



Professional Engineering Socialization at the Intersection of Collective Constructions of Expectations and Individual Shame Experiences

EMPIRICAL RESEARCH

HINDOLO KAMANDA

JOACHIM WALTHER

DAVIS WILSON

NICOLA SOCHACKA

JAMES HUFF

**Author affiliations can be found in the back matter of this article*

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ABSTRACT

Background: Prior work has investigated engineering students' professional formation through the lens of individual experience and from a cultural perspective. The concept of professional shame provides an opportunity to explore students' experiences of disciplinary expectations as situated in a context of engineering social norms.

Purpose: In this study, we investigated (i) how students experienced subjectively not meeting their internalized expectations of what it means to be and succeed as an engineering student and (ii) their reactions and responses to such experiences and how those experiences manifested in the social context.

Methodology: We conducted 10 focus groups involving 38 total participants. We then coded and qualitatively analyzed focus group transcripts using an ethnographic focus on how students encounter and respond to shame within the cultural context. Our data gathering and analysis was theoretically framed by a model of professional shame as a mediating factor in how students interpreted and eventually co-constructed shared engineering expectations and master narratives during their professional socialization.

Findings: We identified six main patterns of responses to shame that students enacted and that, in turn, interacted to form social norms around expectations. These responses, which emerged as nuanced and context dependent, are: (i) hiding (ii) masking (iii) trivializing shame experiences (iv) emulating perceived success markers (v) suffering passively (vi) legitimizing shame experiences. Our findings also demonstrate a complex interplay between the students' individual and professional sense of self that significantly impacts professional socialization in engineering.

Conclusions: Shame has emerged as a key mechanism in engineering professional socialization as students' shame responses influence both their individual identity and the ways they collectively co-produce cultural norms. An awareness of these often-invisible dynamics can enable educators to empathically engage students in ways that allow for vulnerability and struggle while promoting healthy positive development.

CORRESPONDING AUTHOR:

Joachim Walther

University of Georgia, US

jwalther@uga.edu

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Notions of rigor in engineering education have been critically examined for their problematic connotations for engineering learning cultures and negative impacts on students' experience, retention, and diversity (Riley, 2017; Sochacka, Walther, Rich, & Brewer, 2021). Several studies have elucidated this problematic characterization of rigor, including related work on the role of expectations (Kamanda, Walther, Wilson, Brewer, & Sochacka, 2020), academic and nonacademic stressors (Bahmani et al., 2018; Bazeley, 2007; De Castella, Byrne, & Covington, 2013; Thompson, Davis, & Davidson, 1998), as well as a context of high selectivity in engineering programs (Davies & Guppy, 1997; Godfrey, Aubrey, & King, 2010; Slaton, 2010; Valerio, 2014). These dynamics are set against and undergirded by a backdrop of cultural characteristics of engineering learning environments around, for example, competitiveness (Pawley, 2009; Sagebiel & Dahmen, 2006) and masculinity (Akpanudo, Huff, & Godwin, 2018; Holth & Mellstrom, 2011; McLean, Lewis, Copeland, Lintern, & O'Neill, 1997) that have been identified to negatively impact students (Foor, Walden, & Trytten, 2007). An emerging body of work including recent studies in engineering education examines timely issues around student stress (Jensen & Cross, 2021), well-being, and mental health (Ang & Huan, 2006; Furry & Sy, 2015; Hunt & Eisenberg, 2010; Schafer, 1996; Sommerfeld, 2016; Struthers, Perry, & Menec, 2000; Vasconcelos & Almeida, 2018) with their profound impacts on students' learning experiences and outcomes (Bahmani et al., 2018; Bazeley, 2007; De Castella et al., 2013; Hackett, Betz, Casas, & Rocha-Singh, 1992; Thompson et al., 1998).

In the study reported here, we are interested in engineering students' professional socialization (Holland, Lachicotte Jr, Skinner, & Cain, 2001) at the intersection of expectations, disciplinary culture, and individual experience of pressures or stress. More specifically, the aim of the study is to link the often negative, individual emotional experiences students have to influences from the social and disciplinary environment of our engineering programs to understand how this interplay impacts the formation of their professional selves. We draw on the notion of professional shame as a conceptual framework and lens through which we examine students' lived experiences around these issues. Professional shame is defined as "a painful emotional state that occurs when one perceives themselves to have failed to meet socially constructed expectations or standards that are relevant to their identity in a professional domain" (Huff, Okai, Shanachilubwa, Sochacka, & Walther, 2021). Informed by literature in sociology and psychology, as well as our prior empirical work (Huff et al., 2021; Huff et al., 2020; Kamanda et al., 2021, Secules et al., 2021), we anchor this study in the lens of professional shame as a way to closely examine the emotional experiences that undergird professional socialization. Examining emotional aspects of professional socialization helps us to better understand how we can support students in their pathways to becoming engineers—not simply for the sake of increasing retention within the engineering community but rather for the purpose of advancing cultures of well-being and inclusivity. Our previous work has examined the individual experience of professional shame, with implications to advancing personal well-being (Huff et al., 2021), identified specific expectations that reside in engineering education cultures (Kamanda et al., 2021), and the processes by which students construct and enact these expectations (Secules et al., 2021). In this study, we focus our findings on how students construct responses to professional shame, which simultaneously enable them to cope with the painful emotional state while they also reinforce sociocultural narratives that induced their experiences of professional shame. By identifying these responses to professional shame, we aim to provide educators with tools to recognize how education cultures within engineering disciplines might be adversely undermining desired outcomes of social equity and well-being.

To uncover individual experience as situated in the culturally constructed context of the learning environment, we used ethnographically informed focus groups to elicit students' experiences around expectations and particularly the ways in which participants internally processed and socially performed responses to subjectively not meeting those expectations. The qualitative analysis revealed six patterned shame responses that each had significant impacts on students' learning experience and identity development and, at the same time, sent external signals that contributed to social norms and expectations.

In this section, we explore prior work around student stressors and their impacts, the role of engineering culture in the professional formation of students, and emerging scholarship on professional shame. While these factors are individually impactful in education, in this study, we will explore their interplay in the lived experience of engineering students.

Prior research on pressures facing students has identified a range of academic and non-academic stressors resulting from parental expectations, grades, test taking, time pressures, and future plans (Ang & Huan, 2006; Furry & Sy, 2015; Sommerfeld, 2016; Vasconcelos & Almeida, 2018). Related work in engineering identifies similar factors (Kamanda et al., 2020) as well as those unique to engineering students, such as family pressure to study the major (Hackett et al., 1992). In addition to identifying the experience of stress as a major impact of these factors (Archer Jr & Lamnin, 1985; McIntyre, Worsley, Corcoran, Harrison Woods, & Bentall, 2018; Reddy, Karishmarajanmenon, & Anjanathattil, 2018; Schafer, 1996; Struthers et al., 2000), a related discourse is emerging around issues of student mental health (Ang & Huan, 2006; Bayram & Bilgel, 2008; Bottesi, Martignon, Cerea, & Ghisi, 2018; Carleton, Norton, & Asmundson, 2007; Diehl, Jansen, Ishchanova, & Hilger-Kolb, 2018; Grayson, 1998; Heinrich & Gullone, 2006; Hull et al., 2019; Hunt & Eisenberg, 2010) providing a timely reminder of the importance of research on students' emotional challenges.

In addition to psychological impacts, studies have also demonstrated effects of stress on students' learning experience and outcomes (Jensen & Cross, 2021). In the engineering context, Hackett et al. (1992) found that low stress levels and positive outcome expectations increased students' self-efficacy, a factor that, in turn, significantly predicted academic achievement. Related studies identified stress as a key predictor for low student engagement and persistence in engineering and medicine (Bédard, Lison, Dalle, Côté, & Boutin, 2012) as even students with high ability in science often leave STEM-oriented paths due to significant accompanying pressure and emotional distress, whether as adolescents (Webb et al., 2002) or as college students (Hall & Sverdluk, 2016; Webb, Lubinski, & Benbow, 2002). In an overarching sense, student stress and its effects were found to significantly impact students' sense of self and belonging in academic environments in engineering (Felder, 1988) and, more generally, in higher education (Felder, 1988; Parkman, 2016). In the context of diversity and inclusion, prior work has found that the dynamics around stress, learning outcomes, and identity can disproportionately affect students who identify with groups that are underrepresented in engineering (Cokley, McClain, Enciso, & Martinez, 2013; Conefrey, 2001; Foor et al., 2007; Furry & Sy, 2015; Hackett et al., 1992; Jones, Ruff, & Parette, 2013). Associated with influences from their academic environments in engineering programs (Jones et al., 2013; Santiago & Einarson, 1998), underrepresented student populations in engineering may be more vulnerable to negative emotional experiences such as low self-esteem (Santiago & Einarson, 1998). Studies have also identified other related experiences in higher education such as loneliness (Diehl et al., 2018; Heinrich & Gullone, 2006) as well as associated negative outcomes such as decreased academic achievement broadly among university students (Bahmani et al., 2018) and attrition in STEM majors (Valerio, 2014).

In the engineering context, a critical discourse around problematic aspects of educational and disciplinary cultures provides a salient context for the examination of pressures or resulting shame experience for students. More specifically, work on disciplinary cultures and narratives (Committee on Public Understanding of Engineering Messages, 2008; Godfrey & Parker, 2010; Pawley, 2009; Sochacka et al., 2021) has begun to examine their impacts on student learning, retention and diversity (Foor et al., 2007). Prior work has, for example, identified masculinity (Akpanudo et al., 2018; Holth & Mellstrom, 2011; McLean et al., 1997) and competitiveness (Morton, Gee, & Woodson, 2020; Pawley, 2009; Sagebiel & Dahmen, 2006) as cultural characteristics of engineering learning environments. Similarly, studies have identified a prevalent focus on technical aspects and artefacts (Mazurco & Daniel, 2020; Sochacka et al., 2021) over social dynamics and perspectives (Cech, 2014; Garibay, 2015) to be a pervasive and in some ways problematic feature of engineering programs (Walther, Brewer, Sochacka, & Miller, 2020). These cultural characteristics of engineering programs are also associated with the persistent issues of underrepresentation in the field whereby cultural features are not equally attractive to all groups (Committee on Public Understanding of

Engineering Messages, 2008; Faulkner, 2007; Pawley, 2009; Seymour & Hewitt, 1997) or have more direct exclusionary effects (Morton et al., 2020; Riegler-Crumb, King, & Irizarry, 2019).

The individual psychological experiences around expectations, stress, achievement, and belonging have been explored in emerging scholarship around shame. Shame as a psychological concept has been described as a strikingly painful, self-conscious emotion that involves a global devaluation of the self (Lewis, 1971; Tangney & Dearing, 2003). Shame is based on a highly subjective and often harsh, self-defeating evaluation of the self, relative to perceived social expectations (Brown, 2006; Huff et al., 2021). Shame has been explored in the educational context (Felder, 1988; Parkman, 2016; Tempelaar, Niculescu, Rienties, Gijssels, & Giesbers, 2012; Turner & Husman, 2008; Turner, Husman, & Schallert, 2002) and more recently conceptualized as an emotional state relative to organizational contexts (Daniels & Robinson, 2019) and the professional formation of engineers (Huff et al., 2021), doctors (Bynum IV, Artino Jr, Uijtdehaage, Webb, & Varpio, 2019) and nurses (Bond, 2009). This body of work identifies the intensely painful nature of shame experiences for students that often remain hidden in the educational context. In addition, Huff et al. (2021) found a complex interplay of shame experiences with the development and negotiation of personal and professional identities. While focused on internal experiences of shame, this prior study also identified some of the social dimensions of shame experiences whereby students affirm disciplinary and social standards they perceive to have failed and also negotiate their shame experiences through seeking community with others. The framework of professional shame proposed by Huff et al. (2021) served as one of the theoretical frames for this study with more details in the respective section below.

Based on prior work on significance of expectations and profound individual impacts, this study investigates students' shame responses as social actions and considers how they are both anchored in, and contribute to, cultural features of the environment.

THEORETICAL FRAMEWORKS

Our study was informed by two theoretical frameworks that help us define the “social reality under investigation” (Huff, Walther, Sochacka, Sharbine, & Kamanda, 2020; Walther, Sochacka, & Kellam, 2013) and subsequently informed the research design and analysis. First, a prior model of expectations in engineering education (Kamanda et al., 2020) identifies a dynamically interconnected system of expectations for students and describes how distinct ways of students' internalizing these expectations amplify their emotional impact. Second, a framework of professional shame (Huff et al., 2021) illuminates individual, internal experiences of shame, makes their profound psychological impacts visible, and directs our attention to their interplay with cultural features of the context.

A MODEL OF EXPECTATIONS IN ENGINEERING

A prior model of expectations in engineering (see *Figure 1*) categorizes sources that signal, communicate, or define expectations for students and identifies three distinct ways in which students internalize those expectations (Kamanda et al., 2020). More specifically, expectations for students emerge from *superiors* as individuals in an elevated hierarchical position who are sometimes in direct power relationships. A prominent example of this category are instructors who not only communicate academic expectations but can also explicitly or implicitly convey social performance expectations. A related category of *grades* encapsulates academic standards but also takes on a nuanced intersubjective meaning in the cohort as measures of success. Similarly, *peers* serve as a direct comparison and are also a main source of socially constructed expectations around performance and accepted behavior in the major. *Extra-curricular sources* of expectations capture a range of co-curricular activities or achievements that can become a definition marker of success or belonging in the major, for example in the case of internships. *Influences from outside the major* provide external perspectives of how success in engineering is understood and can, for example in the case of parents, have significant impacts on students.

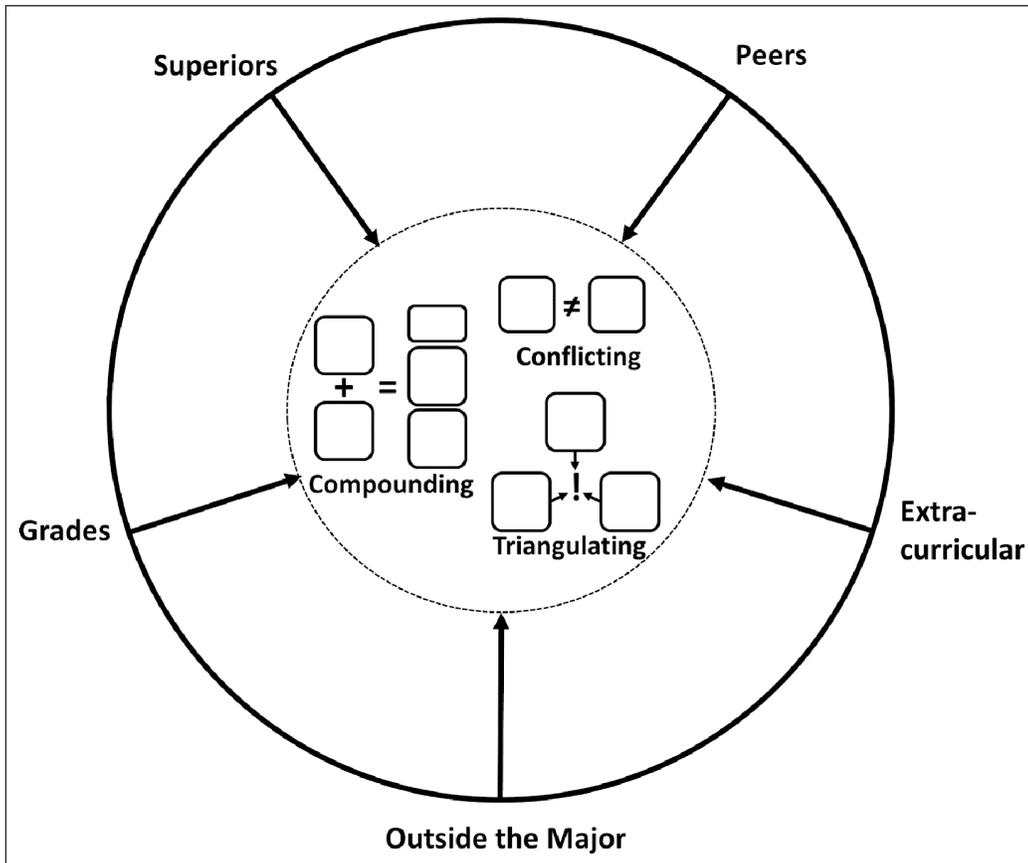


Figure 1 Contextual model for sources of expectations and ways of internalizing expectations (Kamanda et al., 2020).

Individual expectations from these sources are mediated by the cultural context of the discipline and institution to be experienced and internalized in different ways by students. The interplay of multiple sources results in compounding, conflicting, and triangulating of expectations. The mechanism of *compounding* describes a dynamic whereby a student faces a diverse range of expectations that place demands on their time and capacity, thereby amplifying the combined impact on the student's experience, the total weight of the expectations becomes more than the sum of the individual influences. The mechanism of *conflicting* describes multiple expectations that may in themselves be productive but encourage opposed behaviors, norms, or aspects of identity. For example, a perception in the major around the definitional role of hard work as one measure of success in engineering programs can produce a powerful dissonance with outside, for example, parental, expectations around smartness of engineering students linked to effortless achievement of high grades. *Triangulating* of sources describes a mechanism whereby students receive corresponding input from multiple sources thus elevating the importance and weight of a particular expectation. An example is the definitional role that internships can play in students' sense of belonging in the major when this extra-curricular expectation is emphasized by peers, faculty, and student advisors.

In addition to identifying sources and mechanisms, the model identifies a complex, dynamic system of expectations that is socially constructed in the broader educational environments and has significant impacts on students. Through this interplay and the culturally situated co-construction students experience expectations not only around academic standards but also around social performance norms and definitional markers of belonging and identity. With such profound aspects of their educational experience at stake, the dynamic system of expectations sets students up for significant emotional experiences in cases where they subjectively perceive not measuring up to their internalized assumptions of what it means to be and succeed as an engineering student.

In this study, we used the above-described, broad conception of expectations to direct our empirical focus to the contextual, internalized experience of expectations rather than being limited to single, objective markers of performance. This focus informed our data gathering protocols, in

that questions asked students about moments where they subjectively felt that they had not measured up to what they felt was expected of them. Follow-up questions in the protocol were aimed at eliciting the connection between those experiences of not meeting expectations and their relationship to the social context of the program.

A FRAMEWORK OF PROFESSIONAL SHAME

Further exploring the above-described impacts of expectations on students, a model of professional shame (see *Figure 2*) illustrates the interplay of socially constructed expectations and standards of behavior with individual experiences of shame (Huff et al., 2021). The individual's shame experience does not merely respond to a perceived failure to meet academic standards but is situated in a context of social performance expectations that contribute to definitional narratives about being an engineering student and future engineer. In line with research on general shame experiences, professional shame is defined as subjective, sweeping, and often self-defeating judgments that extend beyond issues of individual performance or ability and concern profound questions of personal and professional identity as well as students' sense of belonging in the major or profession. The model further indicates that students' responses to shame occur in an intersubjective context and can, in turn, contribute to the social construction of expectations in the disciplinary and cultural setting.

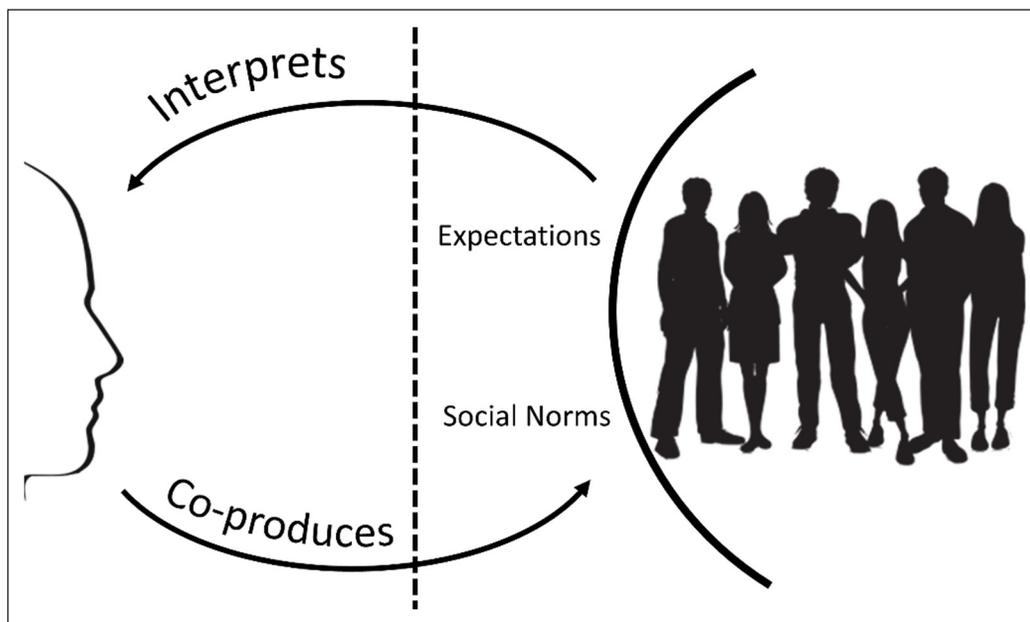


Figure 2 Model of professional shame illustrating individual experiences of professional shame and social impacts of shame responses (Huff et al., 2021).

The notion of professional shame informed the design of this study in two crucial ways. First, the focus on *professional* shame builds on prior psychological work on individual shame while encompassing the social and disciplinary context of those experiences. This focus on the professional cultural context guided our analysis beyond known patterns of *individual shame* to identify shame responses that are unique to professional settings. Second, the notion of professional shame also directed our empirical attention beyond *internal responses* to shame and helped us identify *shame responses as socially impactful actions* that not only shape individuals' socialization in a discipline but also contribute to the co-creation of disciplinary norms and cultures.

RESEARCH DESIGN

The combination of the above theoretical frameworks informed our research design to attend to individual experience of professional shame from not meeting internalized expectations as situated in, and contributing to a broader social context. More specifically, the data collection was informed by an ethnographic approach (LeCompte, 1993; Emerson, 1995) in student focus

groups that elicited meaningful accounts of individual experience framed in the larger discourse and social conventions of the engineering cohort. A total of 10 semi-structured focus groups were conducted with 38 students at two different institutions (see details below). The study procedure was approved by the Institutional Review Board. The focus groups were recorded and transcribed for subsequent analysis.

RESEARCH QUESTIONS

With a focus on students' shame responses and their social manifestations, the study addresses the following research questions:

- How do students experience subjectively not meeting their internalized expectations of what it means to be, and succeed as an engineering student?
- What are students' reactions and responses to such experiences and how do these responses manifest in the social contest?

METHODOLOGY AND METHODS

We conducted in-person focus groups that explored individual students' lived experiences and perceptions around expectations and in particular instances where students felt they did not meet those expectations. The shared discussion in the group provided an understanding of the cultural context in which their experiences of not meeting expectations and potentially resulting moments of shame were situated. While somewhat limiting the depth of individual disclosure of personal experience, the focus group format was conducive to uncovering the cultural, inter-subjective dimensions as the individual's accounts took place in a safe, but nevertheless public forum (Communicative Validation in Walther et al., 2013). In the data we observed that individual students shared individual experiences of perceived failure and often framed them in terms that were appropriate to the group setting. In this sense, the discussion often provided a microcosm of the collective construction of ways of responding to expectations and experiences of shame. For example, individual accounts would often hint at profoundly emotional internal experiences but students would express those experiences and their own reactions in socially acceptable terms that often corresponded to cultural norms in engineering.

The focus group discussions with 2–5 students took about 65–90 minutes and were facilitated by a co-researcher who was not involved in the teaching of the participants' courses. The discussion followed a semi-structured protocol with prompts to elicit individual accounts of subjectively not meeting expectations and follow-up questions that guided students to elaborate on the details and context of those accounts. The focus groups were audio recorded and professionally transcribed with the members of the research team checking the transcripts for accuracy and de-identifying both speakers and individuals named in the discussion. The de-identified data was used for analysis and data presented in this manuscript use consistent pseudonyms for participants.

Research Sites

Data was collected at two institutions, a large research intensive and a small, teaching-focused, and faith-based university.

The research-intensive university offers a comprehensive engineering program with about 2,500 students in eight degree programs. The academic environment is characterized by a significant growth in student numbers and resulted in the introduction of a performance-based enrolment management system. Students apply in their third semester to the major and the selection is informed by grades in core engineering courses and the evaluation of a personal statement. In addition to the demands on students that engineering programs at other institutions share, this application process constitutes additional performance pressures for the students. At the same time, the program has a legacy and current culture of collaboration between students, a strong cohort sense and identification with the major and institution.

The small, teaching-focused university offers five engineering degree programs which enroll approximately 250 students. Although the curricular plan of the engineering programs is, in many ways, similar to the programs at the research-intensive university, the institutional culture at this university is characterized by a holistic focus on the development of whole persons, particularly in relation to faith and spirituality. Students commonly declare their particular engineering major upon admission into the university, and there are no program-specific admission requirements. While students in the engineering program are navigating common expectations of achieving high performance in relation to their coursework, they also actively engage the question of where they should prioritize their engineering activities in relation to who they are as whole persons. Furthermore, the students often have certain professors for multiple courses, which facilitates a salient interpersonal relationship between professors and students at the teaching-focused university.

The diversity of institutional contexts allows the research to uncover robust common patterns and at the same time explore the richness of the ways in which these patterns manifest in the local context (Theoretical Validation in Walther et al., 2013).

Participants and Demographic Information

Across the two research sites, ten focus groups were conducted with a total of 38 participants. **Table 1** below provides an overview of the focus groups in terms of institutional context, participants, and demographic information.

Table 1 Participant demographic data by focus group.

#	INST.	GENDER IDENTIFICATION	RACIAL/ETHNIC IDENTIFICATION	ACADEMIC MAJOR	YEAR/LEVEL
1	RU	4 Men	4 White	Mechanical	1 first-year, 2 sophomores, 1 junior
2		4 Men	4 White	Mechanical	2 sophomores, 1 junior, 1 senior
3		2 Women	1 African American, 1 White	Civil, Mechanical	1 first-year, 1 senior
4		4 Women	1 Asian, 1 Middle Eastern, 2 White	Biological, Computer Systems, Mechanical	1 sophomore, 2 juniors, 2 seniors
5		5 Women	1 African American, 2 Asian, 2 White	Biological, Computer, Mechanical	1 first-year, 1 sophomore, 3 seniors
6	TU	3 Women	2 Hispanic, 1 White	Biological	1 sophomore, 2 juniors
7		4 Men	4 White	Biomedical, Electrical, Mechanical	2 juniors, 2 seniors
8		5 Men	5 White	Computer, Electrical, Mechanical	5 sophomores
9		2 Women, 3 Men	2 Hispanic, 3 White	Biomedical, Electrical, Mechanical	1 sophomore, 4 juniors
10		5 Men	1 Hispanic, 4 White	Mechanical	5 juniors

The sampling strategy and participant recruitment aimed for mostly homogeneous groups in terms of majority and underrepresented participants. Throughout this article, we use the term *underrepresented* to describe gender and racial/ethnic populations, or students who identify with those groups, that are disproportionately underrepresented in engineering. Specifically, our participant pool includes students who identify as women and/or African American, Middle Eastern, Hispanic, or Asian. This research design feature (Procedural validation in Walther et al., 2013) was intended to increase opportunities for participants to co-construct authentic accounts of their experiences (Communicative Validation) in light of the potentially sensitive and emotional qualities of their experiences. More specifically, we observed that in focus groups containing only underrepresented participants, students tended to be more comfortable revealing personally challenging experiences and connecting with other participants' accounts. Similarly, the discussion in groups with majority (i.e., White male) participants tended to emphasize emotional content less and focus more on accounts of individual perseverance or framed individual experience in terms of generalized advice for other students. This sampling strategy did not aim for representation of particular perspectives and we recognize the intersectionality of the identity facets of our participants (Pawley, 2017). Rather, the composition of the focus groups aimed to maximize variation in perspectives and experiences while creating environments where those perspectives could be shared.

Data Analysis

The focus groups were digitally recorded and transcribed. The research team checked the transcripts and de-identified both speakers and individuals mentioned in students' accounts. The de-identified transcripts were imported and organized in NVivo 8 for further analysis.

The iterative analysis progressed from topic coding of accounts in participants' experience-near terms (Geertz, 1974) to interpretive coding that established abstract patterns across the topic codes (Richards, 2005). More specifically, the first level captured how students described instances where they felt they didn't meet expectations in their own terms; categories often used in vivo descriptors to capture both actions and sentiments, such as "power through." In the next step, we clustered these codes and described them at an abstract level to make overarching patterns visible with a focus on understanding individual experience and explicating social impacts, such as "trivializing shame experiences."

The data analysis was conducted by two undergraduate researchers (author 1 and author 3) in collaboration with an experienced engineering education researcher (author 2). The team engaged in multiple iterations with systematic processes of negotiating the emerging interpretations in the whole research team based on review and discussion of primary data (Communicative Validation in Walther et al., 2013). This shared meaning making was supported by systematic documentation in coding reports for each category that followed a common structure and captured the emerging definitions for each code, critically reflective writing about the formation of the category, and notes about connections to other categories (Process Reliability).

FINDINGS

The following presents six main categories of shame responses identified across the data. The first two categories, hiding and masking, resonated with insights from general shame research (Bond, 2009; Brown, 2006; Tangney & Dearing, 2003) but uniquely located the shame responses in the disciplinary and cultural context of engineering. More specifically, the findings show how the shame responses are anchored in particular features of engineering culture and are enacted by students in the social context of the cohort which, in turn, contributes to shared social norms around expectations. The remaining four categories, namely trivializing shame experiences, emulating perceived success markers, suffering passively, and legitimizing shame experiences, emerged as salient features of professional shame in engineering. In particular, these shame responses revealed a complex interplay between students' individual and professional sense of self, dynamics that have significant implications for engineering professional socialization. The responses also emerged as nuanced and context dependent, with multiple students implementing various strains of the same response and enacting varying shame responses in different situations or stages of their engineering education experience.

While the research was designed to elicit participants' experiences of subjectively not meeting expectations, the data also included examples of students' positive responses to feeling challenged by expectations. In contrast to shame, these responses were characterized by students authentically and productively engaging with the emotional challenges experienced. Based on this element of reflexive insight, participants were able to deliberately focus on positive personal or professional growth from a challenging situation. A characteristic element of these productive responses was students' focus on relationships with peers or superiors that included elements of both an empathic connection and of practical support to alleviate and overcome challenges.

1. HIDING

We define the pattern of hiding as students intentionally avoiding situations in which they fear or imagine external evaluation. As a shame response, hiding aims to avert external perceptions, whether real or imagined, that would mirror already-present negative self-perceptions. The hiding pattern is marked by a sense of self-preservation, as students forgo help-seeking behavior in their quest to prevent being or feeling exposed to others. Students utilizing this approach tend to avoid asking questions or demonstrating their ability in an engineering setting. Students who hide tend

to consciously recede into the background in order to avoid such attention, a behavior that may escalate when students are self-conscious of their underrepresented status in engineering or perceive an unsupportive environment.

The following dialogue between female third-year students Cecilia and Olivia aptly illustrates this pattern. It takes place in the context of a larger conversation about common but intimidating engineering stereotypes to which students may not be willing or able to conform, and the ramifications of such perceived discrepancies. Cecilia is a biomedical engineering major and Olivia is a mechanical engineering major.

CECILIA: You get here, and it's like, engineers know everything, they're the smartest people, that's what I hear all the time. And I've come to accept it, you know? But I get in here, and I sit down, and everybody—especially the ones that are top of their class and they're still so smart engineering—it's almost like when you ask a question, I sit in the back a lot, and I will still hear people, if somebody's asking a question, don't get me wrong, but there are not a lot of girls in my class, so most of the time it's guys, and the guys will just be whispering to each other, "Why is he so stupid, why is he asking these questions?" And that's why I don't ask questions. Because I don't want them to say, "Why is she so stupid," because it's not—you know, it's okay—it's kind of okay because he's a dude, but I'm a girl, you know? And it's even worse when there's not a lot of girls. And so they're like she's so stupid, what's she doing here, you know?

OLIVIA: Yeah. Especially about the whole thing about oh, what are women doing in engineering? That's what I got from back home. "Oh, you're a lady in engineering? Like what are you doing here?" (Focus Group 6)

Cecilia begins by describing her experiences with expectations, specifically expectations about being smart which she admits to having internalized as the expectation is triangulated (Kamanda et al., 2020) both within and outside the program ("that's what I hear all the time"). She also reveals that she evaluated herself against other students and concluded that other students are "still so smart in engineering," implying a comparatively negative self-perception. Cecilia then recounts lived experiences where she witnessed her classmates whispering, "Why is he so stupid, why is he asking these questions?" which amplified her own insecurities and prompted Cecilia to regularly withhold her own questions ("that's why I don't ask questions"). Further, she implies that such recurring incidents can render classroom environments less tolerant of questions and more harmful to students already struggling with shame, as those environments echo judgments related to smartness. It seems that she sees value in asking questions and recognizes that others do as well, but she also recognizes a perceived risk associated with being vulnerable in such an environment. Ultimately, she feels compelled to minimize external judgment and decides to join her classmates in their silence.

A notable pattern in our data was that students are less likely to admit to academic struggles if they perceive that they are alone in their predicament. Cecilia's account suggests that this likelihood further diminishes in unsupportive environments. Although such hostile environments likely trouble most students, she laments that the discomfort is potentially more severe for students who are underrepresented in engineering. She even states that "it's kind of okay because he's a dude, but I'm a girl," implying a fear of direct attacks on her sense of belonging within the program. Cecilia feels added pressure because, since "there are not a lot of girls in engineering," negative perceptions about her may extend to the rest of her demographic. These ideas concur with observations made throughout the dataset that underrepresented students exhibited the hiding pattern significantly more than their majority counterparts.

Cecilia's account also illustrates an interplay between internal and external evaluation which even precede her career as an engineering student. Her fear that her peers would say that "she's so stupid, what's she doing here" is shared by Olivia who received similar comments before she even started the engineering program. Such pressures from outside the program appear to have lingering effects in seemingly unrelated settings. The prevalence of such microaggressions (Sue et al., 2007) can motivate students who encounter them to deliberately avoid attention due to a fear of confirming negative stereotypes. These students might even perceive themselves to be

peripheral members of the engineering community—a mindset that can, in turn, shape how they process engineering expectations and respond to shame.

Across the dataset, shame frequently coupled with negative environmental feedback to further discourage vulnerability. Often, this combination silenced students such as Cecilia who perceived the hiding approach as their most secure option while experiencing shame. In a cultural sense, this trend signifies an erasure of meaningful experiences and perspectives that may differ from dominant engineering narratives.

2. MASKING

Similar to hiding, masking describes an individual's effort to shield oneself from external judgment. When masking a shame response, students deliberately maintain a façade of competence and confidence while simultaneously struggling with feelings of inadequacy. This response focuses on appearing capable to others rather than on authentically fulfilling explicit and perceived expectations. This approach stems from a desire to belong, as students privately endure shame experiences in exchange for a positive public image and peer acceptance.

Set in the context of a conversation about how difficult and exhausting it can be to consistently maintain a high level of performance amidst competing expectations, the following exchange illustrates this shame response. Nolan, a junior, and Eli a senior, are both White male mechanical engineering students at the research-intensive institution.

NOLAN: I always feel the need to be more confident about my academic life, than what it actually is, because a lot of times I'm struggling with classes, but I'm also like, yeah, I've got it, don't worry about it. So it's always kind of that mask of like don't worry about me, I'll make it through, but – and there's also me – (laughs) I'm trying to figure out how to phrase this (laughs). There's also this mask of like I make a lot of jokes, right? So that's just my role in the class is I'm the jokester. (laughs) I bring up morale, right? ... But a lot of times I don't feel like making jokes, just because I've been having a crap day, but I always have – whenever I sit down in a chair I'm always like, okay, find a way to make a joke to this class.

ELI: I try to act the same way, but not really for other people specifically, but more like tiny little side comments that cheer me up that other people just so happen to overhear. (laughs) And then they'll laugh about it in class. One of the things I said recently while I was in class, I said if I had subtitles it would just say internally screaming in brackets all the time. (laughs) Because it's so like almost overwhelming how much I'm going through with just things that are happening in my personal life and things that are happening in class and homework and stuff. (sighs) (Focus Group 7)

Nolan begins by expressing a “need to be more confident about my academic life [...] than what it actually is,” suggesting some external pressure for engineering students to appear confident and in control. Subsequently, he admits to frequently “struggling with classes” while trying to convince others that “I got it, don't worry about it.” Nolan's statements indicate some anxiety about being observed too closely by others, so he maintains a confident façade in order to evade feared scrutiny. He strives to assure himself and potential observers of his certainty by cultivating the persona of someone who “will make it through.” To this end, Nolan tries to “make a lot of jokes” and essentially relegates himself to class “jokester,” believing that the student who is always active and buoyant would not be perceived as struggling. He also claims to “bring up morale” with the implication being that only a student who already enjoys high morale could do so. Although he often does not “feel like making jokes” due to his personal struggles, he feels compelled to “find a way to make a joke” in order to mask those struggles and maintain his positive image.

While Nolan hints at personally benefiting from his own cheerful behavior, Eli states this more explicitly (“little side comments that cheer me up”). Eli also describes the personal and professional distress he experiences while making himself and his peers laugh, lamenting that it is “overwhelming how much I'm going through.” He expresses his anguish as a joke perhaps because it is a more acceptable channel in the social context, although it renders his complaints forgettable,

which he apparently prefers. It is interesting to note that this dynamic is recapitulated in the conversation itself as the participants' laughter is contrasted by the content of the conversation and Eli's defeated sigh. Moreover, the vulnerable nature of the discussion above suggests that it represented an opportunity to mutually express concerns and insecurities which students are not often afforded in daily engineering life.

As members of the majority group, Nolan and Eli experience pressure to conform to engineering norms around independence, control and confidence. When they feel inadequate internally, they feign these behaviors in order to convince themselves and others otherwise. However, their majority status in the cohort and outward confidence also establishes this behavior as normal, thus limiting other expressions around negative emotional experiences.

The link of masking behavior to institutional or disciplinary norms emerged as salient in our analysis and this shame response consequently found different expressions in the data set from the two institutions. A candid account by Myles, a fourth-year White male electrical engineering student at the faith-based university, illustrates this dynamic.

Freshman year I was more inclined to put on this fake face. Whereas now not really. It's just people already know me, so I just – I feel like myself, and I think that I'm a pretty genuine person. I can tell who the other genuine people are for the majority of it, but sometimes it is hard to tell because you never know what – if a person's cheating on an assignment or if you – just anything that would flaw their integrity at all. (Myles, Focus Group 7)

Initially, Myles admits, he was previously “more inclined to put on this kind of fake face,” apparently to fit in culturally. He contrasts this statement with a description of his current approach as more genuine and self-assured. Since “people already know” him, much of the pressure he once felt to be an impeccable student and person has diminished, leaving him feeling freer and more authentic. Where students' external projections at the research-intensive institution were often focused on confidence or performance, Myles' account centers on ideals around integrity and authenticity. The behavioral dynamic around masking was similar in both research contexts, but students at the faith-based university often connected this shame response to reconciling engineering expectations with personal ideals in an institutional setting that explicitly values students' integrated development both in their professional and faith trajectories.

3. TRIVIALIZING SHAME EXPERIENCES

The pattern of trivializing shame experiences, or trivializing, is characterized by students downplaying painful emotional experiences associated with perceived or feared failure to meet expectations. Students enacting this response treat emotions as an impediment to success, and often dismiss them as mere distractions to be able to develop a single-minded focus to, as one participant put it, “power through” the task. Accordingly, they request little to no help with their struggles and shut out their social environment. As an external manifestation towards their peers this shame response tends to downplay the effort and uncertainty involved by oversimplifying the challenges of fulfilling expectations.

A group of White male mechanical engineering students' conversation about learning and performance expectations from instructors illustrates this mechanism. The students described not immediately understanding a professor's explanation of a concept and the perceived expectation to gain that understanding without further assistance:

VIC: Usually for me I feel like it's frustrating ... But it motivates me to not want to be frustrated anymore, to figure out the problem so –

BENJAMIN: Yeah, you can either be frustrated, or you can go and figure out how to do it and – Yeah. Get over it. (laughs)

NOAH: You're going to get frustrated pretty quick, but you've got to learn to push that aside and solve it yourself. (Focus Group 1)

Vic acknowledges the emotional significance of the experience as frustrating while also reframing it as a source of motivation to “figure out the problem,” a sentiment that is perhaps more socially desirable in the cultural context of engineering as a field that often posits students as problem solvers. Building on this notion, the participants then frame emotions as obstacles to productivity and problem solving with an intentional element of suppressing the emotions – to “get over it.” Noah affirms this idea “to learn to push that aside and solve it yourself,” a recommendation which oversimplifies both the management of painful emotional experiences, and the process of fulfilling this expectation. His reaction suggests that “figuring it out” is a straightforward process further simplified by eliminating emotional difficulties.

The conversational dynamics of this exchange and the shared way of engaging with emotionally challenging experiences also points to broader socially relevant effects. More specifically, this pattern in the data might represent a broader discourse in the engineering cohort that similarly 1) oversimplifies the significant challenges that engineering students face and 2) denies, or makes invisible, their profound emotional impacts. Across the data, participants offered similar statements often with a degree of outward confidence or framed as generalized recommendations that were disconnected from their emotional experiences, features that would have significant impact imagined in the context of, say, a hallway conversation among students.

Micah, a White male mechanical engineering student, similarly describes minimizing his emotional experience and single-mindedly completing the task at hand when discussing a stressful situation with an important class project:

I guess I did talk to my [partner and to] my older brother who graduated here a while ago. I've got this project, say a prayer just to make sure I can get through it, and then turn my phone off and hunker down in the library for eight hours or so and just get it done, but yeah, I didn't formally reach out to anyone. That was definitely not an inclination of mine. (Micah, Focus Group 2)

Micah's comments provide a glimpse of how daunting the challenge appeared to him (“say a prayer”) and he explicitly describes putting the emotional experience aside to “get it done.” It is interesting to note that this dynamic of isolating himself from his emotions is also reflected in seeking social isolation. He describes his approach to overcoming the challenge as entirely solitary, requiring him to “turn [his] phone off and hunker down in the library for eight hours.” While he mentions potential social support from family members, he dismisses its relevance by subsequently describing his socially isolated approach and explicitly acknowledging his disinclination to seek help from others.

In a direct response to Micah's statement in the same focus group, Derek, a White male mechanical engineering student, further elaborates on the notion of help seeking:

I've talked to my girlfriend about it or something, but I don't reach out to a lot of people about it, because most of my friends are engineering majors. [...] So I don't want to seem like oh, I can't do this, but y'all did it like three years ago or something, you know what I mean? [...] So yeah, like Micah was saying, most of the time you reach out to one or two other people, but for the most part you just hunker down, do it, yeah. That's really all you can do. (Derek, Focus Group 2)

Derek more explicitly acknowledges social support from outside the major and clearly distinguishes this from interacting with other engineering students. In the disciplinary context, his decisions to seek help are constrained by his desire to appear competent to his peers (see Hiding above). Derek's reference to peers who “did it three years ago” indicates that he assumes these students did not experience the same level of challenge. This assumption could be the result of a hallway conversation similar to the one described above, where students trivialize both the magnitude of the challenge and its emotional impacts. Considering the social signals of such responses to others, we observed a level of confidence and apparent concurrence among majority students regarding repressing emotional reactions and avoiding social support.

However, participants in focus groups with only underrepresented student populations tended to describe different ways of responding to shame that more fully acknowledge the complexity of the challenges and the sometimes profoundly painful nature of the experience. In a focus group with only female engineering students, fourth-year biological engineering students Clara and Zoe explored the emotional impact of their fear to not succeed in an engineering fundamentals class:

CLARA: I really can't be withdrawing from stuff, you know? Again, it's one of those things where it's like, can't get a D in something either, so it's like choose your poison, so – but yeah, I feel like that was my most recent not achieving the goal type of thing.

ZOE: I can definitely relate to that, because after taking an exam, like you study so hard for it –

CLARA: Yeah.

ZOE: And you still don't get what you wanted to, that can be real frustrating, and then you have to talk yourself through it, like can you do better? Obviously you can, but how? Next step, what to do. Do you withdraw? Like kind of figure that out.

CLARA: Yeah. And it's stressful, and I feel like you almost need to talk to other people about it too. I had to go talk to my advisor about it and kind of figure out another plan because you know, I just kind of sat around and thought about it myself, and I was like, "Do I tell my parents? Do I not tell my parents?" (Focus Group 5)

In the opening exchange we see Clara and Zoe connect over the sense of desperation they associate with the fear of not doing well in a class. In contrast to the shared narrative in the majority focus group, the participants unpack and add nuance to the emotional state they both recognize. While the male focus group's discussion framed frustration as a distraction to be eliminated, Zoe's use of the word suggests seeing the situation as complex and intractable. Similarly, the phrase "figure that out" is not used to oversimplify the challenge or imply a certain solution, rather Zoe acknowledges her distress and sense of helplessness and affirms her need to engage with and actively process the emotional challenge, to "talk yourself through it." Mirroring the shared unpacking of emotions in this exchange, Clara in turn affirms the significance of the emotion and explicitly states her desire to connect with others. While the connections with others and empathy from others are apparently part of the way in which Clara and other underrepresented participants in the dataset process shame experiences, she also describes a sense of ambiguity around the types of support she can access ("do I tell my parents?"), a dynamic that appears to be anchored in the broader disciplinary expectations for engineering students. Her mention that she "kind of sat around and thought about it herself" speaks to processing her despair, not the apparently simple strategy of seeking social isolation to "power through" the challenge that was discussed by Micah and Derek in the earlier quotes.

This contrast is reflective of a broader trend in the data set, where alternative ways of responding to shame that are grounded in engaging with emotions and seeking support from others, are not perceived as socially desirable or acceptable when trivializing moments of shame becomes established as a norm through the experiences and shared narratives of majority students.

4. EMULATING PERCEIVED SUCCESS MARKERS

The pattern of emulating perceived markers of success, hereafter emulating, captures students' tendency to generate self-assurance by intentionally enacting behaviors and values they associate with engineering success. Students following this pattern attempt to replicate perceived markers of engineering legitimacy they derive from observing their peers or from the values they see reflected in both departmental and institutional culture.

The following quote illustrates the general pattern of emulating and the self-assurance students derive from the process. Benjamin is a second-year mechanical engineering student at the research-intensive university. Here, he responds to a follow-up question from the facilitator about

how he fits his peers into various categories of effort and competence. Benjamin had previously claimed that some of his classmates try to learn and others are “kind of wasting their time.”

I judge it based off who I see here the most ... in the engineering building mostly, because when I was – at least for statics, whenever I was doing my homework, I was doing it down the hall in the 3D lab, so then whenever I saw – you’d see the same people there every day doing their statics homework, so these are the people you’re like okay, you’re working hard, you’re trying to get your homework done and spending hours a day on your homework, and you just never really see the other people. (Benjamin, Focus Group 1)

Benjamin frames his response by suggesting that there is explicit self-judgment and external judgment among students concerning expectations as they observe one another’s behavior. In this case, the expectation is that engineers are hardworking, which he judges “based on who I see here the most.” In focus groups from this institution, we observed numerous instances of peer-to-peer judgments based on visible behavior ranging from answering questions in class to apparent sleep deprivation. Benjamin ties observed behavior of “the same people [who are] there every day” to engineering identity – “these are the people [who] are working hard.” In the context of his own experiences trying to fulfill academic expectations in a challenging Statics course, he also subtly validates his own approach and belonging in the engineering cohort.

He equates success in his Statics course with “spending hours a day doing your homework” – a behavior he exhibits – rather than measurable performances. His assured tone suggests the comfort he draws from this behavior. Evidently, this type of emulating strengthens his perceived engineering identity and replenishes self-assurance lost to potential negative self-judgment around concerns about expectations in the course. The benefit is powerful enough that Benjamin patently prefers association with individuals who appear to demonstrate similar markers of perceived success to “the other people,” because his judgement is based on “who I see here the most.”

As a shame response, emulating allows students to regain a sense of engineering legitimacy by emphasizing values and controllable behaviors that they associate with perceived success and a strong engineering identity.

Within the same behavior pattern, we observed a stark difference in values students emphasize at the two research sites, suggesting a significant influence of institutional and departmental culture on those behaviors and values. Eli, a fourth-year mechanical engineering student at the teaching-focused, faith-based university, was part of a detailed conversation about how interactions with other engineering personnel can influence, as he put it, “how positive and negative you are about your classes [and] social life”. There was a general agreement among participants that these influences can have strong emotional impacts.

Something that we’re reminded of quite often I feel is we’re here to learn to do stuff for other people, because that’s what engineers do. We make life easier for others. And I think that kind of helps with – prudence and thinking about the future, so yes, humility does play a large part, especially with the overall vibe of campus, and the professors to keep our integrity in check, but when it comes down to the base of it all, we’re here to help others. And we’re constantly reminded of that (Eli, Focus Group 10).

Eli describes that a cornerstone value of engineering education at his university is that students are “here to learn to do stuff for other people” because “that’s what engineers do.” After some consideration, he admits that as a student, these values “help with prudence and thinking about the future,” suggesting that he anchors his engineering identity in these values in order to maintain purpose when experiencing shame and doubt about his engineering career, a trend that is reflective of accounts by other students from this institution. These students shift focus from their measurable capabilities to values they relate to a strong engineering identity, in this case a commitment to service and humility, analogous to the above-described focus on hard work at the research institution. Eli communicates the prominence of these values by beginning and ending his

statements with slightly altered versions of “we’re reminded quite often,” implying that he frequently and intentionally applies these perceived values as well. The larger institution evidently reflects these values through the perceptible “overall vibe of the campus” which is aided by superiors, so the culture of the engineering department likely mirrors the culture cultivated throughout the institution.

In response to shame, students may attempt to emulate convenient markers of engineering legitimacy as a way to bolster their perceived engineering identity and regain some self-assurance. They identify these markers based on their perceived image of engineering success, which is defined and reinforced by their engineering environment.

5. SUFFERING PASSIVELY

Suffering passively describes excruciating experiences where students passively endure the overwhelming emotional weight of shame with meager hope for a better future. Often, their emotional torment is magnified by the weight of pressure from outside their engineering environment, particularly parental and financial pressures. A resulting severe sense of isolation may cause students to feel further disconnected from the engineering field, even as they continue in the program.

This pattern is well-illustrated in the following statements by third-year biomedical engineering student, Cecilia. The excerpt is part of a longer monologue describing the influence of parents’ experiences and socioeconomic status on her decision to enter the engineering program, as well as the advice students would give their younger selves to better cope with engineering experiences that may starkly differ from their initial aspirations.

[In my part-time job], I work with babies up to like four-year-olds, and they’re the biggest happiness in my life. [Going to work] is the happiest time I have, and then I come back and I cry for a little bit because I have to do homework – so I would tell myself, just do what you want to do. Because had I believed in myself, I would have tried for sports and everything, because I used to be really athletic, believe it or not, but [being] an engineer has declined what I used to look like. I was good at a lot of sports, and I would have [gone] to college for something, but I didn’t believe in myself, and so I did [engineering]. I just want to make a difference, and I like the teaching part, because I want to – I just like being around kids and – But my mom was like teachers don’t make a lot of money, and there’s that big thing about money, and so I feel like she doesn’t want me to make the same mistakes, so I would tell my younger self to believe in yourself and do what you want to do, because what’s the point in having all the money if I’m not happy? And I’m not happy, you know? (Cecilia, Focus Group 6)

Cecilia vividly describes the disappointment and regret she experiences as an engineering student by contrasting her experience of emotional suffering within the program with joy and hope she enjoys outside of it. She states that working with children is “the happiest time I have,” while the prospect of doing engineering homework drives her to tears. Her distress around engaging with tasks related to her major likely reflects a more painful overall engineering experience. Cecilia further laments her perceived physical decline and withdrawal from sports, and even her opportunity to “make a difference” through teaching, comments that reflect the devastatingly global impact the shame experiences have on her life. These sentiments also suggest that continuously managing professional shame throughout her undergraduate career has devalued both her sense of accomplishment in the major and the anticipated opportunities an engineering degree would provide. In fact, Cecilia directly contrasts her positive financial prospects with her current and expected unhappiness, as she questions “the point of having all this money if I’m not happy.” Accordingly, she conveys an overwhelming sense of regret about choosing engineering as she reiterates that she would advise her younger self to “believe in yourself and do what you want to do.” In other words, the security of an engineering degree is now inconsequential as she dreads her future in the field.

In spite of her disillusionment, she has continued within the program into her junior year, due to a strong combination of financial (“there’s that big thing about money”) and parental (“[my mom]

doesn't want me to make the same mistakes") pressures. She does believe that her mother's direction is well-intended, but ultimately concedes that the outcome has been disappointing thus far as she admits, "I'm not happy." Across the data, participants expressed similarly poignant sentiments of despair, as well as an obligation to complete the program due to parental influence, current financial obligations such as scholarships, future financial prospects, and especially a belief that it is "too late to quit," as a male mechanical engineering student put it in another focus group. This pattern indicates that students who suffer passively through shame might initially hope that their circumstances would improve, but gradually see that hope eroded. However, many of them conclude that it would be too late to leave the major at that point. Relatedly, we observed numerous occasions of engineering students disengaging from the discipline and their own sense of professional identity, with little intention of staying in the field beyond the initial years of their professional career.

In other words, suffering passively has a distinct professional, developmental component, with students feeling progressively more disconnected from the profession while extrinsic factors such as parental influence and financial incentives become increasingly central as these students continue within the program.

6. LEGITIMIZING SHAME EXPERIENCES

Legitimizing shame experiences, or legitimizing, refers to students' tendency to characterize shame experiences as inherent or even definitional elements of engineering education. Since these students view shame experiences as integral to their personal and professional development, they often justify and embrace the degrading effects of those experiences. They might even perceive such experiences to be part of unspoken engineering expectations which are observed in the engineering program and upheld by peers and superiors.

Below we see an example of a student embracing shame experiences as important for development, in the form of a confident monologue by third-year white male mechanical engineering student, Seth. He offered the following comments in the context of a discussion about how one engineering expectation or set of expectations can have global impacts on a student's life, as well as the challenge of overcoming such a magnified obstacle:

I just wonder what people do who don't get broken down like that, you know? I mean, we're really blessed in that way that we get reduced to the pulp, and then it just kind of is able to re-solidify into something better, but I've often thought about that. Honestly – I feel bad for people who don't have it. I mean, what do you do if you've never had to go soul searching like that? What happens when you – Just listening to everybody, the life lessons you pull out of that, what's really important and stuff, I mean, yeah, I really don't care about a 4.0. I'd like a 3.0 and I'm hanging onto that still. You know, but I mean at the end of the day, that's all I really care about. There are way more important things. I just – Kind of serendipitous or funny to hear come out of your mouth, but it's like wow, I think I may have gained some perspective, you know? Actually gotten an education. (Seth, Focus Group 9)

Early on we see Seth assert that "we get reduced to the pulp," vividly describing students' debilitating experiences of identity loss mediated by shame experiences that result from perceived failure in an engineering context. He believes this miserable state often "[re-solidifies] into something better" through an intentional process of introspection and self-inquisition as students "go soul-searching" to rebuild their identity. Seth credits his struggle with important "life lessons" that evidently bolstered his personal and professional development to the extent of paradoxically labelling himself "blessed" to have undergone such an ordeal. Meanwhile, he minimizes the role of academic performance in measuring his achievement as an engineering student, claiming that he maintains what he believes is a satisfactory GPA (3.0), but he does not "care about a 4.0" as there are "way more important things." Specifically, he stresses the depth of his struggle and the "perspective" he believes he gained from it, before ultimately implying that a proper [engineering] education necessitates that students experience and recover from devastating shame experiences with minimal external support.

By generalizing his own experience to the larger student body (“we are blessed”), he presents it as a vital aspect of engineering education, specifically a hazing ritual that apparently should benefit students regardless of their unique circumstances. In fact, he pities “people ... who don’t get broken down like that,” believing that they lack valuable experience and direction (“what do you do”). It is interesting to note that the “people” could refer to either non-engineering students or, more importantly, engineering students who are not exposed to the agonizing shame experiences he described, although either interpretation portrays these experiences as exclusive, formative opportunities for engineering students. Thus, Seth legitimizes shame experiences as specialized vehicles for professional development that all students should navigate as part of their education.

The following excerpt, which features two third-year White male mechanical engineering classmates, illustrates the environmental factors that may influence the legitimizing response. It comes from a larger conversation about participants’ daily experiences with perceived inability to meet the myriad engineering expectations and the sense of despair that may result, as well as how they manage to stay on course in spite of the difficulties:

EZRA: We grumble now in school, but I haven’t heard grown engineers grumble that much. Either they’ve gotten used to it or their lives are just better, [or] maybe it’s because we’re paying [money] for this current suffering.

JAIRO: Yeah, we’re paying instead of being paid.

[...]

JAIRO: I don’t think being happy is an expectation, and if it is, I’m failing at it. Add that to the list of things I’m failing. But I do remember one time where I definitely knew I had failed expectations. [I encountered] one of my professors [who] had just finished grading a test that I did [badly on], so there was a long walk of him telling me how my grades have been dropping and how I can do better, and how I’m expected to do better, because it’s not such a hard class.

So, I knew I had failed “the expectations of my professor,” and he was disappointed in me. And then every test after that, he has reiterated those sentiments, except for the last one that I did considerably better and he didn’t even say a thing. He wasn’t like, “Hey, good job, things are looking up finally, or keep up the good work.” Just an acknowledgement that I did better. No, nothing. [He] just lets me sit in my misery.

(Focus Group 10)

Ezra opens the exchange with a strikingly casual conjecture that “we’re paying [money] for this current suffering,” as if “suffering” is a natural summary of his and other engineering students’ experiences. His assertion apparently stems from his shame experiences in a program that has forced his classmate Jairo to discount “being happy” as an expectation. While Jairo does not define the phrase directly, the context loosely portrays “being happy” as a positive state of personal and/or professional fulfillment. At any rate, this concept of “happy” is presumably absent from his daily engineering experience, which he considers to be marred by frequent perceived failure to meet expectations, hence his working “list of things I’m failing at.” Although the nonchalant tone (“add it to the list”) implies he believes that such a list is reasonable given the myriad expectations he faces, more saliently, he appears resigned to a negative self-perception due to frequently perceiving personal and professional inadequacy.

Relating to Ezra’s characterization of the engineering experience, Jairo describes a memorable event wherein, over multiple interactions, a professor—whose intentions are unclear – seemingly amplifies his shortcomings (“every test [...] he has reiterated those sentiments”) while neglecting to acknowledge his progress, ultimately dampening the significance of Jairo’s achievement and his satisfaction as he continues to “sit in my misery.” By inadvertently worsening a student’s shame experiences and overlooking a clear opportunity to alleviate his misery, the professor appears to signal that Jairo’s negative emotional state is neither noteworthy nor problematic for his overall engineering experience. Such interactions with engineering personnel, coupled with

negative self-perception, can provoke students to “grumble [...] in school” and feel a general sense of dissatisfaction which seems to improve only when they enter the workforce as they “haven’t heard grown engineers grumble that much.” The promise of a happier, lucrative future and the desire to belong to the group of emerging engineering professionals, appear to serve as justification for students to accept misery as part of the journey. More saliently, however, shame experiences, though painful, are depicted as aspects of the engineering program – and perhaps the profession itself – that developing engineers eventually learn to endure.

DISCUSSION

In this study, we examined how students experience perceived failure to meet expectations and specifically their responses to professional shame. In the findings, we explored six shame responses, namely hiding, masking, trivializing, emulating, suffering passively, and legitimizing, to illustrate how they are experienced individually and contribute to shared norms and expectations within the field. Informed by students’ personal inclinations and external social cues, these responses result in a rich landscape of student behaviors that, in turn, bear powerful individual and social significance. More specifically, the shame responses are characterized by self-preserving behavior that often signal a distorted perception of the role of emotions in engineering experiences. Furthermore, in the focus group transcripts, participants are not merely recounting the content of the shame experiences, but through our extensive ethnographic analysis, we were able to highlight the process of shame responses being performed in the social context of the focus groups themselves.

Looking across the shame responses, it becomes apparent that there is a larger dynamic of professional socialization at play, as students exhibit behaviors and beliefs that guide their individual professional development while also co-constructing shared markers of engineering success and belonging. **Figure 3** illustrates the individual emotional and broader social impacts of shame responses that eventually shape students’ identity and co-produce engineering cultural norms.

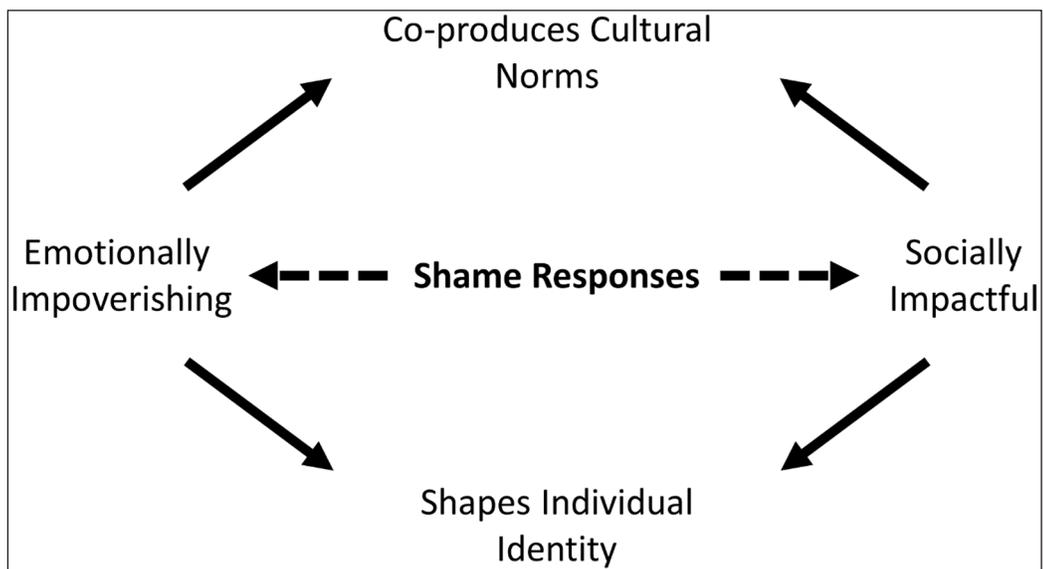


Figure 3 Shame responses at the intersection of individual identity formation and the collective construction of cultural norms.

A shared feature of the shame responses reported in the findings section is that students tend to manage external perceptions at the expense of their significant emotional and often painful internal experiences. This emotionally impoverishing pattern can make internal struggles invisible and prompt students to publicly reframe these experiences to align with engineering social norms they perceive in their environment. For example, when suffering passively through shame experiences in hopes of a fulfilling career as a professional engineer or when trivializing their shame experiences, students neglect to address profound internal struggles while also making

it more difficult for them to connect empathically with their peers, an approach that has been identified as vital for shame resilience (Brown, 2006). Moreover, a distorted perception of the role of emotions in engineering success may cause students to limit themselves by avoiding challenges that may prompt shame responses but could otherwise enhance their development (Dweck, 2015; Hochanadel & Finamore, 2015). Such avoidance occurs most saliently within the hiding and masking patterns where students emphasize self-preservation while limiting or diverting public attention to avoid being exposed.

The diverse set of individual students' shame responses, in turn, generates powerful social signals. For instance, students might emulate behaviors they believe represent engineering success – such as frequently staying late in the computer lab – despite their own inclinations or needs and thereby signal such expectations to their peers. In other shame responses presented in the findings, students misrepresented their emotional challenges to appear more in control by masking or trivializing their shame experiences in the presence of their peers. Such behavior signals that only certain kinds of behavior are acceptable and normalizes them in the engineering environment. For instance, in trivializing their shame experiences, Noah minimized negative emotions as distractions and Micah revealed in his disinclination to seek social support during stressful situations, reactions that publicly spurn empathy and emotional engagement (Cech, 2014).

Students misrepresenting their experiences in this way ultimately broadcast a narrative around embracing rigor and competition (Riley, 2017; Sochacka et al., 2021) while rendering struggle, sharing of emotions, and vulnerability unacceptable in the social context. A parallel dynamic involves students deliberately concealing experiences and tendencies that contradict their perceptions of engineering success, such as requesting help or support from engineering peers and superiors (Herring & Walther, 2016; Wirtz et al., 2018). Due to fear of being judged, Cecilia withdrew into the anonymity of a crowd of classmates who, she believed, understood more than she did. While she might be avoiding negative attention by making her perceived incompetence invisible, she ironically signals that such experiences are rare and should remain hidden. As a result, some students foreground the mechanics of engineering learning in their interactions with their peers, while others silently endure shame and irrepressible emotions such as fear of being unable to provide for their families in the future. The signals – and lack thereof – from the various shame responses aggregate to a deceptive but prevalent image of engineering as a field of dispassionate rigor and competitiveness.

Based on the social impacts of shame responses that make some aspects of students' engineering experiences invisible or others salient, the overall dynamics co-produce social and cultural norms. Larger narratives and cultural features of the engineering environment inform students' decisions to embody more commonly accepted behaviors and perspectives while making the others invisible (Foor et al., 2007). Students might promote and often misrepresent their feats of competitiveness (Sochacka et al., 2021) and stress (Ang & Huan, 2006; Jensen & Cross, 2021) – such as frequent sleep deprivation – to paint a publicly accepted picture of a committed engineering student based on how they perceive the discipline. Some students also make invisible attitudes that they feel do not align with professional engineering culture (Huff et al., 2021), including those around sharing vulnerability, an approach that might otherwise provide productive individual and shared opportunities to process shame (Brown, 2006). These dynamics, in turn, reinforce existing cultural features of engineering as students pursue social and professional belonging. Meanwhile, students who choose to not publicly share divergent preferences, behaviors, and responses to professional shame consequently do not contribute to co-constructing engineering norms. Thus, the discipline remains unrepresentative of these students who perceive a discrepancy between their personal identities and engineering as they understand it, with negative effects on their sense of engineering identity and belonging (Faulkner, 2007). A correlation between these tensions around identity and student persistence has been established in the broader literature (Viviane et al., 2018). In their quantitative study of undergraduate professional identity development and persistence in engineering, Burlison, Major, Hu, and Shryock (2021) found that low professional identification in numerous students led to a non-inclusive environment that perpetuates dominant features of engineering culture and alienates individuals with a different perspective.

These dynamics of social signaling and co-constructing disciplinary norms, in turn, provide a powerful context for individual students' engineering formation (Fabre, 2015). The findings of this study indicate that shame responses can play a central role in how students think of themselves as engineers, and importantly how they engage with emotions in personal and professional contexts. A student with recurring shame events might favor specific response patterns to cope. Over time, those patterns infuse their professional identity, ultimately shaping their self-perception and priming them to evoke those same disciplinary narratives (Pawley, 2009; Sochacka et al., 2021). In a study of college students' psychological well-being and self-regulated learning, Davis and Hadwin (2021) found that patterns of psychological well-being and academic engagement over time may influence regulatory responses to challenges or vice versa. The findings presented here suggest that these response patterns also govern how students prioritize expectations and then evaluate themselves against the co-constructed markers of engineering belonging and success. More specifically, students tended to emulate visible behaviors that lead to – or signal – engineering success, but those behaviors eventually become part of their professional approach after years of practice. Long-term immersion in a system of expectations can impact both professional vision and motivations for continuing within the field. For example, a first-year student who learns to legitimize shame experiences as vital to engineering success eventually becomes a professional engineer or educator who seeks, advocates for, and even perpetuates such experiences. In sum, shame shapes developing engineers' professional identities by determining how they maintain their long-term fit within the field along with the disciplinary narratives they personify.

While the study did not focus on systematically identifying differences across demographic groups, the analysis revealed some key dynamics that were inherently informed by experiences of underrepresentation. More specifically, majority students tended to highlight experiences that concur with conventional engineering narratives, when in focus groups with each other, including those around emotional detachment by publicly legitimizing or trivializing shame experiences, a dynamic that often played out in the focus group discussions themselves. These approaches are often not available to underrepresented students. Due to a sense of visibility and exposure (Settles, Buchanan, & Dotson, 2019), participants belonging to groups that are underrepresented in engineering more frequently described amplified shame experiences that resulted in perceived threats to their engineering status and identity. Prior research confirms that women and other underrepresented students exhibit a less secure identification with the engineering discipline (Brainard & Carlin, 1998; Marra, Rodgers, Shen, & Bogue, 2009; Viviane et al., 2018). In our participants' experiences, such dynamics often led to hiding or passive suffering responses rather than the more socially dominant patterns around trivializing or legitimizing shame experiences. Further, the numerical advantage of the majority group affords them control over cultural narratives, which limits the impact of broader, divergent messages, particularly those informed by the experiences of underrepresented students. These shame-mediated dynamics interact locally to construct an engineering environment wherein culture is far more actively shaped by the majority group than underrepresented groups.

As a result, shame experiences and responses emerge as a key mechanism in engineering students' professional socialization that significantly shapes individual students' sense of professional self while creating and maintaining cultural norms that exclude some student groups from developing and succeeding as engineers.

IMPLICATIONS FOR EDUCATORS

Prior work has highlighted that empathetically communicating expectations and engaging with experiences of struggle is crucial to promoting a constructive learning environment with high student performance (Kamanda et al., 2020). The present study, along with the prior work discussed here, uncovered the extent of shame experiences' detrimental emotional impacts on students' development and identity formation. Since shame experiences result from a perceived failure to meet expectations, educators should be mindful when communicating negative evaluations to students, even as a way to foster motivation. For instance, when suggesting that a particular outcome is achievable for a specific student, we should consider their unique circumstances

and not imply that they should not struggle or that the material is straightforward. Further, we should emphasize that their identities are independent of their ability to meet academic and non-academic expectations and support them in adopting a growth mindset-based approach (Dweck, 2015), to their education when they feel challenged. Considering the evidence that personal struggles can amplify shame experiences, we should also prioritize students' wellness which has a strong correlation to academic achievement (Collings & Eaton, 2021; Davis & Hadwin, 2021) in addition to its general benefits for student satisfaction. Shame also has negative effects on motivation and self-efficacy, which is a well-established factor in student achievement (Schunk, 1989; Witt-Rose, 2003; Yusuf, 2011). We can help mitigate such occurrences through empathy and support, thus advancing students' personal and professional development. Often, the shame responses discussed in this article manifest almost immediately, sometimes automatically. We can further limit shame by promoting empathy and understanding in teaching situations where shame experiences are frequent – as identified by the data – such as when distributing graded tests or during lectures. For example, when publicly inviting questions, we can combat the hiding pattern by adding that other students probably have a similar question. We must strive to create learning environments where students can learn and grow from their perceived failure and where students are inclined to engage in help-seeking (Herring & Walther, 2016; Wirtz et al., 2018).

The inherent invisibility of the socio-cultural dynamics of shame presents multiple challenges to moderating their detrimental impacts. It may be difficult for educators to anticipate shame experience in an effort to counter the results before they take effect. A deeper understanding of expectations and the variety of shame responses described in this article may provide a useful starting point. In addition, we must balance our awareness of these dynamics with measures that honor our students' autonomy and individual privacy. As educators we might be tempted to directly inquire about these experiences, but this approach might lead to some students feeling further exposed and displaying stronger hiding or masking patterns. Instead, as co-producers of cultural norms and expectations, educators should cultivate a supportive and understanding environment that makes room for emotional experiences, vulnerability, and empathy while promoting excellence (Huff et al., 2021; Secules, Sochacka, Huff, & Walther, 2021). Students should be aware that we acknowledge their unique challenges and will support them if they ask. This approach would render their unseen struggles more visible while empowering them to share their specific stories and to inspire others to do the same, fostering a new dynamic around mutual empathy and support, which are more constructive alternatives to shame responses. The result would be a more balanced and inclusive co-construction of engineering norms that ultimately enhance the discipline's development and ability to attract and retain more diverse groups.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR AFFILIATIONS

Hindolo Kamanda

University of Georgia, US

Joachim Walther  orcid.org/0000-0002-5310-8731

University of Georgia, US

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