

Qualifying Exams and Proposals in Science and Engineering: Existing Barriers to Accessibility and Avenues for Change

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Abstract – This research paper presents empirical findings on STEM PhD milestones—primarily qualifying exams (QEs) and dissertation proposals—and the experiences disabled PhD students had or anticipated having while navigating these milestones. Between departments and programs, the format, timing, and structure of QEs and proposals vary greatly, and while there have been positive initiatives to reform these assessments, minoritized student perspectives are often neglected. This study involved interviewing 17 disabled science and engineering PhD students, ranging from second to sixth year, and conducting a workshop with disabled graduate students and faculty allies. Participants described the milestones required for their program, their feelings towards them, and what aspects of these assessments were inaccessible. Many departments did not have a separate QE, while others had multi-day, hours-long, sit-down exams. Proposals ranged from two-page research plan summaries to comprehensive written research proposals with oral presentations and Q&As. The largest sources of inaccessibility in these milestones included unclear and/or shifting expectations and limited opportunities for flexibility or accommodations. Often, these exams have departed from the original goal to assess independent research readiness. We advise that QEs should be eliminated and conclude with a series of questions that challenge programs to reflect on why they have the doctoral milestones they do, whether those milestones are achieving their objectives, and how such assessments/programs can prioritize flexibility and accommodation.

1. INTRODUCTION

In the United States, 28.7% of people have disabilities, forming the largest minority groups [1]. In higher education, there is an underrepresentation of people with disabilities; it is reported that 20% of undergraduate students are disabled. This proportion is halved in STEM programs and continues to decrease throughout higher education, with only 6% representation in STEM

master's programs, and 2% in STEM doctoral programs [2]. The dwindling presence of disabled students is staggering and concerning to us. In this work, we seek to investigate the contribution of doctoral milestones to this decline.

A primary goal of doctoral programs is for students to work towards becoming independent researchers. This is an arduous process, and there are few universal milestones throughout STEM PhD programs for students to receive feedback on their progress [3]. Typically, the beginning of students' doctoral programs includes joining a research group and completing coursework; eventually, students take a qualifying exam (QE), also known as a candidacy or comprehensive exam [4]. Throughout this work, we will refer to this milestone as a QE. Broadly, QEs are assessments to evaluate doctoral student readiness for successful dissertation research, but the specifics of this exam vary greatly between institutions. After QEs, students complete proposals, where they present their research plan for their dissertation. Often this includes a written proposal, a presentation, and answering questions from their committee. Lastly, students defend their dissertations. While the presence of these milestones is fairly consistent in science and engineering, their execution lacks standardization, meaning that each student's doctoral experience varies greatly depending on their advisor and the structure of their graduate program [5], [6].

In recent years, there have been positive initiatives to reform QEs and proposals to better support student well-being and align programmatic goals with student outcomes from this assessment [7], [8], [9], although we see no evidence that these reforms have been made with disabled students at the center. Further, we know that disabled undergraduate students in STEM often employ university accommodations when faced with assessments that, in their original form, are incompatible with their disabilities [10]. However, university accommodations are typically focused on undergrads and coursework and thus leave doctoral students without formalized accommodations for QEs and proposals, two of the most important milestones that doctoral students in STEM face [11]. In this work, we seek to better understand the accessibility of QEs and proposals for disabled students by investigating the following research questions:

- 1) What are the different types of QEs and proposals that are currently being employed in science and engineering doctoral programs?
- 2) What aspects of science and engineering QEs and proposals do disabled doctoral students identify as being inaccessible?
- 3) What can be done to make QEs and proposals more accessible for all students?

2. LITERATURE REVIEW

We begin this literature review by explaining how we define disability throughout this work. Then, we discuss the experiences of disabled doctoral students across disciplines. Finally, we review the existing literature on QEs.

2.1 Our Definition of Disability

Throughout this work, we take an expansive definition of disability, including physical and mental health disabilities, neurodivergence, and chronic illness. We recognize that disability is not a monolith; every disabled person has their own experience, both between and within disability types. By taking an expansive view of disability, we draw from a diverse set of disabled experiences when making recommendations toward doctoral milestone reform.

We primarily subscribe to the social model of disability, which views people as being disabled by inaccessible societal structures, whether physical or institutional [12]. Throughout this work, we intentionally prioritize identity-first language (“disabled students”) rather than person-first language (“students with disabilities”) to emphasize that people are disabled by their environment. While disabled folks should not be solely defined by their disability, it is an important part of their identity, and using identity-first language emphasizes that disability is not a negative thing [13].

2.2 Disabled Doctoral Student Experiences

Most of the literature on students with disabilities in STEM higher education focuses on undergraduates. The academic lives of undergraduate and graduate students vary greatly; undergraduates tend to be primarily focused on coursework, while graduate students are simultaneously students and employees, conducting research and/or teaching [14]. Given that QEs are a post-coursework transition to research, common course accommodations, such as extra time and/or a reduced distraction environment to take exams, often do not align with student needs on QEs [15]. For these reasons, we will not spend time detailing the literature on undergraduate course accommodations in STEM. Instead, we turn to the literature on the experiences of disabled doctoral students in all fields, as there is an insufficient body of work that focuses solely on STEM.

Ableism is rife in doctoral programs; they are time-intensive, with long hours and infrequent breaks normalized as synonymous with research excellence [16]. Physically, academic lab spaces and classrooms are often inaccessible, with narrow passageways, a lack of ADA-compliant ramps, non-adjustable furniture, and software that is incompatible with screen readers [17], [18]. Additionally, it can be challenging to attain formal accommodations outside of classroom settings, especially because prescribed accommodations for doctoral education are rare. For these reasons, flexibility is essential to the completion of doctoral programs for many disabled students.

However, flexibility is dependent on students disclosing their disability status and asking for help. The most common reasons why doctoral students do not use disability support services are fear of stigmatization and disclosure [19]. Additionally, while accommodations can support disabled students, the process to secure accommodations is riddled with bureaucracy, often taking an exorbitant amount of time and paperwork to “prove” disability status [20]. Spier and Natalier [21] found that when students do go through the process of requesting reasonable accommodations, they are frequently denied based on ableist work and timeline expectations

under the guise of rigor. Many disabled doctoral students are forced to “self-accommodate,” or make personal adjustments to their research or teaching practices because of the unavailability of university or advisor support [22]. In investigating the experiences of blind and low vision and deaf and hard of hearing doctoral students in computing, Shinohara et al. described the extra effort that students needed to put forth to complete their degrees in the face of academic ableism as a “burden of survival” [23].

For some students, doctoral milestones such as QEs and proposals can represent a critical juncture for disability disclosure [24]. While faculty advisors’ allyship in the accommodation process can help mitigate some of the barriers disabled students encounter during these milestones [25], reliance on individual support also highlights the limitations of systems that depend on reactive accommodations. Some argue that the very prevalence of accommodations reveals that many assessments, in their current form, are inherently ableist, because genuine accessibility should be proactive [26]. From this perspective, reform should focus not on accommodations alone, but on removing structural barriers so that accommodations become less necessary. We argue that QEs often reproduce ableist norms and have drifted from their primary purpose of assessing readiness for independent research.

2.3 Qualifying Exams and Their Reform

More so than proposals, QEs in STEM lack standardization in both their mode of assessment and their purpose. They may test general knowledge, research specific knowledge, or both, and modalities range from oral presentations to written exams to written research papers [7], [27]. QEs can be so rigorous that students need months to study and prepare [28]. The most commonly stated purpose for QEs is “to ensure students are prepared for dissertation research enroute to their PhD” [29], but it is not often clear how a given QE achieves that goal. In a case study of a chemical engineering doctoral program, Artiles & Chew found that although faculty and students thought their QE was “useful and efficient, the lack of clear objectives limits its value and creates confusion for students” [30]. Further, in a review of the top 10 biostatistics

graduate programs' websites, Bellamy & Sullivan [7] found that while all described the mode of assessment for the QE, few provided a purpose or rationale for the assessment. Further, detailed information regarding QEs is often challenging to obtain, and many programs do not provide clear direction on what or how to study for QEs, meaning that more advanced students are often the only resource doctoral students have to figure out what they need to do to adequately prepare [7]. The onus should not fall on more senior students as it is unfair to expect them to take on unpaid labor, plus it can be time-consuming and take away from their own degree progress. Additionally, communication is often dependent on informal social networks that are not accessible for or accepting of disabled and other minoritized students. This widens gaps in access to important information needed to survive and succeed in a graduate program. For this reason, it has been suggested that QEs may be another piece of the hidden curriculum, or the unspoken rules, norms, and requirements for academic success, disadvantaging minoritized students who lack the necessary institutional knowledge to succeed [9].

Recently, some programs have reformed their QEs to support doctoral students' well-being and align their assessment with the skills students need to develop in their field. Liera et al. [8] suggest that how QE reform happens may be related to the prestige of the institution and the needs of programs' doctoral students. For example, one prestigious university they researched recognized that its admissions process is hyper-competitive, only accepting students with extremely impressive academic records. As such, they decided to eliminate their ultra-rigorous qualifying exam, as they had already screened for academic success with their admissions process.

While this solution worked at a top-ranked institution, other programs may still need to scaffold and assess doctoral students' preparation for research. The second university Liera et al. studied [8], which had a less rigorous admissions process, found its students needed more scaffolding for professional success, leading them to provide more support leading up to the QE. The reformed process prioritized students practicing the scientific discourse expected of

professional chemists. The department created a milestone preparation course, where they had the opportunity to practice the format of their future QE and attend the proposals of more advanced doctoral students to understand the expectations of the assessment when they took it in the future. Similarly, the California Institute of Technology recently reformed its QE format because they recognized that their oral QE did not just test technical concepts but also communication and presentation skills. To better prepare their students and ensure that students from different backgrounds were on equal footing for the assessment, they introduced weekly QE preparatory sessions led by senior graduate students that focused on how to succeed on oral exams [28].

These examples show that QE reform is happening. However, we were unable to find any examples of students being credited as the catalyst for QE reform, let alone considering the inclusion of specific student populations, such as disabled students. We argue that disabled doctoral students should be centered in these conversations to ensure that change is made with accessibility in mind. To that end, our study focuses on the experiences of disabled graduate students who recently completed or anticipated upcoming QEs and proposals.

3. METHODS

3.1 Positionality

The first author identifies as a nondisabled, white woman in STEM. She does not currently identify as disabled but was previously epileptic and has many disabled friends and family members who inform her perspective on this work. She has not yet taken her QE, but being a part of both the STEM Education and Mechanical Engineering departments at her institution has exposed her to a range of QE formats. The second author is a white woman whose disability affects her cognitive function, energy, and mobility. Once starting graduate school, she faced more barriers as a result of being disabled, including difficulty being appropriately accommodated for the QE in her then-program, which motivated her to shift her research focus

to disability in engineering. After changing programs, she was able to access the QE in a way that worked for her access needs. She holds both bachelor's and master's degrees in engineering. The third author is a professor of mechanical engineering and STEM education and advises both the first and second authors. She identifies as a disabled, straight white woman, and is the parent of a deaf child. She holds degrees in materials science and engineering and seeks to improve the experiences of all students through her research and volunteer work. She has served as a graduate program director, associate dean in a graduate school, and has researched graduate education for over 20 years.

For this paper, we intentionally chose not to follow the ASEE formatting guidelines (IEEE). Inspired by our motive to create a more accessible world, and supported by colleagues' recent work, like Cole et al. [18], we could hardly write a paper about accessibility without following Web Content Accessibility Guidelines (WCAG) [31] and general best practices for disability inclusion. In alignment with WCAG 2.2, we used 1.5-point spacing and bolded headings throughout the paper. Additionally, we elected to use Calibri, a sans-serif font, which is easier for neurodivergent people and people with low vision to read. Finally, the rows in Table 1 alternate between two colors for data entries, and a third for headings, also known as “zebra striping,” to improve visual tracking across a wide data set. Readers are advised that there is one uncensored curse word in the Results section. We understand that this may not be palatable for everyone, but we are committed to elevating student voices, which we believe to be incompatible with censorship.

3.2 Interview Study

3.2.1 Recruitment

We recruited participants from a large, research-intensive Southwestern university by hanging fliers in STEM buildings and emailing recruitment materials to STEM departments.

Disseminating recruitment materials through multiple modalities was an intentional choice to

reach the largest number of potential participants, especially because virtual work is particularly common amongst the disabled community. Recruitment materials led prospective participants to a screening survey, which ensured that all selected participants 1) were doctoral students in STEM and 2) identified as disabled, neurodivergent, and/or chronically ill. We reached out to all prospective participants who fit these criteria to participate.

3.2.2 Participants

Our sample consists of 17 participants in doctoral programs in science ($n = 13$) and engineering ($n = 4$), representing 13 programs within 9 departments. The participants reported a wide range of disabilities, including neurodivergence, chronic illnesses, autoimmune diseases, and mental health conditions. The most commonly reported disability was ADHD ($n = 10$); further, 10 participants noted multiple conditions. Participants ranged from second-year to sixth-year doctoral students.

3.2.3 Data Collection

Participants were given the option to interview in-person or virtually. If participants did not specify which, we defaulted to the virtual modality. Additionally, we built in accessibility measures, like sending the interview questions in advance and asking participants for their access needs both in advance and at the start of the interview. Interviews ranged from 30 to 75 minutes, averaging 57 minutes. For longer interviews, we offered a break near the 60-minute mark. We used a semi-structured interview protocol that inquired about many aspects of the graduate school experience. All interviews were conducted by the first or second author, both of whom are graduate students, who disclosed their disability status at the start of the interview. This helped to create an open dialogue, diminishing the power dynamics between researcher and participant. This paper focuses specifically on participant discussions of doctoral program milestones.

3.2.4 Data Analysis

We transcribed interviews using Aiko, a locally-run transcription tool powered by the OpenAI Whisper model. Then, we listened back to the interviews while making manual corrections to the transcripts as needed. This not only ensured accurate transcriptions but also allowed us to familiarize ourselves with the interviews we did not conduct. The work of cleaning transcripts was divided between the first and second authors and an assisting undergraduate researcher. After transcription, we went through the transcript and pulled out all portions of the interview that pertained to doctoral milestones (i.e., qualifying exams, proposals, dissertations, and other departmental requirements). We grouped the quotes by whether they described facts about milestone formats or student experiences with QEs and proposals. Then, we discussed the most important findings to create a simple codebook, forming the basis of our results.

3.3 Workshop on Degree Progression

In addition to interviews, we conducted a series of four workshops that were funded through a grant to increase wellness and engagement in education sponsored by the university's teaching center. Each discussion-based workshop focused on a different topic relating to disabled graduate students, with the goal to co-construct knowledge surrounding the state of disabled STEM graduate students in each of those four contexts. We hosted two of the four workshops in-person and the other two virtually to ensure that students had an opportunity to participate in at least two sessions that aligned with their access needs. The workshop relevant to this paper was titled "Degree Progress Flexibility for Graduate Students with Disabilities" and was hosted in person. The discussions from this workshop are included in our findings.

3.3.1 Participants

Participants for the workshops included disabled graduate students and faculty or staff allies, both in STEM fields. We recruited participants through an announcement forwarded by graduate program coordinators in all STEM disciplines and by emailing any eligible students on the screening survey initially used for the interview study. We encouraged interview

participants to share the opportunity with their disabled lab mates or friends and to fill out the included survey if they wanted to participate. The linked survey asked which sessions they could attend, other logistical and demographic information, as well as if they had suggestions faculty or staff members that they felt would be valuable allies to invite to the session. Any faculty or staff who were named were then invited. Student and faculty participants were compensated for their participation with \$30 per workshop. The degree progress workshop had ten student participants, a few of which participated in the interview study, and two faculty participants. All three authors, along with another graduate student researcher, were present and participated in discussions in a reduced role.

3.3.2 Data

The workshop session was primarily facilitated by the second author, with administrative support from the first and third authors. First, we briefly discussed key findings from existing literature and the interview study. The remaining time, and the majority of the workshop, was spent in two discussion rounds. Participants spent about 15 minutes discussing “What experiences have you had with degree progress, including milestones, flexibility, and accommodations to manage your disability?” We provided a few more specific questions to help prompt participants. To prioritize disabled voices, we encouraged faculty participants to listen more than talk and to ask questions. By shifting the power away from the faculty members, we hoped the disabled student participants would be comfortable with sharing more. Participants were provided with posters, sticky notes, and writing utensils to capture their thoughts in whatever way they deemed fit. Then, we reconvened for small groups to share main ideas. Participants were notified that all papers would be retained for research; additionally, the report-out was recorded, and we clearly stated when the recording started and stopped. This allowed participants to choose what, how, and to whom they shared their experiences. We repeated this process for round two, asking, “How and where can faculty help students get the flexibility they need?”

As noted above, the data retained includes the papers that participants wrote on and Zoom recordings of the report-outs. After the workshop, we transcribed both the papers and the recordings. We did not formally code the workshop data. Because our goal was to use this data to supplement our interview study, we extracted any content that directly supported, contradicted, or was absent from the findings of the interview study. The majority of findings from the workshop supported the interview data, both echoing interview sentiments and introducing new recommendations to support the broader themes.

TABLE 1. FEATURES OF QEs AND PROPOSALS

Department	Program	Participant	Separate QE & Proposal	General Knowledge	Research	Written Exam	Written Proposal	Oral Presentation	Oral Q&A	Assigned Papers to Read
Science Programs										
1	A	1	N	N	Y	N	Y	Y	Y	N
	B	5, 9	N	Y	Y	N	Y	Y	Y	N
2	C	2, 4	Y	Y	Y	Y	Y	Y	Y	Y
3	D	3	N	N	Y	N	Y	Y	Y	N
	E	6	N	N	Y	N	Y	Y	Y	N
	F	8	N	N	Y	N	Y	Y	Y	N
4	G	7, 11	N	Y	Y	N	Y	Y	Y*	N
	H	14	N	Y	Y	N	Y	Y	Y*	N
5	I	13	Y	Y	Y	N	Y	Y	Y	N
6	J	16	Y	N	Y	N	Y*	Y	Y	Y
Engineering Programs										
7	K	10, 15	N	N	Y	N	Y*	N	N	N
8	L	12	N	N	Y	N	Y	Y	Y	N
9	M	17	Y	Y	Y	Y	Y	Y	Y	N

* An asterisk indicates that a quality differs significantly from the other cells with the same value.

4. FINDINGS

4.1 QE and Proposal Structures

In this section of our findings, we focus on the structure of QEs and proposals. These structures differ between departments, but the general progression through milestones is consistent. Doctoral students in STEM take a QE near the completion of their coursework, propose their dissertation research, and then write and defend their dissertations. In some departments, the QE and proposal are not separate assessments but rather are one combined milestone. Our results have a strong focus on QEs, but we also include experiences with proposals, as they are often an intersecting experience. This flow of requirements is illustrated in Figure 1.

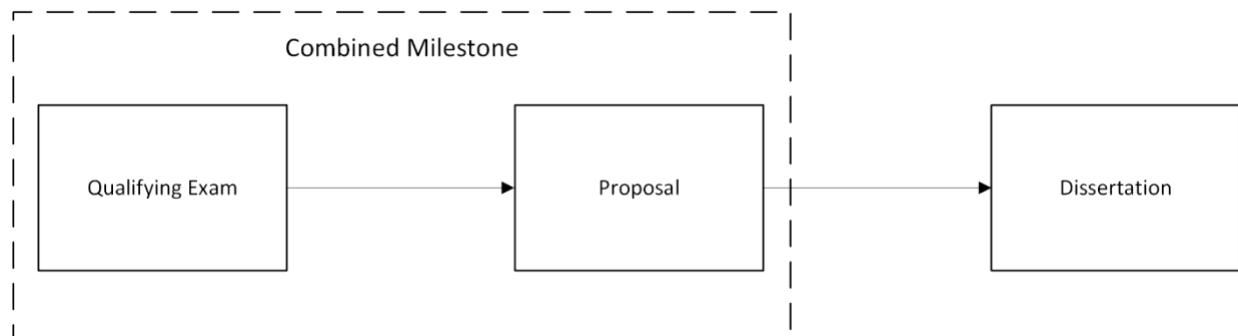


FIG. 1. Progression of Doctoral Milestones. This figure depicts three rectangles, or boxes, in a row. Each box contains text; from left to right the boxes read “Qualifying Exam”, “Proposal”, and “Dissertation”. Between the boxes there are one-way arrows, pointing towards the right. Encompassing the Qualifying Exam and Proposal boxes, is a larger, dashed-line rectangle with the text “Combined Milestone”.

We found that the structure of QEs and proposals varied greatly between and often within departments. This is exemplified by the summary of QE and proposal structures in each of our participants’ program areas in Table 1. The most important differences between doctoral milestones arose in their modality and scope. We define modality as the way in which these milestones were administered, that being written or oral. We define scope as the subject of

these milestones. QEs had the most variety of the milestones we looked at. Some departments' QEs have written exams, others have oral presentations and questioning, and some do not have a QE at all, like departments 7K and 8L. In fact, Participant 12 switched into 8L specifically because it did not have a QE, unlike her former program that required a sit-down exam for which she would have needed to request accommodations. The most time-intensive QE is in 2C, where a student's four committee members each assign around five journal articles or book chapters, or more simply put, the student is assigned around 20 readings. The student then spends two consecutive days writing, dedicating four-hour blocks to each committee member's assigned reading list. This QE, compared to not having a QE at all, illustrates the extreme range of expectations that are possible in STEM doctoral programs.

Most departments have a traditional format for proposals. Students submit a written proposal in advance of an oral presentation, where their committee members can then ask questions. The biggest differences between these proposals lie within specific details rather than overall structure. For example, many proposals are self-scheduled, but some departments require the presentation to be during a department seminar, which is always on the same day and time. This also means that the presentation portion of the proposal is open to the public, as opposed to presenting to the committee alone, which may increase anxiety for students. Additionally, the turnaround time between QEs and proposals is often a year, but for 2C, it is within four to eight weeks of their intensive QE that students have to submit their written proposal and give an oral presentation. The inclusion of general knowledge questions is something that varies within departments as well, like in 1A, which excludes general knowledge from proposal questions, and 1B, which includes general knowledge. Another example of intra-department differences, also relating to questioning, is between 4G and 4H. In 4G, the committee is not allowed to interrupt students with questions throughout their presentation, but this is allowed in 4H. These differences cause confusion for students and faculty alike, especially when faculty serve on committees across a department that includes multiple programs.

While all of the departments in this study require a written proposal, not all of them require a comprehensive research plan. Departments 6J and 7K do not have an oral component at all, and the written proposal was quite short. 7K only requires a two-page research summary, and instead of being used to evaluate research competency, its primary purpose is for student use as a solicitation when approaching faculty members about joining their dissertation committee.

Some departments have additional requirements, including annual seminar presentations (often called “chalk talks”) or required semesters of teaching, and some advisors enforce research group requirements, such as a minimum number of publications. We do not discuss these additional requirements in this paper, but we think they are worth mentioning to understand the entire picture of doctoral milestones in STEM.

4.2 Unclear and/or Shifting Expectations

Participants cited unclear and/or shifting expectations as one of their biggest challenges with their QEs and proposals. These doctoral milestones are widely recognized as high-stress events for students, and unclear standards and milestone formats only add to the stress of these situations. One example of shifting expectations occurred in Participant 11’s proposal. In his program area (4G), the committee is supposed to save their questions until after the oral research presentation. Instead, “it ended up being presentation and questions interspersed for about an hour and 10 minutes, followed by like 20 minutes of just questions.” Participant 11 expressed his frustration with the unexpected format change, saying,

“I wish my committee hadn't fucked up the format. Yeah, I mean, if it weren't for that, I think things would have been fine. I mean an hour of questions is rough either way...like being autistic doesn't help there, but I don't, but like, that's going to be rough regardless of whether or not you have a disability.”

He mentioned that some of his committee members often serve on committees in program areas within the department where interruption is allowed, which he believes caused the change in expectations.

In addition to digressions from established milestone formats, students found that conditions and requirements were not always equal from student to student. Participant 16 was satisfied with the format of her own QE in 6J: an oral research presentation, followed by an hour of questioning on her research and one pre-assigned paper from each of her committee members. However, she saw that the format was inconsistent, explaining “the papers were given to us three weeks in advance, which worked for me, but I think other people maybe didn't get the full three weeks or were given longer papers or there's ways in which it's not quite standardized.” Participant 2 witnessed similar inconsistencies, explaining, “[the QE] can be open book or not, it depends on the professors. It's up to them. They're supposed to tell you way far in advance, but some poor girl in my cohort was just told a week before that it would actually be closed book, which is awful.” The lack of standardization between committee member requirements for QEs and proposals leads to confusion and unnecessary additional stress for doctoral students.

Without clear expectations, some participants failed their QEs or proposals on their first attempt. For example, Participant 5 was told that the scope of their proposal was the readings assigned by their committee and was surprised when they were questioned on broader foundational knowledge. When they failed, they were caught off guard, saying “the biggest thing was nobody fails, apparently. They're lying. They don't [prepare you] for failure. They're instead saying, you're going to pass no matter what.” They were frustrated by the lack of clarity around the scope of their assessment and felt like the only way they learned how to study was by failing the first attempt. This sentiment was echoed in the workshop, and participants wanted greater clarity from their departments on what the potential outcomes were for their QEs and proposals, and what the consequences are for these outcomes.

Additionally, in the workshop, participants discussed that they struggled with ambiguity in the timeline for these doctoral milestones. They felt that the expected timeline for milestone completion was unclear or nonexistent; further, there was not sufficient or consistent

accountability for sticking to departmental timelines. However, other students in the session appreciated that there was not a set timeline for their progression through doctoral milestones, allowing them flexibility to move at their own pace. This suggests that students would appreciate having a clear milestone timeline with room for flexibility if they need it.

4.3 Accommodations and Flexibility

The majority of our participants had not asked for any accommodations on their QEs or proposals. Some participants did not ask because they did not feel like they needed an accommodation for their exam, but they would have asked for an accommodation if they had a different modality of assessment. For example, Participant 12 has university testing accommodations for her ADHD, but says, “I feel like a presentation, like, it just kind of is a presentation. Like, it doesn't require sitting down and concentrating, like, a test or an exam.” However, she also said that if she had a “sit-down test, then I would have definitely, like, requested my time and a half.” Participant 7, who has anxiety, expressed a similar sentiment, saying, “I think if I was in a [program] where [interrupting you during your presentation] was allowed, I would say something because I think that would be like really, really, um, anxiety inducing... I know that I would freeze and like lose everything.” In contrast, Participant 14 felt like being interrupted during their presentation was particularly compatible with their ADHD, saying

[H]onestly, like, that's how I speak to people. So I don't really mind that style. It's kind of fun, because like, you're like, trying to actively say something else. And it's like, ‘what about this?’ And like, that's how I feel in conversation. Just like interject.

This discrepancy illustrates that assessment is not one-size-fits-all, and what works well for one student may not be a fair assessment for another.

Other participants expressed that they could be interested in accommodations, but they did not know what to ask for. Participant 15, who has ADHD, expressed this sentiment well, saying

I guess, I mean, I don't know what I could ask. Um, I almost feel like, cause like an exam is very straightforward, extra time. But for the other things, I don't even know what I could ask for. Um, yeah, I guess more time is always like the thing that I need and it's really hard to, to, to ask for that.

Participant 13 did not feel like it would be acceptable to ask for any accommodations, saying, “yeah, I just, like for me, I never would have thought to ask for accommodations because I feel like they would just be like ‘I can't give you the answers in advance, that's cheating, right?’”

Participant 7 was considering letting her committee know about her anxiety in advance, but worried about their perception of her, saying, “I think it's hard because, especially with quals, everyone gets so anxious and like nervous for that, that I don't, I don't know. I could see it backfiring where it's like, ‘why does she think she's special?’” When we asked Participant 17 if he had asked for any accommodations on his QE, he said that he hadn't because he felt he “just needed to fit the mold.” Each of these quotations also displays embedded ableism, in which accommodations are viewed as cheating or expecting special treatment.

Similarly, in our workshop, participants expressed that there are harmful assumptions that graduate education does not need accommodations like undergraduate education, or that if students have made it to graduate school, they could not possibly need accommodations. This was exemplified by one participant's story of disclosing to their professor and then being denied accommodations because the professor did not think their exams were hard. One of the faculty participants expressed that there are other faculty in their department who do not believe in certain invisible disabilities and are even vocal in their disdain for accommodations for neurodivergence.

From our interviews, it is clear that many science and engineering departments are not fostering a culture of accessibility for their students in these doctoral milestones. As Participant

16 points out, oral examinations are an uncommon method of assessment in most STEM courses. These doctoral milestones, for many students, are the first time they experience this testing modality, making it challenging for them to know what they need to be adequately prepared and accommodated.

A couple of students asked for and received accommodations for their QEs or proposals. Participant 2 has Ulcerative Colitis and was concerned about having a flare-up during his exam, causing him to need to step out for an extended period of time. He discussed this possibility with his proctor ahead of time, establishing an informal accommodation to pause the timer on his written exam if he had a flare-up lasting longer than 20 minutes. Participant 5 asked for closed captioning during their qualifying exams because they were “especially very nervous to figure out what the entire question was.” Other participants expressed that they appreciated having autonomy over when they scheduled their QE or proposal so that they could consider their energy level, sleep cycle, medication efficacy, etc. to ensure they would be evaluated under conditions that supported their success.

Additionally, there were a couple of instances of built-in flexibility in programs’ doctoral milestones. 1B offered “a written portion instead of just the oral general knowledge.” 2C had “recently, kind of under the table, decided to be a little bit more flexible with [the timing of the QE] because a few years ago we had a kidney, a student pass a kidney stone in the middle of their [written QE exam], had to go to the hospital, pass the kidney stone and then come back and finish it the next day.” Neither of these examples is particularly revolutionary, but they open the door for programs to consider offering increased flexibility in their doctoral milestones. That said, it should not take a student experiencing a major medical event for departments to realize that an 8-hour test is inaccessible and that they should give students more flexibility.

4.4 Suggestions for Change

One of the interview questions and part of the workshop focused on students' suggestions for improving the accessibility of QEs and other milestones. Participant 7 recognized that how her QE is currently being administered is not accessible for everyone, saying, "I mean, I'm lucky...I don't have an issue with public speaking; I have an issue with tests. But I know that there are some people where it's the opposite." She suggested that "it'd be really cool if they had a few different options of ways to present the information in a way that, like, and then, you know, students can sort of choose what method works better for them."

Participant 17's issue with his QE was based on the purpose of the assessment. Their QE consisted of two, three-hour in-person exams over their four core courses, followed by a weeklong take-home project. He thought that their QE format was "dumb, because it's like [the QE] does not test your capability to do research." Additionally, he recognized that the QE acted as a bottleneck to degree progress, as "about half of people fail at least one of these portions." When asked what he would do to change the assessment, he had many ideas for alternatives that would be better aligned with doctoral student learning outcomes, including a longer take-home project that was tailored to a student's research area or an oral defense. He thought that

[J]ust focusing heavily on the well, 'did you pass the class, the core classes,' I think that's a fine metric... a sit, sit down written timed exam is, I don't know what that's testing. But like, take home like a mini research project, that's testing research abilities.

Workshop participants realized that ableist attitudes underlie all of the negative experiences they shared about the QEs and department policies, and that overall cultural problems in their departments contribute to inaccessibility. As such, they suggested that departments should prioritize educational training about disability topics, including mentorship and accommodations, for their faculty and staff. The participants felt this training could be a helpful step towards breaking down discriminatory and misinformed behavior within academia.

5. DISCUSSION

Formal assessments allow institutional bias to persist when they uphold strict, ableist parameters for time, location, and environment. **Based on our findings, our main recommendation is to eliminate qualifying exams.** QEs are high-stress events that assess 1) knowledge that has already been assessed through coursework, and/or 2) research preparedness that the proposal will eventually assess. Just because a QE is traditionally offered is not a good enough reason to continue the practice. In fact, most doctoral programs in Europe do not have QEs [29]. However, we do recognize that this may be an unpopular opinion, and some institutions have QE requirements that prevent departments from eliminating these exams [7]. Alternatively, we think that there are opportunities for proposals to be reformed to prioritize accessibility. For both QEs and proposals, we challenge programs to consider the following questions:

5.1 What learning goals are you assessing, and are they in alignment with the mode of assessment?

Assessments should align with clear learning goals, and that includes QEs and proposals. From our findings, we see that the main purposes of QEs are to demonstrate a command of general knowledge, which is typically accomplished by required coursework, and to prepare for independent research, which is likely demonstrated in student proposals. Like Participant 17, we question whether a grueling exam in addition to coursework is required. We argue that the successful completion of required coursework is proof that students possess foundational knowledge in their discipline. If the course itself is not adequate proof, then perhaps courses should be modified, rather than requiring an additional comprehensive exam (i.e., QE). Additionally, we argue that in-person, timed, written exams are not aligned with the goal of preparation for independent research. While independent research does require the ability to recall, understand, and synthesize literature, it never requires someone to do this without access to the literature or within a limited period of time.

5.2 Are the learning goals clear and easy to access? Are students given clear feedback for how to succeed?

Learning goals for QEs should be published in an easily accessible place and provided in advance directly to the student so that they understand for what they need to prepare. Beyond learning goals, a list of expectations and a rubric should be provided. From our interviews, expectations that would be appreciated include whether questions will be held to the end or integrated throughout, if knowledge beyond the assigned readings will be assessed, if the assessment is intended to take the full scheduled time, or if the allotted time is a liberal estimate for the task. These details are important for disabled and nondisabled students alike. Additionally, publishing these standards in a graduate program handbook or website holds committees responsible for following them. It also provides space for students to understand the possible outcomes of their QEs and proposals (e.g. pass, conditional pass, no pass, etc.), and to be provided direct feedback on what they need to do to succeed in future attempts. All of this information would similarly help new faculty members joining a department who are mentoring their first students through such milestones.

5.3 Are accommodations for milestones widely recognized and easy to access?

To make QEs and proposals more accessible, doctoral programs should make explicit that they are willing to be accommodating. This starts by building in and/or offering potential accommodations to students before their assessments. In our findings, we see that some students were anxious to disclose their disability to their committee or ask for accommodations for their QE and/or proposal. Doctoral programs can take the onus off of students to request accommodations by asking them for their access needs when scheduling QEs or proposals and presenting a list of potential accommodations they could provide, like closed captioning, extra time, or alternative modalities of assessment. 1B's option to complete their general knowledge exam in either a written or oral modality is a good example of this sort of flexibility. We see

from previous research that simply telling students that you are willing to accommodate them goes a long way toward opening a dialogue, and we think that offering this flexibility could reduce the stress of these important doctoral milestones [20].

6. CONCLUSION

From our findings, we argue that many aspects of QEs and proposals are both unnecessary and inaccessible, including unclear expectations and rigid requirements without room for accommodations. By centering disabled voices in conversations around doctoral milestones, we prioritize accessibility and inclusion in graduate education, allowing disabled students to persist in a space that has historically been exclusionary. As an added benefit, accommodating disabled people often inadvertently proves useful to non-disabled people (e.g., curb cuts designed for wheelchair users are also helpful for those with strollers or wagons) and temporarily disabled people (e.g., allowing students to pause their exam if needed is helpful to a student passing a kidney stone during their exam). We believe that QE and proposal reform are imperative, and doctoral programs should strive to continuously improve these milestones to meet student needs and prepare them for their future careers.

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