapman University Faculty Manual*; Chapman University, 2016). Similarly, the importance of office hours was highlighted by a recent survey of biology courses at a large research-intensive university, which found that information on office hours was the most commonly reported element found in syllabi for students getting help (Gin *et al.*, 2021). Past work across different disciplines has also suggested possible correlations between office hours attendance and academic performance (Guerrero and Rod, 2013) and instructor immediacy (Cooper *et al.*, 2017). However, this work has been limited, and we are not aware of any studies that have directly examined the impact of office hours on student learning or academic performance in STEM. Similarly, while past work has suggested that attendance at office hours may positively impact student affect like sense of belonging and can help build the instructor–student relationship (Moore, 2020; Guzzardo *et al.*, 2021), there have not been any empirical studies that measure the impact of office hours on student affect.

In addition, there has been relatively little work done examining student and instructor perceptions of office hours across a life sciences curriculum. There is a noticeable gap in knowledge on how students perceive office hours in the life sciences

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*Address correspondence to: Jeremy L. Hsu (hsu@chapman.edu).

and in non–research intensive (R1) universities. For example, past work has been limited to single courses or a closely linked series of courses, primarily in R1 universities and within engineering (Griffin *et al.*, 2014; Robinson *et al.*, 2015; Smith *et al.*, 2017; Briody *et al.*, 2019). These studies have found that most students at these universities do not attend office hours, and that students view office hours as a mechanism of "last resort" for asking questions (Smith *et al.*, 2017). Other studies at large public universities have found that students indicated that students are more likely to attend office hours if they provide useful feedback, are held at convenient times and locations, or are for smaller enrollment courses (Griffin *et al.*, 2014). Similarly, work on instructor perceptions of office hours has also been limited; for instance, Andrade *et al.* (2020) interviewed three engineering faculty on their perspectives on virtual office hours before the COVID pandemic, but there has not been a broader attempt to characterize instructor perceptions of office hours.

In addition to the gap in knowledge about life sciences students' perceptions of office hours, there also remains the issue of little being known about how students view online office hours. The COVID-19 pandemic triggered emergency remote teaching (ERT) across many colleges and universities in the United States, forcing lecture and lab courses to shift online (Brancaccio-Taras *et al.*, 2021; Hsu and Rowland-Goldsmith, 2021; Trust and Whalen, 2020; Walsh *et al.*, 2021; Donham *et al.*, 2022). This transition to remote teaching also caused office hours to shift online, with many instructors using Zoom or other videoconferencing platforms for office hours. While there has been past work examining remote office hours, such work occurred pre-COVID and was limited to other modalities and contexts, such as the use of email and instant messaging chat for office hours (Atamian and DeMoville, 1998; Li and Pitts, 2009; Cifuentes and Lents, 2011) and the use of electronic office hours for distance learning and asynchronous courses (Wallace and Wallace, 2001; Lowenthal *et al.*, 2017). We are not aware of any previous attempts to characterize student perceptions and preferences of online versus in-person office hours after the COVID-19 pandemic and the widespread use of Zoom and other videoconferencing platforms.

Research Questions

Our study focused on the following research questions:

1. Who attends office hours for STEM courses in a comprehensive university's college of science?
2. How did the shift to online office hours during ERT impact students' self-reported frequency of attending office hours?
3. What do students perceive as benefits and barriers to office hours?
4. How do students perceive online office hours?
5. How do instructors' views of office hours align with student perceptions?

Theoretical Framework

Our work is centered around characterizing student and instructor perceptions of office hours. Capturing how different students experience or view an event is an approach used across various discipline-based education research studies, because *how* a student perceives an event can influence the student's actions, learning, and affect (Drew, 2001; Struyven *et al.*, 2005; Osborne *et al.*, 2009; Ankiewicz, 2019). For instance, measuring student perceptions of instructor behaviors in the classroom has been shown to be predictive of various student outcomes, including the amount of student learning (Seidel and Shavelson, 2007; André *et al.*, 2020). Several theoretical frameworks have been proposed for examining different perceptions. For instance, variation theory—a derivative of phenomenography—posits that there are a finite number of characteristics to any given phenomenon that shape a students' perception and that students' lived object of learning (what they actually learn) depends upon how they perceive the enacted object of learning (i.e., what occurs inside the classroom; Bussey *et al.*, 2013). Thus, our goal here is to characterize what students and instructors view, perceive, and think about office hours, given that such perceptions may influence students' likelihood of attending office hours in the future, their self-efficacy, or their sense of belonging in the science community (Willson-Conrad and Kowalske, 2018).

In addition, variation theory highlights that there can often be a misalignment between the instructor's intended object of learning as compared with the student's lived object of learning (Bussey *et al.*, 2013). In these cases, instructors and students perceive classroom experiences differently, with students viewing or experiencing activities in a different manner than what instructors intended. Misalignment between student and instructor perceptions in the classroom can lead to negative impacts on learning and student affect (Mesa, 2012; Wakimoto *et al.*, 2019; Park *et al.*, 2021). Our work thus characterizes instructor perceptions of office hours to determine whether there are differences in how students and instructors perceive office hours, because any misalignment could influence the actions that instructors take to promote and hold office hours and how likely a student is to attend office hours.

As part of characterizing student perceptions of office hours, we explore students' motivations for attending office hours. Student motivation is a complex and broad term that includes many overlapping constructs (e.g., intrinsic motivation, value, interest, mindset) and theories (e.g., expectancy-value theory, implicit theories; Eccles, 1983; Hulleman *et al.*, 2016; Linnenbrink-Garcia *et al.*, 2016; Richardson *et al.*, 2020). We apply the self-determination theory (SDT) to consider students' motivations for attending office hours. SDT posits that, for students to develop intrinsic motivation, their needs for autonomy, competence, and relatedness must be met in some way (Vallerand, 1997; Ryan and Deci, 2000; Deci and Ryan, 2013). Students have many extrinsic and intrinsic factors that motivate them. As such, SDT posits that there is a continuous range of motivational states that integrates different levels of extrinsic and intrinsic motivation, starting with amotivation (students who have low self-efficacy and do not want to act; Deci and Ryan, 2013; Hewitt *et al.*, 2019). This continuum also includes students relying on external motivation (extrinsic reward), identified motivation (students who value the activity), and intrinsic motivation (where an activity is interesting or fun, i.e., inherently satisfying to complete; Koestner and Losier, 2002; Deci and Ryan, 2013; Jeno *et al.*, 2017; Richardson *et al.*, 2020). Here, our work focuses on using the SDT framework to situate and contextualize students' self-reported motivation for attending STEM course office hours.

TABLE 1. List of classes for which students were invited to complete the survey.

Course number	Course subject	Course level
Biology 204	General biology I	Introductory
Biology 205	General biology II	Introductory
Biology 208	Introduction to molecular genetics	Introductory
Biology 498	Biology senior capstone	Upper level
Chemistry 140	General chemistry I	Introductory
Chemistry 150	General chemistry II	Introductory
Chemistry 301	Inorganic chemistry	Upper level
Chemistry 331	Organic chemistry II	Midlevel
Chemistry 411	Analytical chemistry II	Upper level
Chemistry 441	Physical chemistry II	Upper level
Biochemistry 336	Biochemistry II	Upper level
Biochemistry 350	Medicinal chemistry	Upper level
Biochemistry 436	Advanced molecular genetics	Upper level

Study and Institutional Context

This study was conducted at a private, comprehensive university with R2 classification in southern California, with STEM classes typically ranging in size from 10 to 80 students per class. Given that our university does not have graduate programs in the life sciences, office hours are held directly by instructors, although undergraduate supplemental instructors also hold their own office hours. The university began the Spring 2021 semester with fully remote online teaching (with instructors encouraged to hold synchronous online classes), before shifting to optional, in-person learning following spring break in March 2021. Our student survey was deployed the week after spring break to capture student perceptions of online office hours midsemester before any instructors were able to offer in-person office hours that semester. The university was fully remote during the previous semester (Fall 2020), with only online office hours for nearly all STEM classes. Thus, first-year students (those who started in Fall 2020 or Spring 2021) who completed the survey that semester would not have had the opportunity to attend any office hours in person, while second-year students and above would have had the opportunity to do so in previous semesters, when nearly all STEM office hours were in person.

METHODS

Student and Instructor Surveys

Students were recruited through key courses frequently taken by life sciences majors at our university. Seventeen instructors teaching 13 different courses (Table 1) were asked to distribute the online survey to students in their classes through the learning management system. To incentivize completion, a drawing was held to randomly provide students with gift cards, and instructors were also encouraged to incentivize completion by providing a small number of bonus points for students in their classes. The chosen classes represent key courses required of life sciences majors at all levels, including introductory biology and chemistry (taken predominantly by first-year STEM majors) and organic chemistry (taken predominantly by second-year STEM majors). Similarly, we targeted key upper-level classes taken by STEM majors in their third year and above, including biochemistry as well as the capstone course required for all biology majors. Students were instructed that they only needed to complete the survey once, even if they were enrolled in more than one of the target courses. Responses were filtered to remove any duplicates. Students self-reported demographic information (gender, ethnicity, class year, first-generation student status, and transfer student status) and were instructed to reflect upon all their STEM classes when completing the survey, answering questions about their perceptions of, motivations for attending, and attendance in instructor office hours.

We also recruited all full-time instructors who were teaching undergraduate courses in the college of science that semester to complete an instructor survey. Instructors were recruited through our college of science email list and were asked about their perceptions of the goals of, benefits from, and barriers to office hours.

Given a lack of previous instruments about office hours, both surveys were developed de novo (see Supplemental Materials). While the timing of survey deployment (and the necessity to deploy the survey at the transition back to in-person learning) precluded the use of any cognitive interviews to validate the items, we used an iterative process to design the instrument with the research team. After discussion of the general research questions of the project, survey questions were proposed by each research team member, independently reviewed, and examined for clarity. Questions underwent several rounds of refinement through these meetings, and we iterated through several versions of the questions. In addition, we used a post hoc process after survey deployment, wherein a random subset of 60 responses (more than 10% of total responses) for each question was chosen, and each member of the research team was asked to independently read this subset and determine whether there were any concerns about response process validity. None were identified.

This project was reviewed and deemed exempt by the Chapman Institutional Review Board.

Responses

We gathered 531 unique student responses. While it is challenging to discern how many students the survey was sent to, given that we did not have access to course rosters, we are confident that this represents a large majority of students targeted. For instance, the total enrollment of the targeted classes was 1032 students; however, students can be enrolled in more than one of the targeted STEM classes, so the number of unique students is fewer. When we asked students to report which classes they were enrolled in for the survey, we found that this summed up to 783 student enrollments in the targeted STEM classes, representing 75.9% of the total enrollment possible. The responses thus represent sampling from most life sciences majors enrolled at our university that semester (883 students total). While there are likely students enrolled in these core STEM classes who are not life sciences majors, we chose key required STEM classes that consist predominantly of STEM majors. In addition, the demographic breakdown of survey respondents closely tracked the demographic profile of science majors and our university's student population.

Twenty-eight instructors completed our survey, representing approximately 64% of eligible full-time instructors who taught undergraduate classes in the college of science during Spring 2021.

TABLE 2. Codes for the perceived goals and benefits to attending office hours[a]

Code name	Description: attended office hours to…	Percent of student codes	Percent of instructor codes
Content clarification	Ask questions or review course material, including going more in depth into related concepts	53.5%	41.1%
Homework help	Receive assistance on problem set, lab report, or other assignment	15.3%	5.4%
Listening to others	Pay attention to other students' questions	8.7%	Not cited by instructors
Test preparation	Get ready for quiz, exam, or other in-class assessment	7.5%	Not cited by instructors
Assessment follow-up	Ask questions or clarifications on an exam, quiz, or homework once it has been returned to the student	6.6%	1.8%
Time with professor/ student	Receive more individual attention from the instructor, including to get to know the instructor better	5.6%	19.6%
Practice	Request or complete additional problems relating to course content	2.3%	5.4%
Study skills	Discuss ways to study and metacognition	Not cited by students	10.7%
Professional support	Discuss careers, research, internships, and other career-building endeavors	Not cited by students	10.7%
Inclusivity	Become more involved and establish a classroom culture where all students are welcomed	Not cited by students	3.6%
Collaboration	Meet other students to form study groups	Not cited by students	1.8%

[a]Responses are provided for both students and instructors; several categories were only cited by either students or instructors.

Coding of Responses

For most of the student questions, coders (J.L.H., M.R.-G., and E.B.S.) first independently read 60 responses per question (11.3% of total responses) and came up with a list of codes for each question using an inductive, grounded-theory approach. Following this, the codes were compared, and a consensus list of codes was generated. Each author coded each of the 60 responses using this consensus list of codes, and disagreements were discussed and resolved. Each coder then independently coded another 30 responses (5.6% of total responses); interrater reliability was calculated using these samples. Fleiss's kappa (Fleiss, 1971) was calculated using ReCal (Freelon, 2010) and was 0.76, indicating substantial agreement (Landis and Koch, 1977). Given the large number of responses and the high interrater reliability, the remaining 441 responses were then divided among the three coders and independently coded. After coding was complete, another random subset of 30 responses was independently coded by all three authors, and Fleiss's kappa was again calculated to ensure that interrater reliability remained high and that the codebook generated was still reliable. The value of kappa was 0.81, similar to the value of kappa for the initial subset, indicating that interrater reliability was still high.

For the instructor questions, given the relatively small number of responses, coders independently generated codes after reading all responses and then discussed the codes and came to a consensus. Following this, coders independently coded each response, and disagreements were discussed with all three coders to reach a consensus.

RESULTS

Who Attends Office Hours for STEM Courses in a Comprehensive University's College of Science?

Overall, the majority of students (354 of 531, or 66.7%) reported they had attended at least one office hour for a STEM course in Spring 2021. First- and second-year students reported significantly higher rates of attending office hours (70.9%, $n = 409$) than their third- and fourth-year (and above) counterparts (52.5%, $n = 122$; Pearson's chi-square test, $p < 0.01$). There was no significant difference in the rates of self-reported office hours attendance between first-generation and non–first generation students; between underrepresented minority (URM) students (any student who self-identified as Black, Latinx/Hispanic, or Native American) and non-URM students; between transfer and non-transfer students; and between males and females (there were too few nonbinary students to analyze).

How Did the Shift to Online Office Hours during ERT Impact Students' Self-Reported Frequency of Attending Office Hours?

Of the surveyed students, 331 (62.3%) were at our university in Spring 2020, the last semester that offered in-person office hours before the transition to online learning, and thus online office hours. Over a third of students (34.1%) reported attending office hours less frequently after office hours became online, while approximately one-fourth of students (26%) reported attending at a higher frequency. There was no difference in any demographic status (i.e., gender, first-generation, transfer, and URM status) between those who reported attending office hours at a higher frequency and those who reported attending at a lower frequency. The remainder of the students stated that they attended office hours at about the same frequency or did not remember.

What Do Students Perceive as the Benefits to and Barriers to Office Hours?

Most students (53.5% of respondents; Table 2) indicated that they attend office hours for content clarification. This theme of content clarification also was the most frequently reported theme by students (53.8% of all coded segments; Figure 1A). Students also cited coming to office hours to get help on

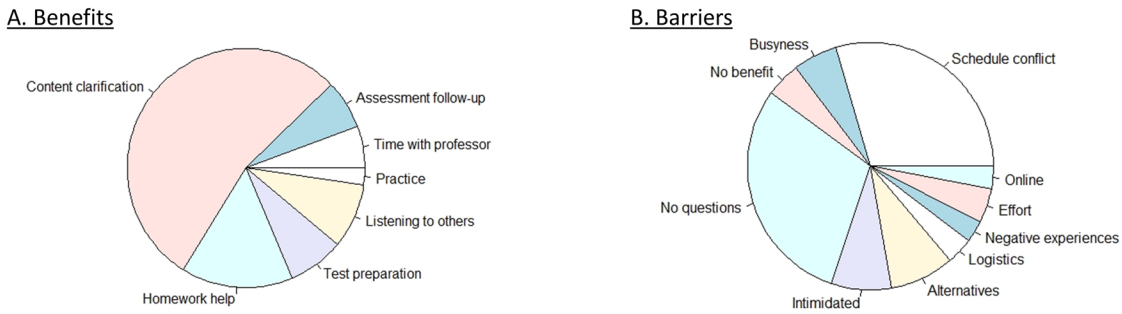

FIGURE 1. (A) Student responses concerning why they attend office hours. Pie chart showing total number of coded segments by total number of codes. Respondents who indicated that they did not attend office hours this semester were not included. The description of each code is included in Table 2. (B) Student responses concerning why they do not attend office hours. Pie chart showing total number of coded segments by total number of codes. The description of each code is included in Table 3.

homework, problem sets, lab reports, and other assessments (7.5% of respondents; 7.6% of coded segments). Students also reported coming to office hours to go through exams, quizzes, and other assessments after these items had been handed back (6.6% of respondents and total codes) and to receive more individual attention from the instructor, including wanting to get to know the instructor better (5.6% of respondents; 5.7% of total codes). Nearly 10% of students (8.7% of respondents and total codes) reported coming to office hours to listen to other students ask questions.

There was no pattern of differences in why students attend office hours when data were compared by class year, gender, first-generation status, transfer status, and URM status. The only significant difference was that a higher percentage of females (11.4%) than males (2.5%) reported listening to other students in office hours as a reason for attending ($p < 0.01$, Pearson's chi-square test with post hoc Bonferroni correction).

When students were prompted about why they did not attend office hours (for any STEM class), the most common response was that they did not have any questions or felt that they fully understood the course content (29.9% of codes; 41.4% of respondents; Figure 1B; Table 3). The second most common reason was that the course's office hours directly conflicted with another class or activity (40.9% of respondents; 29.5% of codes). More than 10% of students (10.9% of respondents; 7.9% of codes) conveyed that they were intimidated by office hours, perceived them as scary, or identified a social stigma surrounding attending office hours. Similarly, other students (4.1% of respondents; 2.9% of total codes) cited previous negative experiences with office hours as a reason for no longer attending.

TABLE 3. Codes for the perceived barriers to attending office hours[a]

Code name	Description: Did not attend office hours because they…	Percent of student codes	Percent of instructor codes
No questions	Had no questions to ask or felt like they fully understood the course material	41.4%	31.1%
Schedule conflict	Had activities or other commitments at the same time as office hours	40.9%	16.4%
Alternatives	Received help through other means outside of office hours (e.g., reaching out to friends or attending supplemental instruction sessions)	11.7%	3.3%
Intimidated	Had negative feelings of office hours, e.g., were too nervous to attend office hours, perceived them as scary, or identified a social stigma surrounding attending office hours	10.9%	18.0%
Busyness	Were too busy or overwhelmed to attend office hours (but did not state a specific time conflict with office hours)	8.2%	Not cited by instructors
No benefit/underestimating benefits	Did not perceive an advantage for attending office hours	6.3%	1.6%
Lack of effort	Did not try to attend office hours, including citing their own laziness or lack of motivation	6.3%	26.2%
Logistics	Had various structural barriers that prevented them from attending office hours, including if they noted that they did not know the schedule or could not find the location	4.9%	Not cited by instructors
Previous negative experiences	Had attended office hours previously and had a bad interaction or experience	4.1%	3.3%
Online	Did not like having office hours online, including citing Zoom fatigue	4.1%	Not cited by instructors

[a]Responses are provided for both students and instructors; several categories were only cited by students.

TABLE 4. Student perceptions for advantages of online office hours

Code name	Description: perceived an advantage of online office hours as…	Percent of student codes
Logistics (convenience)	Easier to attend than in person due to the convenience of online office hours	63.9%
Less intimidating	More comfortable, eliciting lower levels of anxiety, and less pressure than in-person office hours	11.4%
Online features	Able to use specific aspects of online conference platforms, such as screen sharing, polls, breakout rooms, or recording the interaction	6.9%
More students	Able to accommodate a greater number of students than in-person office hours	4.0%
Timing	Facilitating instructors holding office hours at more nontraditional times, such as during the evenings or during weekends	3.1%
Multitasking	Able to attend office hours for a few minutes between classes or attend office hours while on a break at a job or other commitment	2.8%
Collaboration	Easier to collaborate or meet students	1.7%

There were no systematic differences in responses across the different demographic groups. However, a larger percentage of first- and second-year students (43.1%) cited that they had no questions or understood the course content, while only 27.9% of third-year and above students mentioned this reason (Pearson's chi-square test with Bonferroni correction, $p < 0.01$).

How Do Students Perceive Online Office Hours?

Students were asked what they saw as advantages and disadvantages of online office hours compared with in-person office hours (Tables 2 and 3). The most common advantage students perceived (63.9% of codes) was that online office hours were easier to attend than in-person office hours, citing the convenience and flexibility of not needing to allocate time to go to an in-person event. Intriguingly, the second most common response (11.4% of codes) was that students found online office hours less intimidating, leading to less stress and anxiety from the interaction. None of the other advantages cited by students of online office hours were conveyed by more than 10% of respondents. There were no differences in responses by class year, gender, transfer, or URM status, except that a higher proportion of third- and fourth-year students cited using features of the online office hours platform (such as screen sharing, polls, breakout rooms, or recording the interaction; see Table 4) than did first- and second-year students ($p < 0.01$, Pearson's chi-square test with post hoc Bonferroni correction).

Students perceived a number of disadvantages surrounding online office hours (Table 5). The most common disadvantage (30.3% of codes) was that the format led to a lack of connection and engagement, with students mentioning it was harder to connect with instructors and engage in conversation. Similarly, the next two most common challenges cited related to students perceiving the online format as making it harder to learn the content or convey questions (14.3%) and not being able to draw things or share visuals as easily (10.9%). Students were also concerned about general online fatigue, Internet and other technological issues, and the lack of privacy and ability to hold one-on-one conversations with the instructor in an online office hour setting. There were no differences in responses based on any demographic attribute.

Students were also asked to indicate their preference/likelihood for attending office hours in the future once the pandemic was over, depending on office hours format. Students were divided in their preference, with nearly equal amounts of students stating that they would be more likely to attend if office hours were in person (40.5%) compared with students who indicated that they would be more likely to attend if office hours

TABLE 5. Student perceptions of online office hours disadvantages

Code name	Description: perceived a disadvantage of online office hours as…	Percent of student codes
Lack of connection and engagement	Being more challenging to connect to instructors than in person and not being able to build relationships with instructors	30.3%
Content challenges	Harder to understand content or convey questions and ideas	14.3%
Lack of ability to write and draw	Not being able to draw or write things as easily as in-person office hours	10.9%
Format	Leading to online screen fatigue, or cited general uneasiness with interactions in an online setting	8.6%
Technology issues	Being prone to Internet connectivity or other computer issues	6.8%
Less private	Not being able to have an individual conversation without others overhearing or having less access to one-on-one time with the instructor	6.6%
Long wait	Having to wait longer to receive assistance due to more students being present in office hours than when office hours were in person	4.7%
Less collaborative	Being harder to work together with peers or instructor, including citing that online office hours do not allow multiple conversations at once	3.3%
Lack of motivation	Leading to a lower drive to participate or increased complacency to not join	2.2%

TABLE 6. Preferences of in-person versus online office hours by gender[a]

	Prefer office hours in person	Prefer office hours online	No preference
Females (n = 361)	36.2%	42.9%	19.5%
Males (n = 163)	49.1%	27.6%	23.3%

[a]There were too few nonbinary students to analyze.

were online (38.1%). While there were no differences in preference by first-generation, transfer, or URM status, a higher percentage of females than males (42.9% and 27.6%, respectively) indicated that they would prefer to attend office hours online (Pearson's chi-square test, $p < 0.01$; Table 6).

When prompted to reflect on what they would like to see instructors do in the future, most students indicated that they would prefer instructors offer a mix of in-person and online office hours. Very few stated that they would prefer all office hours online (5.3%) or in person (9.8%). Instead, the plurality of students indicated they would prefer most office hours in person, but still having some online (31.1%), with the second most common response indicating that they would prefer an even split of office hours in person and online (28.7%). Far fewer students (17.6%) indicated that they would prefer most online but some in person.

How Do Instructors' Views of Office Hours Align with Student Perceptions?

Instructors provided a variety of perceived benefits for students attending office hours (Figure 2A; Table 2). Many of the perceived benefits (students seeking content clarification, wanting individual time with instructors, etc.) matched what students identified (Figure 3). However, there were key differences in several areas. For example, a greater percent of instructors viewed spending individual time with students as a benefit compared with students who viewed receiving individual time from instructors as a benefit ($p < 0.01$, Fisher's exact test, two-tailed, with post hoc Bonferroni correction). Instructors also perceived several additional benefits or goals that students did not perceive. These include professional support (career guidance, research opportunities, feedback for applications, general advising, etc.), which was listed by 21.4% of faculty. Similarly, 21.4% of faculty also listed study skills, including metacognitive strategies, as a goal or purpose of office hours. This was not listed by students as a reason for attending office hours.

Instructors provided several reasons for why students do not attend office hours (Figure 2B; Table 3). Most of these reasons aligned with student perceptions. For instance, the most frequent response of why students do not attend office hours was the same for both the student and instructor survey, with both groups identifying that some students do not attend office hours if they do not have questions (Figure 4). However, the second most frequent response instructors provided was a lack of effort or motivation from students (57.1% of instructors; 26.2% of codes). In contrast, relatively few students (6.3% of respondents; 4.5% of codes) mentioned a lack of effort as a reason for not attending office hours ($p < 0.01$, Fisher's exact test, two-tailed, with post hoc Bonferroni correction). The third most common response from instructors was that students may be uncomfortable asking questions, including being intimidated or perceiving their questions as making them appear foolish or dumb (39.3% of respondents; 18% of codes). A higher percent of instructors perceived students as being intimidated than the percent of students who indicated this reason on the survey (10.9% of respondents; 7.9% of codes), although this difference was not significant.

DISCUSSION

Office Hours Attendance

Our study examined both students' attendance at office hours in STEM classes as well as their perceived goals and barriers to attending office hours. Most students (66.7%) reported attending at least one office hours session for a STEM course during Spring 2021. This number matches our perceptions of the culture of office hours at our college, where full-time instructors typically hold 4–6 hours of office hours each week and encourage students to attend. Small class sizes (typically ranging from 10 to 80 for STEM classes) may also contribute to increased instructor immediacy and student motivation and trust and students being more comfortable attending office hours (Bolander, 1973; Hai-Jew, 2007). Interestingly, in contrast to past literature that has found that first-generation students, URMs, and transfer students may need additional instruction to become familiar with college resources and norms and thus may use these resources less frequently (Corple *et al.*, 2019), we found no differences in self-reported office hours attendance based on

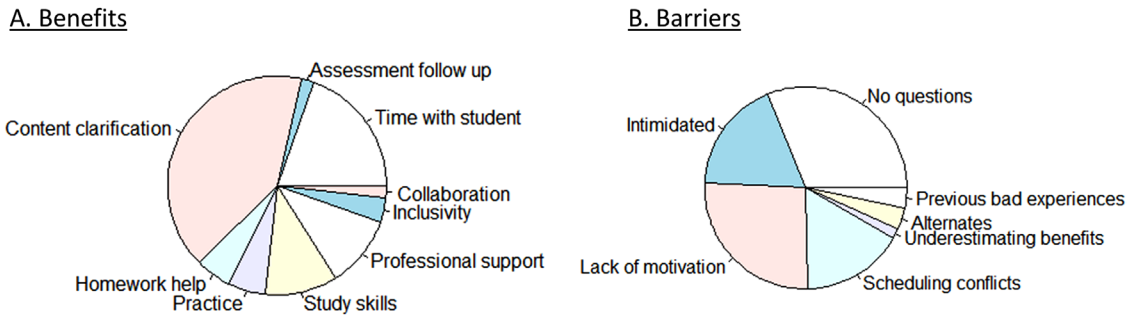

FIGURE 2. Instructor responses for (A) perceived benefits of office hours for students and (B) perceived barriers for students attending office hours. Pie chart showing total number of coded segments by total number of codes. The description of each code is included in Table 2 (perceived benefits) and Table 3 (perceived barriers).

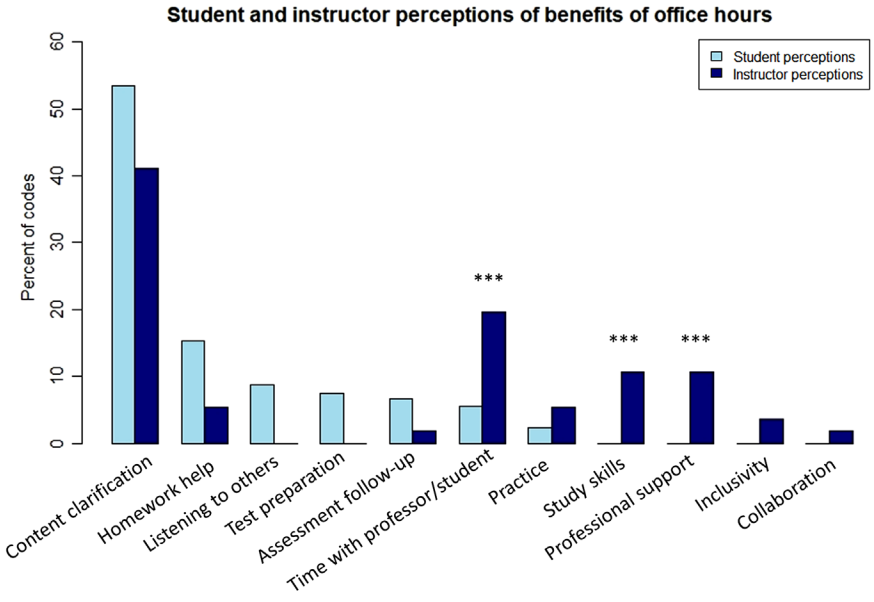

FIGURE 3. Comparisons of student and instructor perceptions of benefits of office hours. Triple asterisks indicate significance of $p < 0.01$ (Fisher's exact test, two-tailed, with post hoc Bonferroni correction)

any of these identities or on gender. Future work will need to explore how these students became familiar with office hours and what strategies were used that contribute to all students self-reporting equal rates of attendance.

However, first- and second-year students reported attending office hours at a much higher rate than their counterparts in the third year and above. We grouped first- and second-year students together, because they reported near-identical rates of attendance, and many of the core, required STEM classes are taken by first- and second-year students. Third- and fourth-year STEM students, in contrast, usually have much more flexibility in the curriculum and are able to take upper-division electives that typically have smaller class sizes. To explore possible reasons why students in different class years attend at different rates, we compared the reasons students in the different class years reported for attending or not attending office hours. Interestingly, the only significant difference between class years was that a larger percentage of first- and second-year students cited that they had no questions or understood the course content than their third-year and above counterparts, with no other differences in their reported motivation or barriers for office hours. This difference is intriguing, as we in general expect *lower* rates of office hours attendance if students have fewer questions, yet first- and second-year students reported attending more frequently despite a higher percentage stating that they had no questions or fully comprehended course concepts. Given this, our data do not provide any explanations for why first- and second-year students attended office hours more frequently than their more senior counterparts.

In addition, it is unclear if the differences in rates of attendance are due to a student's year in college or due to the specific courses that first- and second-year students take compared with third- and fourth-year students. For instance, while there are no unifying courses taken by most third- and fourth-year students, given the diversity of elective courses, the majority of first-year students (84.9%) reported taking an introductory biology course. Similarly, most first-year students were enrolled in introductory chemistry (79.4%), and most second-year students were enrolled in organic chemistry (68.8%). This correlation between class years and courses taken is likely driven by the required courses for most life sciences majors at our university, as well as requirements for professional schools (e.g., medical school). Thus, perceptions of office hours by first- and second-year students may be impacted by each student's number of years in college and/or by specific attributes in introductory biology and chemistry classes, and more work is needed to determine the extent that different factors shape student perceptions of and experiences in office hours. While our data do not provide any insights into these differences, one possible reason could be due to differences in the self-efficacy of STEM students at different points in their degrees. For instance, past work has found that women

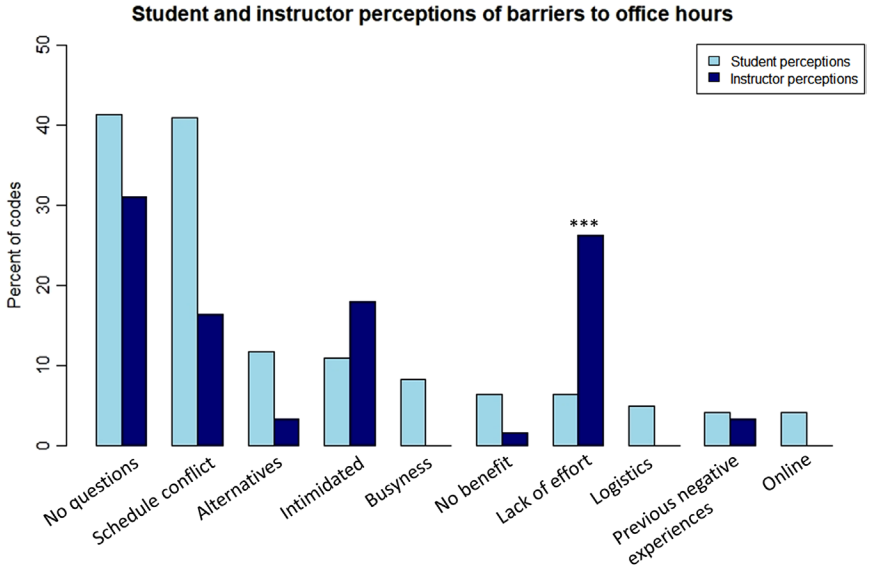

FIGURE 4. Comparisons of student and instructor perceptions of barriers to office hours. Triple asterisks indicate significance of $p < 0.01$ (Fisher's exact test, two-tailed, with post hoc Bonferroni correction).

engineering students show an increase in self-efficacy after spending a year in an engineering program (Marra *et al.*, 2009) and that introductory biology students tend to show an increase in self-efficacy over the course of the semester (Ainscough *et al.*, 2016). It is thus possible that third- and fourth-year students may have higher confidence in their ability to succeed, which may contribute to these different rates of attendance. Similarly, upper-division courses at our institution tend to be smaller than introductory classes. Given that past work has found an inverse correlation between perceived learning and class size, it is possible that students perceive that they are learning more and do not need office hours as much or may feel more comfortable asking questions in these smaller class settings (Chapman and Ludlow, 2010). Finally, another possibility is that upper-division students may have increased commitments. For instance, many leadership positions in extracurricular activities are often held by students in the third or fourth year of college, and third- and fourth-year students may be more likely to participate in independent research, given past studies that have revealed that first- and second-year students in general tend to have low knowledge about research and how to get involved (Cooper *et al.*, 2021; Rodríguez Amaya *et al.*, 2018). These increased commitments may lead to a higher rate of schedule conflicts with office hours for third- and fourth-year students.

Impact of Online Office Hours

We also investigated students' self-reported frequency of attending office hours after the shift to ERT and online office hours. Despite the plurality of students reporting that they attended office hours less frequently after the shift to ERT, one-fourth of students reported attending at a higher frequency. This aligns with national trends and our own experiences: Students became less engaged, more stressed, and less likely to attend office hours after the transition to ERT, with multiple structural barriers that may have prevented some students from participating or engaging in online instructional activities (Hsu and Goldsmith, 2021). However, it is interesting that nearly a fourth of students reported attending more office hours after the online transition. This may be due to the convenience of joining office hours online (the most commonly cited response for advantages of online office hours), which eliminates commuting or walking to the instructor's office or another location on campus. Interestingly, the second most common advantage of online office hours cited by students is that they are less intimidating than in-person office hours, suggesting that online office hours may encourage a broader group of students to attend. Thus, it appears that the shift to ERT impacted students in different ways: While overall more students reported attending less frequently, the change in format may have benefited a subset of students who reported attending office hours more frequently after the shift to online office hours or those who may be more comfortable with online office hours.

Despite this advantage of online office hours, more students stated that they preferred in-person office hours versus online office hours. Intriguingly, there were gender differences in preferences, with females more likely to prefer office hours online than males. Our survey does not provide any insight into possible reasons for this difference, which may be worth exploring in the future. There were no differences by gender when examining what students cited were disadvantages of online office hours, with the most common response being that online office hours were less engaging. We note that the concept of engagement is a broad term that encompasses many dimensions, including aspects of behavior, cognition, and student affect (Christenson *et al.*, 2012; Lawson and Lawson, 2013; Reeve and Lee, 2014; Wiggins *et al.*, 2017). Here, students indicated that they had more trouble connecting with instructors, building relationships with the instructor or classmates, or feeling involved in online office hours, likely reflecting changes in affective engagement (i.e., students' social interactions and attitudes in office hours). However, given that the various dimensions to engagement are interrelated, it is possible that the shift to online office hours also caused changes in cognitive and behavioral engagement, though more work is needed to examine these specific dimensions of engagement (Lawson and Lawson, 2013).

The second and third most commonly cited disadvantages of online office hours were that the format made it harder to ask questions and learn content and made it more difficult to communicate visuals and models. The lack of ability to draw may exacerbate inequities in the student body, as students with access to tablets may have an easier time communicating visuals and models in online office hours. However, despite these disadvantages, most students indicated that they would prefer that instructors offer a mix of in-person and online office hours, with a plurality stating that they would like slightly more in-person options than online options. These preferences will likely be context dependent; for instance, colleges and universities with a greater proportion of commuter students or nontraditional students who have work and family obligations may see differing preferences in their student bodies than students at other campuses with a greater percentage of students in residence (Forbus *et al.*, 2011).

Student Motivations for Attending Office Hours

We also explored student reasons for attending office hours, with students describing various motivations for why they attended. Students primarily reported that they were motivated to attend office hours to ask questions about the content, a response that may align with either extrinsic or intrinsic motivation. For example, applying the SDT framework, those who are intrinsically motivated and find understanding the material as satisfying may be driven to attend by this enjoyment of learning the material (Deci and Ryan, 2013). This state of intrinsic motivation is associated with other successful learning strategies, which could contribute to these students attending office hours to ask questions and clarify the content due to genuine interest (Wæge, 2007; Deci and Ryan, 2013; Linnenbrink-Garcia *et al.*, 2016). It is also possible that students who reported the primary motivation for attending office hours to get questions answered, in contrast, may be driven by identified regulation, where students have internal (intrinsic) motivation but are guided toward an extrinsic goal (Hewitt *et al.*, 2019). Those students may enjoy the content and are motivated to ask questions due to genuine interest, but are also driven due to external pressures, such as doing well on exams and obtaining a good grade in the class for career goals. Finally, it is possible that some of the students who identified asking questions as their main reason for attending office hours may be relying solely on extrinsic motivation. In this case, the students may not value the course concepts or be driven by any internal desire to know

more about the material or understand the concepts. Instead, these students may be motivated solely by external pressures, such as getting good grades or receiving honors and accomplishments based on grade point average (Lei, 2010).

The second most frequent reason why students reported attending office hours was to get help on homework, problem sets, lab reports, and other assessments, aligning with literature showing that frequent, formative assessments can spark student metacognition and allow them more chances to practice and take ownership of their own learning (Haak *et al.*, 2011). This need to complete assignments is likely an extrinsic motivator for most students: While students may still have intrinsic interest (identified regulation), other students may be motivated solely by this external factor of the need to complete assignments to pass the course.

However, despite having many students indicate that getting help on assignments was a main reason why they attended office hours, there was a lower frequency of students who cited attending office hours to review feedback from assessments that had been handed back to students (e.g., asking questions about an exam problem once the exam has been released). This may be due to a variety of reasons, including structural challenges (e.g., some classes may not allow students to keep past exams), the fact that not all students may review feedback from assessments, or students being satisfied with posted answer keys and explanations from the instructor. It is also possible that this difference can be attributed to students who are driven by extrinsic motivation but not by any intrinsic interest in the material. These students are likely motivated by the external need to complete assignments and would come to office hours to get help to accomplish that goal, but would not be motivated to attend office hours to review the feedback, given that the extrinsic reward obtained by completing the assignments would be complete at that point. Further work is needed to explore how students process feedback from such assessments and the impact on office hours engagement.

Interestingly, nearly 10% of students reported coming to office hours to listen to other students ask questions, suggesting that office hours can help student peer learning. This response aligned with the culture of our institution, where many faculty hold office hours in conference rooms and other spaces that allow for a larger number of students to attend, work together, and listen to other questions. Online office hours likely also facilitated the ability of students to listen to other students' questions. This response was also the only category in which perceptions differed among any of the demographic characteristics (class year, gender, first-generation status, transfer status, and URM status): A higher percentage of females (11.4%) reported attending office hours to listen to other students than males (2.5%). More work is needed to explore whether gender is indeed a factor in how students perceive this benefit of office hours.

Our results indicate that some students may be attending office hours more due to extrinsic factors than for intrinsic reasons. As such, instructors may wish to encourage students' intrinsic motivation, which is correlated with better learning and academic performance (Lin *et al.*, 2003; Lei, 2010; Orsini *et al.*, 2015; Linnenbrink-Garcia *et al.*, 2016). Instructors can implement strategies to address the three main components of SDT—the need for autonomy, competence, and relatedness—and increase intrinsic motivation of students to attend and engage in office hours (Stefanou *et al.*, 2004; Orsini *et al.*, 2015). Past work has focused on general classroom practices that increase intrinsic motivation, and we are not aware of any work that has examined approaches that could impact students' intrinsic motivations in the context of office hours. However, it is likely that similar interventions and strategies focused on increasing autonomy, competence, and relatedness in the context of office hours will increase students' intrinsic motivation and thereby have positive effects on their learning. For example, instructors can promote autonomy by describing the importance of reflection, reviewing feedback, and acting on the feedback by attending office hours, thus encouraging students to take ownership of their own learning (Linnenbrink-Garcia *et al.*, 2016; Ryan and Deci, 2020). This feeling of autonomy can promote competence, and instructors can describe how office hours are a good mechanism for students to obtain additional feedback and practice problems together to increase student mastery of the material (Urdan and Schoenfelder, 2006). Finally, instructors can take the time in office hours to build interpersonal relationships, asking students about their career goals and other aspects that extend beyond course content, thus promoting relatedness (Sparks *et al.*, 2015; Linnenbrink-Garcia *et al.*, 2016).

Student Barriers to Attending Office Hours

We also asked students why they did not attend office hours for some or all their STEM classes. The most common reason provided was that students did not have any questions or felt that they fully understood the course content. We did not collect student grade data, so it is challenging to determine whether those not attending for certain classes did have a strong grasp on the material, or if students overestimate their own ability in STEM courses, given that past studies have shown that students tend to be poor judges of their own learning (Deslauriers *et al.*, 2019). Interestingly, these data contrast with past studies at large public research-intensive universities where the clarity of content during class was found to not be a predictive factor of students' office hours attendance (Griffin *et al.*, 2014). It is possible, however, that this difference stems from the higher percentage of students attending office hours in this study versus previous studies in which most students have not attended office hours, leading to differences in student motivations and barriers for attending office hours. The second most common reason provided was structural in nature, with students indicating that the course's office hours had a direct conflict with another class or activity (40.9% of respondents; 29.5% of codes). This aligns with past work that indicates convenient times and locations of office hours can cause students to attend office hours more frequently (Griffin *et al.*, 2014). These data thus suggest that scheduling of office hours remains a barrier to student attendance and that instructors should consider strategies to ensure that their office hours are accessible to as many students in the course as possible. These include spreading out office hours across times, scheduling some office hours at times outside the traditional workday, offering rotating office hour times, or polling students to check availability before setting office hours times.

The third most common response was students indicating that they were intimidated by office hours, perceived them as

scary, or identified a social stigma surrounding attending office hours, thus likely associating office hours with increased stress and anxiety (Hsu and Goldsmith, 2021). This included students who stated that attending office hours was a sign of weakness or that they felt like they would only be needlessly bothering the instructor. A smaller percentage of students also cited previous negative experiences with office hours as a reason for no longer attending. Taken together, these reasons suggest that instructors should take explicit steps to improve the perception of office hours and to ensure that students view them as inclusive and welcoming environments for all students. Such steps may include discussing the goals and purpose of office hours, framing them as a resource for all students, and explaining the norms of office hours. We also highlight this as an opportunity for future research: While there has been recurring work examining how to promote inclusivity in the biology classroom (e.g., Campbell-Montalvo *et al.*, 2020; Cooper *et al.*, 2020; Hales, 2020; Gin *et al.*, 2021), we are not aware of any work examining what factors influence inclusivity and student stress and anxiety in office hours.

The reasons for not attending office hours provided by students identifying with different demographic groups were also largely the same. However, a higher percentage of first- and second-year students indicated that they had no questions than their third-year and above counterparts. This may be due to first- and second-year students lacking the metacognitive or studying skills to recognize gaps they have in their understanding (Yip, 1998; Choi, 2006), though more work is needed to explore this. Similarly, a higher percentage of females indicated that they had no questions, indicating that this area may be beneficial to explore in future studies.

Instructor Perceptions of Office Hours

There were several disconnects when comparing instructor and student perceptions of office hours. For instance, while instructors and students both reported content clarification and getting help on assignments as the most common reasons for attending office hours, instructors perceived several additional benefits or goals of office hours that students did not list, such as professional support (career guidance, research opportunities, general advising) and study skills. These data suggest that there may be differences between how instructors and students are viewing the goals of office hours and that instructors envision additional benefits that students may not be seeing. Instructors may consider explicitly listing and discussing these benefits to incentivize students to attend office hours and establish the norm that office hours can be used for these purposes.

There were similarly major disconnects between the barriers perceived by instructors and students to attending office hours. The second most common response for why students do not attend office hours provided by instructors was lack of motivation in students. In contrast, only a small percentage of students stated that lack of effort was a barrier to attending office hours. These data demonstrate an interesting misalignment between instructor and student perceptions: instructors may hold negative perceptions toward those students who do not attend office hours, while very few students ascribe not attending due to a lack of effort, instead providing a plethora of other reasons for why they do not attend. While students may not be aware or willing to disclose lack of motivation, we urge instructors to consider that many other barriers, other than lack of motivation, may be hindering students from attending office hours.

Limitations

This study is limited to one institution with self-reported student demographic data, and student and instructor perceptions of office hours may be heavily influenced by institutional, instructor, and course contexts. In addition, students were deliberately surveyed during the optional transition back to in-person learning, meaning that students' preferences and reflections surrounding online versus in-person office hours may be more heavily influenced by their recent experiences with online office hours. Despite these limitations, our study is the first to provide a broad examination of student perceptions of STEM office hours across life sciences majors in an entire college of science. In addition, we provide the first study we are aware of that examines office hours at a comprehensive university with smaller class sizes, where most students report having attended office hours. These findings thus provide significant insight into how students and instructors in these contexts view office hours and offer valuable suggestions for instructors on how to increase student attendance and engagement at office hours.

Future Directions

There are several areas of possible future research to build upon our work. First, our research is limited by relying on student self-reported data from one time point. Future studies that incorporate institutional data about student demographics or instructor data on who is attending office hours will provide more insight into who is attending office hours and at what frequency. In addition, there is an urgent need to investigate what factors directly shape student perceptions of office hours, student experiences at office hours, and the impact on student learning and affect. It is likely that many different factors, such as class size, number of years in college for each student, experience with previous office hours, format and location of office hours, and specific instructor actions, likely shape students' attitudes and experiences in office hours. Similarly, it is likely that institutional context and culture influences student perceptions of and experiences in office hours. Given this diversity of variables and the changing modalities caused by the shift to ERT, it was not possible for us to draw conclusions regarding factors that influence student perceptions of and experiences in office hours from a survey of students in an entire college of science at one time point. We were also unable to track the impact of attending office hours on student learning or affect. Future work that uses longitudinal surveys of students across a term (or even beyond a term) or research that uses pre–post surveys to measure the impact of specific interventions is needed to provide insight into factors that shape student perceptions and experiences in office hours. Similarly, future work is needed to investigate factors that influence inclusivity in office hours and to explore steps that instructors can take to promote an inclusive and welcoming office hours environment.

Implications for Instructors

Based on our data, we recommend instructors take the following steps to promote office hours attendance and engagement:

1. **Explicitly discuss the norms of office hours, including the possible benefits of office hours.** Students perceive fewer benefits from office hours than instructors do, and some students hold negative perceptions of office hours. Increased efforts to explain the goals, benefits, and expectations of office hours may make students more comfortable and more likely to attend office hours Similarly, instructors may wish to consider ways to facilitate discussing some of these topics in office hours, such as career development and study skills, which can be valuable for students' academic and professional development (Durkin and Main, 2002; McCartney *et al.*, 2022).
2. **Explore ways to remove structural barriers for office hours.** Our data demonstrated that time conflicts remain the largest barrier for student attendance at office hours at our campus. Instructors can take steps to mitigate such conflicts by polling students on their schedules, rotating their office hours schedule, or including office hours times outside the traditional workday. Similarly, providing some online options for office hours may reduce these structural barriers, given that students may view the ease and convenience of online office hours, including the ability to drop in for a quick question, as a major advantage. This may have large benefits for commuter students and those who are juggling work and family commitments.
3. **Provide structured opportunities for practice and feedback.** Our results indicate that most students come into office hours if they have questions or to get help with homework. Similarly, many students do not come into office hours if they perceive that they have a full understanding of course content. Thus, it is likely that the more formative assessments that an instructor can provide to students to guide their learning and spark metacognition, the more likely it is that students will attend office hours. These practices have been shown to increase student learning and retention (Freeman *et al.*, 2011; Haak *et al.*, 2011) and may also lead to greater student participation and engagement in office hours.
4. **Promote an inclusive environment in office hours.** Our survey showed that nearly 15% of students indicated that they either were intimidated by office hours or had previous negative experiences, a number potentially higher at other institutions with larger class sizes. Thus, instructors can take steps to make students feel welcomed and included in office hours. Beyond discussing the norms of office hours, instructors can consider alternate locations for office hours outside their offices (e.g., a conference room) where students may feel more comfortable attending, explicitly encourage students to attend in groups, and take the time to connect with students during office hours with topics beyond the course content.

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REFERENCES

Ainscough, L., Foulis, E., Colthorpe, K., Zimbardi, K., Robertson-Dean, M., Chunduri, P., & Lluka, L. (2016). Changes in biology self-efficacy during a first-year university course. *CBE—Life Sciences Education*, *15*(2), ar19. doi: 10.1187/cbe.15-04-0092

Andrade, B.-L., Pakala, K., Bairaktarova, D., Hagemeier, D., & Subbaraman, H. (2020). Faculty perspectives on the impact of virtual office hours in engineering courses. Paper presented at: 2020 ASEE Virtual Annual Conference Content Access, Virtual On Line. https://scholarworks.boisestate.edu/mecheng_facpubs/114

André, S., Maulana, R., Helms-Lorenz, M., Telli, S., Chun, S., Fernández-García, C.-M., … & Jeon, M. (2020). Student perceptions in measuring teaching behavior across six countries: A multi-group confirmatory factor analysis approach to measurement invariance. *Frontiers in Psychology*, *11*. www.frontiersin.org/article/10.3389/fpsyg.2020.00273

Ankiewicz, P. (2019). Perceptions and attitudes of pupils towards technology: In search of a rigorous theoretical framework. *International Journal of Technology and Design Education*, *29*(1), 37–56. doi: 10.1007/s10798-017-9434-z

Atamian, R., & DeMoville, W. (1998). Office hours—none: An e-mail experiment. *College Teaching*, *46*(1), 31–35.

Bolander, S. F. (1973). Class size and levels of student motivation. *Journal of Experimental Education*, *42*(2), 12–17. doi: 10.1080/00220973.1973.11011454

Brancaccio-Taras, L., Mawn, M. V., Premo, J., & Ramachandran, R. (2021). Teaching in a time of crisis: Editorial perspectives on adjusting STEM education to the "new normal" during the COVID-19 pandemic. *Journal of Microbiology & Biology Education*, *22*(1), ev22i1.2679. doi: 10.1128/jmbe.v22i1.2679

Briody, E. K., Wirtz, E., Goldenstein, A., & Berger, E. J. (2019). Breaking the tyranny of office hours: Overcoming professor avoidance. *European Journal of Engineering Education*, *44*(5), 666–687. doi: 10.1080/03043797.2019.1592116

Bussey, J. T., Orgill, M., & Crippen, J. K. (2013). Variation theory: A theory of learning and a useful theoretical framework for chemical education research. *Chemistry Education Research and Practice*, *14*(1), 9–22. doi: 10.1039/C2RP20145C

Campbell-Montalvo, R. A., Caporale, N., McDowell, G. S., Idlebird, C., Wiens, K. M., Jackson, K. M., … & Moore, M. E. (2020). Insights from the Inclusive Environments and Metrics in Biology Education and Research Network: Our experience organizing inclusive biology education research events. *Journal of Microbiology & Biology Education*. doi: 10.1128/jmbe.v21i1.2083

Chapman, L., & Ludlow, L. (2010). Can Downsizing College Class Sizes Augment Student Outcomes? An Investigation of the Effects of Class Size on Student Learning. *The Journal of General Education*, *59*(2), 105–123. doi: 10.5325/jgeneeduc.59.2.0105

Chapman University. (2016). *Chapman University Faculty Manual*. Orange, CA.

Choi, J. Y. (2006). Metacognitive evaluation method in consecutive interpretation for novice learners. *Meta: Journal des Traducteurs/Meta: Translators' Journal*, *51*(2), 273–283. doi: 10.7202/013256ar

Christenson, L. S., Reschly, L. A., & Wylie, C. (Eds.) (2012). *Handbook of student engagement*. New York, NY: Springer.

Cifuentes, O. E., & Lents, N. H. (2011). Increasing student-teacher interactions at an urban commuter campus through instant messaging and online office hours. *Electronic Journal of Science Education*, *14*(1), 1–13.

Cooper, K. M., Auerbach, A. J. J., Bader, J. D., Beadles-Bohling, A. S., Brashears, J. A., Cline, E., … & Brownell, S. E. (2020). Fourteen recommendations to create a more inclusive environment for LGBTQ+ individuals in academic biology. *CBE—Life Sciences Education*, *19*(3), es6. doi: 10.1187/cbe.20-04-0062

Cooper, K. M., Cala, J. M., & Brownell, S. E. (2021). Cultural capital in undergraduate research: An exploration of how biology students operationalize knowledge to access research experiences at a large, public

research-intensive institution. *International Journal of STEM Education*, *8*(1), 6. doi: 10.1186/s40594-020-00265-w

Cooper, K. M., Haney, B., Krieg, A., & Brownell, S. E. (2017). What's in a name? The importance of students perceiving that an instructor knows their names in a high-enrollment biology classroom. *CBE—Life Sciences Education*, *16*(1), ar8. doi: 10.1187/cbe.16-08-0265

Corple, D., Zoltowski, C. B., Eddington, S., Brightman, A. O., & Buzzanell, P. M. (2019, June 15). *What you need to succeed: Examining culture and capital in biomedical engineering undergraduate education*. Paper presented at: 2019 ASEE Annual Conference & Exposition. https://strategy.asee.org/what-you-need-to-succeed-examining-culture-and-capital-in-biomedical-engineering-undergraduate-education

Deci, E. L., & Ryan, R. M. (2013). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Springer Science & Business Media.

Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences USA*, *116*(39), 19251–19257. doi: 10.1073/pnas.1821936116

Donham, C., Barron, H. A., Alkhouri, J. S., Changaran Kumarath, M., Alejandro, W., Menke, E., & Kranzfelder, P. (2022). I will teach you here or there, I will try to teach you anywhere: Perceived supports and barriers for emergency remote teaching during the COVID-19 pandemic. *International Journal of STEM Education*, *9*(1), 19. doi: 10.1186/s40594-022-00335-1

Drew, S. (2001). Perceptions of what helps learn and develop in education. *Teaching in Higher Education*, *6*(3), 309–331. doi: 10.1080/13562510120061197

Durkin, K., & Main, A. (2002). Discipline-based study skills support for first-year undergraduate students. *Active Learning in Higher Education*, *3*(1), 24–39. doi: 10.1177/1469787402003001003

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., … & Midgley, C. (1983). Expectancies, values, and academic behaviors. In Spence, J. T. (Ed.), *Expectancies, values, and academic behaviors, Freeman* (pp. 75–146). San Francisco, CA: W. H. Freeman.

Fleiss, J. L. (1971). Measuring nominal scale agreement among many raters. *Psychological Bulletin*, *76*(5), 378–382. doi: 10.1037/h0031619

Forbus, P., Newbold, J. J., & Mehta, S. S. (2011). A study of non-traditional and traditional students in terms of their time management behaviors, stress factors, and coping strategies. *Academy of Educational Leadership Journal*, *15*, 109–125.

Freelon, D. G. (2010). ReCal: Intercoder reliability calculation as a web service. *International Journal of Internet Science*, *5*(1), 20–33.

Freeman, S., Haak, D., & Wenderoth, M. P. (2011). Increased course structure improves performance in introductory biology. *CBE—Life Sciences Education*, *10*(2), 175–186. doi: 10.1187/cbe.10-08-0105

Gin, L. E., Scott, R. A., Pfeiffer, L. D., Zheng, Y., Cooper, K. M., & Brownell, S. E. (2021). It's in the syllabus … or is it? How biology syllabi can serve as communication tools for creating inclusive classrooms at a large-enrollment research institution. *Advances in Physiology Education*, *45*(2), 224–240. doi: 10.1152/advan.00119.2020

Griffin, W., Cohen, S. D., Berndtson, R., Burson, K. M., Camper, K. M., Chen, Y., & Smith, M. A. (2014). Starting the conversation: An exploratory study of factors that influence student office hour use. *College Teaching*, *62*(3), 94–99. doi: 10.1080/87567555.2014.896777

Guerrero, M., & Rod, A. B. (2013). Engaging in office hours: A study of student-faculty interaction and academic performance. *Journal of Political Science Education*, *9*(4), 403–416. doi: 10.1080/15512169.2013.835554

Guzzardo, M. T., Khosla, N., Adams, A. L., Bussmann, J. D., Engelman, A., Ingraham, N., … & Taylor, S. (2021). "The ones that care make all the difference": Perspectives on student-faculty relationships. *Innovative Higher Education*, *46*(1), 41–58. doi: 10.1007/s10755-020-09522-w

Haak, D. C., HilleRisLambers, J., Pitre, E., & Freeman, S. (2011). Increased structure and active learning reduce the achievement gap in introductory biology. *Science*, *332*(6034), 1213–1216. doi: 10.1126/science.1204820

Hai-Jew, S. (2007). The trust factor in online instructor-led college courses. *Journal of Interactive Instruction Development*, *19*(3), 11–25.

Hales, K. G. (2020). Signaling inclusivity in undergraduate biology courses through deliberate framing of genetics topics relevant to gender identity, disability, and race. *CBE—Life Sciences Education*, *19*(2), es2. doi: 10.1187/cbe.19-08-0156

Hewitt, K. M., Bouwma-Gearhart, J., Kitada, H., Mason, R., & Kayes, L. J. (2019). Introductory biology in social context: The effects of an issues-based laboratory course on biology student motivation. *CBE—Life Sciences Education*, *18*(3), ar30. doi: 10.1187/cbe.18-07-0110

Hsu, J. L., & Goldsmith, G. R. (2021). Instructor strategies to alleviate stress and anxiety among college and university STEM students. *CBE—Life Sciences Education*, *20*(1), es1. doi: 10.1187/cbe.20-08-0189

Hsu, J. L., & Rowland-Goldsmith, M. (2021). Student perceptions of an inquiry-based molecular biology lecture and lab following a mid-semester transition to online teaching. *Biochemistry and Molecular Biology Education*, *49*(1), 15–25. doi: 10.1002/bmb.21478

Hulleman, C. S., Barron, K. E., Kosovich, J. J., & Lazowski, R. A. (2016). Student motivation: Current theories, constructs, and interventions within an expectancy-value framework. In Lipnevich A. A., Preckel F., & Roberts R. D. (Eds.), *Psychosocial skills and school systems in the 21st century: Theory, research, and practice* (pp. 241–278). Cham, Switzerland: Springer International Publishing. doi: 10.1007/978-3-319-28606-8_10

Jeno, L. M., Raaheim, A., Kristensen, S. M., Kristensen, K. D., Hole, T. N., Haugland, M. J., & Mæland, S. (2017). The relative effect of team-based learning on motivation and learning: A self-determination theory perspective. *CBE—Life Sciences Education*, *16*(4), ar59. doi: 10.1187/cbe.17-03-0055

Koestner, R., & Losier, G. F. (2002). Distinguishing three ways of being highly motivated: A closer look at introjection, identification, and intrinsic motivation. In Deci, E. L., & Ryan, R. M. (Eds.), *Handbook of self-determination research* (pp. 101–121). Rochester, NY: University of Rochester Press.

Landis, J. R., & Koch, G. G. (1977). An Application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. *Biometrics*, *33*(2), 363–374. doi: 10.2307/2529786

Lawson, M. A., & Lawson, H. A. (2013). New conceptual frameworks for student engagement research, policy, and practice. *Review of Educational Research*, *83*(3), 432–479. doi: 10.3102/0034654313480891

Lei, S. A. (2010). Intrinsic and extrinsic motivation: Evaluating benefits and drawbacks from college instructors' perspectives. *Journal of Instructional Psychology*, *37*(2), 153–160.

Li, L., & Pitts, J. P. (2009). Does it really matter? Using virtual office hours to enhance student-faculty interaction. *Journal of Information Systems Education*, *20*(2), 175.

Lin, Y.-G., McKeachie, W. J., & Kim, Y. C. (2003). College student intrinsic and/or extrinsic motivation and learning. *Learning and Individual Differences*, *13*(3), 251–258. doi: 10.1016/S1041-6080(02)00092-4

Linnenbrink-Garcia, L., Patall, E. A., & Pekrun, R. (2016). Adaptive motivation and emotion in education: Research and principles for instructional design. *Policy Insights from the Behavioral and Brain Sciences*, *3*(2), 228–236. doi: 10.1177/2372732216644450

Lowenthal, P., Dunlap, J., & Snelson, C. (2017). Live synchronous Web meetings in asynchronous online courses: Reconceptualizing virtual office hours. *Online Learning Journal*, *21*(4). www.learntechlib.org/p/183778/

Marra, R. M., Rodgers, K. A., Shen, D., & Bogue, B. (2009). Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self-efficacy. *Journal of Engineering Education*, *98*(1), 27–38. doi: 10.1002/j.2168-9830.2009.tb01003.x

McCartney, M., Roddy, A. B., Geiger, J., Piland, N. C., Ribeiro, M. M., & Lainoff, A. (2022). Seeing yourself as a scientist: Increasing science identity using professional development modules designed for undergraduate students. *Journal of Microbiology & Biology Education*, *23*(1), e00346–21. doi: 10.1128/jmbe.00346-21

Mesa, V. (2012). Achievement Goal Orientations of Community College Mathematics Students and the Misalignment of Instructor Perceptions. *Community College Review*, *40*(1), 46–74. doi: 10.1177/0091552111435663

Moore, M. Z. (2020). Fostering a sense of belonging using a multicontext approach. *Journal of College Student Retention: Research, Theory & Practice*. doi: 10.1177/1521025120944828

Orsini, C., Evans, P., & Jerez, O. (2015). How to encourage intrinsic motivation in the clinical teaching environment?: A systematic review from the self-determination theory. *Journal of Educational Evaluation for Health Professions*, *12*. doi: 10.3352/jeehp.2015.12.8

Osborne, R. E., Kriese, P., Tobey, H., & Johnson, E. (2009). And never the two shall meet? Student vs. faculty perceptions of online courses. *Journal of Educational Computing Research*, *40*(2), 171–182. doi: 10.2190/EC.40.2.b

Park, E. S., Harlow, A., AghaKouchak, A., Baldi, B., Burley, N., Buswell, N., … & Sato, B. (2021). Instructor facilitation mediates students' negative perceptions of active learning instruction. *PLoS ONE*, *16*(12), e0261706. doi: 10.1371/journal.pone.0261706

Reeve, J., & Lee, W. (2014). Students' classroom engagement produces longitudinal changes in classroom motivation. *Journal of Educational Psychology*, *106*(2), 527–540. doi: 10.1037/a0034934

Richardson, D. S., Bledsoe, R. S., & Cortez, Z. (2020). Mindset, motivation, and teaching practice: Psychology applied to understanding teaching and learning in STEM disciplines. *CBE—Life Sciences Education*, *19*(3), ar46. doi: 10.1187/cbe.19-11-0238

Robinson, R. J., Culver, D., Schertzer, M. J., Landschoot, T. P., & Hensel, E. C. (2015, March 13). Understanding the causes for low student office hour attendance. Paper presented at: ASME 2014 International Mechanical Engineering Congress and Exposition. doi: 10.1115/IMECE2014-38698

Rodríguez Amaya, L., Betancourt, T., Collins, K. H., Hinojosa, O., & Corona, C. (2018). Undergraduate research experiences: Mentoring, awareness, and perceptions—a case study at a Hispanic-serving institution. *International Journal of STEM Education*, *5*(1), 9. doi: 10.1186/s40594-018-0105-8

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68–78. doi: 10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, 101860. doi: 10.1016/j.cedpsych.2020.101860

Seidel, T., & Shavelson, R. J. (2007). Teaching effectiveness research in the past decade: The role of theory and research design in disentangling meta-analysis results. *Review of Educational Research*, *77*(4), 454–499. doi: 10.3102/0034654307310317

Smith, M., Chen, Y., Berndtson, R., Burson, K. M., & Griffin, W. (2017). "Office hours are kind of weird": Reclaiming a resource to foster student-faculty interaction. *InSight: A Journal of Scholarly Teaching*, *12*, 14–29.

Sparks, C., Dimmock, J., Whipp, P., Lonsdale, C., & Jackson, B. (2015). "Getting connected": High school physical education teacher behaviors that facilitate students' relatedness support perceptions. *Sport, Exercise, and Performance Psychology*, *4*(3), 219–236. doi: 10.1037/spy0000039

Stefanou, C. R., Perencevich, K. C., DiCintio, M., & Turner, J. C. (2004). Supporting autonomy in the classroom: ways teachers encourage student decision making and ownership. *Educational Psychologist*, *39*(2), 97–110. doi: 10.1207/s15326985ep3902_2

Struyven, K., Dochy, F., & Janssens, S. (2005). Students' perceptions about evaluation and assessment in higher education: A review. *Assessment & Evaluation in Higher Education*, *30*(4), 325–341. doi: 10.1080/02602930500099102

Trust, T., & Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. *Journal of Technology and Teacher Education*, *28*(2), 189–199.

Urdan, T., & Schoenfelder, E. (2006). Classroom effects on student motivation: Goal structures, social relationships, and competence beliefs. *Journal of School Psychology*, *44*(5), 331–349. doi: 10.1016/j.jsp.2006.04.003

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. *Advance. Experimental Social Psychology*, *29*(1), 271–360.

Wæge, K. (2007). Intrinsic and extrinsic motivation versus social and instrumental rationale for learning mathematics. In *Proceedings of the 5th Congress of the European Society for Research in Mathematics Education*. Lanarca, Cyprus: University of Cypress.

Wakimoto, D. K., Lewis, R. E., Rush, D., & Nogueiro, K. (2019). Missing the process for the product: Tension between instructor goals and student perceptions of eportfolios as personalized action research. *International Journal of ePortfolio*, *9*(2), 65–74.

Wallace, F. L., & Wallace, S. R. (2001). Electronic office hours: A component of distance learning. *Computers & Education*, *37*(3), 195–209. doi: 10.1016/S0360-1315(01)00046-X

Walsh, L. L., Arango-Caro, S., Wester, E. R., & Callis-Duehl, K. (2021). Training faculty as an institutional response to COVID-19 emergency remote teaching supported by data. *CBE—Life Sciences Education*, *20*(3), ar34. doi: 10.1187/cbe.20-12-0277

Wiggins, B. L., Eddy, S. L., Wener-Fligner, L., Freisem, K., Grunspan, D. Z., Theobald, E. J., … & Crowe, A. J. (2017). ASPECT: A survey to assess student perspective of engagement in an active-learning classroom. *CBE—Life Sciences Education*, *16*(2), ar32. doi: 10.1187/cbe.16-08-0244

Willson-Conrad, A., & Kowalske, M. G. (2018). Using self-efficacy beliefs to understand how students in a general chemistry course approach the exam process. *Chemistry Education Research and Practice*, *19*(1), 265–275. doi: 10.1039/C7RP00073A

Yip, D. (1998). Identification of misconceptions in novice biology teachers and remedial strategies for improving biology learning. *International Journal of Science Education*, *20*(4), 461–477. doi: 10.1080/0950069980200406