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Virtual "Happy" Office Hours: The Student Experience

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ABSTRACT

Traditional office hours are typically poorly attended for a variety of reasons, including the limitations imposed by faculty office space constraints in terms of simultaneous student participation. Virtual office hours are an option for instructors to support their students through a virtual learning environment. Research suggests that virtual environments are beneficial to both learners and educators, offering more flexibility in the learning process. Further, participation in office hours provides a platform for student-instructor interaction, claimed in the growing body of research to improve student learning experiences overall. This paper describes the design and structure of virtual office hours offered in three undergraduate energy-related mechanical engineering courses (Thermodynamics, Fluid Mechanics, and Heat Transfer) before the COVID-19 pandemic. The student learning experience was analyzed through an assessment of student responses on anonymous end-of-course evaluations. Findings revealed that students appreciated the virtual office hours and felt that they were more accommodated than could have been in a traditional office hour setting. Findings suggested as well that students appreciated the virtual setting more as they progressed through a series of courses offering virtual office hours. Findings from our study can be helpful for a broader audience of researchers and educators in an educational environment that is increasingly online.

INTRODUCTION

Virtual office hours are an effective way of increasing student-student interaction, student-instructor interaction, and student learning overall (Li and Pitts 2009; Lowenthal et al. 2017; Guerrero and Rod 2013). The virtual environment creates more flexible options for meeting locations, as all parties are not constrained by physical environment (Figure 1). Online space also creates a lower stress space for students to express their thoughts and ask questions (Hill and Fitzgerald 2020). As traditional office hours are typically poorly attended, virtual office hours increase the instructor's availability to students, while also providing a space that has no limit on physical attendance (Li and Pitts 2009; Lowenthal et al. 2017; Guerrero and Rod 2013; Smith et al. 2017). Virtual office hours can be implemented in any type of course, regardless of subject matter or instruction type, as their design can be modified to fit each course's needs. The frequency of virtual office hours, and the software through which they are held, are up to the professor's discretion as to what would work best for their course.

The virtual office hours analyzed in this study were held at a university in the Northwestern United States by one Mechanical Engineering faculty. The faculty held office hours for 26 total sections of three sequential courses: Thermodynamics, Fluid Mechanics, and Heat Transfer. These courses took place from the spring 2013 semester to the fall 2018 semester, including summer courses. Rather than calling them office hours, they were renamed "Happy Hours" based on an anonymous student comment, with the goal of reducing perceived formality of an office hour setting. These "Happy Hours" were one-hour sessions held on Zoom (video conference software) outside of traditional business hours.

Figure 1. Virtual office hours visual representation of students participating from any location.

BACKGROUND

Depending on the course type and needs of the students, virtual office hours can take a variety of forms. Virtual office hours may be used to entirely replace traditional office hours, or they may be used in conjunction with traditional office hours to provide students with both options (Meyers 2003; Wallace and Wallace 2001; Li and Pitts 2009; Badia and Colosimo 2013). Virtual office hours may also be implemented on a provisional basis, such as offering an opportunity for test review, or using them to assist students on a particularly challenging subject (Lowenthal et al. 2017). Virtual environments can also be used as another method of communication with students, by scheduling video or voice calls with individuals or groups (Lillie and Wygal 2011). Some instructors have also made themselves available through instant messaging platforms (Andrade et al. 2020; Edwards and Helvie-Mason 2010). The use of social media platforms enables instructors to provide quick resolutions to students' questions without the need to divulge personal contact information such as cell phone number.

Traditional office hours have a poor reputation for a variety of reasons (Mineo 2017). Students may not see the value in attending them, may not have specific questions to ask, or may find their instructor intimidating (Mineo 2017). Faculty offices can typically only hold a few students at a time, meaning that they are not available to all students at the same time if multiple show up. It was also found in a study at California State University-Fullerton that, due to the low participation by students, faculty members themselves did not attend their own office hours 42% of the time (Guerrero and Rod 2013). Since many students do not regularly attend office hours, there is a sizeable probability that their instructor will not be available when they have questions that need to be answered.

In a study by Smith and colleagues (2017), researchers surveyed the student population (over 700 students) to examine why students do not typically attend office hours, and what misconceptions may alter their perception of the benefits. Contrary to common assumption, the biggest hindrance for students to attend office hours was not the time nor the fact that they were held on campus (Smith et al. 2017). According to Smith and colleagues, students do not attend office hours because they either do not understand why office hours are beneficial, or they are not sure how to capitalize on those benefits (Smith et al. 2017).

Furthermore, it was found that the primary reason students choose to attend office hours is to interact with their instructors outside of the classroom (Smith et al. 2017; Lowenthal et al. 2017). Developing a student-instructor relationship is proven to enhance students' academic experience by increasing student grades and improving the school's retention rate (Guerrero and Rod 2013). A primary challenge in increasing student attendance of office hours thus appears to be to decrease the widespread negative perceptions of office hours, in particular the perception of instructors as intimidating (Mineo 2017).

While the virtual office hours studied in this paper focused on working through problems as a group, many instructors have found it helpful to simply make themselves available virtually at the same time as their traditional office hours (Wallace and Wallace 2001; Li and Pitts 2009; Badia and Colosimo 2013). Being simultaneously available both in-person and virtually, students can access the instructor regardless of location, alleviating the stress involved with scheduling physical meetings (Wallace and Wallace 2001; Li and Pitts 2009; Smith et al. 2017). Faculty can then communicate with students through an environment in which the students are comfortable. This mode of virtual communication can be done through email, instant messaging on social media platforms like Facebook (Gunawan et al. 2018), arranging virtual calls over Skype, GoToMeeting, or Google Hangouts, or any other software that allows one-on-one or group communication (Dickrell 2013).

When students can interact with the professor and each other, learning online is comparable to learning in-person (Edmonson and Segalewitz 2005). To simulate a physical environment, some courses have incorporated the use of software that create an entire virtual world to demonstrate concepts and/or create a literal virtual classroom, including Minecraft, Second Life, Terf, and other laboratory simulators (Schuster et al. 2015; Potkonjak et al. 2016; Avanzato 2018; Goeser et al. 2011). It has also been found that these virtual environments produce greater student engagement than asynchronous platforms for learning due to the increased social presence (Claman 2015).

Lowenthal and colleagues implemented virtual office hours in a course as a test review option, holding four sessions throughout the semester. The researchers found that 50% of students attended at least one session, with 25% attending all four (Lowenthal et al. 2017). After surveying students about their experience, it was found that, while students did attend to ask questions about the course, the primary motivation for attendance was to get to know the instructor (Lowenthal et al. 2017). These results show that students understand the value in developing a relationship with their faculty members and believe that it is a good use of their time (Lowenthal et al. 2017). Group tutoring sessions are another resource that some courses implement as a means of supporting their students outside the classroom (Schubert et al. 2016; Yang and Pakala 2017). Group tutoring sessions, like Peer Educator (PE) sessions as referred to in this study, are typically run by a student and held a few times per week; however, they also may be held by the instructor in a physical space that accommodates a larger group of students (Yang and Pakala 2017; Schubert et al. 2016). In one study at the University of Rhode Island, group sessions were held twice a week for 90 minutes each (Mendes et al. 2017). As session attendance was not required for the student grade, the attendance at sessions varied (Mendes et al. 2017). Several students would show up consistently, but attendance would greatly increase at the session ahead of an exam (Mendes et al. 2017). This study found that, of 800-900 students who were offered group tutoring sessions, only 10% attended "regularly", which they considered to be seven sessions or more in a semester (Mendes et al. 2017). Those students

did average one grade increment higher than their peers who did not attend sessions, but only a fraction of the student population was reached with this method (Mendes et al. 2017).

This paper reports the results of implementing virtual office hours (Happy Hours) for the thermal-fluid courses: Thermodynamics, Fluid Mechanics, and Heat Transfer. These subjects were taught over the period of spring 2013 to fall 2018, comprising a total of 26 courses. The course breakdown was 13 sections of Thermodynamics, 9 sections of Fluid Mechanics, and 4 sections of Heat Transfer. These courses spanned spring, summer, and fall sessions over the 5 years analyzed.

THEORETICAL FRAMEWORK

This study was developed to specifically understand the student perception of virtual office hours, as students may not find the same benefits from an activity that their instructor anticipates. Prior studies have shown that students' learning, and actions, are influenced by how they perceive the activity, which is largely out of the instructor's control (Hsu et al. 2022; Osborne et al. 2009). Student perceptions of instructor behaviors have also been found to effectively predict student learning (Hsu et al. 2022; André et al. 2020). While instructors do their best to design activities and instructional techniques that will promote student learning, it can be challenging to understand the effectiveness of those activities through traditional classroom evaluations, such as homework assignments or exams.

There are many different theoretical frameworks that can be used to analyze both perceptions and student learning. This study utilizes Variation theory, which states that there can often be a disconnect between a student's experience of learning and the instructor's intended experience of learning (Bussey et al. 2013). This disconnect, if present, can negatively impact not just student learning, but also a student's general engagement or interest in class. The goal of this study is to understand which classroom activities students perceive to be beneficial, in order to determine if the implementation of virtual office hours is a productive use of time.

HAPPY HOURS IN ACTION

In this section the virtual office hours (Happy Hours) are described in detail. These sessions were implemented in sophomore/junior level thermal-fluid science courses at Boise State University. These 3-credit hour courses were delivered in person and the typical enrollment in these classes was about 50 to 70. Happy Hours were held twice a week throughout the entire semester, entirely replacing traditional office hours. Sessions took place on nights before lectures to clarify questions

prior to class and were especially beneficial reviewing content relevant for in-class quizzes or exams. Happy Hours typically occurred at 8pm, with the intention of accommodating the greatest number of students' schedules. As they were held in a virtual space, students could join the session regardless of their physical location. The sessions were also recorded, allowing students who could not attend to review the discussed content. In addition, students could return to the Happy Hour video recordings to help them study later in the course.

Happy Hours were hosted on Zoom, a video-conferencing platform, and prior to fall 2018 they were held on BlackBoard Collaborate, a video-conferencing software hosted by the educational platform Blackboard. The change in the video platform did not change the design of the Happy Hour session. During sessions, only the instructor shared their screen. Students were free to chat with each other and the instructor through an instant messaging chat window. When students had questions, they could either type them into the chat box or use the "hand raise" tool, which notifies the instructor that the student would like to unmute and ask a question. At that point, the instructor could call on individuals, so students know whose turn it is to speak. When there were many students in attendance, it was particularly necessary to delegate official speaking roles. During the hour-long session, no new course content was discussed. The instructor sent out practice problems a day or two in advance, giving students the opportunity to work on problems ahead of time. During the session, the group worked through the practice problems as a team. The instructor projected their iPad screen for all students to see and recorded the steps needed to progress through the problem. The instructor designed the environment to be a collaborative setting where students could discuss options with each other and compare answers. By completing the problem set together, the students were more likely to have a better understanding of the correct approach. This made in-class work, assessments, and homework easier to complete. Misconceptions were often efficiently resolved as a group, rather than students having to research on their own or wait until the next lecture to ask questions. The instructor also observed that these office hour interactions improved the atmosphere inside the classroom.

Throughout the semester, students were required to attend 16 help sessions. Students had the option of attending Happy Hours or PE Sessions. PE sessions are in-person help sessions that are held by a student employee on campus. The Happy Hours were held twice each week for 15 weeks, and the PE sessions were held a minimum of three times per week at a variety of times, with times set at the start of the semester based upon availability of the class and the PE. If there were two PEs during a semester, there may be eight to ten sessions per week. The students who are PEs are often intentionally selected by the instructor, having previously completed the course successfully. PEs have thus demonstrated their understanding of the material and are able to assist students during the sessions by either helping with individual problems or working through questions as a group. Unlike Happy Hours, specific problems are not sent out ahead of time. This time is intended for

homework help, clarifying content, or working through projects. While the instructor does not hold in-person office hours, PE sessions give students an opportunity to receive in-person help outside of the classroom with someone who has a deep understanding of the material.

The video below depicts an actual Happy Hour session. The video is shared with permission from the students who are in the video. Most of the visual field is in use by a screen casting of the instructor's iPad, where the group is working through a problem that was shared ahead of time. The instructor can be heard on the microphone, asking questions of the group, and then reiterating the student responses as they work through the next steps. The chat window is seen on the right side of the screen, where students are asking questions, suggesting answers to their peers' and the instructor's questions, and confirming that they are following along with the content. The chat window also allows students to send individual questions to the instructor and to their peers throughout the session, beyond just having the full group conversation going.

Happy Hour example 1: https://youtu.be/S5qx4sdUZRI

This virtual environment encourages students to be actively involved throughout the entire session. Students work through problems on their own document while following along with the class, allowing students to ask their questions without the potential distractions and pressures of a large lecture environment. This helps take away some of the pressure or anxiety associated with asking questions in front of a large crowd, as students can type their questions at any point during Happy Hour. If students are not actively participating, it is clear to the instructor as they may not be interacting in the chat window, and the instructor can check in with them to see if they are confused.

The second video shared here showcases student to student interactions in Happy Hour. As for the first video, permission from the students involved was obtained. Students are encouraged to answer each other's questions, involve others in the conversation, and contribute to discussions during the session.

Happy Hour example 2: https://youtu.be/jscgYTuZrnk

Before we present the study methodology, we summarize best practices for hosting virtual office hours learned over multiple years of conducting them and relate these lessons to the existing literature:

Maintain a consistent schedule of hosting virtual office hours -

Whether it is for test preparation, or a weekly schedule, regularity is easier for students to plan around, and the schedule should be easily accessible by students (Caraway 2019; Orr 2020).

Ensure active participation -

Asking for input from the group and individual participants maintains active participation by the students in attendance (Orr 2020; Bolliger and Martin 2018).

Offer extra credit or make attendance part of the grade -

Once students see the value of attending firsthand, they will attend consistently. Encouraging students to come initially is challenging, and incentivizing attendance typically increases participation (Orr 2020).

Using a tablet for screen sharing is best, but an additional camera pointed at a piece of paper is sufficient -

Being able to freely write is important for subjects that frequently use symbols, diagrams, and/or equations (Gregori and Martinez 2021). Active learning, such as working through problems, is more effective than a session solely dedicated to question and answer (Venton and Pompano 2021).

METHODOLOGY

To apply the Variation theory (Bussey et al., 2013) in the interpretation of our results and to understand which classroom activities students perceive to be beneficial, helping us determine the efficacy of the virtual office hours we crafted a guiding research question: *How do students perceive Happy Hours experiences regarding their learning?* The researchers in this study utilized content analysis to analyze the qualitative data obtained from two questions on the course evaluation, *"What barriers to learning, if any, did you experience in this course?"* and *"What aspects of this course were most valuable to your overall learning experience?"* These two questions were included in every analyzed course evaluation, with the same wording, and were chosen to provide insight on whether students viewed Happy Hours as a hindrance or a benefit.

Participants

In total, over 1000 student evaluations were analyzed in this study. Nearly every student enrolled in each course submitted their course evaluations. No demographic data was collected due to the anonymity embedded in the university's course evaluations. Course evaluations were used to collect data for this study as they tend to have a very high submission rate. However, historically these courses have had the following demographics: 34% first-generation college students, 84% male, 16% female, 20% underrepresented minority, and 74% White.

Data Collection

The course evaluations analyzed in this study are distributed by the university for all courses each semester. The evaluation period is open for the last two weeks of each semester, closing the night before finals week. During this two-week span, students are sent reminder emails to encourage participation and remind students of the importance of feedback, both for the instructors and the university. Evaluations are not accessible by faculty until after final grades are posted by the Registrar's Office, eliminating the possibility for professors to allow the feedback to impact the grades they award.

Student responses are entirely anonymous, and instructors only receive data showing the number of students who completed evaluations and what their responses contained. To encourage participation, the instructor who conducted this study did offer an extra credit incentive to students who provided a screenshot of their survey completion. These screenshots do not include any responses to questions, only a list of the courses for which they submitted evaluations. The extra credit incentive for these courses was a bonus of 25 points out of a total of 1000 possible quiz points, offering an extra 0.025% to their total grade.

Analysis

Content analysis was conducted to translate the qualitative data from course evaluations into quantitative data for analysis. This coding was conducted by multiple coders. The first round was conducted by one researcher on all Heat Transfer evaluations, as there were only 150 responses. Heat Transfer was selected for the course to analyze first, as it had the lowest number of evaluations, and provided a preliminary insight to inform the selection of coding categories. The second round was conducted by two researchers and covered the entire data set.

Round 1

Reviewing the Heat Transfer evaluations, the researcher analyzed both questions from all four courses, noting commonly mentioned topics. The smallest data set was used for this step to understand what typically appeared in the evaluations, and how best to organize them. The researcher constructed the following thematic coding categories for each of the two questions:

1. *What was valuable to your learning?*

   Happy Hours, PE Sessions, Class Structure, Extra Resources/Technology, The Instructor, Miscellaneous

2. *What was a barrier to your learning?*

   None, PE Sessions/Happy Hours, Course Material, Exams/Quizzes, Class Structure, Personal Reasons, Miscellaneous

In the categories for barriers to learning, PE Sessions and Happy Hours were combined into one category, as most responses that mentioned either were about the students' ability to attend sessions, or that their attendance at these sessions counted as part of their grade. In each semester, 5% of students' grades was based on their total attendance at both Happy Hours and PE sessions. The grade does not distinguish between the two sessions, and as a result, the coding was done accordingly to include both sessions in one category. The above themes were then used to categorize the course evaluations for all 26 sections of the three courses (Thermodynamics, Fluid Mechanics, Heat Transfer).

Sorting process

To convert the student responses into numerical data, the researcher kept a separate data table for each question in each course. These tables were organized both by category and by semester. The researcher reviewed each question, and whenever a student response mentioned one of the categories, that category received a "+1", until all responses had been categorized. In the questions about valuable course aspects, anything sorted into the Happy Hour category had to explicitly mention or clearly imply the use of Happy Hours. If a comment mentioned "help sessions" or "LA sessions" (Learning Assistant sessions), it was sorted into the PE Session category. The LA program is a campus-wide tutoring program, while PE Sessions are specific to the Mechanical Engineering Department. Many students use their titles interchangeably.

Round 2

A second researcher was given all course evaluations for the 26 sections, along with the categories used to code the round 1 data. This researcher then refined the categories in a way that better suited the data set, if applicable. These refined categories were then used by both researchers to independently code the data.

The "valuable to learning" categories were agreed to be the same as used in round 1. The researchers generated a new list of categories for the "barriers to learning" question and used it for the second round of analysis. The following thematic coding categories were used for "barriers to learning" in round 2:

What was a barrier to your learning?

None/Room Issues, PE Sessions/Happy Hours, Material Comprehension, Exams/Quizzes, Class Structure, Organization, Speed, Technical Issues, Miscellaneous

PE Sessions/Happy Hours were again merged into a single category, as most responses referenced their relevance to their grade. Class Structure was intended to encompass the way

that lectures/homework were conducted, in terms of what activities were done or what content was covered, while the Organization category aims to encompass how course structure affects one's grade, including that homework is not required. The Speed category was used to categorize comments about how much time was spent on each topic in class, which was more frequently applied in the summer sections of courses. Technical Issues was used for comments about iPads, as iPads were only implemented into certain semesters and affected the way that information was delivered to students. Room Issues were combined with None because issues such as temperature and furniture did not affect the way information was given to students regarding their learning.

FINDINGS AND DISCUSSION

Our study is based on the Variation theory (Bussey et al., 2013) that focused on what instructors do and how students perceived these activities to add to their learning. We assumed that the Happy Hours offered by the instructor involved in this study are equally crucial for students learning each of the three energy-related subjects (Thermodynamics, Fluid Mechanics, and Heat Transfer). By concentrating on what the instructor did to support students' learning of these subjects and what students experienced, we captured what is needed for learning to take place during the virtual office hours. As suggested by the Variation theory, the "object of learning", in our case, the Happy Hours, can be affected by what the instructor does or says, the student's own reflections, other students, or the learning materials.

By examining the variation in students' experiences and perceptions of the Happy Hours, rather than the differences between, we argue that variation theory is useful for describing the virtual Happy Hours from the perspective of how it is experienced, and that these different ways of experiencing virtual office hours in turn be utilized in analytical and pedagogical ways. Even though there was a variation of students' perceptions and experiences, Happy Hours were seen as valuable to students' learning in each of the three courses. This trend increased as students progressed through the course sequence. Thermodynamics, Fluid Mechanics, and Heat Transfer are taken in sequential order, typically starting in the second semester of sophomore year, and ending with Heat Transfer in the second semester of student's junior year. Thermodynamics is also seen as one of the hardest courses for Mechanical Engineering students, as it is one of the first upper division courses taken and can cause students to struggle.

In the above Figure 2, all three courses are individually modeled with their responses to the question "*What aspects of this course were most valuable to your overall learning experience?".* This

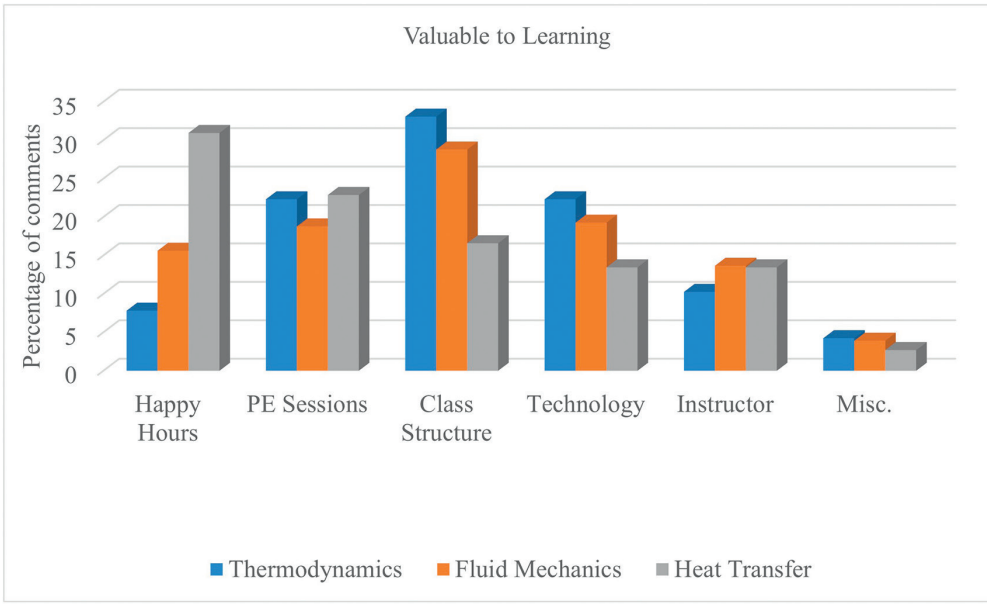

Figure 2. Cumulative percentages of responses for all three courses regarding course aspects that students perceived as valuable.

chart demonstrates students' perceptions of what was most beneficial to their learning throughout the semester. While the percentage of responses that mentioned PE Sessions remained relatively consistent across all three courses, the percentage of responses that mentioned Happy Hours varied and increased as students progressed through the thermal-fluid course sequence. Across all Thermodynamics courses, Happy Hours were only explicitly mentioned in 8% of responses. In Fluid Mechanics courses, that number roughly doubles to 16% of responses, and roughly doubles again in Heat Transfer to 31% of responses. The response rate for PE Sessions remained between 18-23% in all three courses, which shows that while students appreciate the in-person sessions, the virtual office hours proved to be more helpful with the instructor.

The increase in responses mentioning Happy Hours is also paralleled by a decrease in responses about the structure of the course, regarding lectures, homework, in-class problems, and exams. There is a variation in decrease as students progressed through the three-course sequence, the responses about Class Structure decreased from 33% to 17%. A similar decrease in responses is also seen in the Technology category, which encompasses the course website and extra resources made available for students. It is likely that students, over time, obtained more benefit from working with their peers and someone with experience than listening to lectures and working on assignments independently.

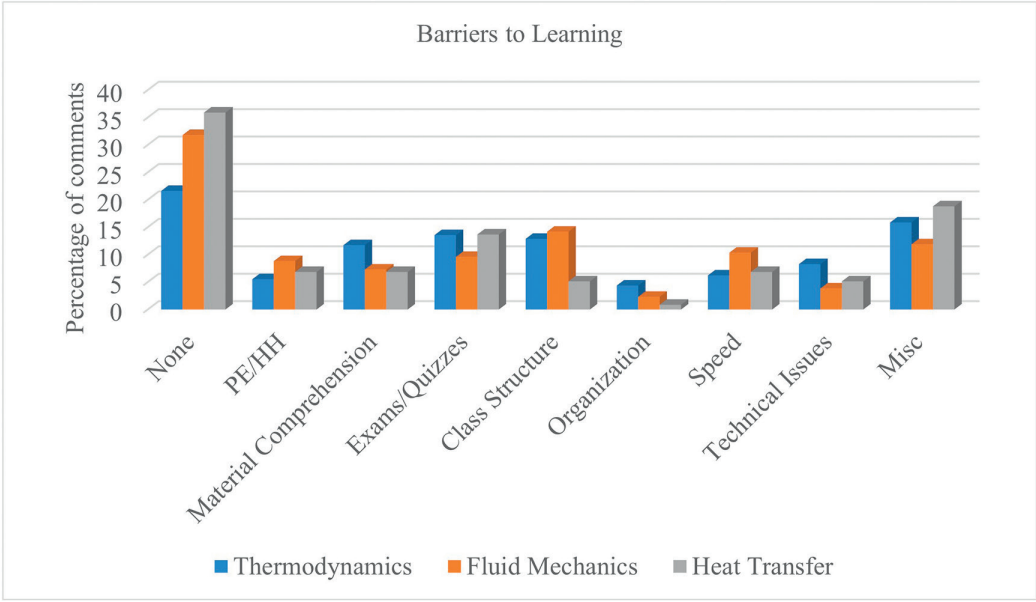

Figure 3. Cumulative percentages of responses for all three courses in regard to students' perceived barriers to learning.

In the above Figure 3, all three courses are individually modeled with their responses to the question "*What barriers to learning, if any, did you experience in this course?"* The responses were relatively consistent across all three courses, with the most frequent response being that there were no barriers to learning. In the three courses, the students' ability to attend PE Sessions and Happy Hours received 5%, 9% and 7% of responses, respectively.

While the student opinion of Happy Hours is important to understand, it is also crucial to examine how many students attended each session, done in Table 1. For each of the three courses taught, one semester each was selected at random to analyze the attendance at Happy Hours, and courses are each from different semesters. When the percentages are translated to numbers of students, Happy Hour attendance varied from a minimum of 2 students to a maximum of 44 students. This suggests that virtual office hours can reach a wider range of students. Traditional office hours can typically

Table 1. Happy Hour statistics regarding live attendance at sessions, reported in percentages.

Course	Total Students	Average Attendance	Minimum Attendance	Maximum Attendance
Thermodynamics	74	36%	13%	59%
Fluid Mechanics	64	29%	8%	47%
Heat Transfer	50	41%	1%	70%

Table 2. Student responses to both free response questions.

What barriers to learning, if any, did you experience in this course?	*What aspects of this course were most valuable to your overall learning experience?*
"The Happy Hours and PE sessions were hard for me to make because of dates and times conflicting with work. I mentioned it in the beginning of the semester, but it could not be adjusted."	"The Happy Hours were one of the most beneficial parts of the class. Really getting the time to do extra problems with real time feedback and in a place where you can go back and watch the problems again, was super helpful."
"Trying to attend all of the extra activities that were held, like PE sessions. It seemed like they were needed to attend if a really good grade was wanted."	"I really liked the Happy Hours. They took more time outside of class, but it kept the material fresh in my head and it's nice to be able to keep learning in the comfort of my own home."
"Attending 16 LA sessions was challenging. My schedule only allowed me to attend one a week, and I struggled to make sure I could be at the one session every week."	"Happy Hours, this gave me time to do more practice problems and ask any questions I had during this time. There is no pressure, and it is purely for the students learning."
"I wasn't able to attend any of the L.A. sessions or Happy Hour sessions due to my work schedule and me having to provide for my family. This didn't allow me to get hands on learning, I had to do it by myself, which wasn't a bad thing it just didn't allow me to get the 5% grade from the attendance. I believe it's unfair to require attendance to those when some students actually can't make it to them and they can't get that 5%, which could be the difference between them passing the class or not."	"The Happy Hours were great! I wish more teachers would offer happy hours over PE sessions. The Happy Hours were very convenient since I'm unable to attend PE sessions working full time."

only accommodate a few students at a time due to limits on the physical space. This bottleneck results in wasted time for students if they must wait to speak with their professor. Virtual office hours could, in theory, accommodate the entire classroom population for the entirety of the hour, as there is no limit on attendance in a virtual space.

Table 2 below presents examples of student responses that were thematically coded by the research team. The example responses were obtained from multiple courses across multiple semesters.

Alongside the two open-response questions, one other question regarding Happy Hours was asked of students. Students were asked to respond to the following prompt - *"Supplemental materials/resources provided by the instructor were extremely helpful (YouTube Videos, Happy Hours)"*. A Likert scale of 1-5 with a score of 1 was correlated with Strongly Disagree, 3 was Neutral, and 5 was Strongly Agree. This question was not included in every course, but rather was asked of three Thermodynamics sections, six Fluid Mechanics sections, and two sections of Heat Transfer. This was an instructor-created question and wasn't added until partway through the analyzed semesters. As seen below in Table 3, the students found supplemental materials helpful, as all three courses had an average score of over 4.6 out of 5. As this question was written by the instructor, it was not included in other evaluations throughout the College of Engineering to provide a point of comparison. This data was included to show the generally very positive attitude towards Happy Hours.

Table 3. Average scores, out of 5, in response to "Supplemental materials/resources provided by the instructor were extremely helpful (YouTube Videos, Happy Hours)".

Course	Average Score
Thermodynamics	4.6
Fluid Mechanics	4.6
Heat Transfer	4.8

The findings shared above have shown the variation in effectiveness of virtual office hours in students' learning before the COVID-19 pandemic, suggesting that many of the ways students and faculty have adapted to a virtual learning environment can continue to be effective when in-person learning and working become the norm again. The transition to virtual learning was challenging for both engineering educators and engineering students, as the previous instruction method included hands-on activities and group work to help students understand the content (Ahmed et al. 2020). Having successfully implemented virtual office hours before it was necessary, this research proves that students are still able to effectively learn content and work with their peers in a virtual environment, and that virtual instruction environments can improve students' learning experience.

One major benefit of virtual office hours is the sense of community that the virtual space provides (Orlov et al. 2021). Students and faculty both experienced a sense of isolation after the loss of their campus community and struggled to make connections with the absence of a physical classroom (Hill and Fitzgerald 2020; Orlov et al. 2021). Campuses had to rapidly move online, and fully virtual learning is often detrimental to students as the lack of student engagement limits the ability to learn (Stott 2016). The implementation of virtual office hours and virtual classrooms allowed for student-instructor and student-student connections to be enhanced, and facilitated connection between faculty, students, and peers (Orlov et al. 2021). While new literature is coming out regarding the impact of COVID-19 on higher education, there aren't many studies currently published on the impact of office hours in the virtual environment. Much of the literature being published is in regard to managing the rapid transition to online learning, or on mental health in both students and faculty. The rapid transition to, and prolonged use of, online learning left many faculty members discouraged about their careers, overworked, and without work-life balance (Tugend 2020).

For the courses discussed specifically in this paper, virtual office hours were already typical, and provided a sense of normalcy during the rapid transition to online learning and the quick closure of campuses nationwide. The students already understood how this environment worked, and it helped smooth out the stressful transition that many students experienced.

FOLLOW-UP STUDY

The data discussed in this study was collected by asking about what aspects of the course students found to be either a benefit or a hindrance, without specifically asking about Happy Hours. This study was inspired by the trend of earlier semesters mentioning Happy Hours and the study was carried out from there. Immediately following this study, another follow-up study (IRB approved) was initiated to ask students in three courses, each with a different instructor, specific questions about their experiences with Happy Hours. The follow-up study included four research questions and appropriate constructs (focus areas) were developed by the study researchers.

Perceived Learning: In what ways did attending virtual office hours impact students' perceived learning of engineering-related course content?

Student Instructor Interactions: Does offering virtual office hours increase contact time between students and instructors, and student interaction?

Student Satisfaction: Are learners satisfied with attending virtual office hours?

Student Motivation: What factors motivate students to attend virtual office hours?

For comparison to this paper's study, a snapshot of data from a manuscript in preparation is being shared. The data reported here in Tables 4 and 5 was obtained from a Heat Transfer course in 2019 taught by the same instructor from this paper's study, and Heat Transfer is only one of three courses being analyzed in this study. There were 52 students enrolled, and 50 students completed the survey. In Tables 4 and 5, seen below, sample of both quantitative and qualitative data are presented. It can be seen in Table 4 that on a Likert scale, with 3 being neutral, the students generally agreed that their virtual office hours positively impacted their learning, interactions, satisfaction, and motivation. While each of these statements received an average positive response from students, they very strongly agreed that virtual office hours helped their learning and increased their access to the instructor.

Table 4. Average scores regarding students' level of agreement to the listed statement.

Research Question Focus	Statement	Average Score
Perceived Learning	Attending virtual office hours positively impacted my learning of content in this course	4.6
Student Instructor Interactions	Availability of virtual office hours increased my access to the course instructor	4.6
Student Satisfaction	Virtual office hours were an efficient use of my time	4.4
Student Motivation	My motivation of reaching out to my instructor using virtual office hours is usually high	3.9

Table 5. Student responses to short answer questions for each overarching research question.

Research Question Focus	Short Answer Question	Sample Response
Perceived Learning	In a few words, state why or why not attending virtual office hours helped you master content in this engineering course?	"It is a more relaxed environment to learn in. At home rather than being at school makes it really convenient. It also really helped to have the teacher there doing it with us so we knew we were doing it correctly."
Student Instructor Interactions	In a few words, state how the availability of virtual office hours increased your access to the course instructor. If it did not necessarily increase access, please state the reasons why.	"For the most part, I'm always available during the Happy Hour time slot each week so I know I can get help if I need it. Regular office hours are often hard to fit into my schedule."
Student Satisfaction	Please describe why you think virtual office hours were or were not an efficient use of your time.	"Sometimes watching Happy Hours after they were finished was more beneficial for myself and my time. I could work through the problems at my own pace and pause/speed up the video as needed."
Student Motivation	Please describe your reasons why you chose to attend, or not to attend, the virtual office hours offered in this course.	"I prefer virtual office hours because they tend to work better with my schedule, and it's less intimidating in a virtual setting. I think in three years I've attend face to face office hours maybe two or three times – either it doesn't fit in my schedule, or it was intimidating to talk to a professor."

Table 5 shows sample responses to one short answer question for each focus area of the study. The main theme that arose in this data was that students found virtual office hours to be a convenient time to contact their instructor, and they found themselves more motivated to communicate with their instructed in the virtual environment over in-person office hours. The students who did not find virtual office hours beneficial either found them unnecessary for their comprehension, or they had scheduling conflicts and were unable to attend.

The study described in this paper and the follow-up study confirmed the best practices identified in the literature that aid in student learning. Even students' experiences across the different subjects varied, overall students appreciated the time that virtual office hours were hosted which provided them with greater flexibility to join the sessions (Caraway 2019; Orr 2020). Further, student to student interaction facilitated active learning (Orr 2020; Bolliger and Martin 2018). Students participated in the virtual office hours rather than regular office hours and saw the value of their engagement in addition to receiving participation points (Orr 2020). The technology such as screen sharing, and digital writing helped students actively engage with the course content while working on problems (Venton and Pompano 2021).

LIMITATIONS

The original study was conducted due to the observation that Happy Hours were repeatedly mentioned in course evaluations, thus the evaluation questions were not tailored to gather specific

information about Happy Hours. Only one section is taught each semester and virtual office hours were always used in the instructor's classes. Therefore, the use of Happy Hours cannot be compared with the teaching and learning in courses where it was not used. This study was done pre-pandemic, and though the findings are still highly relevant to teaching and learning during the ongoing pandemic and beyond, the pandemic imposed some specific challenges. Student and instructor burnout, trauma, mental health repercussions are major issues during and post-pandemic. Those factors have not been included in the data collected for this study. Demographic data was not collected owing to the nature of the end of semester course evaluations. Confounding factors could not be analyzed such as classes with and without the Happy Hours.

CONCLUSION

This study aimed to understand the student perceptions and benefits of virtual office hours in a sequence of thermal-fluid courses. Thematic coding was used to analyze over 1000 student comments in response to two guiding questions: "*What barriers to learning, if any, did you experience in this course?"* and "*What aspects of this course were most valuable to your overall learning experience?"* Both questions were asked in the same phrasing across 26 total sections of three courses: Thermodynamics, Fluid Mechanics, and Heat Transfer. These courses are traditionally taken by second- and third-year mechanical engineering students, and the data was obtained from fall, spring, and summer semesters over five years from the same instructor. The results from this study confirm the literature that virtual office hours are held in a variety of forms (Meyers 2003; Wallace and Wallace 2001; Li and Pitts 2009; Badia and Colosimo 2013).

The findings also confirm that students benefit more from virtual office hours than traditional office hours. This study found that the average attendance at Happy Hours was 36% of Thermodynamics classes, 29% of Fluid Mechanics classes, and 41% of Heat Transfer courses. Those sections were all 50 students or larger, proving that more students can participate in virtual office hours than traditional office hours as the virtual space has no limit on attendance (Li and Pitts 2009; Lowenthal et al. 2017; Guerrero and Rod 2013; Smith et al. 2017).

The literature review suggested that students do not attend traditional office hours because they do not know how to capitalize on the benefits, and they feel that they cannot attend unless they have a specific question to ask (Smith et al. 2017). The virtual office hours analyzed in this paper (Happy Hours), combat this problem by providing a structure for every session where students are given the problems ahead of time and are then solved as a group during the session. Students know exactly what will be covered ahead of time and have a chance to formulate their questions before the session. If students are not able to work on the problems ahead of time, they know that they will

still benefit from attending because they can work through the problems with the group. Students found this format of virtual office hours beneficial to their learning, as the study findings reveal.

This study confirmed that virtual Happy Hours were beneficial to students' learning. Given that some students prefer in-person help, a combination of virtual office hours and in-person assistance, either through group tutoring or traditional office hours, would be effective at benefiting a larger group of the students. In conclusion, recording the patterns of variation in students' experiences and perceptions of the Happy Hours do not ensure that all students will benefit from this type of learning. It is up to the instructor to integrate the variation of students' experiences and perceptions into their curriculum. These variations can guide instructors toward proper inclusion of virtual office hours and appropriate pedagogy that can add to students' learning.

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