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Exploring Variations in STEM Instructors' Approaches to Office Hours

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ABSTRACT

Office hours are an integral component of science, technology, engineering, and math (STEM) courses at nearly all colleges and universities. Despite their ubiquity as a support mechanism, there has only been limited work examining how instructors approach office hours and what shapes these approaches. Here, we conduct a phenomenographic study to investigate how instructors of STEM courses experience office hours and how these experiences may impact their approaches to promoting and managing office hours. We identified variations in how instructors promoted office hours, the modality of office hours (i.e., when and where office hours were held), and how instructors facilitated learning during office hours. These variations spanned from student-centric (strategies instructors use with students' interest in mind, e.g., wanting to increase student learning, accessibility, comfort, etc.) to instructor-centric (strategies the instructors use with their own self-interest in mind, e.g., saving time and/or bandwidth, personal needs, comfort, etc.). Additionally, we identify several challenges and barriers, including a lack of formal training or opportunities to discuss office hour approaches with other faculty, and conclude with general recommendations for instructors and administrators in STEM departments for engaging and supporting students during office hours.

INTRODUCTION

Office hours—defined here as “nonstructured instructional time set aside outside class for students to interact with the instructor of the course and receive help” (Hsu *et al.*, 2022)—are an integral component of science, technology, engineering, and math (STEM) courses at nearly all colleges and universities, with many institutions outlining mandates in their faculty manuals and/or handbooks that instructors provide office hours for students (e.g., *Chapman University Faculty Manual*; Chapman University, 2024). Despite their ubiquity as a support mechanism in STEM courses, most research regarding office hours is relatively recent, and limited in the context of STEM. Work thus far has focused on the impact of office hours on academic performance (Guerrero and Rod, 2013), instructor immediacy (Cooper *et al.*, 2017), sense of belonging (Moore, 2020), student-instructor interactions (Guzzardo *et al.*, 2021), and motivations and barriers for attending office hours (Hsu *et al.*, 2022).

However, most of these studies primarily investigate student experiences at large research-intensive universities and within engineering disciplines (Griffin *et al.*, 2014; Robinson *et al.*, 2015; Smith *et al.*, 2017; Briody *et al.*, 2019). These studies have indicated that students prefer to not attend office hours and view them as a last resort for asking questions (Smith *et al.*, 2017) or that students are more likely to attend office hours if they perceive them as helpful, if they are scheduled at convenient times, or if they are for a smaller sized course (Griffin *et al.*, 2014). While most of the current literature on office hours for STEM students focuses on engineering, there are a few exceptions. For example, when reviewing syllabi from a research-intensive university, Gin *et al.* (2021) found that office hours were the most reported element listed for students to receive help for the course.

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Additionally, Hsu et al. (2022) described students' perceptions on the benefits of, and barriers to, attending STEM course office hours at a comprehensive university, finding that students did not recognize as many benefits for attending office hours as instructors did.

Most of this literature has focused on examining student experiences in office hours as well as the affective and academic impact of students who attend office hours. However, there has been limited work exploring how STEM course instructors structure their office hours and view their experiences in office hours. Past work has examined instructor attendance at their scheduled office hours, with Pfund et al. (2013) finding that nearly a fourth of instructors were not present or available at their scheduled office hours. Other past work has examined instructors' perceptions of office hours. For example, Hsu et al. (2022) found that while instructors and students had many areas of overlap on perceived benefits of attending STEM course office hours (e.g., students seeking content clarification, wanting individual time with instructors) there were also key differences. For instance, instructors, but not students, identified that office hours were a place for professional support and learning of study skills. Similarly, instructors did not recognize the full range of barriers that students provided for reasons why they did not attend office hours, often holding negative perceptions of students who do not attend.

Here, we conduct a phenomenographic study to investigate how instructors of STEM courses experience office hours and how these experiences may impact their approaches to promoting and managing office hours. We address the following research questions:

1. What aspects vary among instructors' approaches to promoting and holding office hours in STEM courses at one private, comprehensive university?
2. What challenges and barriers do instructors identify for holding successful office hours in STEM courses?

THEORETICAL FRAMEWORK AND RESEARCH APPROACH

We rely on phenomenography, a qualitative research approach that seeks to characterize how different people experience or think about a given phenomenon (Åkerlind, 2005a; Åkerlind, 2005b; Booth, 2008). This approach, which seeks to identify aspects that vary in people's experiences and conceptions of a given phenomenon, has been used in multiple other biology education research studies, including in studies that characterize how STEM faculty view diversity (Lo et al., 2022), how students perceive successful research (Zuckerman and Lo, 2022), and how students approach problem-solving in biology (Sung et al., 2022; Hsu et al., 2024). Such phenomenographic approaches rely on identifying different aspects (i.e., features of a given phenomenon) that individuals focus upon or experience differently, and then determining the variation within each of these aspects (Marton and Pong, 2005). This approach thus contrasts with phenomenology; while both center on examining a given phenomenon, phenomenography focuses specifically on identifying variations in how participants experience each aspect of a phenomenon (Barnard et al., 1999; Larsson and Holmström, 2007; Zuckerman and Lo,

2022). Thus, here we center our work on defining how instructors of STEM courses experience office hours and the variation within their experiences.

In addition, instructors are often given wide latitude over how to promote, manage, and run office hours. There has not been any past work, to our knowledge, that has characterized the variation in instructors' approaches to office hours. Given that there is often little to no formal training provided to instructors on how to conduct office hours, instructors' approaches can be influenced heavily by their past experiences running and leading office hours. Thus, our phenomenographic approach allows us to define and characterize the different aspects that may vary in how instructors approach office hours, as well as the reasoning behind such instructional approaches, in order to generate a thorough perspective on how instructors experience, think about, and approach office hours in STEM courses.

MATERIALS AND METHODS

Institutional Context

This study was conducted at a private, comprehensive university in Southern California. We chose to focus only on instructors' experiences with STEM course office hours at one institution for different reasons. First, by including instructors from one institution, we can provide a more comprehensive examination of what aspects may vary in how instructors approach STEM course office hours without needing to account for different logistical and institutional norms. For instance, there are no teaching assistants within any of the STEM courses at this university, ensuring that instructors of the course are the only instructional staff that students could go to for help. While some courses at the university have supplemental instructors, who are undergraduate students who lead optional weekly review sessions and their own peer office hours, as well as drop-in tutoring (a service offered through the university's Tutoring and Learning Center), none of the STEM courses have graduate teaching assistants. Similarly, course sizes are relatively small, with many of the introductory and lower-division STEM courses taught in multiple sections to keep enrollment sizes small in each section. For example, each section of introductory biology and chemistry usually does not exceed 80 students, and enrollment in upper-division courses is typically much smaller, around 10–30 students, depending on subject and term.

In addition, by focusing on one institution, we are able to include faculty across STEM fields, including multiple faculty in biology as well as in related STEM fields (e.g., chemistry, physics, etc.). Given that biology students often take courses in these other STEM disciplines, our approach allows us to characterize the range of different possible approaches to office hours that biology and other STEM students may experience at one institution. Finally, we have previously studied student and instructor perceptions of STEM course office hours at this institution, relying on surveys of STEM students and faculty to characterize motivations and barriers for attending office hours (Hsu et al., 2022). We are thus able to compare our results from this study, which examines instructor approaches to STEM course office hours, to these perspectives identified previously.

We also provide information on faculty teaching load and expectations here for additional context. First, all instructors are expected to offer office hours. However, the guidance provided in the faculty handbook is very general, stating only that instructors “should have regular office hours throughout the week” (Chapman University, 2024). Thus, the amount and frequency of office hours offered by each instructor may vary, as may the structure, modality, and format of office hours. Most tenure-track faculty are contractually obligated to teach two courses a semester, while instructional faculty teach four courses a semester. Finally, most faculty have access to an office, though some instructors (particularly those who are postdoctoral fellows or those who hold instructional faculty positions) may have shared offices.

Participant Recruitment

We recruited instructors of STEM courses through sending emails to the faculty listservs for the College of Science and Technology, the College of Health and Behavioral Sciences, and School of Engineering and inviting interested faculty who taught undergraduate STEM to complete a screening survey. For the context of this study, we targeted these three colleges as they held faculty who fall under the definition of STEM (NSF, 2024); however, our final pool included some faculty who do not traditionally fall under STEM (health sciences) and were missing some disciplines within STEM (social sciences). While the health sciences are not always seen as traditional STEM fields, these faculty self-identified as STEM instructors and were therefore invited to join the participant pool. The listservs include all full-time faculty at the institution, including members of a postdoctoral research and teaching program who teach undergraduate courses each semester. Twenty faculty responded to this survey out of the 97 total eligible faculty within these units. To ensure that instructors had experiences with office hours, the screening survey was only open to any instructor who was either currently teaching an undergraduate STEM course or were on a temporary hiatus but planned to return to teach the following semester. All faculty who indicated interest were contacted to schedule an interview, and we were able to interview 18 of the 20 faculty who had initially completed the survey. The final sample included 10 instructors from the College of Science and Technology (including mathematics, physics, chemistry, and the life sciences), four from the School of Engineering, and four from the College of Health and Behavioral Sciences (Table 1). These included instructors from the following disciplines: Life Sciences (4), Chemistry (2), Mathematics (3), Physics (1), Health Sciences (3), Psychology (1), and Engineering/Computer Science (4). To protect participants' identities and given the relatively small size of our institution, we only report aggregated demographic data for the title/rank of our participants and their field of study and are not reporting any other demographic characteristic from our participants. We have assigned pseudonyms to all participants, and also are not divulging the discipline of individual instructors when discussing their responses.

Development of Interview Protocol

We created a semistructured interview protocol centered around several topics relating to office hours following an

TABLE 1. Fields of study and ranks of participants

Field of study	Number	Rank/title of participant	Number
Life Sciences	4	Postdoctoral Fellow	3
Chemistry	2	Instructor	1
Mathematics	3	Assistant Professor	3
Physics	1	Assistant Professor, Instructional	2
Health Sciences	3	Associate Professor	3
Psychology	1	Associate Professor, Instructional	1
Engineering or Computer Science	4	Full Professor	5

iterative process (Rubin and Rubin, 2011). Given that phenomenography explores the variation within participant experiences, semistructured interviews are the preferred method as they provide broad guiding questions that then allow the participants to fill in the parts of the phenomenon that are most pertinent to their experience (Han and Ellis, 2019; Zuckerman and Lo, 2022). To develop the interview protocol, the research team independently brainstormed potential areas of variation within instructor approaches to STEM course office hours, drawing upon our extensive experiences with our own office hours and talking to colleagues about office hours. We then generated potential interview questions centered around these themes and those identified in our previous work (Hsu et al., 2022). Next, we met to discuss and refine these questions for clarity. Finally, we validated the interview protocol through cognitive interviewing with three instructors of STEM or STEM education courses. In cognitive interviews, we tested the interview protocol on nonparticipants to gather feedback on how these nonparticipants understand and interpret the interview questions, allowing us to further clarify and refine the interview protocol (Willis, 2015).

Our final semistructured interview protocol (Supplemental Materials) consisted of several sections including asking instructors to describe a typical office hour (where they were held, who attended, the type of instruction they gave) and to describe a successful and unsuccessful office hour. We allowed the instructors to self-define what a successful office hour looked like to capture the differences in perspectives. In addition to these questions we also asked how, whether at all, their approach to office hours has changed over time and whether they ever discussed office hour strategies with other instructors to explore how instructors communicate and learn about office hour strategies.

Interviews

One author (D.F.) conducted the semistructured interviews, giving participants a choice of either in-person or Zoom. Interviews took between 30 min and an hour and participants were provided a gift card as compensation for their time. We relied on the lead author conducting the interviews given her status as a postdoctoral fellow (who teaches multiple classes at the institution) working under the mentorship of the senior

author (J.H.). Doing so avoided any tenure-track or tenured faculty interviewing other faculty, which could potentially lead to concerns over balance of power given that senior, tenured faculty at our institution are often on junior faculty tenure and promotion committees, causing potentially biased responses in the interview. None of the faculty interviewed have any direct or indirect power over the interviewer, thus facilitating more open responses from the interview participants. All interviews were audio recorded and transcribed.

All procedures were reviewed and approved by the Chapman University Institutional Review Board.

Data Analysis

Two authors read through the same two transcripts (representing over 10% of all interviews) and independently generated tentative conceptual labels (Saldaña, 2015) that captured variations in instructors' experiences with office hours. The researchers then practiced dialogic reliability to reach agreement on the conceptual labels "through discussion and mutual critique of the data and of each researcher's interpretive hypotheses" (Åkerlind, 2005a, p. 331). While all authors practiced reflexivity throughout the research process, discussing their social identities, positionality, power relationships, and preunderstandings to address relational competence (Jones et al., 2021), the two coding authors often reflected on their identities and experiences while coding the data; we elaborate on authors' positionalities in the next section. After discussing the similarities and variations within the data, the two researchers developed broader categories that captured the variations of the phenomenon, that is, how faculty experience and navigate office hours (Marton and Pong, 2005). The researchers then coded one more transcript independently (representing over 16% of all interviews) using these broader categories to calculate interrater reliability. Cohen's kappa was calculated at 0.726 using ReCal2 (Freelon, 2010), indicating substantial agreement (Landis and Koch, 1977). The two coders then each reviewed and coded half of the remaining transcripts using the consensus codebook. When areas of uncertainty would arise, the two researchers would discuss each case to reach consensus.

Positionality of the Authors

Positionality statements allow authors to share with the reader a brief snapshot of aspects of their identities and experiences that influence the way the researcher may approach and interpret the data (Bourke, 2014). As discussed above, the authors practiced reflexivity throughout the research process to continually unpack new insights or discuss disagreements in interpretation. The first author identifies as a White queer woman, who is the first in her family to complete a college degree. She is currently a postdoctoral fellow and has degrees both in science (Bachelors and Masters) and education (Ph.D.). The second author identifies as a white cisgender woman with a MS in Educational Research. She was a nontraditional, first-generation college student and is currently the Operations Administrator for the College of Science and Technology, while also serving as a part-time research assistant for the biology education research group. The last author is a tenure-track assistant professor of biology, who identifies as an Asian American man.

RESULTS

We identified multiple aspects of instructors' approaches to office hours that varied from student-centric to instructor-centric approaches (Table 2). These include how instructors communicated the availability of office hours and strategies they employed to increase student attendance (promotion of office hours); when and where faculty held their office hours (modality of office hours); and the strategies faculty deployed while running office hours to attend to students' needs (management of office hours). Here we define student-centric approaches as strategies instructors use with students' interest in mind (i.e., wanting to increase student learning, accessibility, comfort, etc.) and instructor-centric approaches as strategies the instructors use with their own self-interest in mind (i.e., saving time and/or bandwidth, personal needs, comfort, etc.). Student-centric and instructor-centric strategies are not always at opposition with one another, and as seen below, will often occur simultaneously. In addition, we uncovered that many instructors received little to no formal training on office hours and did not often engage in conversations with their colleagues around how to run office hours. This led many instructors to feel unsure whether they were using the best strategies to increase student attendance or learning while in an office hours session.

Promotion of Office Hours

Instructors engaged in different strategies to increase students' attendance of office hours for student-centric reasons, including in sharing the belief that attendance would be beneficial to student learning and understanding of the classroom content with students. For instance, Alex believed that the best strategy to incentivize student attendance was to make them useful for student learning. *"I think there's a lot of word-of-mouth things that happen from students"* he commented. *"I think the best thing that I can do to increase attendance in my class or attendance in my office hours is to make them worthwhile for students."* Here, Alex reveals that he is making decisions around office hours driven by a goal of increasing the perceived utility of office hours for students. Alex went on to describe how he felt he could make office hours better by promoting work between students and by intervening when students became stuck. *"If 5 students show up to the first one, and understand that they are performing better, because they can work with their peers and if they really get stuck, I will prompt them with a couple of questions,"* he commented. *"Then the next time 10 people show up."* Alex's response indicates a student-centric way of thinking that places student benefits at the forefront, where he attempts to appeal to the perceived usefulness of student office hours in student learning. Other instructors also cited specific, actionable steps they had taken with the goal of increasing the perceived utility of office hours to students. For example, several instructors cited direct and sometimes personalized outreach to students to encourage them to come to office hours in order to benefit the students. *"I would email all the students [with a group project due soon] like 1 or 2 weeks ahead of time being like, look, do you guys want to meet? When you want to meet?"* stated Tracy. *"So I was making some pretty active efforts to get them to come."* Tracy here is conveying an active, student-centric approach to communicate about office

TABLE 2. Outcome space for STEM instructors' conceptions of office hours

Aspect	Conception I (student-centric)	Conception II (instructor-centric)
Promotion	Instructors used various strategies to increase student attendance in office hours in order to benefit students.	Instructors chose not to communicate about office hours to reduce attendance, saving instructors time and effort.
Modality	Instructors made decisions on modality/structure based on increasing student accessibility and access.	Instructors made decisions on modality and structure for personal reasons including time, duties, or emotional capacity.
Management	Instructors made decisions on the management of office hours with the goal of promoting student learning.	Instructors made decisions on the management of office hours to better suit the instructor's personal preferences or scheduling

hours with their students, indicating that they are willing to take extra steps as an instructor to promote office hours attendance with the hope of benefitting their students. Other instructors took less direct steps to promote their office hours, though still driven by the goal of helping students. For example, Rebecca indicated that *"I'll put at the bottom of the agenda slide like, 'hey, don't forget my office hours.'"* Similarly, Ramon stated *"when there's an assignment, I refresh [student's memories and say], 'remember, I'm here'"* and Carmen indicated that *"I just remind them that I'm there for them."* While Rebecca, Ramon, and Carmen's approaches are not necessarily as direct as Tracy's personalized email to students, their approaches are all driven by the goal of increasing student attendance and appealing to students' perceived utility of office hours, letting students know that office hours can be directly beneficial for them.

In contrast, we also identify several instructors who take student-centric approaches to promoting office hours that do not rely on appealing to students' perceived utility of office hours. Instead, these instructors use various nonacademic motivators or appeals to emotions unrelated to academics to increase students' attendance. For instance, multiple instructors highlighted how they bring food to office hours and use this to appeal to students. *"Sometimes I bribe them with food,"* Francis commented. *"I have these little bowls, where I put candy in them, to try to get them. And it's amazing how many students you can get to come just for chips."* Francis does not make any direct appeals to students' perceived academic utility of office hours, but instead chooses a student-centric approach that instead appeals to students' motivation by bringing in candy and chips to office hours. Similarly, Elizabeth highlighted playing a video game in office hours and inviting students to come to office hours to play the video game in office hours while getting their questions answered. *"I did a Stardew Valley [video game] office hours, to have it be like low key where it's just like, I'm gonna play Stardew Valley, and like, you can come join me and talk to me while I do this,"* she stated. Like Francis, Elizabeth is not making any direct appeals to change students' perceived sense of academic utility of office hours, but instead makes a student-centric appeal using video games as a motivator for students. Finally, other instructors attempted to use humor and playful guilt to appeal to students, again not directly addressing students' perceptions of office hours' academic utility. *"Sometimes I say, you know, I can [be] awfully lonely [in office hours],"* Francis said. *"You know, imagine me alone in that room. For three hours and all*

I do is sit and look at the wall." While Francis's statement at first appears to be instructor-centric (discussing his own supposed loneliness in office hours), he appears to be appealing to students' emotions as a way to promote students' office hours attendance, jokingly telling them that he needs company in office hours as a way to promote students coming to office hours.

However, while many faculty took a variety of student-centric approaches to promoting office hours, other faculty reflected on instructor-centric decisions about promoting office hours that did not necessarily center student benefits and instead were driven by benefits to the instructor. For example, Robert stated *"No, I don't want to [promote office hours to my students]. I have other things to do,"* indicating that he took no direct actions to promote office hours to his students, with the goal of preserving additional time for his other responsibilities. This decision to not communicate about office hours or encourage students to attend is designed to benefit the instructor, with no reflection on how this may impact students. Others made decisions that prioritized the instructor but conveyed an inherent tension in their choices about benefiting either the students or the instructor. *"Every semester I think I'm going to require students to attend my office hours,"* Tony stated, indicating that he believes there is an academic benefit to making office hours mandatory for students. *"Then every semester I chicken out. And that's a combination of me being hesitant to require students to do stuff outside of class, and part of it is maybe my own self-preservation, like 'Oh, if I make it like super easy then all my students will be coming all the time.'"* Here, Tony struggles with this tension between an action that he thinks would benefit students but not be beneficial for himself. While Robert does not give any thought to how his actions may impact students, Tony communicates that he sees inherent value for students if he promotes office hours by making them mandatory (i.e., a student-centric way of thinking). However, Tony declines to take this step (even though he thinks it would benefit students) for his "own self-preservation," indicating that he is afraid that taking this step of requiring office hours would lead to students coming to him in office hours frequently and thus presumably limiting time for his other responsibilities. While Tony feels this tension between benefitting the students and himself, the instructor-centric approach ultimately prevails, with Tony acknowledging that he is "chickening out."

Other instructors also cite this tension between what they think will benefit students and what they think will benefit

themselves, sometimes acknowledging both logistical limitations and perceived limitations of their own abilities. “*I have not tried to increase participation [in office hours],*” commented Elizabeth. “*Because it’s, it’s a bit busy already.*” Similarly, Maria recognizes that she could be doing more. “*I’m just trying to emphasize [office hours] and encourage people to come,*” Maria states. “*I could do that more in both my classes. But I think I generally always have a pretty good turnout.*” Both Maria and Elizabeth imply that they think office hours are beneficial for students, but that they are not taking any additional action to promote office hours because of how busy the office hours are already, thus potentially prioritizing their own desires to have a calmer office hour (instructor-centric) over having additional students come to office hours (student-centric). We also acknowledge that Maria and Elizabeth may be constrained by many logistical factors, such as the capacities of their offices and their perceived ability to assist a large group of students in office hours, that shape their decisions to not promoting office hours more. Finally, other instructors communicated that they did not promote office hours because they were unsure about their own capacity to help students. For example, Alessia commented that “*I do feel like this semester, I wasn’t sure what [I was doing.] So it was kind of hard to be like, ‘Come to office hours; it’ll help’ because I don’t know [if it will help] either.*” Alessia’s response illustrates another potential tension that some instructors may face when thinking about office hours and how to promote office hours in class. Her response indicates that she recognizes that she should promote office hours and that office hours should be beneficial for students (i.e., she acknowledges the student-centric approach) but is concerned about her own ability to help students in office hours due to lack of knowledge around the classroom content. Alessia is thus indicating that she is concerned about how her unfamiliarity with the classroom content will be viewed by students and that she is unsure whether her office hours will actually benefit students.

Modality

We also identified variations in instructors’ choices on where and when they hold office hours (i.e., the modality of office hours) and their reasoning for these decisions. We identified that some faculty explicitly chose the modality of their office hours to best suit the instructor (an instructor-centric approach), while others deliberately made student-centric decisions to better engage students or promote their learning.

First, we find variation in whether or not instructors hold drop-in office hours or require appointments for office hours. Senior instructors often described that holding drop-in office hours was unhelpful to their productivity, highlighting an instructor-centric approach to their decisions. For example, Robert spoke to not setting aside time for office hours, saying, “*I don’t go sit there. Because nobody drops in... I’d just be sitting there anchored to a desk when there’s so much to do.*” Robert thus sets office hours by appointment, deliberately prioritizing his own productivity without any regard to student’s ease of access to office hours and the potential structural barriers that requiring appointments for office hours may create for many students.

Alex, another senior instructor, had a similar approach, although his reasons were for both himself (instructor-centric) and students (student-centric). Alex said:

I found over the past 15 years that having 2 hours, 3 days a week, blocked off for office hours just does not work for me and does not work for students... I’m pulled in a million different directions, you know, research expectations, leadership expectations, administrative expectations, personal expectations... The idea that I can hold 2 hours and sit in my office and do nothing, if nobody shows up just does not work for me... And so I have been pretty loosey goosey about having formally set office hours... So I don’t tend to follow the rules is the short answer.

Alex here echoes similar reasoning to Robert, indicating that he is prioritizing his own productivity by cutting drop-in office hours and instead only offering office hours by appointment. Alex recognizes that he is not following university policies that mandate drop-in office hours and cites the other responsibilities that are part of his position beyond just teaching and supporting students. In contrast to Robert, however, Alex provides some student-centric reasoning for his decision as well by mentioning how offering drop-in hours “*does not work for students.*” Alex appears to come to this conclusion by citing the lack of attendance in their drop-in office hours, and thus believes that offering office hours by appointment only will better serve both the students and instructor. Like Robert, though, Alex does not provide any deeper reflection on why students did not come to their drop-in office hours, with no recognition of potential structural barriers for student attendance at office hours. For instance, past work has identified that knowing about office hours is a part of the “hidden curriculum” (Giroux and Penna, 1979), or the unwritten norms and expectations that are part of college that are not explicitly made accessible to all students, and neither Alex nor Robert appear to recognize the many potential barriers that students face for attending office hours (Hsu et al., 2022).

Other instructors also cited how they did not offer drop-in office hours and instead relied on office hours by appointment only, but instead cited explicitly student-centered reasons for their decisions. Tony highlighted how he thought that students did not enjoy attending drop-in office hours and preferred individual appointments. “*I suspect, students prefer to meet with me one on one,*” he stated as his reasoning for removing drop-in office hours, highlighting how his decision to only offer office hours by appointment was driven by the perceived benefit of student comfortability with individual meetings. Other instructors also did not hold formal drop-in office hours but instead relied on an open-door policy for students. Todd, for example, commented that “*I leave my door open. And students could come in any time,*” highlighting how he thought this policy served students better than more formal drop-in hours. Todd’s decision provides another example of instructors making changes to their office hours modality for the perceived benefit of students.

These examples show how four senior faculty all had the same approach to not holding drop-in office hours during a formally set time, but ranged in their reasons from instructor-centric, to a mix of both, to student-centric. These faculty

mentioned that they changed their approaches over time as they believed setting a designated time did not work for either the students, themselves, or both. However, one instructor, who was a postdoctoral fellow, discussed the opposite, as he went from not holding structured hours for instructor-centric reasons to holding them for student-centric reasons. Luca said:

I just thought, “Hey, we all use email, they can easily email me and tell me, I want to come anytime.” But would it hurt me that I sit there 2 hours a week doing anything in my office, having some snacks and water if I needed to, and just giving students the option to walk in? Now I see, that is a good idea.

Luca’s comment conveys a shift in their thinking from instructor-centric to student-centric. Luca changed his reasoning after conversing with other faculty about holding office hours (discussed in further detail in the section below on challenges and barriers). His reasoning indicates a change in philosophy about office hours and a realization that requiring students to email to request a meeting may create structural barriers for students to work with him, illustrating how providing opportunities for faculty to discuss how they hold office hours, and their challenges and opportunities, may spark instructors to reflect on their own practices and potentially shift to more student-centric approaches.

Like Luca, most faculty chose more traditional approaches in setting designated times to hold drop-in office hours. However, there were variations in the choice of where to hold them (online vs. in-person) and in their rationales (instructor-vs. student-centric) for choosing those locations. For example, many faculty discussed their decision to hold office hours in person (rather than online) since they felt that in-person office hours were better for connecting with students and building interpersonal relationships. Elizabeth noted that Zoom would be better for her personally, but that she believed holding them in person would benefit the students more. *“It’s obviously more cozy when I can be like half pajamas [with a Zoom office hour],”* she commented. *“But I think that in person is better for [explaining] math... [over Zoom] you definitely lose that personal touch to it.”* Similarly, Robert explained, *“I think Zoom is perfectly fine. And obviously more convenient for some things, but I’m guessing if you need interpersonal touch...There could be something key missing and some situations.”* Here, Robert highlights that while he views Zoom office hours as adequate, he believes in-person office hours would benefit students more. In these two examples, we see how instructors balance the tension between an approach that they perceive would be more convenient for them (Zoom) versus an approach they perceive would be better for the student (in-person). It is important to note, however, that while Robert here pointed out that in-person office hours were better for students, he did not believe in holding office hours (as illustrated in his quotes in the above sections). In contrast, there were no examples of instructor-centric approaches to holding in-person office hours. This may be because in-person office hours provide little instructor-centric benefits, as they tend to be less flexible and require more resources from the instructors.

While the above faculty felt that in-person office hours were better for students, some also chose to hold most or all

of their office hours on Zoom. Most faculty spoke of student-centric reasons for holding Zoom office hours. For example, Tony stated that *“half of the students were willing to meet with me, or preferred to meet with me, on Zoom, because maybe they’re back in their dorms or apartments or something,”* indicating that he felt like virtual office hours are more accessible to students. Chad simply stated, *“So a lot [of office hours happen] on Zoom. Mostly because it’s, again, an easier barrier to entry.”* Both these instructors demonstrate student-centric reasoning for their choice of office hours modality, indicating that the instructors are prioritizing what they perceived as benefits for students when choosing their office hours modality. Tony and Chad both pointed to how virtual office hours increased accessibility for students who may need to meet outside regular meeting times or need flexibility in their ability to be on campus. While most faculty gave student-centric reasons for preferring virtual office hours, Elizabeth and Tracy differed in that they had both instructor- and student-centric reasons. Tracy mentioned that the flexibility of holding virtual office hours were helpful in times where she needed to prioritize balancing her personal life, saying *“I did a couple online when my kid got sick, so I’d be home unexpectedly.”* Elizabeth discussed how she started a Slack channel where students could ask questions as they arose but that she would answer only during her regularly scheduled office hours. In this way, Elizabeth negotiated a student-centric approach (creating a Slack channel that students could access at any time of day) with an instructor-centric approach (only answering those questions during office hours for time management purposes).

Management

Finally, we identified variations in the strategies that faculty deployed while running office hours to attend to students’ needs. Instructors discussed primarily student-centric approaches to managing office hours, suggesting that the majority of faculty are employing strategies that they perceive help students get the most out of their time in office hours. However, those strategies varied among instructors. For instance, faculty who taught more than one course per semester had to decide whether or not to hold separate office hours for each of their courses or to do combined office hours available for students in any of their courses. Instructors largely believed that the combined format was simpler for students to understand, gave them more time options to choose from, and if the course content allowed, promoted student interactions. For example, Alessia expressed, *“I really like having all of them at once. And they can all come to the same place. And it gives them more time to choose from, too.”* Susan described how creating course specific office hours was *“less efficient and confusing”* to students and that after trying to create separate spaces she finally just held open office hours for all of her courses.

Another area that instructors had to manage was high office hour attendance. Many instructors discussed how they managed high office hour attendance to make sure that the students’ needs were being met. Maria discussed her approach for a busy office hour by describing how she went from one student to the next, commenting *“I’ll answer one question, the next question the next one. And kind of keep it going...So it could take a long time, because I want to answer the question entirely.”*

Alessia also spoke to the difficulty of managing a busy office hours session, but discussed how she directly communicated her strategy with students so they understood that she may not be able to give them 100% every day,

You're just kind of like always running around. And that does feel bad too, because it feels like you're not giving your 100% to every student. You can get like 50% right now and I'll give you 10%. But tomorrow we'll switch it. You're dividing your time to like get them at least above the "not on fire hurdle."

Similarly, Rebecca said she explained her strategy to students during a busy office hour so that they knew what to expect, saying, *"I try to be really careful not to let one student or one group of students dominate the office hours. I'll say, 'I'm going to do a problem with you. And then I'll let you work'."* These approaches center the faculty as the primary facilitator of learning, but other faculty managed busy office hours by utilizing other students in attendance. For example, Susan discussed how she asks students that she has already helped to help classmates that come in after them, *"And then when another student comes in, it'll just be like, 'Oh, why don't you work with so and so? And like, compare notes.'"* Elizabeth echoed this sentiment, stating *"the other thing that I've tried to do is sort of get students to help each other or answer each other's questions."*

While faculty named mostly student-centric approaches for managing office hours, a few faculty discussed strategies that were both student-centric and instructor-centric, with all of the instructor-centric approaches based on protecting the instructors' time. For example, in the comment above, Susan encouraged students to work with one another to make sure all students were being assisted, but she also mentioned preferring this strategy so that she could be *"doing something else."* In her interview, Elizabeth mentioned that many of her former students would still drop by to catch up with her or ask her questions about their current classes. While she attempted to keep her office hours open for both former and current students, at times this strategy could be overwhelming, forcing her to choose her current students over her former students. She said, *"when you're approachable, students ask a lot more of your time... my priority is my current students who actually need to pass my classes."* Chad spoke to a similar idea, saying, *"So there's this balance between how much time you can give your students to help them [which takes] away from other things that you need to be doing."* These examples highlight the tension between student-centric and instructor-centric approaches that instructors balanced when managing office hours.

Challenges and Barriers to Holding Office Hours

The previous sections identified three aspects that varied in instructors' approaches to office hours. However, faculty also discussed many challenges and barriers to holding office hours, including little formal training and little opportunity to discuss office hours with colleagues.

Many faculty expressed concern that they received no formal training on office hour approaches and were often unsure whether the practices they were engaging in were the best for the students. Tony discussed how he believed this was a

broader problem in academia, saying, *"...it sounds just emblematic of academia in general. It's kind of like there's no real training."* Multiple instructors expressed frustration over not knowing best practices. For example, toward the end of Tracy's interview, she exasperatedly said, *"What's the secret? To help out these students? I would love to figure out what are the key steps to getting the students to succeed."* This unease in "getting it right" made faculty feel anxious about their office hour approaches. Francis felt *"a little bit uneasy"* when he wasn't sure if students were going to attend. He elaborated on this, saying, *"I mean, I feel like I'm not very good at office hours. That is, I feel like I'm just winging it."* Stephanie was worried about students feeling comfortable to let her know when they did not understand a topic and was unsure how to make them feel more comfortable. She said, *"they have this question, you explain it to them, and they say, 'okay, great' but they are actually confused and they don't communicate that... they're like, 'Okay, she explained it to me, I'm supposed to get it. I'll just pretend like I did.'"* Similarly, Tony felt that he lacked the resources to solve the problem of student engagement in office hours, saying *"maybe I should just think and read more on the topic."* Maria expressed that she wished that were more resources available, like a *"list of guidelines of things others have done."* Ramon also felt a little lost and discussed how the interview made him question the point of office hours,

Well, I guess no one explicitly tells you what you need to do in office hours, or what they should be for? So, I guess it's like, they assume everyone knows. It makes me think, "why are we holding these? Why are we doing this?" We have no measure of success.

Only one faculty out of the 18 spoke about a structured learning opportunity for office hours. Maria described how her previous institution incentivized faculty projects and conversations on different topics, including one on office hours:

At my old institution, we were part of a group of science professors who met like, once a week or so and people would have these projects that they got paid to change something about it, and one was for office hours.

Maria's case was unique, as most faculty struggled to find resources on office hour approaches.

Faculty also discussed the impact of discussing office hours with other colleagues. Stephanie believed that office hours were not talked about enough. *"I think office hours are a really vital part of pedagogy because it allows that one-on-one instruction for students, makes you more accessible, makes you more representative of the university community,"* she comments. *"But we never talk about office hours."* When asked whether he ever had conversations with other faculty around office hours, Robert simply said, *"no"* and Adam felt that *"no one is going to care,"* adding that he would *"love to know a better way."* However, a few instructors did find colleagues to discuss office hours with and mentioned how helpful this could be. Luca's shift earlier from instructor-centric to student-centric office hour modality happened when he came to the university, saying *"when I came to [this institution], I started conducting office hours the way people do around here."* Other instructors discussed how they would ask questions of colleagues when

they became frustrated or wanted to know how another instructor may handle a certain kind of situation. Valeria said, *“I would get frustrated because I would have students come in and I just felt like they weren’t utilizing [the office hours] how I thought they should. So I definitely asked around how [other instructors] run their office hours.”* Overall, faculty struggled in both finding opportunities and resources on how to run office hours, as well as finding others who would discuss their approaches. However, as we can see by Luca and Valeria’s experiences, these interactions can be helpful in learning about, and/or gaining confidence in, approaches to office hours.

DISCUSSION

Our results indicate that there are a wide range of approaches in promoting office hours, choosing the modality of office hours, and managing STEM course office hours at one institution. We find that while many instructors make decisions around office hours based on student-centered reasons (i.e., making explicit decisions about how they approach office hours to best support students), that some instructors instead identify instructor-centric reasons instead as justification for their approaches. In addition, we found a range of challenges and barriers that instructors identify for holding effective office hours. Our work adds nuance to the current literature by exploring the choices instructors make when approaching the promotion, modality, and management of their office hours and describing the challenges and barriers that instructors face in making those decisions.

In addition, our work extends the existing work done at this institution (Hsu *et al.*, 2022), which utilized student surveys to characterize their motivations and barriers for attending STEM course office hours. This work also surveyed instructors about the perceived benefits for students attending office hours and perceived barriers for students coming to office hours. This past work identified that instructors perceived fewer barriers for students attending office hours than students reported; similarly, our work here highlights how some instructors are likely not considering student perspectives when making instructional decisions about office hours or are not always making decisions that put students’ needs over their own. In contrast, we also identified that many instructors are making instructional decisions about office hours to benefit students. Our past work revealed that students still perceive a range of barriers to attending office hours, including structural barriers (e.g., time conflicts) and intimidation of office hours (Hsu *et al.*, 2022). Here, we see instructors attempting to navigate instructional barriers through offering a range of modalities including virtual, in-person, and Slack, as well as having both set office hour times or open-door policies. Instructors also took a range of approaches to promoting office hours, ranging from attempting to change students’ perceived utility of office hours as an academic resource to appealing to extrinsic motivators by bringing in food or playing video games at office hours.

Interestingly, our study identifies that many instructors are taking instructor-centric reasons for their office hours approaches citing the need to prioritize their own work and because of a perceived lack of time. This aligns with past work that has identified that the competing demands faculty of-

ten face can lead to a lack of pedagogical innovation, particularly in larger research-intensive universities (Sabagh and Saroyan, 2014). While our study was not conducted at a R1 university, instructors still appeared to be facing tensions between their research, administrative, and service roles and their time commitment for teaching, with the instructors who chose instructor-centric approaches to office hours often prioritizing these other responsibilities. Given that universities often prioritize research outputs over teaching, with many universities providing more benefits to tenure-track research faculty than nontenure track teaching faculty including political (i.e., voting), financial (higher salaries), and job security (tenure vs. nontenure), the need to focus on research over other duties could be especially true for early career tenure-track faculty. In the particular context of our participant population, we also highlight how these instructors may face a tension in their professional identity with little professional incentive for pedagogical changes, representing potential barriers for changing their approaches to office hours or adapting more student-centric ways of holding office hours (Brownell and Tanner, 2012). Similarly, our participants highlighted a lack of training as a major barrier for developing more effective office hours practices, again aligning with past literature examining supports and barriers for faculty pedagogical reform (McCourt *et al.*, 2017). Even participants who made student-centric decisions questioned whether their approaches were the most effective and expressed a desire for access to additional professional development opportunities to share ideas and learn more about holding office hours, suggesting that there is an opportunity for the STEM education community to develop and provide further resources to instructors.

Our results also identify some commonly used approaches, but also some potential missed opportunities for promoting student engagement in office hours. For instance, when asked what they do to promote student office hour attendance, instructors seemed to primarily 1) discuss the benefits of office hours to understanding course content, 2) remind students of office hours, or 3) provide nonacademic motivators (e.g., food and video games) for attending office hours. We highlight how very few instructors mentioned discussing the norms of office hours with their students as a technique for increasing student attendance at office hours. Given the presence of a “hidden curriculum” in higher education, it is possible that many students may not be familiar with the idea of office hours or its norms (Orón Semper and Blasco, 2018), and our work suggests that few instructors at our university are explicitly discussing these norms. For example, we see widespread variation among instructors in the format of office hours and whether or not an appointment is needed for office hours, or whether an instructor welcomes students dropping by the instructor’s office outside a list of set times, and it can be challenging for students to navigate these different norms across different classes and instructors. Discussing these norms and often unwritten rules can help clarify office hours and lead to greater office hours engagement from students.

Similarly, we see that instructors in our study tended to appeal to the academic utility of office hours, discussing course-related benefits with students. However, none of our instructors mentioned discussing broader benefits of office hours with students to attract more students, despite our past work

showing that instructors view a broader range of potential benefits for students who attend office hours than students (Hsu et al., 2022). For example, instructors often see office hours as a space where they can discuss careers, internships, and professional development with students, or go through effective study strategies with students, benefits that few students recognize (Hsu et al., 2022). Despite this, none of our instructors mentioned sharing these potential benefits with students, and we speculate that doing so could likely attract more students to attend office hours (or encourage students who are already attending to discuss a broader range of topics) by allowing them to see more benefits of office hours.

We also note that multiple instructors provided nonacademic motivators, such as food or video games, to incentivize student attendance at office hours. These incentives likely serve as a source of extrinsic motivation for students to attend office hours, by providing a direct reward (eating candy or chips or playing a video game) in exchange for coming to office hours to also discuss academic topics (Vallerand, 2000). More work is needed to examine how these extrinsic rewards may influence student motivation for attending office hours, given that students' motivation can be shaped by a complex interplay between both extrinsic and intrinsic motivators (Vallerand, 2000). Past work has identified that students who are intrinsically motivated tend to outperform their peers who are primarily extrinsically motivated, and thus future work is needed to develop interventions that promote students' intrinsic motivation for attending office hours (Mayer, 1994; Deci and Ryan, 2013).

Implications for Instructors and Administrators

Our work leads to several implications for STEM course instructors and administrators. For instance, there is an urgent need to provide support and training for instructors on how to best promote and manage office hours. Our work revealed that almost none of the participating instructors had received any professional development or training on office hours, though many indicated that they would participate in workshops or other trainings, if offered. Thus, we urge Centers of Teaching and Learning, STEM departments, and professional societies and networks to offer professional development centered on engaging students in office hours. Participants indicated that even informal forums and discussions on how other instructors run their office hours would be beneficial, suggesting that even options that require relatively low cost or time may have large benefits for instructors. Similarly, we also identified that some instructors relied on other modalities, such as Slack, to supplement more traditional office hours. Instructors may wish to consider these options that may increase accessibility of office hours, particularly for commuter students or nontraditional students that may not be able to make synchronous or in-person office hours as easily, and should discuss both the norms of office hours and the wide range of potential benefits for attending office hours with their students. Finally, we believe that instructors are often balancing their administrative and research responsibilities with their teaching responsibilities, with little incentivization from the university to manage office hours effectively. Because research has shown that office hours can be an impactful tool for student learning (Guerrero and Rod, 2013), it is important for the university to show a

value for office hours beyond mandating that all instructors hold them and provide adequate resources and incentives for instructors to engage with students at office hours.

Future Directions for the Biology Education Research Community

Our work leads to several future directions for the biology education research community. First, our results identify that instructors are holding different conceptions on office hours, which are likely shaping their instructional decisions on promoting, structuring, and managing office hours. While our work explores the reasoning behind these decisions, identifying that some instructors take more student-centric approaches while others instead prioritize their own experience, we did not investigate factors that shaped these perspectives. Similarly, we did not investigate how instructors taught their courses (i.e., to what extent they were using evidence-based pedagogies like active learning), and future work will need to examine whether there are correlations between instructional approaches in the classroom and in office hours. Similarly, our work did not examine how these different approaches and conceptions to office hours impacted student learning, engagement, or sense of belonging, and future work will need to integrate both student and instructor perspectives to gain further insight into whether certain office hour approaches can be more beneficial than others. Future work could also explore other variations that may be important to understanding instructors' approaches to office hours, including class size, student level (i.e., first year students vs. seniors), instructor experience and rank, and differences between disciplines. While these were all touched upon during this research, the limited sample size prevents us from making any substantial inferences in these variations.

Limitations

We acknowledge several limitations of our work. First, our work involved instructors at one institution, and we recognize that institutional structures (e.g., presence of teaching assistants, class sizes, etc.) and institutional norms may have a large impact on how both students and instructors approach office hours. Similarly, we recognize that our sampling may be subject to response bias, given that some instructors may be less willing to participate in interviews (even with a gift card incentive) than others, and that some instructors (e.g., those who care more about teaching) may be more likely to participate in these interviews. Additionally, we also acknowledge that both qualitative and quantitative approaches have strengths and weaknesses and can answer different research questions. In the context of this study, we believe a wider quantitative approach could be useful to answer several research questions that a smaller qualitative approach could not, such as quantifying the types of approaches (instructor vs. student centric) based on both instructor demographics and institution types. This type of approach could allow for more insight across university contexts and help in the creation of more targeted interventions. Despite these limitations, however, our work offers the first investigation we are aware of that explores how STEM instructors conceptualize and approach office hours, generating important new insights into our understanding of how instructors approach office hours.

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