To Record or Not to Record? Collaborating through Conflict

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POSITIONALITY STATEMENT

We acknowledge that the authors all vary in disability status, and those disabilities represented by the authors are far from representative of the entire community. We also represent faculty, staff, and students from a wide range of backgrounds who were initially at conflict over the issues presented. Through surveys, discussions, and compassionate, active listening, we have come together to understand the concerns and needs of these varied viewpoints and come to a consensus to create this work.

INTRODUCTION

The benefits of lecture capture in university education have been a somewhat controversial topic, with numerous studies falling on opposite sides of the debate. A recent review by Banerjee carefully examined 71 peer-reviewed educational research articles, mostly in STEM fields [1]. These studies document numerous benefits of lecture capture for individual students, including improved learning, higher academic performance, better work-life balance, the ability of students to complete and understand their own notes, overcoming language barriers, enhanced student interest in lectures, support for students with disabilities, reduced student anxiety, and perceived improvements in quality of teaching. Given many of the benefits of recording lectures, and particularly for students in marginalized groups such as those with disabilities or where English is not their first language, whether or not to record lectures can be seen as an equity issue. Providing lecture recordings to all students, regardless of university-dictated accommodations on an individual student level, enables all students to easily access course materials if they need to miss class when sick or traveling and removes the need for disabled students to disclose their disability status to instructors. Given that disability status is often unreported, and thus all who may be eligible for accommodations may not be receiving them, removing the need to disclose or register to receive accommodations is particularly beneficial.

However, studies also document numerous potential drawbacks of lecture capture, including reduced lecture attendance, increased technical complexity of delivering lectures, challenges getting students to view the recordings, reduced instructor-student interaction, encouragement of superficial learning and/or procrastination, and anxiety or discomfort of some instructors about being recorded. Faculty, who often want the best for students but disagree on how to achieve that, in particular, often express concern about lack of attendance as a result of providing recordings–believing that attending lectures is what is best for their learning. Unfortunately, given that regular class attendance in and of itself is an equity issue, particularly for those with chronic illnesses and other disabilities, this practice of not recording often begs the question of "best for who or what populations?" Instructors must think about who they are including or not including by recording.

Banerjee reconciles these seemingly conflicting conclusions by carefully delineating the benefits to individual students of lecture capture as a supplemental resource (for which there is overwhelming evidence) [2] vs. the aggregate impact on class attendance and performance when students view recordings as a substitute for live lectures and in-class interaction [3]. Researchers

agree on the need for additional studies that carefully define the context in which recordings are being used. Thus, a principal motivation for this study is to better understand the impact of lecture capture in the context of our own program from a variety of viewpoints, including student and faculty perception, as well as data on lecture viewing, course performance (measured by grade), and student engagement. Our goal has been to inform decisions about lecture recording based on program-specific data rather than instructor/student intuition or extrapolation from published studies that may or may not share the same context as our program and students.

We achieved this goal through a collaborative process in which the Diversity, Equity, Inclusion, and Accessibility (DEIA) Committee worked with two student champions advocating on behalf of their peers to study and discuss the impact of recordings on students in the post-pandemic era. This process involved surveying students on the ways in which they use recordings, surveying the literature to determine the impact of recordings, analyzing data on student performance as a function of course engagement and lecture watching for courses that recorded lectures, discussing the impact of recordings on student learning at faculty meetings, and creating a recording guide for faculty that helps faculty record while honoring their differences in pedagogy. We believe this process provides a framework for other institutions to mirror when faced with disagreements in practice–a framework that is data-based, collaborative, and gives a voice to students and faculty alike.

METHODS

Students were surveyed to understand the ways in which they utilize classroom lecture recordings.

In response to personal experience and feedback from peers, an anonymous survey was developed by one of the two undergraduate student champions looking to advocate for the students within the department (Table 1). It was then deployed via Google Forms to the department's undergraduate and graduate student populations. Students were asked to share information about their class standing, use of classroom recordings, attendance habits, and identity status–including whether or not students utilize the University of Washington (UW) Disability Resources for Students (DRS) services to receive course accommodations. This data was collected for program evaluation and was determined to be "not research" by the UW Human Subjects Division (HSD).

Table 1. Survey to assess student usage of lecture recordings and impact on attendance.
Note that any question with an asterisk (*) was added to the survey after the original posting time and does not have responses from all survey participants.

Question	Response Option/Type
What is your class standing in Chemical Engineering?	● Sophomore ● Junior ● Senior ● Graduate student (M.S. or Ph.D.) ● Do not want to share
Do you use lecture recordings when they are available?	● Yes ● No ● None of my classes have had recorded lectures
Please check any personal identities you hold and feel comfortable sharing.	● English is not your first language ● Student who receives UW DRS accommodations ● Student who does NOT receive UW DRS accommodations ● Impacted by chronic illness and/or mental health concerns ● Deaf, Hard of Hearing ● Long commute (more than 30 mins to campus) ● Parent or caregiver (illness of a dependent requires missing class) ● Other (fill in)
Do you use the lecture recordings for any reason other than to skip going to class in person? Note: staying home when sick or having another reason to miss lectures is a legitimate reason to not be in class, select "yes" if this is the case.	● Yes ● No, I only use them for skipping lecture ● N/A
How do you use the lecture recordings? (For example: reviewing for exams, taking better notes after class, watching at home when sick, using the closed captions feature to improve understanding, etc.)	Open-ended response
Is there anything else you'd like the department faculty to be aware of regarding lecture recordings?	Open-ended response

Are you more likely to miss class if you know a recording will be available?*	● No, my attendance is not impacted by recording availability ● Yes, I don't skip classes without reason, but I am more likely to stay home when sick if a recording is available ● Yes, I skip class when I know I can view the recording ● Other
Are there other things professors could do to make classes more accessible to you?*	Open-ended response
If you skip class (without a specific reason like missing a bus or staying home when sick), could you please share why?*	Open-ended response

Quantitative and qualitative survey data was analyzed across all student responders independent of class standing. For qualitative questions, responses were analyzed by binning responses into categories based on theme and summing the number of responses in a given category.

Student lecture recording usage data was collected from Panopto for undergraduate students in four core courses and analyzed across their course performance and, when available, course engagement.

Data on each individual student's views and downloads for individual recordings, as well as total view time across all recordings (in minutes) was collected using the university's licensed recording software, Panopto, which automatically catalogs this data. This data was downloaded from Panopto for the courses shown in Table 2, all of which utilized lecture recordings that were widely available to all students regardless of accommodation status. For courses conducted recently (Fall 2023), course instructors were asked to rate students on an engagement index, where students were categorized as either High, Medium, or Low engagement (or Indeterminant if insufficient information available to determine a category). Faculty were given the following guidance for determining the engagement index for each student (Table 2).

Table 2. Engagement index category criteria given to faculty in determining individual student engagement level.

Engagement Index Category	Features
High	The student often or most times did a combination of the following: attended class, attended office hours, asked questions on Slack/Canvas/email, or otherwise engaged in the course actively. For example, a student who attended class every day or a student who attended class most days and often attended office hours; or a student who didn't attend class often but for reasons due to illness, disability, or other reasonable conflict and was otherwise highly engaged via effort or offline mediums.
Medium	The student sometimes engaged in ways listed in the High category, but was inconsistent.
Low	The student infrequently engaged in ways listed in the High category, such that they were highly unengaged in the course. This can include having missed many assignments/homework/quizzes/exams, rarely attended class and office hours, and did not seem to put significant time toward the course.
Indeterminant	Do not remember/cannot determine with the information/knowledge available.

This portion of the research study was assessed by the UW's HSD and determined to be human subjects research that qualifies for exempt status (STUDY00019504). Data was collected from four undergraduate core courses that took place between Winter 2023 and Fall 2023 (Table 3). The student performance and engagement indicators were determined independent of recording data and later matched with recording viewing data. Note that at our institution, students earn a GPA score for each course on a scale of 0.0 to 4.0, with increments of 0.1, where a score of 0.0 indicates below a 50% in a course and thus failing, a score from 0.7 to 4.0 is considered passing and maps onto individual course percentage as dictated by the instructor, and scores from 0.1 to 0.6 cannot be earned.

Table 3. Courses that utilized lecture recordings and collected Panopto, course performance, and (when available) engagement-index data.

Course and cohort	Quarter	Number of Students	Panopto Data	Engagement Index Data	Course Performance Data
Undergraduate junior core course	Winter 2023	57	Yes	No	Final GPA grades
Undergraduate junior core course	Fall 2023	81	Yes	Yes	Final GPA grades
Undergraduate senior core course	Fall 2023	57	Yes	Yes	Final GPA grades
Undergraduate senior core course	Fall 2023	58	Yes	Yes	Final GPA grades

Recording-usage survey data was shared with the department's DEIA Committee and with faculty broadly at a faculty meeting.

Once the recording-usage survey data was collected, this data was presented to the department's Diversity, Equity, Inclusion, and Accessibility (DEIA) Committee to highlight the overall findings and their specific relation to learning equity issues. A faculty member was then tasked with determining what engineering education research literature indicated about the benefit of classroom recordings on student learning and impact on attendance, as this is the primary concern for faculty who are hesitant to record their lectures. A summary of these findings was then paired with the summary of the survey data and presented to the department faculty at faculty meeting.

A recording guide was created to facilitate faculty adoption of classroom recordings independent of teaching style.

After broader discussion of the survey results with faculty members, a document was created with summaries of the various student uses of classroom lecture recordings and benefits on learning, summaries of research literature findings on classroom recordings, and detailed instructions on how to share and create lecture recordings catered to individual instructor teaching style. The document was created and endorsed by members of the DEIA Committee, and sent to the department faculty broadly.

RESULTS

After large numbers of students expressed a strong desire for classroom recordings, we as a department, and specifically the DEIA Committee, set out to understand how students are using recordings, what impact the use of recordings has on their attendance based on course data, and to use these findings in combination with literature findings to come to a consensus as a department as to whether or not to implement recordings in our engineering courses. First, we ran a department-wide recording-usage survey, in order to understand how students use recordings.

Recording-usage survey data is representative of the undergraduate population and a wide range of personal identities.

The majority of students who filled out the recording-usage survey were undergraduate students (Figure 1) spanning sophomores (n=29, 35% of department sophomore population), juniors (n=42, 79% of department junior population), and seniors (n=33, 61% of department senior population). Few graduate students (n=3, 3.5% of department graduate population) responded to the survey, and one student opted not to share their class standing. Thus, all data was analyzed together in aggregate across student populations.

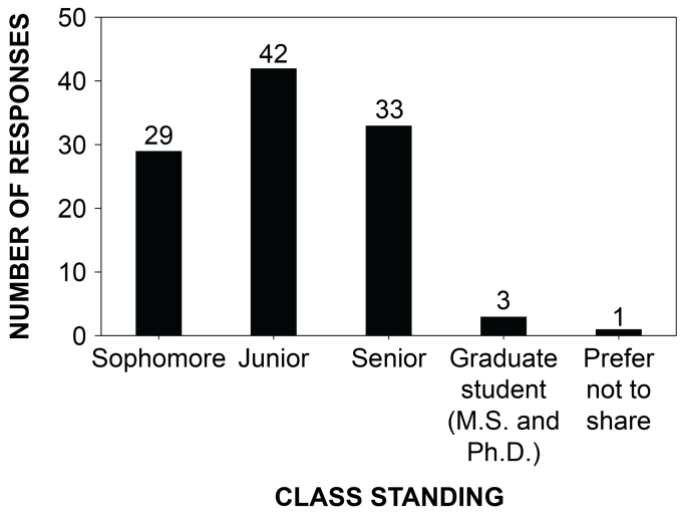

Figure 1. Recording-usage survey responder self-identified populations within department.

The students who filled out the survey were asked to select all of the personal identities they hold that might impact their course engagement and were found to span a range of these identities (Figure 2). Of the total survey respondents (n=108), the largest identity groups were students who indicated that English is not their first language (n=27, 25%), students impacted by chronic illness and/or mental health concerns (n=26, 24%), and students with long commutes of 30 or more minutes to campus (n=30, 28%). Of note, though the majority of students indicated that they do not receive UW DRS accommodations (n=59, 55%), 14 of these same students indicated that they are impacted by chronic illness and/or mental health concerns. This finding means that only 46% of the students who indicated that they have a chronic illness and/or mental health concern, and thus may be eligible for disability accommodations, are actually receiving accommodations. Common accommodations for students with these disabilities include being allowed to record lectures if they are not provided or utilize extended test time. Multiple studies have shown that students frequently hide their need for accommodations and decline to or delay activating accommodations [4]. Additionally, case law shows a pattern of students being denied their accommodations in higher education environments [5]. These studies may provide insight into student decision to not seek accommodations even when eligible, and our survey results suggest that similar trends could be occurring in our institution.

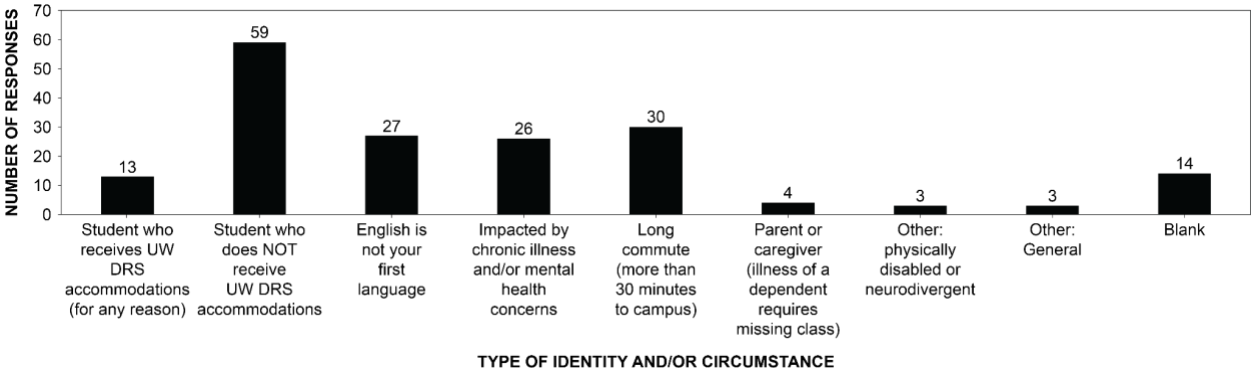

Figure 2. Student self-identified identities that could impact their course engagement. Student identities and/or circumstances selected from a list of options with the ability to specify other identities of importance to them. Students were able to select all identities that applied.

Many students use classroom lecture recordings and few believe they solely use them to skip lectures.

We also sought to understand what fraction of students utilize lecture recordings. The vast majority of students (n=103, 95%) indicated that they use classroom lecture recordings, which is 97% of students who had lecture recordings available to them (Figure 3A). Additionally, the vast majority of students (n=101, 94%) indicated that they use the lecture recordings for reasons other than to skip going to class in person (Figure 3B). As many faculty are concerned about the impact of making lecture recordings available on student attendance, this data is reassuring that students do not believe they actively make decisions on whether to go to class based on recording availability.

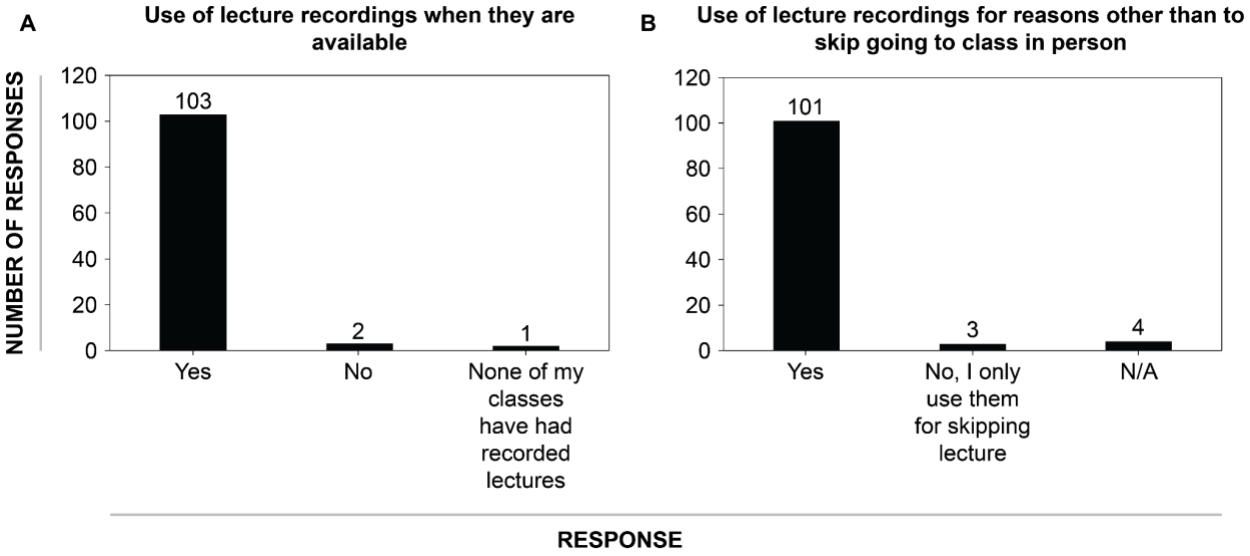

Figure 3. Student use of classroom recordings and impact on attendance. A) Number students who utilized lecture recordings. **B)** Number of students who use the lecture recordings for reasons other than to skip going to class in person.

To further assess the impact of recording availability on attendance, a survey question was later added to the survey after its initial release to understand if students are more likely to miss class if a recording was available (Figure 4). Within this response, students were asked to indicate if their choice to skip class was with or without valid reason (such as illness). Note that about half of the total survey respondents (n=55, 52%) did not have access to this question and thus it was marked as blank (unavailable). Of the students who did have access to this survey question (n=53), most students indicated that either their attendance is not impacted by classroom recording availability (n=22, 42%) or that they do not skip class without a reason but are more likely to stay home when sick if a recording is available (n=26, 49%), while few (n=4, 7.5%) indicated that they skip class when they know they can view the recording. This further indicates that students believe that their decision making on whether or not to skip lecture without a definitive reason is not impacted by recording availability. In fact, recording availability helps students make safe, responsible decisions about whether or not to attend class when ill, which helps prevent spread of disease and benefits the broader community. One student noted in the

survey, "*If UW really wants to encourage students to stay home when sick, I think it really needs to make the at-home class experience as analogous to in-person class as possible. I don't usually think of myself as a sickly person, but since starting this major I've been ill relatively often, and it is stressful enough trying to rest while also not fall too far behind on work (because even with deadlines pushed back to accommodate, letting work slide leads to hell later) while knowing I'm missing valuable class content. I think UW cannot have it both ways: if it wants to encourage students to care for their health and the health of others, it needs to support students in being able to stay as much on top of things as possible even when they are sick. Recordings are a really valuable part of that.*" This comment highlights the inherent conflict universities often present to students by asking them to take care of themselves and others while in college, but not providing them with the resources to do so without compromising success in their classes.

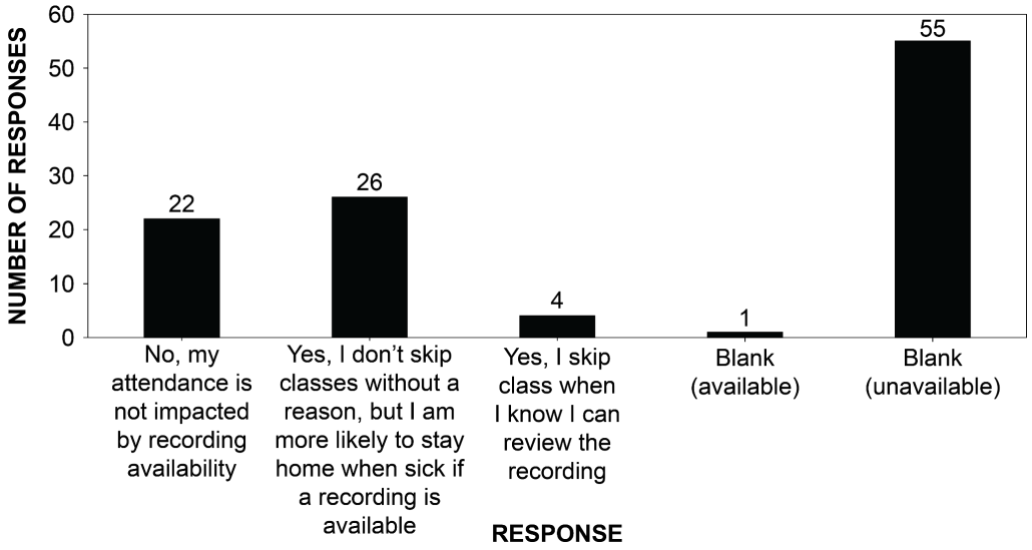

Figure 4. Impact of lecture recording on student decision to go to class. Note that about half of the total survey respondents (n=55, 52%) did not have access to this question and thus it was marked as blank (unavailable).

To further understand the reasons that students skip class, we asked students in a qualitative survey question to share why they skip class (without a specific reason like missing a bus or staying home when sick). Students could provide multiple answers to this question, and the question did not limit students to provide reasons only when recordings were available. Though this survey question was only available to about half of the total survey respondents (n=56, 52%) as it was added after initial survey release and half of those it was available to left it blank (n=27, 50%), a wide range of responses were provided by those who responded and binned into categories. Some of the more common reasons included limited time due to other work (finishing other assignments, studying for exams, etc.) (n=6, 11%), not feeling as if attending is worth it (teaching style doesn't work for them, distracting environment, etc.) (n=3, 5.6%), sleeping in (n=4, 7.5%), or having a long commute and choosing to not go to class (n=2, 3.8%). These reasons all indicate that students are making value assessments on class versus other demands on their time, including other classes. For example, one student indicated that "*sometimes I have to prioritize classes over one another depending on midterm and final schedule so its [sic] nice to be able to still watch a video,"* while another student noted that "*Because my commute is 1.5 hours (one way), I will sometimes want to watch a recorded lecture to save time. This is*

especially the case if I only have one class that day." Even for the students who may be choosing not to go to class due to lack of value, it is not always lack of value in the content, but perceived lack of value in the time spent in class compared to being able to go through the same content in a different manner. For example, one student noted that "*Sometimes it's better to go at a different pace than the lecture is at. I get distracted when the professor talks too slow or need to rewind when it's too fast, so having a recording is sometimes more helpful than going in person."* Not all students are necessarily able to learn equally well in the standard classroom environment, but it does not mean that they do not want to engage with course content. In alignment with this, another student noted that "*videos also allow students to learn in different models beside the "standard" creating inclusivity."*

Meanwhile, many other students responded to the same survey question with reasons that indicated absences outside of their control, such as sickness and/or mental health concern (n=6, 11%), travel issues such as long commute/missed bus/inclement weather that prevents travel (n=3, 5.7%), travel for academic events (conference, graduate school interview or visit weekend) or extracurricular conflict (n=2, 3.8%), or family emergency (n=2, 3.8%). For example, one student importantly noted that "*some factors that would prevent me from coming to class are personal family issues (i.e. having to stay home to assist relative [sic] when they are sick). Sometimes it is just due to mental health. This needs not to be underestimated. Sometimes it is just hard to get out of bed and attend class.*" This student highlights an important reality that students face–that the timing of class is not always compatible with their challenges with their personal lives and mental health, and these mental health challenges in particular have only increased since the start of the COVID-19 pandemic [6]. Overall, we believe these data indicate that students believe the reasons that they skip class are often independent of recording availability, as these reasons, both within and beyond student control and/or ability to manage time properly, exist across all classroom settings.

Students utilize recordings to support and improve their learning and further engage with course content.

To further understand the ways in which students utilize classroom lecture recordings, we asked students to provide all the ways in which they utilize classroom recordings in an open-ended question and binned responses by category (Figure 5). Students reported that they primarily use lecture recordings to edit or fill in partially missed lecture notes even after attending class (n=63, 58%), review lecture notes to master material or improve understanding (including the use of closed captions) (n=53, 49%), review for exams or quizzes (n=45, 42%), catch up when sick or otherwise unable to attend lecture (n=45, 42%), and to help with homework (n=14, 12%). Given that the greatest response was to edit or fill in partially missed lecture notes despite attending class, this indicates that a large number of students believe they are using both in-person attendance and lecture recordings to support their learning. Some of the reasons students cited for needing to edit or fill in lecture notes included the instructor writing faster than they can keep up with, picking up details they missed such as things the professor said but did not write, and correcting mistakes in their own notes. For example, one student noted that "*I will review my notes to make sure I wrote down everything I needed to. Sometimes the professor writes too fast and I need to add to my notes,*" while another noted that "*Sometimes you don't remember the context for your notes and looking back at the lectures is really helpful. Also I think that I would*

retain more information if I could rewatch the lectures as there is a lot of material that would need to be covered." Two students (1.9%) even indicated that they prefer to go to class and listen to the professor and use the recordings to take notes later, indicating that they use the recordings to engage more deeply and listen more actively during in-class time. Overall, students believe they are using lecture recordings to enhance their understanding of material and support assessment completion and performance, indicating that recordings provide significant pedagogical value independent of student identity.

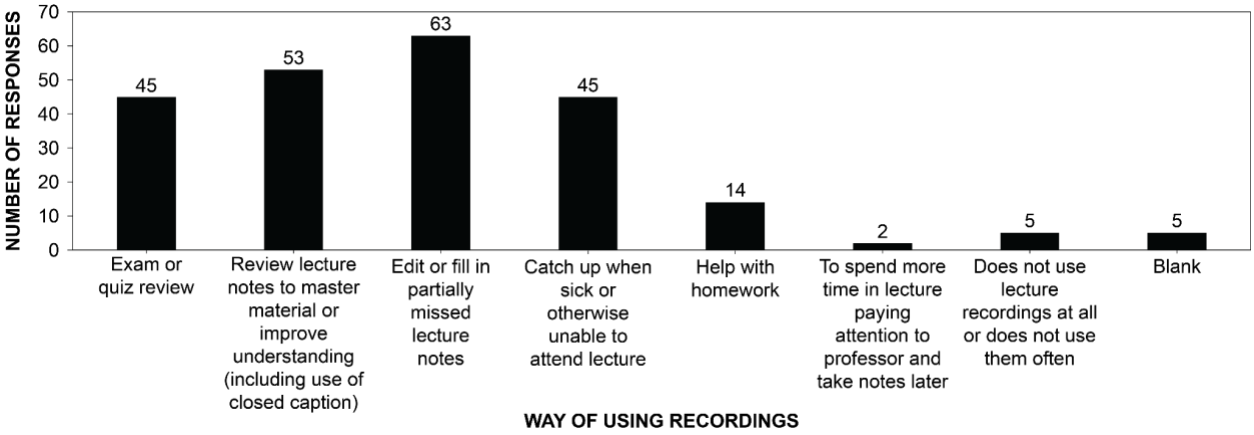

Figure 5. Students use classroom recordings in diverse ways to engage with course content. These categories were created by assessing, summarizing, and binning student qualitative survey responses, and most students indicated more than use of lecture recordings.

Recordings are a learning resource for all, but are particularly important for students with disabilities as they support an equitable learning environment.

The recording-usage survey elucidated the many ways students believe they are using recordings, as well as many reasons students may be unable to attend a lecture, such as caring for relatives, illness, wage-earning employment, and long commutes; however, it also underscored the positive impact of lecture recordings on disabled students. Several of the qualitative comments elucidated how recording availability impacts some disabled students' ability to learn and/or attend class.

Nearly a quarter of the students surveyed (n=26/108, 24%) reported having a chronic health or mental health concern that impacts their learning ability in a traditional lecture setting. Students with chronic health concerns and physical disabilities may be forced to stay home and miss class more often than those without these disabilities as a result, as one student noted that "*Recorded lectures are great for people with disabilities that force us to stay home sometimes!*" Another student noted that "*Recorded lectures is one of the strongest accessibility resources for me as someone who requires DRS accommodations. It gives me a strong opportunity to succeed especially because my disability does prevent me from attending more than some days.*" The quantitative survey data showed that students are more likely to stay home when sick if recordings are available, and this was echoed in the qualitative data, as one student noted "*I do think that for the classes there aren't recordings for, I am more likely to show up for when I am not feeling well (feverish, coughing, headache, etc.).*" Meanwhile, students who choose not to come to class sick to keep others from getting sick noted that *"...in each of the last three*

quarters I've fallen ill for weeks at a time. In the last two quarters, I had classes where I was, in effect, punished for it. I was able to catch up in courses that recorded lectures, and I was never able to catch up in the courses that didn't. However after the fact, all my courses suffered from my falling behind in one. I have to say, I'm sick and tired of being punished for falling ill." Not only are students without these disabilities feeling punished for making the decision to protect others from illness, but students who are already susceptible to increased risk of illness may be reluctant to attend class even when healthy if they expect their classmates to be ill and in class. As one student summarized, "*It takes a lot of stress off the shoulders of students with busy schedules or difficult lives to have access to classes they might have to miss due to other circumstances.*" Practices that encourage all students to stay home when sick make the classroom setting more inclusive for healthy as well as immunocompromised and/or chronically ill students.

Access to lecture recordings enables students to repeat or clarify information multiple times, if needed, to digest critical information in a setting more conducive to their individual needs; and the survey showed how this way of engaging with course material may particularly benefit students with learning or physical disabilities. One student with learning disabilities noted that *"…access to recordings is being treated as a privilege students have to earn by attending, rather than a resource. This also punishes students with learning 'differences' or learning disabilities, because those who would benefit from the ability to review lectures are being denied the resources. In my case I have one, possibly two learning disabilities…"* Whether students have a disability or not, one student noted that "*Having lecture recordings in the digital era improves the accessibility of learning materials and IMPROVES engagement instead of demotivating engagement. A good lecture attracts students regardless if recording is provided. Lecture recordings also accommodates different learning styles.*" Physical disabilities can also impact student engagement with courses, learning, and use of lecture recordings. When asked how students use recordings, one student responded *"For note taking. I can't write very well due to disability."* Students with hand-mobility impairments or other physical disabilities that make note-taking hard can use the recording to review and update notes at a later date and pace of their choice. This benefit of lecture recordings can be extended to students with other types of physical disabilities not captured in the survey–such as mobility related disabilities that make class access and attendance challenging.

We also note that per the self-reported identity data in the survey, these identities or challenges in learning can be intersectional and compounding. Many student respondents indicated more than one identity that can impact their ability to engage with course material. Students may be able to keep up in courses without recordings if they miss the bus 1-2 times in a quarter or are sick for 3 days, but a neurodivergent student who has a long commute and an illness may experience a compounding effect on the ability to attend class and derive the desired educational benefit.

Students recognize that recordings provide a resource for all, and advocate for this resource on behalf of themselves and their peers, including identifying recording availability as an accessibility issue. One student requested that faculty "*Please make them available whenever possible, they're a great modern addition to the classroom environment and some of my peers are struggling significantly more in classes where they aren't present due to scheduling/commute*

conflicts." Another student noted that "*Not to be rude or anything, but why is recording classes such a hot topic? It makes the classes more accessible to students, and it's really not an excuse for skipping lectures (at least for the vast majority of students). We have it as difficult as possible, so implementing this one small thing honestly shouldn't be that controversial.*" These quotes highlight how students are pleading with faculty to record lectures to support both accessibility and learning.

Overall, one student summarized the advantages of providing lecture recordings as a resource to all in the survey: *"I strongly believe that lecture recordings should be standardized within the department. Many students rely on these resources to refine their conceptual knowledge, work on homework problems, and review for exams. Posted lecture notes (when available) may lack critical context that is provided in-class. Recordings are immensely helpful in understanding this context; I do not believe that other resources (asking a friend for clarification, office hours, etc.) can or should act as a replacement for this function. Lecture recordings also serve as the best resource that students can access when unable to attend class due to illness. This is especially difficult with intensive and fast-paced workload often presented by ChemE courses. Again, lecture notes are often not an adequate substitute for the context provided in-class. Finally, I view lecture recordings as an inclusivity and accessibility issue. There are a plethora of good reasons a student may miss class or not take full advantage of class time. Many of these have to do with physical/mental wellness and disabilities (e.g. ADHD, hearing impairment). I believe that making lecture recordings standard policy will allow the department to better serve the diverse needs of our student body."* Students recognize that recordings support all students' learning, particularly those with disabilities.

Lecture recording viewership data seems to support student uses of lecture recordings identified from the recording-usage survey.

Based on the results of the recording-usage survey, the DEIA Committee set about trying to understand the impacts of recordings on student outcomes in the pedagogy literature. This literature suggested that individual students benefit from use of recordings, as outlined in the introduction.

Given the findings from literature and the recording-usage survey on the benefits of recording, we set out to determine how data from courses on student views of recorded lectures and engagement with courses outside of watching recordings (e.g. course and office hours attendance, asking questions on or offline, and other forms of engagement) impacted course performance.

A significant concern among faculty regarding wide adoption of lecture recordings was a belief that usage of recordings would lead to lower course engagement overall. We collected data from four courses across the undergraduate core curriculum, two junior courses and two senior courses, and tracked total individual student recording views across the quarter (in minutes) and faculty-perceived level of engagement to determine the relationship between these factors as well as their impacts on final course grade (GPA) (Figure 6).

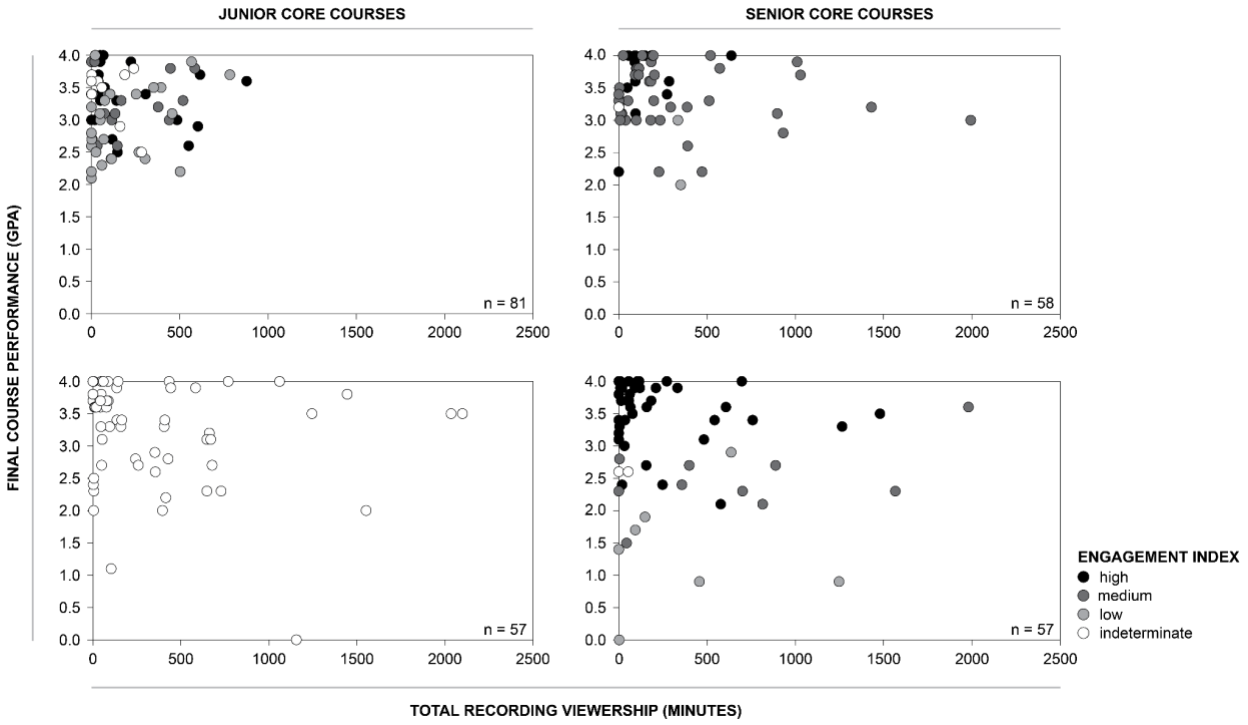

Figure 6. Student course performance as a function of total recording minutes watched and perceived engagement level across the quarter in four core undergraduate courses. Each dataset corresponds to a course in Table 3. Junior core courses are shown in the left column and senior core courses are shown in the right column. Each data point represents a student and is colored by the faculty-perceived and assigned engagement index level.

The data do not show a discernible correlation between perceived engagement or grade outcomes with recording viewership. We acknowledge that our engagement index is not a well-defined metric, as each faculty created the index using different interpretations of the given criteria, with some favoring primarily attendance while others more formally accounted for attendance along with other modes of engagement like asking questions in class and attending office hours. We also note that a more rigorous quantification of engagement would be warranted to draw more concrete conclusions, and some classes or teaching styles are more likely to see outcomes that are dependent on engagement levels. However, regardless of method of quantification by each individual faculty, engagement index levels provide at least a comparative metric within each class, and supports the conclusion that students of all levels of engagement utilize recordings, not just individuals with low engagement.

Given that students across all total viewership amounts received a distribution of grades, the data suggest that viewing recordings is not a predictor of final score. We note that without a control case of a course without recordings, we cannot draw a conclusion about the aggregate impact of watching recordings on grades overall. Nonetheless, the data provides insight about how students are making use of the recordings. Based on total viewership time (Figure 7), only a small fraction of students watch more than ~500 min (30% or fewer per course). This value corresponds to ten 50-minute lectures in total if viewed to completion (such as if students are sick for a period of time) or to small amounts of every lecture across the quarter (such as if students are filling out missed notes or reviewing concepts periodically). This observation concurs with the students'

self-reported data from the recording-usage survey that claims students do not frequently use videos as a replacement for lectures, and are instead using them as a supplemental resource for either reviewing content periodically or for watching videos during periods of acute illness in which they need to miss class. Overall, the data support the findings from the student surveys on the ways in which recordings are being used.

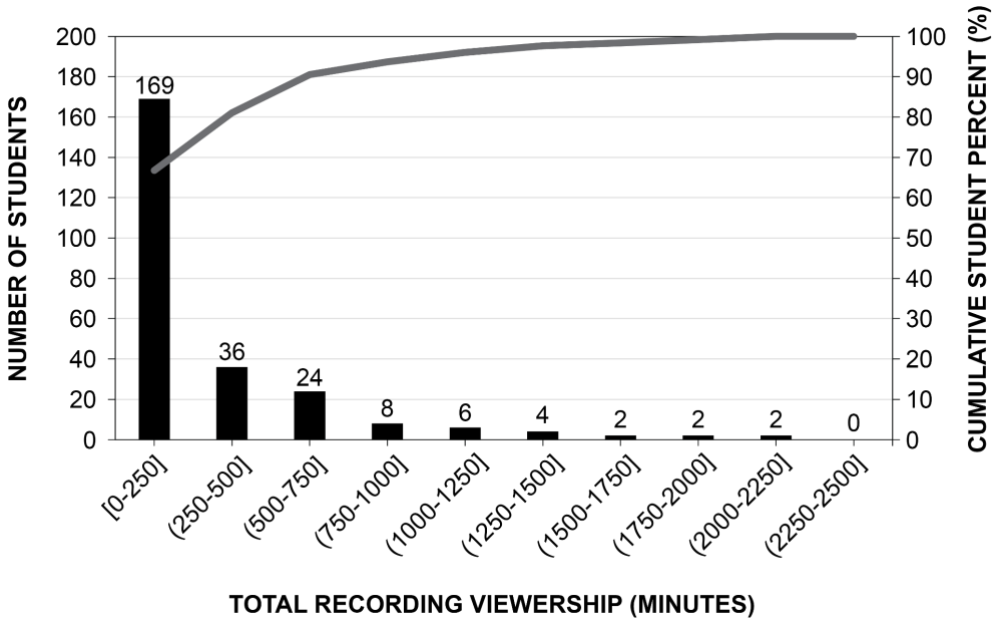

Figure 7. Total recording viewership across number of students and cumulative student percentages across all four courses. Number of students (left y-axis, black bars) binned by total recording viewership in minutes (bin size of 250 minutes). Cumulative student percent across all bins shown in gray line (right y-axis).

Importantly, we do not see a large number of low perceived engagement students watching high volumes of videos, which was the primary concern that faculty had about providing recorded videos. We believe these data are sufficient to allay the concern that large numbers of students are likely to use lecture recordings as a replacement for lecture attendance. Rather, these data are consistent with students' self-reported use of these recordings as a supplemental resource.

DISCUSSION

We developed a process of collaborating through conflict to get department faculty aligned on whether or not to create lecture recordings.

The overall process we used to guide our lecture recording policy involved a number of elements, including collecting data from students on their actual and perceived use of lecture recordings, studying the literature on the known impacts of lecture recordings on students generally, assessing the impact of this practice in our own courses, presenting this data to faculty to build consensus, and then creating tools for faculty to implement this policy effectively. We believe that together these steps comprise a useful general framework for making pedagogical decisions that actively listens to all parties and works in their best interests.

In our department, the Diversity, Equity, Inclusion and Accessibility (DEIA) Committee played an important role facilitating the conversation and moving forward action on this issue, as it had been identified as an essential access issue by students. The DEIA Committee consists of faculty, staff, undergraduate students, graduate students, and postdoctoral trainees, and is co-chaired by one faculty member and one staff member. The committee's charge is to advance diversity, inclusion, equity, and accessibility for the department as a whole.

When students approached the DEIA Committee with their accessibility concerns related to recording, there had already been some discussion in the committee about recordings, access, and the impact on teaching load. The DEIA Committee agreed to support student efforts to obtain more information about student recording usage and to facilitate cross-departmental conversations to promote understanding with the hope that together a solution could be reached that would be generally presumed to promote inclusion and accessibility for both students and faculty within the context of a maintained or improved educational experience.

One of the very first opportunities to impact the conversation was in the development of the recording-usage survey, initiated by one of the undergraduate student champions. Though initially intended to serve as more of a petition or view of students' desires for recording, with the support of the DEIA Committee, the survey was revised before circulation to instead more clearly address questions and concerns about educational quality, student engagement, and access with the hope that it would provide a more effective addition to this conversation than a petition may have. Through this survey, we uncovered that students viewed recordings as both a resource for all–using recordings to do things like study for exams, complete homework assignments, make up notes when ill, edit or complete notes missed during class, and generally to review material–but also as an equity and access issue in supporting students with both physical and mental disabilities and other life-related circumstances that make typical course engagement more challenging.

A critical step in the incorporation of recordings in teaching was getting agreement and buy-in from departmental faculty members. In parallel with and independent of the survey development and deployment, another undergraduate student champion played a critical role in cultivating individual faculty buy-in for supporting and providing lecture recordings and recognized the need for a tool-based solution to lower the barriers toward providing recorded lectures. This student's intersectional identities and unique life experiences and circumstances create barriers to learning in classrooms without recorded lectures. This student took it upon themself to lead conversations and share their story and background with individual faculty members one by one to express the importance and impact of recordings to not only themselves, but to all students with diverse needs, circumstances, and ways of learning. These conversations not only helped cultivate empathy and understanding, but helped reveal barriers and resistance to faculty providing lecture recordings.

As a result of conversations with this student champion and relaying of these discussions to the DEIA Committee, it was decided early in the development process that faculty support would require that recordings (a) be something the students expressly and strongly wanted, (b) were pedagogically beneficial to student performance, and (c) were sufficiently easy to implement, such that faculty would not be excessively burdened in implementing them. It would also be

necessary to overcome reticence among a small group of instructors, who either did not philosophically believe that recordings provided a sufficient benefit to justify the additional effort or who believed recordings were an active barrier to promoting a positive educational experience for engineering students, such as by discouraging attendance. While the recording-usage survey expressed the student desire for recordings, we still needed to address the second two criteria.

As a next step, the DEIA Committee determined it was necessary to investigate the current literature findings on the impact of recordings on student learning, whether a benefit or a detriment, and compare these findings to the survey data. In order to accomplish this, the DEIA Committee identified a committee member with an interest in engineering education who was among those highly skeptical of the educational value of recording. This faculty member was initially quite concerned that recording live lectures using tools like Zoom and Panopto could have a detrimental impact on students based on research focused primarily on flipped classrooms. DEIA Committee leadership asked this faculty member to complete a brief literature review of lecture recordings and to provide a pedagogical perspective to the conversation.

A DEIA Committee meeting was dedicated to the topic of lecture recordings and the agenda included presentations from the undergraduate student champion and organizer of the survey and our faculty member completing the literature review. It was at this point that the faculty member who conducted the review stated that the literature collectively showed little to no impact on attendance from lecture recordings while providing a clear educational benefit. Combined with the very high student response rate to the surveys and the compelling responses, as well as the recording data from courses in our department that supported the findings from the recording-usage survey, the DEIA Committee then determined that the path forward should be in communicating these results to our broader faculty group and moving forward with identifying ways to eliminate or reduce barriers to recording for faculty members.

The faculty involved in this investigation were then invited to present their research at an all-department faculty meeting to build consensus and support from among the entire faculty. Before this meeting, leaders of the DEIA Committee and one of the undergraduate student champions engaged in individual conversations with several faculty to incept early buy-in. At the faculty meeting, the recording-usage survey data was then able to effectively represent the students' interest and voices, while the faculty champion used the literature evidence that had been identified to express strong support for moving from a conversation of "whether or not" to record toward the question of "how" to record. Prior to the meeting it was anticipated that our faculty champion's data would likely provide enough support for the idea that the committee should be prepared for next steps. When that support was confirmed, the DEIA Committee announced an upcoming resource to support creation of recordings with options for different teaching styles and formats and an intention to identify quantifiable markers to test assumptions that recordings would have a positive impact on students in this department as was shown in the literature review and recording-usage survey.

We created a lecture recording guide to support faculty in supporting students while honoring differences in teaching pedagogy.

The DEIA Committee felt that reaching faculty would require proving that not only did students want recordings and would benefit from them, but also that recording could be relatively easily implemented regardless of differences in content delivery method, other teaching pedagogy, and comfort level with technology. Inclusive teaching pedagogy indicates best practices for creating equitable classrooms and learning environments, however not all faculty can readily adapt their classroom practices to match these practices nor do all practices necessarily align with their teaching pedagogy. It requires significant time and effort to implement some of these changes, and the burden of this additional work can be particularly high for those who are not comfortable with or do not actively use modern technology in their teaching. Though we successfully got faculty to see the benefits of classroom recordings, we wanted to minimize additional teaching burden on faculty by creating a how-to guide that enables faculty to learn how to record their lectures in a way that does not require they change their original lecture delivery format (i.e. writing on a white board, using PowerPoints, writing on a tablet).

The recording guide provides faculty with a summary of the benefits of classroom recordings for both faculty and students, of what engineering education literature says about student use of classroom recordings, and the findings from the recording-usage survey. Although the benefits of lecture recordings for students have been outlined in this paper, there are many benefits for faculty as well. These include the ability to meet a multitude of federally mandated student accommodations simultaneously and with reduced effort, manage fewer individual decisions regarding when and how to disseminate missed information (e.g., sick day requests, travel requests), create a more equitable and accessible classroom and learning opportunities, removing pressure on students to attend class when sick, and create a library of recorded course material, which can be useful to instructors when they need to miss class themselves (e.g., due to travel or sickness).

Subsequently, the guide provided faculty with a visual flowchart to enable them to decide how to share recordings with students and with which students (Figure 8). The first decision faculty often need to make is whether or not to share recordings with all students independent of whether or not they have university-approved accommodations or limit the recording availability to only students with approved accommodations. Once faculty decide on who to share the recordings with, detailed instructions on different methods by which to do so, including use of learning management systems (LMS) like Canvas or through YouTube. Each option outlines the technological or other material requirements of the method, steps to execute it, pros and cons of the chosen method, considerations, and a rating of technical complexity and expected time/effort on scales of high-medium-low. While the choice is ultimately up to faculty, our DEIA Committee highly recommends that faculty disseminate recordings to all students in the class through Canvas/Panopto (or other LMS), as this option gives students the greatest benefit, equitably benefits all students, and requires the least effort on the part of the faculty.

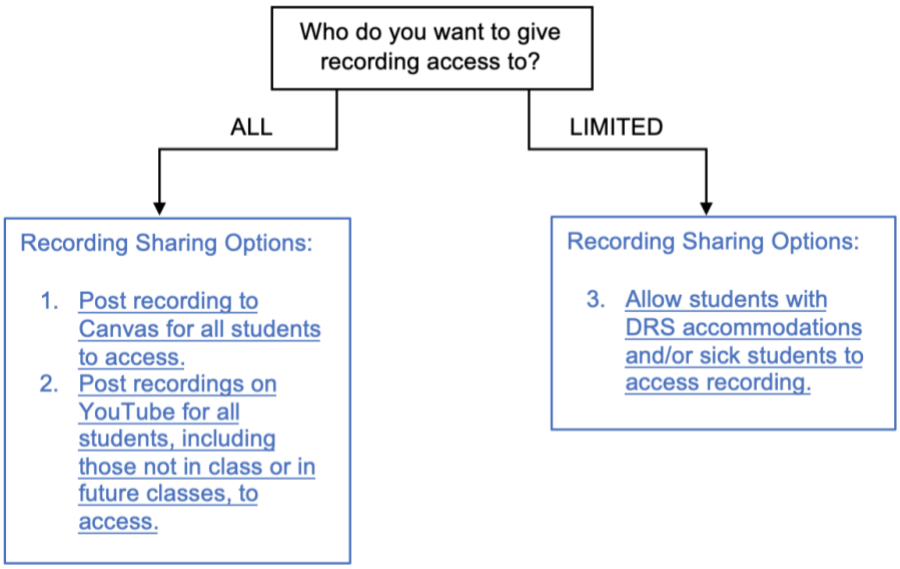

Figure 8. Flowchart indicating options for sharing lecture recordings with students.

Once faculty have decided on how to share the recordings, a decision needs to be made about how to create the recordings in the first place. Given that faculty have differing methods of delivering course content–spanning the use of black/white boards, PowerPoints, or tablets–we wanted to provide faculty with options that catered to their already in-place content delivery method. Thus, we created a flowchart that helps faculty learn how to record their lectures after accounting for whether or not faculty write on a whiteboard and if they walk around during class (Figure 9). Other options include recording lectures outside of class or customizing the recording to accommodate the use of multiple screens (such as if you want to alternate between writing notes on a tablet and showing programs such as Excel or Python on a laptop). Each option outlines the technological or other material requirements of the method, steps to execute it, pros and cons of the chosen method, considerations, and a rating of technical complexity and expected time/effort on scales of high-medium-low. The guide also includes detailed instructions for use of the associated tools such as Zoom and Panopto, including integration with Canvas. Though some of these tools are specific to what is used at our institution, the flow chart is adaptable to any instructor looking for minimally invasive ways to create lecture recordings.

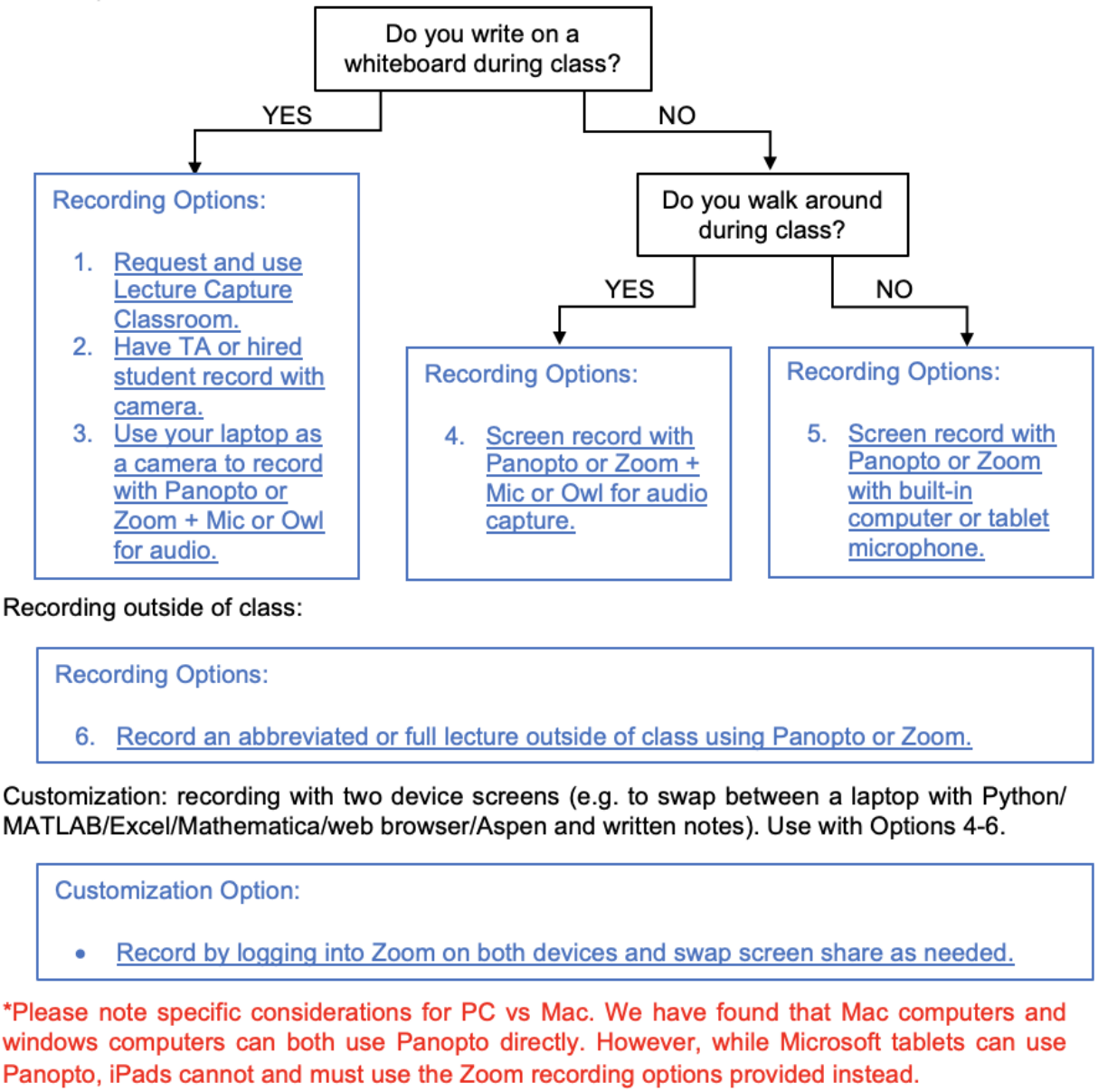

Figure 9. Flowchart indicating options for creating lecture recordings to support students within the framework of existing teaching style and content-delivery method.

With the development and dissemination of this recording guide, we hope to lower the technological barrier and burden of creating lecture recordings on faculty to encourage further adoption of this inclusive teaching practice.

We will revisit our assumptions that the reality in our specific department aligned with early data from student surveys and from our literature review.

Having now shared the lecture recording guide, we hope to gathered data to review the way recordings are in fact being created and used in the department and to share widely with department constituents as a way to evaluate the initial impact of the program, maintain

transparency, and build support for the value of engaging in change processes like this one in the future. We also hope to more formally assess the impact of recordings on student course attendance, engagement, and performance through analysis of courses with and without recordings and use this data to continue to guide improvements.

CONCLUSION

There are many institutional barriers to inclusion and access in traditional university spaces. These issues contribute to well-documented and persistent representation gaps, particularly in engineering, and it is often difficult to find solutions that fit within or can break beyond the constraints of institutional hierarchies, policies, and traditions. In this paper, we document the process that our department used to identify a need, build consensus among multiple stakeholders, take action, and then continue to evaluate. In this case, the need was to improve access to our undergraduate core courses. We identified and shared multiple sources of data supporting the benefits of supplemental lecture recordings, enabling us to quickly reach consensus. We then shifted our focus to the development and implementation of a tool to ensure lecture recordings were possible to deliver in a wide range of teaching styles and gathered data that confirmed the educational value of lecture recordings and lack of correlation between engagement and use of lecture recordings.

In our program, students use these lecture recordings extensively irrespective of their level of engagement or academic performance. Students themselves shared diverse reasons for using recordings and ways of using recordings, and the quantitative recording viewership data clearly supported student assertions that recordings were primarily being used as a supplemental resource and little evidence was found for students using recordings as a replacement for attending class, as faculty had feared. Furthermore, students with diverse identities and circumstances identified lecture recordings as an important tool for improving equity and access. In addition to providing valuable data on our department's decision-making and experience of implementation of lecture recordings, we hope this case study serves as a model, both for ourselves and for other departments, for achieving continuous improvement in diversity, equity, inclusion, and accessibility.

AUTHOR CONTRIBUTIONS

ERC conceived of the recording-usage survey. ERC and NM co-developed, co-deployed, conducted initial analysis of the survey and presented the findings to the DEIA Committee, which includes Co-Chairs NM and DSB and members ANP, SA, and KLB. Simultaneously, KLB cultivated buy-in for recordings with individual faculty through personal meetings and chaired the DEIA Universal Design for Learning (UDL) sub-committee charged with finding tool-based solutions for faculty that encourage the use of UDL principles in courses, where some members of this sub-committee ultimately helped create the recording guide. SA conducted a literature review of the impact of recordings on students and presented these findings and the recording survey findings at a faculty meeting. ANP conducted a detailed analysis of the survey, including the qualitative data. SA, ANP, and NM conceived of the Panopto recording viewership data collection and analysis, where data was collected by ANP, SA, and DSB and data was

analyzed by ANP, NM, and DSB. ANP, DSB, and SA created the recording guide. ANP, NM, KLB, SA, and DSB wrote and edited the manuscript and ANP created the manuscript figures.

ERC and KLB are co-first authors of this paper. ANP and NM are co-corresponding authors of this paper.

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REFERENCES

[1] S. Banerjee, "To capture the research landscape of lecture capture in university education," *Computers & Education*, 160, 104032, Jan. 2021, doi: 10.1016/j.compedu.2020.104032

[2] Leadbeater, W., Shuttleworth, T., Couperthwaite, J., & Nightingale, K. P. "Evaluating the use and impact of lecture recording in undergraduates: Evidence for distinct approaches by different groups of students," *Computers & Education, 61,* 185–192, 2013, doi: 10.1016/j.compedu.2012.09.01

[3] Edwards, M. R., & Clinton, M. E. "A study exploring the impact of lecture capture availability and lecture capture usage on student attendance and attainment," *Higher Education, 77,* 403-421. 2019, doi: 10.1007/s10734-018-0275-9

[4] Evans, N.J., Broido, E.M, Brown, K.R., Wilke, A.K. *Disability in Higher Education: A Social Justice Approach*. Jossey-Bass, 2017, pp. 267.

[5] Evans, N.J., Broido, E.M, Brown, K.R., Wilke, A.K. *Disability in Higher Education: A Social Justice Approach*. Jossey-Bass, 2017.

[6] McLafferty, M., Ward, C., Walsh, C.P., O'Neill, S., Bjourson, A.J., McHugh, R., Brown, N., McBride, L., Brady, J., & Murray, E.K. "College Student Mental Health and Wellbeing Prior to and during the COVID-19 Pandemic". *Educ. Sci., 13,* 1154, 2023, doi: 10.3390/educsci13111154