WIP: Students' Experiences with Engineering Classroom Exams

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Background

This Work-in-Progress (WIP) paper is part of a larger project focused on promoting fairness in engineering assessment. It explores the undergraduate engineering classroom exam experiences of racially minoritized students at Primarily White Institutions (PWIs). Despite efforts in the United States to advance diversity, equity, and inclusion in engineering (e.g., [1], [2]), significant disparities in educational outcomes persist between White engineering students and their racially minoritized peers [3]. Systemic barriers and racialized experiences hinder their success [4], [5], [6], with research showing that racially minoritized students bring numerous strengths to engineering. These challenges contribute to disparities in outcomes, including differences in sense of belonging (e.g., [7], [8]), course drop or withdrawal rates (e.g., [9]), persistence in engineering education and careers (e.g., [10], [11]), and earnings in the STEM workforce [3]. While researchers have investigated issues that contribute to lower academic outcomes for racially minoritized students such as classroom inclusion (e.g., [12], [13]), hidden curriculum (e.g., [14], [15]), co-curricular and identity-based support, and social capital (e.g., [16], [17], [18]), there is limited research on how engineering classroom assessment practices may contribute to this phenomenon. This paper aims to address this gap by examining engineering classroom assessment practices and understand their possible role in perpetuating inequities.

Instructors use various assessments, such as homework assignments, graded projects, quizzes, and exams, to evaluate and certify the knowledge and skills that individual students have acquired and can demonstrate. These assessment results are compiled and reflected in a final grade for the course. The final grades from all courses are averaged to calculate the Grade Point Average (GPA), a single metric representing a student's academic performance. Recruiters often use GPA as a key criterion when evaluating applications for internships, graduate programs, and full-time positions. High GPA students tend to attract attention and opportunity, while low GPA students are often overlooked [19], [20]. As a result, classroom assessments and the resulting grades and GPA's significantly impact students' futures and act as gatekeepers, particularly for undergraduate engineering students. Given the critical role of assessments and their consequences, it is important to understand the practices that either support or hinder students' ability to demonstrate their acquired learning and abilities. This study focuses on students' experiences with undergraduate engineering classroom exams, as exams are high-stakes assessments that typically contribute the most to a course's overall grade [21].

Examining how students experience exams is crucial, as exams are inherently stressful and may contain underlying biases. Research has shown that exam stress and anxiety can negatively affect student retention and well-being, particularly for racially minoritized students [22], [23]. Despite the widely recognized stress associated with exams, some educators continue to believe that exams are beneficial in helping students develop stress-coping mechanisms [22], [24]. However, it remains unclear whether instructional strategies implemented before exams effectively help students manage stress, as few documented examples of such practices exist. Studying students' perspectives on exams can also reveal biases in the way exam content is designed, taught, and implemented. This is because assessments, specifically exams, often reflect sociocultural values and beliefs, typically those of the dominant culture. Consequently, students' experiences with exams are shaped by their cultural identities and may be influenced by cultural biases embedded within the assessments [25], [26]. Understanding these experiences provides insights into the

instructional supports students need and how to design exams that more equitably evaluate student learning.

Thus, in this WIP, we examine the experiences of racially minoritized engineering students with classroom exams. Our overarching research question is: *How do racially minoritized students experience engineering classroom exams in college?* This paper presents preliminary findings based on semi-structured interviews with four racially minoritized engineering students.

Conceptual framework - Hidden curriculum in engineering educational assessments

We use the concept of hidden curriculum [27] to guide our research and result interpretation. More specifically, we view the concept of hidden curriculum from an assessment point of view, using data on student experiences with engineering classroom exams to explore what hidden curriculum looks like for racially minoritized students. Hidden curriculum refers to any type of implicit, unofficial, or unintended messages, content, expectations that occurred in an educational setting [27]. In engineering education, Villanueva et al. [14] have been exploring the key factors that hidden curriculum stands on and use them to identify and understand the mechanism of hidden curriculum. These key factors include emotions, self-efficacy, self-advocacy, and awareness [14], [15]. More specifically, Villanueva et al.'s model describes that an individual recognizes hidden curriculum through hidden curriculum awareness, which is processed by emotions. Emotions are then regulated by self-efficacy, which ultimately sustains and reinforces the individual's self-advocacy. While Villanueva et al.'s conceptual model is focused on the coping mechanism upon discovering hidden curriculum, our study uses Villanueva et al.'s work on identifying hidden curriculum in engineering classroom exams based on the described mechanism.

Examining hidden curriculum from the assessment perspective entails evaluating the alignment between how the assessment is designed and administered to how students experience them. Hidden curriculum in educational assessment, or more particularly in exams, have been documented as a separate set of expectations additional to the explicitly stated expectations and requirements of the exams [28], [29]. Even with formally stated requirements, varying interpretations can occur depending on the audiences (i.e., the students), and the communicators (i.e., the instructors). As a result, students may adopt different learning or test-taking strategies in the face of unclear, implicit, or highly individual exam expectations or interpretations of expectations [30], [31], [32]. Recently, researchers have examined hidden curriculum in educational assessment by looking at students' experiences, emphasizing on the alignment between the assessment's objective, how the assessment's objectives were conveyed to the students, and how students perceived such objectives and messages (e.g., [31], [33]).

Thus, in this study, we examine student's experiences in taking engineering exams focusing on the alignment between exam expectations (explicit and implicit) and students' perceptions. Through this, we identify existing hidden curriculum in engineering assessments and how such hidden curriculum affect students' emotions, self-efficacy, and self-advocacy.

Method

We conducted qualitative research, relying on individual semi-structured interviews and thematic analysis, to explore how racially minoritized students experience undergraduate engineering exams. Qualitative research allows the researcher to "learn from the participants in a setting or a

process the way they experience it, the meanings they put on it, and how they interpret what they experience" ([34], p.28). Additionally, qualitative research allows researchers to collect rich, in-depth data to capture the participant's point of view and examine constraints of everyday life [35]. In the context of this study, qualitative research allows us to understand students' experiences of engineering exams and identify potential barriers or supports from the students' perspectives.

The semi-structured interview contained 14 questions in total. For this WIP, questions center around exam experiences in undergraduate engineering courses. We recruited participants through a minority in engineering center listserv at a large R1 institution in the Midwest US. The recruitment specified that we were studying students who identified in a racially minority. Interested participants were asked to contact the researchers by email. Participants received a $50 stipend as compensation after the interview. At the time of this paper, we had four participants. Table 1 contains the demographic information of the participants in this study. The interviews were semi-structured with questions focusing on student learning, preparing, and taking exams in high school versus college. We analyzed the interview transcripts using thematic analysis, allowing the researchers to identify patterns of participants' lived experience within the data [36]. Two researchers on the team individually read each transcript several times to gain a comprehensive understanding of how the research participants experience engineering exams. They met twice with a qualitative research expert to discuss and develop themes from the data.

Table 1 *Participant demographic information*

Student Pseudonym	**Gender**	**Major**	**Year in school**	**Race/Ethnicity**	**High school type**	**Exam accommodation**
James	Man	Chemical engineering	Senior	White and Latino/Mexican and German	Private	No
Mark	Man	Mechanical engineering	Junior	White and Hispanic	Public	Yes
Kelley	Woman	Chemical engineering	Senior	African American	unknown	No
Kevin	Man	Material science engineering	Junior	African American/Caribbean	Public	No

Preliminary Findings & Future Works

We identified hidden curriculum in three areas related to engineering exams: knowledge of how to prepare, implicit expectations on student's financial and social circumstances, and exam content. Firstly, students *do not know how to prepare for exams* based on the information available. All four participants revealed that instructors provided insufficient, inaccurate, or unclear information about what will be covered in exams. For example, both James and Kelley talked about how content briefly mentioned in lectures (i.e., single bullet point on lecture slides or verbally brushed over during class) would show up as high point exam questions. Mark recounted a review session where the instructor covered content that did not show up in the exam at all. These mixed and unclear messages from instructors left our participants confused about what specific content to study and how to prepare for their exams. The second type of hidden

curriculum includes a set of *implicit expectations for students* embedded in how instructors help students to prepare for exams or in what students felt are useful to help them prepare. For instance, both James and Mark indicated that instructors tend to host review sessions outside of normal class time, expecting students to attend, without consideration for other obligations such as working. Other participants mentioned a lack of learning materials currently made available, which led to the need to pay for learning services to obtain notes and past exams. Furthermore, students also perceive implicit expectations about their social networks. For example, Kelley spoke about how prior to joining certain social circles and professional organizations she had no access to obtaining privately held past exams resources, and she lacked social connections to students from older cohorts. This hindered her performance in certain classes in which she did not have access compared to her counterparts who did have the access. Finally, hidden curriculum was found in the *exam content*. All participants in our study cited incidents of exam questions assessing problem-solving ability that were not covered in lecture nor practiced in homework assignments, with exam questions assessing content on a more difficult, unseen level than homework or practice problems. Additionally, it was alarming for us to learn that one of Mark's instructors used the exam to assess students' ability to regulate negative emotions during exams. Mark's instructor wanted students to "get scared" when faced with a difficult exam problem.

As a result of the hidden curriculum, three out of four participants in our study experienced great emotional or physical toll, which led to decreased self-efficacy, or worse, stop pursuing engineering. James viewed engineering exams as "de-incentivizing" because they "don't test [him] on the subjects" and is considering a career change despite his initial passion for chemistry in high school. Kelley described engineering exams as "mentally draining", "discouraging", and thus, "hard to motivate [herself] to keep going." Mark, on the other hand, reported alarming incidents of himself and a friend unable to maintain physical health (i.e., lack of exercising, dehydration, and nutrients deprivation) because they needed to prioritize studying and extracurricular activities over self-care.

Classroom assessments, particularly exams, have a large role in students' engineering education. Our preliminary findings indicate that other than institutional, interpersonal, and nonspecific interactions [37], nuances about how exams are designed, administered, and discussed in engineering classrooms become a way of conveying messages of hidden curriculum to students. We found that hidden curriculum exists in engineering assessments in different forms and negatively impacts racially minoritized students' wellbeing, self-efficacy, and retention. Specifically, expectations that students automatically know how to access previous semester exams, can attend review sessions scheduled outside class hours, and have social networks to support their achievement create barriers to students' achievement on exams. These practices that are implied through hidden curriculum create advantages for students who belong to large social networks within each given major and have monetary or social resources, something that racially minoritized students at large, PWI's frequently do not have [37], [38]. Ultimately, such practices serve to create disparities in achievement between students with large networks, historical course records, and few obligations and students with smaller networks and responsibilities beyond classwork. For future works, our focus is to learn about the experiences of more students from multiple institutions and other engineering disciplines. We expect to yield more insights on engineering exam experiences, ultimately providing insights to engineering departments and instructors of the implicit hidden messages they embed in their engineering assessments and

provide education practitioners with recommendations on how to improve engineering assessment methods.

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