# Student-based Recommendations to Increase Accessibility in Undergraduate Engineering Programs: "If there's people who can't access it, then it's not accessible."

Emily Landgren
Walker Department of Mechanical Engineering
University of Texas at Austin
Austin, TX, USA
emilyland@utexas.edu

Maura Borrego
Walker Department of Mechanical Engineering
University of Texas at Austin
Austin, TX, USA
maura.borrego@austin.utexas.edu

***Abstract*—This research paper explores what disabled students, both those with and without formal accommodations, want from their schools and instructors to better access their education. This work describes a range of barriers to equitable access to education, as experienced by undergraduates in their engineering classes. Additionally, it formalizes disabled engineering students' recommendations for university systems and instructors to ease the burden the students face.**

## I. INTRODUCTION

The population of college students with disabilities is rising each year [1], yet, disabled voices are largely absent from the literature, so it is important to understand disabled students' experiences in engineering [2]. STEM disciplines in particular are less accessible due to norms and curriculum requirements. Frequent examinations, expectations for group work, and an emphasis on hard work [3, 4] in STEM all decrease disabled students' access to education. Unavoidable course requirements, and sometimes instructors that teach them, are prevalent in STEM degrees, especially engineering [5]. Between norms and degree structure, STEM courses often offer less flexibility.

Another major challenge for college students with disabilities is navigating an onerous process to attain formal accommodations [6]. A higher education institution's compliance with federal laws related to access for students with disabilities is typically delegated to a disability resource center (DRC) with which students must provide documentation and register [7]. DRC staff determine which accommodations may be appropriate, such as those focused on notes, exams, flexibility with time, and space. Students must then meet with each instructor each semester to request and adapt such accommodation to each of their courses [5]. Thus, much of the burden of acquiring accommodations is on students [6], even though meeting students' needs is invaluable to student success.

To expand disabled students' representation in the literature, this study gathered experiences from both those registered and not registered with their university for accommodations. The current study found that regardless of accommodation status, students faced barriers to access their education – some of these barriers were the same for those with and without accommodations, and others were very different. Both groups faced difficulty conversing with instructors and getting critical needs met, like access to recorded lectures. Students also witnessed and experienced ableism regularly [8], which often discouraged them

from asking for support, a finding that was similarly supported by Goodwin [9]. Some accommodations frequently failed, like the peer note-taker accommodation, which prevented registered disabled students from utilizing resources that the university agreed they need to succeed. This supported the data that there is a measurably lower chance of disabled engineering students using their accommodations compared to their non-STEM peers [10]. Students without accommodations had to decide which supports were most crucial to request from instructors beyond those supported and enforced by the university.

### *A. Lenses*

This study utilizes several lenses during data synthesis: Universal Design for Learning, ableism, and bottlenecks. Universal Design for Learning (UDL) is the practice of designing learning to be accessible to all (or most) students by removing barriers from the learning environment [11]. UDL recognizes that while it is unlikely individual accommodations can be eliminated entirely, application of UDL principles can significantly decrease the need for individual accommodations**.** Ableism is a series of structures, norms, and interactions rooted in marginalizing those with mental, physical, or other perceived differences from the non-disabled norm [2]. Ableism was especially pertinent in our prior analysis of these interviews [8] and informs how the struggles that disabled students face are created at systemic and social levels. By changing the norms and structures that pose additional challenges for students with disabilities, UDL is a direct response to ableism. We also used bottlenecks to view how disabled participation in engineering was limited. A lens of bottlenecks brings into focus how power, privilege, and oppression create a slimmer structure of opportunity for those, including students with disabilities, who need different support to reach normative outcomes. These restrictive opportunity structures can be societal and institutional, in the same vein as ableism. Viewing ableism as a bottleneck illuminates the ladder of barriers disabled students have to climb to succeed [6].

We, the authors, typically take a social view of disability in presenting information for engineering instructors to change their practices to be more accessible to all students. A social perspective of disability defines disability as a consequence of inaccessible environments, rather than an inherent problem in individuals. In other words, the environment is disabling, which in this case is the classroom and administrative system of obtaining accommodations. Instructors can use the insights gained from these interviews to develop awareness for accessibility in the classroom beyond formal accommodations and become aware of the ways formal accommodations fail to remove all barriers. Student interviews informed this paper's recommendations to improve their access to education, especially when implemented together. Recommendations include both instructor- and administrative-level supports.

## II. METHODS

### A. *Positionality*

Both authors hold engineering degrees and identify as white, disabled women. The first author, whose disability affects her cognitive function, energy, and mobility, is working towards a graduate engineering degree. This research came to fruition out of the frustration we felt after the first author experienced numerous barriers to accommodations and faculty support during her first year of graduate school. We are motivated by this experience to increase accessibility in engineering education for disabled students, and by extension, all students.

B. *Recruitment*

Participants for this study were recruited by flyers and department announcements at a Southwestern public university's engineering school. Interested students completed a screening survey, and those who were engineering students and identified as disabled, qualified. Ultimately, eleven interviews were conducted with a mix of students registered and not register for formal accommodations. This was an intentional decision to understand the experiences of students with and without formal accommodations [6]. Additionally, some students who are registered no longer bother discussing them with instructors because they have been discouraged by prior experiences.

C. *Participants*

Of the 11 participants, 7 were registered for accommodations with the university, and 4 were not. Participants represented only two engineering disciplines: mechanical (n = 4) and chemical (n = 7). Most participants were in their third year or above in their degree program (n = 9). Participants' disability and accommodation status are listed in Table 1. To honor how participants identified, disability types are worded in the way participants disclosed them. A range of demographics were also collected and reported elsewhere [8] since they were not central to the current analysis, but do represent a diverse range of gender identity, sexuality, and race.

TABLE 1. DISABILITY AND ACCOMMODATION STATUS OF PARTICIPANTS.

| ***Participant*** | ***Disclosed Disability*** | ***Registered for Accommodations?*** |
|---|---|---|
| 1 | MS | Yes |
| 2 | ADHD, Anxiety, Autism, Clinical Depression | No |
| 3 | Anxiety, Depression, OCD | No |
| 4 | OCD | No |
| 5 | Chronic Neurological Condition | Yes |
| 6 | ADHD, MDD | Yes |
| 7 | Severe Anxiety, Autism, Borderline Personality Disorder, Chronic Severe Depression, Dyslexia, IBS, PCOS | No |
| 8 | ADHD, GAD, MDD | Yes |
| 9 | ADHD, Anxiety, POTS | Yes |
| 10 | ADHD, GAD | Yes |
| 11 | ADHD, ASD | Yes |

ADHD = Attention-Deficit/Hyperactivity disorder
ASD = Autism spectrum disorder
GAD = Generalized Anxiety Disorder
IBS = Irritable Bowel Syndrome
MDD = Major Depressive Disorder
MS = Multiple sclerosis
OCD = Obsessive compulsive disorder
PCOS = Polycystic Ovary Syndrome
POTS = Postural orthostatic tachycardia syndrome

D. *Interviews*

The first author conducted all 11 interviews and followed a semi-structured protocol. She disclosed her status as a disabled engineer at the beginning of all interviews. To increase access, participants were given the choice of an in-person or virtual interview. When scheduling, participants were informed that the interviewer would wear a mask to all in-person interviews. Interviews were recorded, and on average, lasted 36 minutes. Participants were provided with a list of questions in advance and asked if they had any unmet access needs both before and at the beginning of the interview. Participants were asked questions that focused on their experiences as a disabled student. Students with accommodations were additionally asked which specific accommodations they had and described the process of obtaining them. Participants without accommodations were asked why they didn't have them and to describe any barriers preventing them from obtaining accommodations.

*E. Analysis*

Audio recordings of the interviews were transcribed by GMR Transcription Services and then further edited by the first author to correct transcription errors and remove filler language. First-cycle coding resulted in three high-level codes: ableist experiences, presentations of internalized ableism, and best practices. For this paper, we decided to isolate best practices. The first author continued to code findings in best practices into four subcodes: Process Problems, Accommodation Problems, Other Problems, and Wish List. Both authors discussed emergent findings in multiple meetings and participated in writing and editing the results together.

*F. Limitations*

There are two significant limitations of this study. The first is small sample size. While qualitative research traditions inherently value focused studies in a specific setting, to generalize these recommendations, more participants would be needed to be included. Further, participants representing a wider range of disabilities, majors, and other backgrounds would help to consider transferability of recommendations. The second limitation is that this study was conducted at a single institution. Some experiences around the DRC and efficacy of accommodations may not be transferable to other institutions, which we hope have different procedures that bypass some of the issues identified in this study.

## III. RESULTS

Results are presented by the four main codes of best practices. Process Problems come from any participant, regardless of accommodation status. These discussions included how the process to obtain accommodations had too much paperwork, cost too much money, or required too much executive function. Accommodation Problems focus specifically on interviews from participants who are registered for accommodations. These students found some accommodations ineffective and, when compounded, created a more significant barrier to their overall education. Complaints about specific accommodations mainly focused on the note taking and testing center accommodations. Other Problems addresses any instructor practice or classroom norm that has limited the participants' access to their education. Lastly, Wish List is a compilation of what participants voiced would be helpful either as a formal accommodation offering, or a standard classroom practice. The most popular request was for recorded lectures

which were common during the beginning of the COVID-19 pandemic, but have recently become less common.

*A. Process Problems*

This subcode includes any problems students faced with the logistics of getting and implementing accommodations such as the diagnosis, required paperwork, or talking with professors. As Participant 11 summarized well, “most of the problems” he has experienced, come “from just the system that is set up."

1. *Getting Accommodations*
    a. *Timeline & Cost*

Participants vocalized frustration over the long wait times to get appointments with the DRC or medical appointments to receive diagnoses that qualify for accommodations, as well as the financial burden of obtaining diagnoses, which often led to even more time lost as they saved up money for medical bills.

Participant 1 was wrestling with the idea of needing accommodations, and when she finally started the process, close to the start of the new semester, she “couldn't get an [intake] appointment until a month later,” and it “was discouraging to me.” Participant 6 also agreed that “the wait times definitely… leave something to be desired.” Even Participant 8, who initially described the process as “straightforward,” recalled that the DRC “didn’t have that many available times” and when it was time for her appointment, she almost missed it because “they forgot to send... out the Zoom meeting code.” Instances like this were made more difficult by the pandemic, because remote staff meant that office phones went unanswered, and there would not be a way to reach someone quickly as mentioned by Participant 8.

When Participant 10 started the process to get accommodations in January, he was not granted any until April. In the “multiple months before I got anything – I was just hanging in the balance.” In addition to the time he waited for his accommodation appointment, he also had to wait two months prior to get tested for ADHD, for which he needed a formalized diagnosis in order to be approved for accommodations.

Not only did these wait times impact Participant 10’s access to accommodations, but he “would’ve gotten accommodations a year sooner because I was thinking about it for an entire year…but I didn’t want to get tested because of the price.” He hopes the DRC can “figure out a way to work with the school psychology department” and “add more people to the school so that more people can get diagnoses” because “I know so many people who have diagnoses or have symptoms or issues, and they don’t get it addressed either because of cost…because of all the bureaucracy – whatever.” He noted that he is already paying a significant amount of money to the university for his tuition and “shouldn’t need to [pay that much for a diagnosis] … to be able to get help.” He also believes that “there would be so many more people doing well, especially in engineering, if it wasn’t expensive, if it wasn’t time consuming to go through the process.” Participant 8 stated, “[I] genuinely think that if I did have the accommodations when I first came to college that I would not be doing a fifth year” of college to earn an undergraduate degree.

Participant 7 did not have any formal accommodations, citing "one of the major factors was I had to pay extra for the testing center to send the letter to… [the DRC]." They "remember it being over $100, and it already cost a lot to get tested." Because of this extra charge and the fact that they were "diagnosed much later" in their degree, they decided they'd rather forgo accommodations and "not deal with it and then have my grade suffer a little bit."

It is worth noting that even though participants had negative experiences with the DRC's process, it was mostly attributed to the system, paperwork, timeline, and cost. Fortunately, most participants felt supported by the DRC staff member to whom they were assigned, like Participant 6 who found that the staff "were overall pretty understanding" and wanted to help her "understand my options." When Participant 1 did not think she needed certain accommodations that were offered to her, the staff member encouraged her to accept them "'just in case later on this comes back up then you'll have it there just in case' and [the staff member said] 'at any time you notice anything is even worse, then come back and talk to us, and we can even add some more adjustments.'"

*b. Paperwork*

Even after scheduling a DRC appointment, it did not guarantee accommodations if students did not have the proper paperwork in place. Participant 10 described the process of getting accommodations as "awful."

> The way that they set up all their paperwork meant I had to go to kind of specific people that they recommended, wait for the test to be done, wait for the forms to get done – they wanted forms submitted a certain way from that particular psychologist or psychiatrist. Then, they wanted additional forms to be filled out in a very specific way. (Participant 10)

*2. Interacting with Instructors & TAs*

Another major barrier for students implementing their accommodations is having to discuss the accommodations with every instructor, every semester. Multiple participants had nearly identical comments about this step. When Participant 3 was discussing it, she exclaimed, "oh, my God, that is so stressful!" and explained that the "anxiety associated with then every step you'll have to take once you do get the accommodations" prevents her from using her accommodations. Not only does "the whole process at the start where you have to reach out to your professors... telling them about your accommodations always" makes Participant 5 "very nervous" and "fills me with a little bit of anxiety," but it is also the "the first interaction I usually have with my professor" – not her preferred first impression. "Once a professor reached out first," Participant 5 told us. "That was very nice. I really appreciated that. It's wonderful. I loved that a lot."

Participant 7 also emphasized how talking to instructors has impacted their decision to get accommodations, saying that they are "terrified of authority figures, so that's why I don't talk to professors," and it doesn't help that they "have heard some horror stories about having to defend your accommodation to the professor and…not even receiving it." When the DRC explained the accommodation process to her, Participant 8 thought it "sounded pretty daunting... getting the letter to the professors and setting up the meeting."

Not only is this process of communicating about accommodations with instructors difficult on students, but it can also be "kind of difficult for the professor" (Participant 10). Participant 10 feels that the DRC keeps "changing the way that they're doing accommodations and having to schedule stuff" which impacts the implementation of accommodations since "a lot of [instructors] don't even know that there were changes." He repeatedly identified frustration and anger as the major emotions he felt throughout the process with the DRC and believes "they could make it a lot better of an experience." He concluded this thought by sharing, "I wish that the process was [simpler]…and the departments were training their [instructors] better on [accommodations]…so I didn't have to go and do that for them," referencing a story he told about having to teach to his instructors how to submit tests to the testing center, which in turn created even more work for him as a disabled student. Participant 7 also believes "professors need to get trained on how to approach accommodations and just kind of accept them. There are clear accommodations that students can get, and for you to be like, 'No, that's not fair,' that's not for you to debate. That's just what it is."

A few participants also identified gaps related to Teaching Assistants (TAs), which are commonly used in the undergraduate STEM courses at a large institution like this one. Participant 5 noticed that there is "no communication there between the professors and the TAs [about accommodations]," and "there's no official way you're supposed to reach out to your TA." It is unclear if "you're supposed to talk to your TA about that or anything.... And for things like labs where you never see your professor at all, I don't really know what you're supposed to do." When she has approached TAs, they tell her to discuss it with the professor, but she also doesn't "know if the professor tells the TA about your accommodations or anything." It is clear that students with accommodations aren't guided in addressing TAs, and that TAs don't know how to navigate accommodations.

On top of that, Participant 7 thinks TAs can also be "a little scary, especially the ones that are degrading to students about when they perform…not up to the standard." From witnessing behaviors like this, they decided they are "never talking to" those TAs, which again, prevents any room for conversation about support they need in the class. It is unlikely that accommodations are addressed at all in TA training, and it is also concerning to the extent that TAs are preparing for faculty positions and may someday become professors who reproduce these intolerant attitudes and experiences.

### *B. Accommodation Problems*

Of the seven participants with formal accommodations, five of them discussed how certain accommodations don't work as intended, have major flaws, and sometimes are more problematic than helpful.

#### *1. Class Materials*

At this institution, the note taker accommodation allows students to receive notes from a classmate, all through an anonymous portal. This accommodation relies on the instructor to find a class volunteer to offer their notes, and for that volunteer to regularly upload their notes. Some instructors did not recruit a notetaker, no one volunteered, especially in smaller classes, and/or volunteers uploaded their note infrequently or in large batches, such as right before an exam, instead of after each class.

Participants 5 & 6 highlighted how they have difficulty getting class materials, particularly class notes provided by volunteer notetakers. Participant 6 told us "I also have the note-taking volunteer accommodation for when I can't attend or when I can't concentrate in class." Once, she asked an instructor "for that accommodation, and then, he just sat on my email for about a month." She did not hear from her instructor about accommodations until "the day before an exam" and "he asked me if I needed accommodations for a different testing room." Participant 6 expressed she didn't need that, but since she still hadn't received notes, she asked "'Can we sit down sometime and discuss getting a note-taker for me?' and [the instructor] said, 'I don't know how to go about doing that.'" Both note lack of communication, and the instructor's lack of implementation knowledge caused the student to suffer. Participant 8 avoids using the notetaker accommodation because she feels badly about creating extra work for one of her peers. Participant 5 reaffirmed problems with this accommodation, explaining that "there usually isn't a volunteer to get class notes from" so she has "never gotten [notes]" and because of the consistent failure, she doesn't try anymore.

In addition to not getting notes from a classmate, Participant 5 also cannot access class materials "like the slides and PowerPoints" regularly, despite this also being one of her formal accommodations. She thinks that her "professors just forget a lot, and I just don't wanna keep asking…just every day for those. It's awkward sometimes." Both Participants 3 & 4 also mentioned instructors' lack of timeliness in posting class materials can impact their success. As a working student, Participant 3 said the engineering schedule can be difficult to manage when "everything gets piled up to the end of the week, because the professors will release stuff at the end of the week." Participant 4 added that the longer instructors take after the class to post materials, the less likely it is students will access them, which negatively impacts her understanding of the content. Participant 9 also has the accommodation to receive digital course materials "but the professors that just write on the whiteboard" do not post their notes to the course management site. She also struggles with her accommodation to audio record classes. She says that an "audio recording, it's not enough" mostly "just because of the nature of ADHD."

2. *Testing*

A few participants also experienced difficulty with their testing accommodations, mostly with the campus testing center. This testing center has additional rules that are not consistent with the norms applied for student taking the exam proctored in an engineering classroom. The center requires instructor approval for something as simple as using more paper than the exam sheets provided. Clarifying questions that come up during exams are difficult to relay to instructors by the testing center, which proved another barrier. The testing center also prohibits snacks or drinks and requires students to sign out of the exam if they want to eat or drink. This can be a barrier for certain disabilities that rely more on food and water to manage their disability.

Participant 8 has never used the testing center because "the hours are rather narrow, it's a bit of a hassle to book it, so what my professors kind of do – they'll find an empty classroom…or they'll find an empty office…and then have [students with testing accommodations] take the exam in there." Overall, she thinks this is "easier [than the testing center] for both us and the professor because we don't have to go and reserve a testing room or anything weeks in advance." Participant 3 also prefers the practice of instructors booking multiple rooms for testing because it is less "stressful."

Participant 10 says all of his problems with exam accommodations center around “the logistical stuff.” For students to utilize the testing center, instructors have to send the center their exam far in advance, which is typically not a smooth process. One of Participant 10’s instructors “writes [exams] like two hours before we take the exam... and ... he was making edits during the exam.” He thought to himself out loud, “if I have to go and do the exam with extra time in a different room, and [the instructor is] not there to contact me and tell me what I need to change or I can’t ask questions to his TAs…because even they don’t understand his edits, and they’re the only people who can help us.” While the testing center will attempt to contact instructors with student questions during exams, that process relies on instructors checking their emails frequently. This is also very difficult for mistake-ridden exams like those described by Participant 10.

Instead of the testing center, Participant 10 “found that I really haven’t had any issues whenever the professor sets up a separate room for students with accommodations. I had that for one of my classes last semester, and it was fine – because he knew what room it was, he set it up, he had one person…I guess monitoring the two of us that were in there. It was really simple.” While this experience was significantly more positive than using the testing center, there can still be issues when instructors set up their own accommodation room, because sometimes "they also kinda used it as an overflow room.” He typically wouldn’t "have a problem with that except [the non-accommodation students] were being really loud... and I could not focus.” Regardless, he thinks “the private room is nice though because you don’t have to work with the whole logistical issues of getting a time for the testing center, making sure that your exam is properly written – I’ve had to fight with the testing center before” to get extra paper for the exam. Ultimately, he secured permission for extra paper, but he felt that he “wasted time arguing with [the testing center staff] that [he] could be spending doing my exam. This shouldn’t be a big deal, but it was. I had to prove it to them.” Participant 10 felt frustrated that he had to “organize everything” with the testing center so prefers being proctored by the professor. The instructors “know what we’re supposed to have, what we’re not supposed to have. I can have snacks; there’s usually more space… It’s just I enjoyed having that separate room where the professor controlled it.”

Participant 9 echoed a lot of what Participants 8 & 10 spoke on. Like Participant 10, she also prefers when the instructor arranges their own space for students with exam accommodations, to the extent that if an instructor prefers to “go through the testing center... I would rather not use my accommodations at all than have to do [the testing center].” She described the testing center as “locked down” and elaborated that “they don’t let you have your water with you.” This, along with the unfamiliar people and location, contributes to “massive changes in routines" which in turn, produces more anxiety for her. Overall, she feels the testing center is “just not worth it.”

In addition to problems with the testing center, participants had difficulty implementing their extra time or quiet testing environment accommodations. Participant 5 said she “just [doesn’t] get extra time on [pop quizzes] because [she has] another class to get to.” If she knows in advance the course includes pop quizzes, like when instructors “have pop quizzes on their syllabus, I try to work something out.” But often instructors do the pop quizzes at the end of class and suggest that she “’can stay an extra like…10 minutes.’ And I’m like ‘I have class after, and it takes me longer to get to my next class.’” When she has brought this up, her instructors “are just not very concerned. It’s a little frustrating."

3. *Universal Design for Learning during COVID*

Participants also spoke to not wanting to ask for accommodations when professors already made some effort at accessibility in their class. In the first couple years of the COVID-19 pandemic, Participant 6 had often forgone using her accommodations "just because of COVID, a lot of professors upload their stuff online anyway." Even though she had better access to course materials, she also felt like she "wasn't able to get any specific help for [her] disability" because she feared she would be perceived as asking for special treatment due to the existing class-wide accommodations instructors made for COVID. While implementing general course accessibility is favorable, it should not be used as a reason to forgo individualized supports for students.

*C. Other Problems*

1. *Autism in Engineering*

While only three participants described themselves as autistic, a few important considerations came from their interviews. Participant 2 struggles with group work, describing it as "a big barrier." Because he is autistic, he "can't process both things at the same time. I can't think about a…complex physics, or whatever problem, and maintain a conversation at the same time." He ultimately avoids group work unless it is a formal requirement for the assignment.

A unique finding from Participant 11 was the difficulty he experienced with networking, and the lack of resources to support him and his neurodivergent peers through it. Internships are encouraged experiences and often required for hireability after graduation. But Participant 11 expressed that he and fellow autistic friends are "are incredible at what they do, and then, they're just not very particularly good at talking to people," so something should be done to support neurodivergent engineers through navigating science communication, career fairs, interviews and other interactions. If the support is provided by someone neurotypical, it doesn't work for him, so he would like to see neurodivergent engineers creating resources using their own strategies, and "as collateral for helping neurodivergent [students] with that, neurotypicals benefit too. So, there stands to be a reason to do it and not lump it in with just disability accommodation services" (Participant 11).

Lab instructions are often presented at the opening of class, and students then have to complete the entire protocol on their own, often from memory. Not only are there "so many instructions and so many things to learn at once," there are "lots of steps to remember, [and] lots of steps that are implied" (Participant 11), which are often not evident to him because of his autism. Participant 11 said they honestly feel that "the hardest part of lab is listening to what they're saying at the beginning."

2. *Course and Curriculum Structure*

Participants mentioned numerous parts of course and curriculum design that they struggle with. Participant 4 thinks "the most like difficult thing that professors do is just move too quickly." Participant 10 thinks something "professors could do in general is…be more understanding of students' schedules." He has had instructors give extra work over breaks, which can take away from important time to rest.

The chemical engineering curriculum is structured in "a straight line" where every semester is full of the next semester's prerequisites. This proved to be a barrier for Participant 8

when she failed two classes and was “pushed back a semester.” From what she sees from her peers, not all engineering disciplines are structured this way, but because her major is, she has to do “the fifth year because of my failing two key classes.”

*3. Financial Advising*

Participant 2 had to withdraw from all of his courses during his penultimate semester due to a major depressive episode. When he returned to school the following semester, he found he was unable to access federal financial aid. The reason was that he had reached the maximum credit allowance. It took him some time to figure out that the courses he dropped the previous semester counted towards this limit. At the time of withdrawing from classes, he was not advised of this consideration. When recounting the situation, he expressed disappointment that he hadn't been informed of the policy and counseled on alternatives (such as medical withdrawal, which may not have counted toward the cap on credits) and planned financially for his final semester. Engineering curricula are notoriously crowded with specific degree requirements and little flexibility, which is not necessarily taken into consideration when federal financial aid policies are set.

*D. Wish List*

This sub-code encompasses anything participants shared in response to being asked if there was anything else instructors or the university could do to support them, regardless of accommodation status. Participants mostly discussed wanting course recordings, more care and initiative from instructors, and a way to offer feedback to instructors about accessibility.

*1. Course Recordings*

Of the eleven participants, ten spoke about how helpful lecture recordings had been for them, and how they wished this practiced continued. During the first two years of the COVID-19 pandemic, it was very common at this institution for instructors to record their lectures, but since then, many instructors have abandoned the practice.

Not only were course recordings the most common request from participants, but they were also the most emphasized one, with participants using phrases like “really, really huge,” (Participant 2) and “really, really helpful” (Participants 8 & 9) to describe how recordings during the height of the COVID-19 pandemic benefited them. Participant 8 rewatched lecture recordings to “go back to that specific part where [the instructor was] doing the problem…and then figure out what it is that I missed,” which was a similar experience to Participant 4, who also liked “watching each step by step of an example being worked out... even if I had already seen that example.” Recordings allow students to “go back and review the material whenever” they need to (Participant 9), which is especially helpful in studying for exams (Participants 4 & 9). Recordings also proved useful to Participant 7, since most had “automatic transcripts, and I liked them because I could ‘control F’ [search] the transcript, and kinda go back to where I was lost, and rewatch it.” Even just “worked-up examples… available for us on [the course site] would be good” (Participant 6).

Unfortunately, when students have requested for course-recording to continue, instructors resist, “and their rationale for [not recording] is to make people show up to class” (Participant 9). This participant also labeled required attendance as “inherently ableist,” since there are many

reasons a disability might prevent a student from coming to class. Other participants also felt resistance from professors and even felt it when they asked for a smaller form of support like “a standardized set of notes” which is one “thing that most professors would be resistant to” (Participant 2).

2. *Course Calendars*

Students requested a list of topics planned to be covered in each class session, even if plans change. Participant 3 said it is “really helpful” when professors include a semester schedule detailing what topics and chapters are anticipated to be covered in each class. Some instructors do this, but not all, and “even without having accommodations... for any student I feel like that's just good to have.”

3. *Communication & Check-Ins*

Instructors can help reduce the communication burden on disabled students by reaching out to students with accommodations at the beginning of each semester. Participant 5 said that "once a professor reached out first to me” to discuss accommodations and “that was very nice.”

It is clear from the results presented above that at least some engineering instructors do not prioritize or make time for accommodations – even formal ones the institution has a legal responsibility to provide. Students conclude from their interactions with these instructors that requesting accommodations may not be worth the effort. Therefore, engineering instructors who are passionate about accessibility may need to frequently and conscientiously communicate their support to students. Participant 1 would like to “just know that [instructors] care a little more,” and that they are “actually thinking about how they want their students to be a little more successful.” This could be achieved by instructors having a “check in every so often with [students with accommodations] to see 'How are your accommodations working out? Are [your accommodations] actually working? How is the class going for you? Are you understood?’” She made sure to clarify that she is not expecting check-ins “every week... but maybe when midterms come around” to see how the student is feeling because instructors should “already know that obviously those students have a [need for extra] help in certain areas.” Participant 9 echoed a lot of the same sentiments saying that check-ins would help instructors show “a little bit more care towards their students.” She has had non-STEM instructors check in, which has made her feel supported, but this hasn’t ever happened with an engineering professor. This is not surprising since “a lot of engineering just does feel very impersonal... that’s the culture. But that doesn’t have to be the culture” (Participant 9).

4. *Feedback on and for Instructors*

At the end of the semester students, can fill out an optional course and instructor evaluation, but these do not typically include questions about willingness to accommodate individual needs or implementation of accommodations. Participant 10 thinks there should “be an extra section” on the end-of semester evaluations, “or a different [evaluation]... for accommodations.” He wants to students to be able to “make comments for professors whether we have accommodations or not” and even add feedback about how their teaching and classroom practices “fit into [accommodating students].”

## IV. DISCUSSION

The disabled students in this study merely wanted equitable access to their education and are asking instructors and administrators to help them with this. The results outlined what students are saying. In this discussion, we address why the effort to create accessible classes is necessary and offer suggestions of how to do so.

Barriers to obtain accommodations largely included the cost of diagnostic tests, appointments and documentation; the amount of paperwork required by the university and delays in getting appointments with doctors and the DRC. Once students had accommodations on file, there were barriers to contacting instructors about them. Participants often felt anxiety and fear associated with discussing accommodations with instructors, especially since it is often the first interaction they have with an instructor. Some cited personal or peer's negative interactions with instructors as contributing to anxiety and fear. Both of these factors are so widespread that it even prevented some students from registering for accommodations at all.

Even after accommodations are implemented, they are not always successful or helpful in the way intended. Notes often go unprovided due to the lack of volunteers or instructor failure to follow through on recruiting a volunteer. The testing center often creates more hassle than it is worth when students struggle to contact instructors with exam-related questions, have access to their snacks and water, and are restricted from supports like extra paper that are usually not limited – and are often encouraged – in engineering testing environments. When instructors fail to follow through implementing accommodations such as note takers or supplying course materials, it discourages students from asking in future classes, and it interferes with their ability to learn and review content.

Because asking professors to implement accommodations is daunting, and because not all disabled students can obtain accommodations, taking steps towards accessibility class-wide can have a large impact. In fact, proactive course adjustments for accessibility may save instructor time in the long run. Ensuring course materials are uploaded in a timely manner and providing lecture notes (opposed to students having to rely on unreliable volunteer notetakers), increase access to course content, and therefore, could increase understanding. These strategies align with UDL, which increases access for everyone regardless of disability status, but would especially help students who cannot attain formal accommodations or those experiencing temporary disability or illness. There are many reasons students may miss class or need to catch up on course content, such as emergencies, temporary illness, and family responsibilities. Following these and other UDL recommendations can increase access for all these students.

Some students experienced unique challenges, like managing group work or networking and communication. Given the rapid increase in students diagnosed as neurodivergent in recent years [9], such concerns should not be ignored. The variety of symptoms associated with various disabilities makes it difficult to identify course structures that will support all students without making things more challenging for others. Therefore, it is important for instructors to signal their openness to feedback about accessibility of their course policies and practices.

## V. RECOMMENDATIONS

Our title quote comes from Participant 7, which in its entirety reads, “if there’s people who can’t access [engineering], then it’s not accessible, so we should change it so…as many people can access it” as possible. Here, we summarize the data into actionable lists for different audiences to work towards that change. Box 1 presents recommendations for instructors, and Box 2 presents recommendations for university administrators and DRC staff.

While lists of recommendations for accessibility can be found, few, if any, are based directly on student data. All recommendations below have been synthesized from these interviews. They should not be taken as an exhaustive list of how to address all the needs of students with disabilities.

BOX 1. INSTRUCTOR RECOMMENDATIONS.

1. **Record lectures.** When equipment allows, recording lectures allows students to rewatch content they missed or do not yet grasp. These can also be made available for any student when they inevitably experience illness, family emergency, or other disruption to their learning. Emphasizing the importance of attendance and having flexible attendance policies can allay some concerns that making material so accessible will discourage students from attending class regularly.
2. **Post course materials before the next class.** This allows students who missed class or who need to review content the ability to pace their work and show up to the following class prepared.
3. **Publish a course schedule** that lists what topics and/or chapters you expect to cover each class session.
4. **Familiarize yourself with your institution’s accommodation practices.** This ensures that accommodations are implemented quickly and with as few mistakes as possible. DRC case workers listed on the DRC website and accommodations letters are a resource that can be contacted by faculty at any time.
5. **Be proactive on discussing and implementing accommodations.** Reaching out to students with accommodations first can reduce their burden and signal your willingness to support them. If you have a large class, you can send a welcome email to the entire class which also asks any students with accommodations to sign up for a time to meet via a provided calendar link.
6. **Remember, students are in your class to learn.** Giving them the tools they need to do so should not be taboo. Although it sometimes feels like accommodations requests (particularly undocumented ones) stem from laziness or lack of commitment, it can go a long way to assume all students want to be successful in your course.
7. **Solicit feedback** from all students about your course accessibility. Then use the feedback to make small changes immediately and in subsequent course offerings.

BOX 2. UNIVERSITY ADMINISTRATIVE & DRC STAFF RECOMMENDATIONS.

1. **Equip classrooms with equipment to record lectures.** Automatic lecture capture can reduce the barrier for many instructors to record and make their lectures available to students.
2. **Increase instructor responsibility for discussing and applying accommodations.** Instructors may need more resources and training to ensure smooth implementation.
3. **Improve accommodation efficacy.** In this study, students described not getting the full benefit of the note taker and testing center, and offered realistic alternatives.
4. **Work to clarify and streamline the requirements for attaining accommodations.** Reducing paperwork could increase students' ability to apply for accommodations. Adding a flowchart, or other easy-to-follow guide for the accommodation process, posted in prominent places could also support students through this process.
5. **Help students afford necessary diagnoses** by partnering with a university health center, offering scholarships for diagnostic appointments, and/or covering doctors' office charges for submitting documentation.
6. **Solicit feedback** on accommodations process and efficacy to continue improvement. Although each student is in a unique situation, there is a relatively small set of accommodations communicated to instructors on which students could provide feedback to DRC staff.

## VI. CONCLUSION

Absent institution-specific data, this paper gives engineering instructors and administrators some starting points for better supporting students with disabilities. As researchers, we conscientiously balanced large sample size with the emotional burden these interviews place on our disabled student participants. This study builds on the literature on postsecondary students with disabilities while providing engineering-specific context to accommodations challenges. We note that particularly for instructors, some of the recommendations are relatively low effort to implement and observe the difference. Throughout all the interviews, it was clear participants just wanted to feel equally valued as their non-disabled peers by their instructors and administrators. Disabled students see any and all effort you put forth to help support them, which, ideally, is something you as an instructor feel more equipped to do after reading this paper.

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