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Post-Pandemic Motivations and Barriers for Office Hours Attendance in Biomedical Engineering

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Introduction

Office hours represent one of the most common and longstanding support mechanisms in higher education, providing dedicated time and space for student-faculty interaction outside the classroom [1], [2], [3], [4], [5]. Despite their prevalence in engineering programs, there has been relatively limited investigation of how students perceive and utilize office hours, particularly at large research-intensive universities where core-curriculum class sizes tend to be substantial [6], [7], [8], [9].

The efficacy of office hours is especially relevant in biomedical engineering programs, where students must master complex interdisciplinary content while developing professional competencies [5], [8], [10]. The integration of biological and engineering principles presents unique challenges that may require additional support and clarification outside of regular class time [9], [11], [12]. Research has consistently demonstrated that meaningful student-faculty interactions outside the classroom correlate positively with academic performance, student satisfaction, and persistence in engineering programs [2], [13], [14], [15], [16], [17]. These interactions can enhance students' academic self-concept, motivation, and sense of belonging in engineering [10], [15], [16], [18].

However, office hours often remain underutilized, with students reporting various barriers including inconvenient timing, perceived intimidation, and uncertainty about their purpose [1], [4], [11], [13], [17]. Recent studies have documented that even when students are struggling academically, they may hesitate to seek help during office hours [3], [8], [12], [13]. This reluctance can stem from multiple factors, including students' perception that they should be able to solve problems independently, concerns about appearing unprepared, and difficulty aligning their schedules with available office hours [4], [6], [11], [18], [19].

Additionally, the competitive nature of many engineering programs may create social barriers to help-seeking behavior [10], [15], [19]. Recent studies have highlighted a disconnect between institutional intentions for office hours and student perceptions. While faculty and institutions view office hours as opportunities for meaningful mentoring and academic support, many students see them as a ‘last resort’ when facing academic difficulties [6], [11], [12], [18]. This mismatch may be particularly pronounced at research-intensive universities, where large class sizes and research demands can impact the accessibility and quality of student-faculty interactions [8], [10], [15], [16].

The COVID-19 pandemic fundamentally disrupted traditional office hours delivery, forcing rapid adoption of virtual formats [6], [8], [12]. While virtual options can increase accessibility and reduce scheduling conflicts, they may present barriers to building the kind of rapport that facilitates effective mentoring relationships [3], [4], [17]. As institutions return to primarily in-person instruction, understanding how students engage with office hours in this post-pandemic context has become increasingly important [4], [8], [20]. These experiences have raised important

questions about how to optimize office hour delivery going forward, as students' comfort levels and participation patterns vary significantly between in-person and virtual formats [6], [11], [12].

The relationship between office hours attendance and academic performance remains complex and incompletely understood [1], [2], [14]. While some studies suggest a positive correlation between office hour participation and course grades, others have found more nuanced relationships that vary by student demographics, course level, and type of academic assessment [2], [8], [11], [16]. Furthermore, students often underestimate the broader benefits of office hours beyond immediate academic assistance, such as career guidance and research opportunities [10], [12], [14], [18].

This work examines several key questions about office hours in biomedical engineering education:

RQ1a) What are the motivations and barriers that BME students report in relation to office hours attendance?
RQ1b) How do these motivations and barriers intersect?
RQ1c) To what extent do demographic factors (gender, race, first-generation status) manifest in the motivations and barriers reported?

RQ2a) How does the implementation of an inclusive office hours approach impact students' motivations and barriers to attendance?
RQ2b) To what extent do demographic factors (gender, race, first-generation status) manifest in these reported motivations and barriers?

By addressing these questions, this research aims to deepen our understanding of how better to support student success through this vital but often underutilized academic resource.

Methods

This work received an "exempt from continuing oversight" determination by the authors' institutional IRB.

Course selection and participant recruitment

Biomedical engineering students were recruited from two core engineering courses required for the undergraduate degree: a 200-level fluid mechanics course, intended for sophomores, and a 300-level neurophysiology for engineers, primarily taken by upperclassmen and graduate students. These courses were chosen both out of convenience and because of their diverse enrollment, representing under- and upper-classmen as well as MS and PhD students, thereby offering a comprehensive view of the BME student population.

Two IRB-approved surveys were distributed to students in these courses via a weblink on the university's learning management system. Participation was optional, anonymous, and there were no incentives or course credit earned for completing the survey. Surveys were administered during one academic year, to one course in the fall (neurophysiology) and one in the spring (fluid mechanics).

Survey design and implementation

The surveys provided opportunities to self-report demographic information including gender, ethnicity, class year, first-generation student status, and whether or not they identified as an underrepresented minority student based on other identities not specified such as sexuality, disability status, nationality, *et cetera*. During analysis, participants were also categorized as "imputed any minority" if they identified as belonging to an ethnic group other than White/Caucasian, were first-generation students, or self-identified as underrepresented minorities.

The surveys were deployed primarily as pre-/post- surveys to explore the effects of an office hours inclusive practice intervention [20] with Likert-type questions exploring the effectiveness of the office hours intervention and relationships between students and instructors. Both surveys included optional open-response questions—data from which are the focus of this paper—to explore perceived barriers and motivations to attending office hours. The survey design underwent preliminary review, including consultation with students (not enrolled in these courses), and refinement to ensure clarity and relevance. The pre-course survey asked:

1) *In previous courses (at [this institution] or elsewhere), what motivated you to attend office hours?,* and
2) *In previous courses (at [this institution] or elsewhere), what discouraged or prevented you from attending office hours?*,

whilst the post-course survey asked:

1) *Why did you choose to attend office hours [in this course]?*

Analysis

Coding analysis

The open-ended student responses were analyzed using an inductive approach. Codes were identified and developed iteratively through collaboration and with comparison to prior work in this field [4]. An initial round of coding was conducted independently by the primary coder using data from the 50 responses from the thermodynamics class. The revised coding scheme was then applied to the remaining responses—those from the neurophysiology class. To ensure the codes and subcodes captured themes well across the dataset and were robust to different coders, a constant comparative approach was employed to further refine codes through about three further rounds of iteration.

Interspersed with code development were two additional tasks: 1) data were additionally coded using a codebook from the literature [4] to explore how other approaches perform when used on the data of this study, and 2) individual codes for motivations and barriers were grouped into themes. Initially different themes were identified for the motivations data and the barriers data but as the individual codes were refined, a set of three themes were selected to be common to both motivations and barriers data.

Finally, two additional coders were added to the team who had not been involved with the initial code identification. Two further rounds of individual code application and collaborative review

resulted in no changes to the three themes, but some subcodes were combined, added, and most code descriptions were revised.

For the results presented in this paper, all data were coded by all three coders. Fleiss' kappa [21] was calculated for each codebook to evaluate the performance of the codes with different coders. Fleiss' kappa is a statistical measure that assesses the reliability of agreement between multiple raters with categorical ratings; perfect agreement is described with $\kappa = 1$, whereas agreement no better than random is described as $\kappa = 0$.

All code disagreements were discussed and resolved as a team that included the senior author who was not one of the three coders.

Statistical analysis

To examine demographic differences in reported motivations and barriers, Fisher's exact test was employed with Bonferroni corrections for multiple comparisons. Fisher's exact test was selected over chi-square tests due to the small sample sizes in some demographic subgroups and the presence of cells with expected frequency counts fewer than five. This test provides exact *p*-values rather than asymptotic approximations, making it particularly appropriate for analyzing categorical data with small, unbalanced samples. Separate tests were conducted for each motivation and barrier code across demographic categories (gender, race, first-generation status), with significance levels adjusted using the Bonferroni method to control for familywise error rate.

Network analyses

Because each motivation or barrier response could be assigned multiple codes, research question 1b (How do motivations and barriers intersect?) was explored using simple network analyses. Co-occurrence patterns were analyzed in three ways. First, frequencies were calculated for each motivation code's co-occurrence with other motivation codes. Second, the same analysis was conducted for barrier codes, where co-occurrences between barrier codes were identified. Finally, because motivation and barrier responses were linked by respondent ID, cross-category relationships were analyzed. The frequency with which each motivation code co-occurred with barrier codes was determined, and the frequency with which each barrier code co-occurred with motivation codes was also determined.

Essentially, four specific sub-questions were investigated under RQ1b; these were RQ1bi) For each reported motivation, which other motivations are reported? RQ1bii) For each reported barrier, which other barriers are reported? RQ1biii) For each reported motivation, which barriers are reported? and RQ1biv) For each reported barrier, which motivations are reported?

Coding with the codebook of Hsu *et al.*

Finally, to explore potential disciplinary and institutional differences, the data of this study were also analyzed using the coding scheme developed by Hsu *et al.* [4]. That codebook was developed and used for data collected from biological sciences undergraduates at an R2 institution during remote and hybrid learning, but nonetheless, is the most relevant work from the literature.

Results

Responses

Data were collected from 124 unique students across two courses: 50 of 54 students (93%) from fluid mechanics and 77 of 103 students (75%) from neurophysiology, with three students enrolled in both courses. To assess sample representativeness, respondent demographics were compared to the broader BME department population. The fluid mechanics course consisted entirely of undergraduates. In the neurophysiology course, among students who specified their academic level, 43 were undergraduates and 20 were graduate students. Open-ended question response rates varied by question type: 106 students provided motivation data and 102 provided barrier data. Response lengths for motivations and barriers data were 10.1 ± 7.1 words, and 12.1 ± 9.5 words, respectively.

Table 1: Demographic Table of Students Surveyed, totals do not necessarily reach 124 because some students did not respond to all questions.

Demographic Category	Response	Count
Gender	Female	73
	Male	48
	Other OR Prefer not to say	3
First-generation college student	Yes	24
	No	99
Race	White/Caucasian	47
	Hispanic/Latinx	13
	Asian or Pacific Islander	52
	Black/African American	11
	Middle Eastern/North African	3
	Prefer not to say	4
	Multiple	33
Self-identify as other identities not mentioned like sexuality, disability status, nationality, etc	Yes	39
	No	61
Imputed* any minority?	Yes	99
	No	28

*Imputed any minority classifies all students based on if an individual self-identified as belonging to an ethnic group other than White/Caucasian, were first-generation students, or self-reported as any otherwise unspecified underrepresented minority.

Motivations and barriers BME students report in relation to office hours attendance

Addressing RQ1a, the initial emergent themes identified from the codes for motivations were: *academic support and achievement*, *social and relational factors*, and *practical considerations*. Themes that grouped the codes for reported barriers were: *logistical challenges*, *psychological barriers,* and *quality of experience*. As part of the iterative coding approach, and to enable direct comparisons between motivations and barriers data, three themes that could be used for both motivations data and barriers data; these were:

1. Academic: students were encouraged or discouraged to attend based on assignments, learning, and academic support, or perceived lack of need or of support offered.

2. Social and Psychological: students were encouraged or discouraged to attend based on peer and/or instructor factors and whether or not they felt welcomed or intimidated in the environment, and relational factors with peers or instructors
3. Logistical: students were encouraged or discouraged to attend based on logistical considerations such as scheduling or location, or only used as a last resort.

These themes served to group together nine sub-codes for reported motivations and ten sub-codes for reported barriers. Themes, grouped sub-code names, and descriptions are presented in Tables 2a and 2b along with number of responses with each code and the Fleiss κ for the three coders.

Table 2a: Codes counted for the perceived goals and benefits to attending office hours, out of 106 responses

Theme	**Sub-code**	**Description:** Students attended office hours because they…	**Count**	**Fleiss' κ**
Academic	Assignment-focused Study	…need to receive assistance on homework, project, or other assignment	57	0.99
	Unspecified Academic Support	…have a desire to solidify understanding of course material general topics	31	0.70
	Concept-focused Study	…have a desired to solidy understanding of material, course content, or concepts	25	0.76
	Exam-focused Study	… seek assistance in studying for an upcoming exam or quiz	24	0.95
	Expansion and Application	…want to explore beyond course content	3	0.80
Social & Psychological	Peer Motivators	… seek collaboration with peers or the opportunity to listen to their questions or opinions, or knowing that peers would be present	13	0.90
	Instructor Relationships	… want to talk with professor/TAs, build relationships with professor/TAs, or value their positive qualities	9	0.97
Logistical	Convenience	…prioritize time efficiency and convenient scheduling	5	0.93
	Last Resort	…are seeking support due to perceived failure or lack of alternatives	3	0.76

Intersections of reported motivations and barriers

Multiple codes were assigned to approximately half of all responses (motivations: 51/104; barriers: 48/101). While many responses received multiple codes within a single theme, cross-theme coding was less frequent: 19/104 (18%) of motivation responses and 37/101 (36%) of barrier responses included codes from different themes. A small subset of responses received no codes. Area-proportional Venn diagrams in Figure 1 illustrate these thematic co-occurrences.

Network analysis visualizations show the frequency and co-occurrence patterns of specific codes. Within motivations (Figure 2, left panel), Assignment Focused Study (A1) was the most frequently applied code (67 students) and showed connections to multiple other codes, the most frequent co-

occurring code was Exam-focused Study (A5) which totaled 17 counts. For barriers (Figure 2, right panel), the strongest co-occurrence was of Unhelpfulness (A1) and Too Many/Too Few (SP3), appearing together in 6 student responses.

Table 2b: Codes counted for the perceived barriers to attending office hours, out of 102 responses

Theme	Sub-code	Description: Students attended office hours because they…	Count	Fleiss' κ
Academic	Unhelpfulness	…perceived that office hours did not meet their needs	25	0.76
	Utilization Uncertainty	…had a lack of specific questions, were unsure how to utilize OH, struggled with purpose ambiguity or preparation anxiety	16	0.93
	Other Students' Questions	…found other students' questions unhelpful, too basic, or irrelevant	8	0.91
	Didn't Need Additional Support	…believed coursework was manageable without additional help	6	0.81
Social & Psychological	Too many/too few	…were frustrated with overcrowded office hours or did not want to be the only attendee	28	0.91
	Intimidation	…were too scared to attend, felt they might be judged for "bad questions," struggled with preparation anxiety	18	0.76
	Professor Issues	… had negative experiences with professors or a lack of tailored support	11	0.71
	Lack of Motivation	… found it difficult to form a habit or had lack of motivation to attend	3	0.62
Logistical	Inconvenience	…felt like the location or time made attending not worth it	21	0.92
	External Factors	…were not able to attend office hours due to scheduling conflicts, could not attend even if they wanted to	20	0.92

The cross-question network analysis (Figure 3) revealed that the most frequent co-occurrence between a motivation and barrier was Assignment Focused Study (A1) and Too many/too few students (SP1), appearing together in 20 student responses.

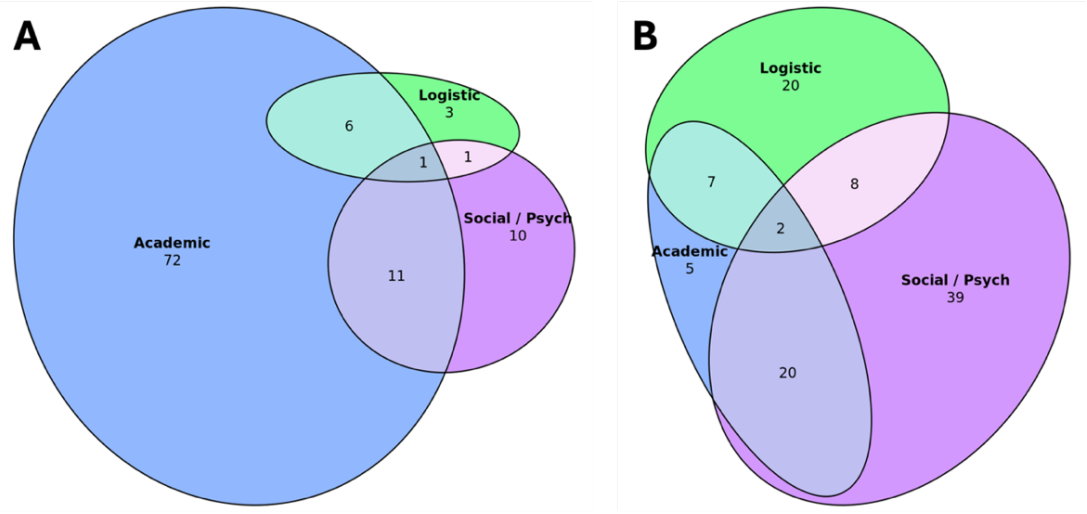

Figure 1: Area-proportional Venn diagrams for responses coded with codes from a single theme or multiple themes. **Panel A**: reported motivations for attending office hours; **panel B**: reported barriers. Panels are not to scale with each other.

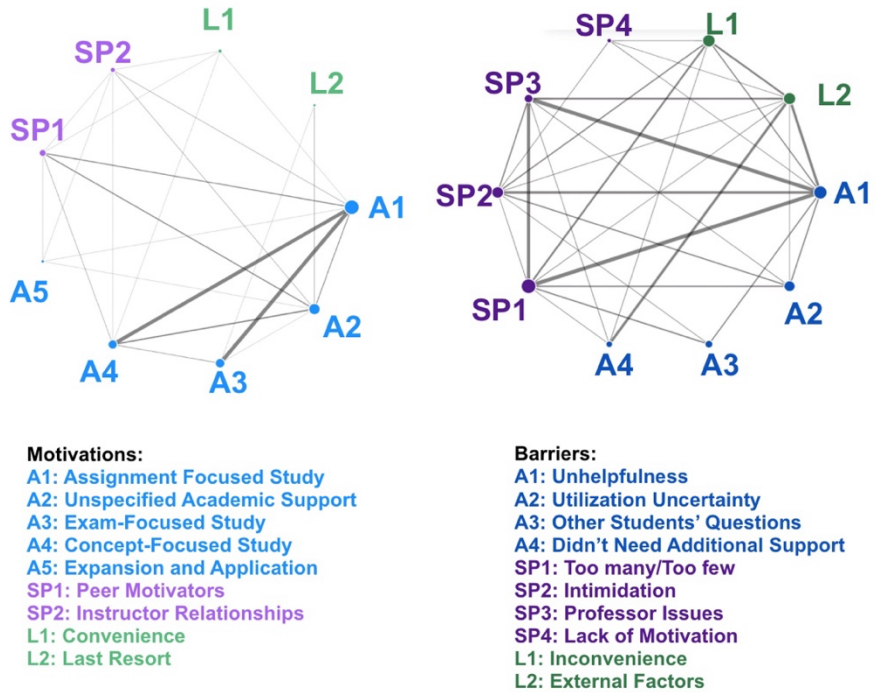

Figure 2: Network visualization of code co-occurrences in student responses. **Left Panel** show relationships between motivation codes; **Right Panel** represents relationships between barrier codes. Node size indicates frequency of individual code occurrence in responses. Line thickness indicates how often codes appear together. Colors denote thematic categories: academic (blue), social/psychological (purple), and logistical (green). Legend identifies specific codes for each node. Largest nodes (Motivation A1 and Barrier SP1) represent 57 and 28 student responses respectively; thickest connecting line represents 21 (Panel A) and 9 (Panel B) student responses containing both connected codes.

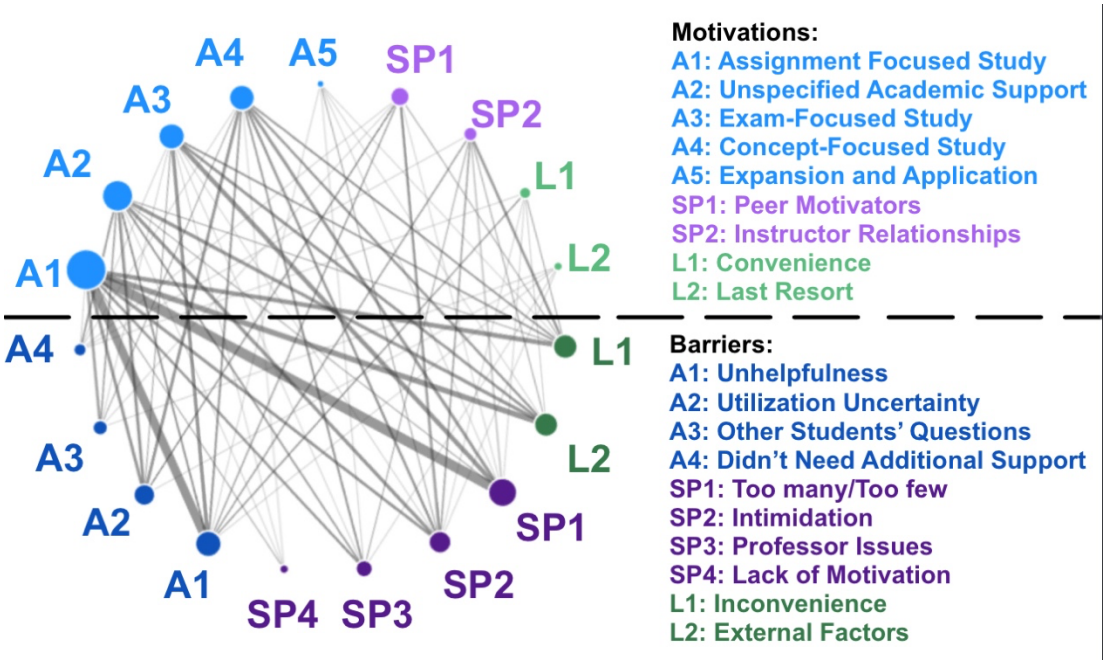

Figure 3: Network visualization showing relationships between motivation codes (above horizontal line) and barrier codes (below line). Node size indicates frequency of code occurrence in student responses. Connecting line thickness indicates how often codes appear together. Colors denote thematic categories: academic (blue), social/psychological (purple), and logistical (green). Legend identifies specific codes. Largest node represents 57 student responses; thickest connecting line represents 20 student responses containing both connected codes.

Coding scheme of Hsu et al.

Results for applying the codes generated by Hsu *et al.* [4] to the pre-course survey data of this study are presented in Tables 3a and 3b. Results are reported as percentages for ease of comparison with Hsu *et al.*'s data.

Table 3a: Codebook developed by Hsu *et al.* [4] for motivation data. Percentages of responses reported by Hsu *et al.* and for the data from this study using this codebook.

Code name (Hsu *et al.*)	**Percent of student codes (Hsu *et al.*)**	**Percent of responses (these data)**
Content Clarification	53.5 %	38.7%
Homework help	15.3 %	55.7 %
Listening to others	8.7 %	2.8 %
Test preparation	7.5 %	22.6 %
Assessment follow-up	6.6 %	1.9 %
Time with professor/student	5.6 %	8.5 %
Practice	2.3 %	0.9 %
Study skills*	0 %	0 %
Professional support*	0 %	0.9 %
Inclusivity*	0 %	0 %
Collaboration*	0 %	8.5 %

*Four codes for reasons to attend office hours were derived by Hsu *et al.* from their parallel dataset with responses from faculty but did not appear in data from students.

Table 3b: Codebook developed by by Hsu *et al.* [4] for barriers data. Percentages of responses reported by Hsu *et al.* and for the data from this study using this codebook.

Code name (Hsu *et al.*)	**Percent of student codes (Hsu *et al.*)**	**Percent of responses (these data)**
No questions	41.4 %	14.7%
Schedule conflict	40.9 %	34.3 %
Alternatives	11.7 %	5.9 %
Intimidated	10.9 %	17.6 %
Busyness	8.2 %	30.4 %
No benefit / underestimating benefits	6.3 %	22.5 %
Lack of effort	6.3 %	3.9 %
Logistical	4.9 %	2.9 %
Previous negative experiences	4.1 %	8.8%
Online	4.1 %	2.9 %

Demographic factors

No statistically significant differences in reported motivations or barriers emerged across demographic groups after applying Fisher's exact test with Bonferroni corrections for multiple comparisons. Trends at uncorrected alpha levels included: first-generation students reported *peer motivators* more frequently and *conceptual understanding* less frequently than their non-first-generation peers (p = 0.043 and p = 0.127, respectively with odds ratios of 2.8 and 6.6, respectively). Additionally, female students and undergraduates more frequently cited *intimidation* as a barrier (p = 0.024 and p = 0.110, respectively with odds ratios of 2.3 and 2.4, respectively).

Post-intervention survey results

Fewer students (n = 39) completed the post-course survey deployed in the fluid mechanics course compared to those that completed the pre-course (n = 50). After Bonferroni correction for multiple comparisons, no statistically significant differences were found with regards to reported motivations and barriers between the pre- and post-course data, or by demographic subgroup. However, there were some observed trends of note: intimidation as a reported barrier to office hours attendance decreased substantially (from 30% of pre-course responses to 0% post-course), and Social and Psychological factors as a motivation for attending office hours increased (from 30.0% to 46.9% of responses).

Discussion

Strong response rates were achieved in this study, with 93% participation in fluid mechanics (50 of 54 students) and 75% participation in neurophysiology (77 of 103 students). The sample included both undergraduate and graduate students (20 graduate students in the neurophysiology course), and the demographic composition was generally representative of the broader BME department population. The high response rates and demographic representation together suggest that useful inferences about the broader BME student population can be drawn from these data.

However, several factors should be considered when interpreting these results. Response rates varied between pre- and post-surveys, with lower participation observed in the post-course survey (39 versus 50 students). This difference in response rates between survey administrations must be considered when interpreting the longitudinal impacts of the office hours intervention. Additionally, many of the open-ended responses received were relatively brief, often consisting of only a few words or a single sentence. The brevity of these responses suggests that students might not have engaged in deep reflection about their office hours experiences, potentially limiting the depth of insights that can be drawn from the qualitative data.

Student motivations and barriers

Three primary themes governing students' engagement with office hours were identified through the analysis: academic factors, social/psychological factors, and logistical considerations. Assignment-focused study was found to be the dominant motivation for attendance (63% of respondents), indicating that office hours are primarily viewed as a resource for immediate academic support rather than longer-term professional development. Due to the brevity of student responses, however, it was not possible to meaningfully distinguish between different types of assignment (e.g., homework assistance, exam preparation, or assignment feedback). This limitation in response specificity suggests that future work examining the nature of assignment-focused help-seeking may benefit from more structured response formats or follow-up interviews. Nevertheless, the prevalence of *assignment-focused* motivation somewhat aligns with prior work in which office hours were found to be viewed primarily as a “last resort” when facing academic difficulties rather than as opportunities for meaningful mentoring [22]. However, while the coding scheme here explicitly included “last resort” as a motivation category, it was reported by only 7% of respondents, suggesting that students' assignment-focused help-seeking may be more proactive than reactive in nature.

The dominance of assignment-focused motivations, combined with relatively low reporting of expansion of learning (7%) and instructor relationship building (9%), suggests a potential missed opportunity. Significant contributions to students' intellectual and professional development have been documented to be made when faculty members take an interest in students' academic progress [23]. The limited focus on these broader benefits that was observed indicates that the value of office hours beyond immediate academic assistance may be underestimated by students, a pattern that has been similarly noted in recent literature [8].

With regard to reported barriers, the findings highlight the complex interplay between logistical and psychological factors. The high prevalence of intimidation as a barrier (35% of respondents) is particularly noteworthy and consistent with previous research. A pattern of "professor avoidance" has been documented wherein students rarely initiate contact with faculty outside the classroom, often due to perceived hierarchical differences [24]. This suggests that efforts to increase office hour utilization must address not only practical barriers but also the underlying social and psychological factors through which students are deterred from seeking help.

The identification of *too many/too few students* as a significant barrier (30% of respondents) presents an interesting paradox. Physical limitations in traditional office settings have been noted to create bottlenecks in student-faculty interactions [25]. However, the data suggests that the absence of other students can be equally deterring, potentially due to increased perceived intimidation in one-on-one settings.

Intersection of motivations and barriers

Network analysis revealed important patterns in the intersection of motivations and barriers. Multiple codes were assigned to approximately half of all responses (motivations: 51/106; barriers: 48/102), indicating substantial complexity in students' decision-making regarding office hours attendance. The less frequent occurrence of cross-theme coding (18% for motivations, 36% for barriers) suggests that students' perceptions tend to cluster within thematic areas rather than spanning multiple domains.

The strong co-occurrence between the motivation code *Assignment Focused Study* and the barrier code *Too many/too few students* (28 responses) indicates that students' primary academic motivation frequently conflicts with capacity constraints. This tension has been noted to be particularly relevant in the context of large research-intensive universities, where class sizes and research demands can impact the accessibility and quality of student-faculty interactions [8].

The relationship between *Unhelpfulness* and *Lack of Motivation* as co-occurring barriers suggests a potential feedback loop through which negative experiences reinforce reluctance to attend. This finding aligns with previous research wherein the importance of positive office hour experiences in shaping student engagement patterns has been emphasized [16].

Demographic considerations

Although statistically significant differences across demographic groups were not found after Bonferroni correction, several uncorrected trends warrant discussion. The more frequent reporting of 'peer motivators' and less frequent reporting of 'conceptual understanding' by first-generation students suggests potentially different help-seeking patterns among this population. Additional barriers in navigating expectations (from instructors) and academic help-seeking have been previously documented among first-generation students [26].

Female students more frequently cited intimidation as a barrier, which is consistent with prior literature. Personal, professional relationships with professors have been found to be valued by female students, although traditional office hour settings may be found intimidating [16]. Additionally, it has been noted that women in engineering programs may feel particularly vulnerable in situations where their understanding is continually challenged [27].

Impact of inclusive office hours intervention

The effectiveness of intentional efforts to create more welcoming office hour environments is suggested by the decrease in *intimidation* as a reported barrier following the intervention (from 30% to 0% in pre-/post-course responses). While this dramatic reduction must be interpreted cautiously given the lower post-survey response rate, it nonetheless suggests meaningful impact. The concurrent increase in Social and Psychological factors as motivations (from 30% to 47%) indicates a potential shift in how these interactions are viewed by students, with movement beyond purely academic support toward more holistic engagement being observed. Given the sample size and number of comparisons, these changes should be interpreted as preliminary evidence warranting further investigation in future studies.

Comparison with prior work

Interesting differences in student motivations and barriers were revealed through the application of Hsu *et al.*'s coding scheme [4], though these differences must be interpreted within their distinct contexts. The present study examined BME students at a private R1 university after returning to fully in-person instruction, while Hsu *et al.* studied biological sciences students at an R2 institution during remote and hybrid learning.

Notable differences emerged in how students utilized office hours across these contexts. Higher percentages of students citing homework help were found in the present study (54% vs 15%) and similarly for *test preparation* (23% vs 7.5%). These patterns may reflect the unique challenges documented in integrating biological and engineering principles [8], or may be explained by institutional differences between quarter and semester systems—different institutional course pacing (term lengths and when major exams are scheduled) has previously been shown to correlate with differences in how students prioritize studying and the approaches taken (e.g. focusing on content understanding versus ‘cramming’ for exams [28]).

Regarding barriers, the frequency of reported scheduling conflicts remained relatively consistent across contexts (34% vs 41%), suggesting persistent logistical challenges. However, higher rates

of reported *intimidation* were observed in the present study (17.6% vs 10.9%), though interestingly *intimidation* appeared in 18% of instructors responses coded by Hsu *et al.*. It should further be noted that Hsu *et al.*'s data were collected during periods of remote and hybrid learning, when student perceptions and utilization of office hours may have been particularly influenced by the modality through which they were delivered. The differences observed between these studies may therefore reflect not only disciplinary variations but also temporal changes in how office hours were conceptualized and accessed during the transition to remote learning. Thus, while these comparisons provide interesting points for future investigation, the substantial differences in institutional context, discipline, time period, and survey prompts should be considered when interpreting these results.

Limitations and future directions

Several limitations must be considered in the interpretation of these results. The self-reported nature of the data may be subject to recall bias, particularly for questions about previous course experiences. The variation in response rates between courses, questions, and pre/post surveys potentially introduces selection bias. Additionally, while the study provides good representation across academic levels, the relatively small sample size of graduate students (20 students) limits the ability to draw strong conclusions about this population.

While this study examines student perspectives in two required BME courses with relatively large enrollments, student responses about prior experiences were likely shaped by similar required course contexts. The pre-course survey timing and course settings may have prompted students to reflect primarily on their experiences in other large-enrollment, required courses rather than smaller, upper-level electives or technical specialization courses where office hour dynamics may differ substantially. Future work examining office hour utilization across different course contexts within the BME curriculum would provide valuable insights into how course size, level, and requirements influence student engagement patterns.

The timing of this study, conducted when many students had experienced some form of online or hybrid learning during their academic careers, must also be considered. However, it should be noted that this timing represents an improvement over existing work such as Hsu *et al.*[4], whose data were collected entirely during periods of remote and hybrid learning. The present study's data collection during the return to primarily in-person instruction provides valuable insights into the transition period, though student perceptions and behaviors regarding office hours may still differ significantly for those who begin their university education in fully in-person settings. Future work examining office hour utilization patterns among students who have not experienced pandemic-era learning modalities would provide valuable comparative insights.

Future research directions should include examination of the long-term impacts of inclusive office hours interventions, particularly their effect on student academic outcomes and professional development. Additionally, investigation of how virtual and hybrid office hour formats might address some of the identified barriers while maintaining the benefits of in-person interaction would be valuable, particularly given previously documented student receptiveness to virtual office hours [6].

Implications for practice

Several practical implications for engineering educators are suggested by these findings. The prevalence of intimidation as a barrier indicates a need for intentional efforts through which more welcoming office hour environments may be created. The importance of peer presence suggests potential benefits from group office hours or structured peer support during office hours. The limited recognition of broader professional development benefits indicates an opportunity through which the full value proposition of office hours might be better communicated to students.

The success of the inclusive office hours intervention in reducing intimidation barriers suggests that meaningful impacts on student engagement can be achieved through relatively straightforward changes to office hour implementation. However, the persistence of logistical barriers indicates that multiple approaches, potentially including hybrid delivery models, may be necessary through which accessibility for all students can be optimized.

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