The Role of Expectations in the Educational Experience and Professional Socialization of Engineering Students

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Academic and non-academic expectations contribute to students' stress and impact achievement and retention. This qualitative study investigates how expectations are socially constructed in engineering programs and internalized by students. Data was collected in focus groups with 38 participants at two universities. Using constant comparative methods, findings identify sources of expectations and mechanisms by which students internalized these. Sources comprise academics, superiors, peers, extra-curricular, and influences from outside the major. The mechanisms of compounding, conflicting, and triangulating show that the interplay of expectations amplifies their emotional impacts. Implications for educators are to communicate academic standards without inadvertently reinforcing problematic social performance expectations.

Keywords: engineering education, expectations, student well-being, professional socialization, student experience

INTRODUCTION

Student stress has received increased scholarly attention across a wide range of disciplines (Ang & Huan, 2006; Felder, 1988; Furry & Sy, 2015; Grayson, 1998; Hull et al., 2019; McIntyre et al., 2018;

Parkman, 2016; Ramirez-Arellano et al., 2018; Reddy et al., 2018; Struthers et al., 2000), and more recent discussions around student mental health (Bayram & Bilgel, 2008; Bottesi et al., 2018; Carleton et al., 2007; Diehl et al., 2018; Grayson, 1998; Heinrich & Gullone, 2006; Hull et al., 2019; Hunt & Eisenberg, 2010) provide an urgent and timely reminder of the profound importance this aspect of the student experience. Prior research on academic and non-academic pressures (Furry & Sy, 2015; Kohn & Frazer, 1986; Sommerfeld, 2016; Verger et al., 2009) has explored their impacts on stress (Archer Jr & Lamnin, 1985; McIntyre et al., 2018; Reddy et al., 2018), anxiety, and mental health (Bayram & Bilgel, 2008; Bottesi et al., 2018; Diehl et al., 2018; Grayson, 1998; Heinrich & Gullone, 2006; Hull et al., 2019; Hunt & Eisenberg, 2010; Verger et al., 2009). Related strands of scholarship have explored negative impacts of stressors on students' learning experience and outcomes (Bahmani et al., 2018; Bazeley, 2007; De Castella et al., 2013; Thompson et al., 1998) as well as their self-efficacy and sense of belonging (Cokley et al., 2013; Felder, 1988; Foor et al., 2007; Parkman, 2016). In the context of diversity research, scholars have found that minority students can be disproportionately impacted by those stressors and their consequences (Cokley et al., 2013; Conefrey, 2001; Foor et al., 2007; Furry & Sy, 2015; Hackett et al., 1992; Jones et al., 2013).

The study reported here is set in engineering, a learning environment often characterized by perceptions of high academic standards (Riley, 2017; Sochacka et al., 2014) and set in a cultural context of competitiveness (Pawley, 2009; Sagebiel & Dahmen, 2006) and high selectivity (Davies & Guppy, 1997; Godfrey et al., 2010; Slaton, 2010; Valerio, 2014). Studies in this disciplinary context found that the range and extent of expectations on engineering students are critically relevant for student achievement (Hull et al., 2019; Jones et al., 2013) and retention (Valerio, 2014), with a particular focus on the impacts on underrepresented groups in engineering (Conefrey, 2001; McGee & Martin, 2011). A related strand of the engineering education discourse examines cultural influences and pressures on students' experiences and their professional socialization within the overall context of engineering programs (Godfrey & Parker, 2010; Lameres et al., 2019; Pawley, 2009; Sagebiel & Dahmen, 2006; Sochacka et al., 2014).

The study reported here focusses on the role of expectations in shaping engineering students' overall experience and thereby explores some of the causes, trigger, and dynamics that underlie the impacts of stressors discussed above. More specifically, we are interested in how students come to experience and understand overall expectations of what it means to be and succeed as an engineering student. While stated academic performance standards play a role in students' experiences, we defined expectations more broadly as the implicitly assumed or explicitly stated markers of success and belonging in an engineering program that are collectively constructed in the academic environment. Studying the broad experience of expectations in engineering is particularly relevant as the context is likely to make the profound impacts on students visible in terms of both their individual learning and their overall socialization in the program.

To understand both collective construction and socially situated individual experience of expectations, focus groups with an ethnographic orientation towards the broader cultural context were used to elicit rich student accounts and shared narratives. The qualitative analysis of the focus group data uncovered categories for sources of expectations and distinct patterns in the ways students come to internalize these expectations. These findings have significant theoretical implications for our understanding of how expectations are formed and received by students, insights that also inform tangible recommendations for educators around the ways we communicate academic performance expectations.

LITERATURE REVIEW: EXPECTATIONS, IMPACTS, AND PROFESSIONAL SOCIALIZATION

A growing strand of scholarly dialogue in higher education explores connections between students' emotional experiences caused by pressures and stress and student achievement and retention. Relevant studies identify general academic pressures including parental expectations, grades, test taking, time pressures, and future plans (Ang & Huan, 2006; Furry & Sy, 2015; Sommerfeld, 2016; Vasconcelos & Almeida, 2018) as well as those unique to engineering students, such as family pressure to study the major (Hackett et al., 1992). Some studies specifically focus on student stress (Schafer, 1996; Struthers et al., 2000) and impacts on students' mental health (Ang & Huan, 2006; Hunt & Eisenberg, 2010).

Students often experience anxiety due to the stress induced by these expectations as well as fear of failure to fulfill them (Cokley et al., 2013; De Castella et al., 2013; Hunt & Eisenberg, 2010; McClain et al., 2016). In the context of a study on psychological distress in college students, Bottesi et al. (2018) found that anxiety and intolerance of uncertainty can lead to negative beliefs and outcomes expectations that can affect student performance (see also: Carleton et al., 2007). A study of engineering students (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 (Bédard et al., 2012) as even students with high ability in science often leave STEM majors due to significant accompanying pressure and resulting physical and psychological distress (Hall & Sverdlik, 2016; Webb et al., 2002).

Minority students can be disproportionately impacted by such emotional experiences due to their socio-demographic characteristics (Bayram & Bilgel, 2008; Cokley et al., 2013; McClain et al., 2016; Phillips, 2015) in conjunction with their academic environments (Jones et al., 2013; Santiago & Einarson, 1998). As such, minority students may be more vulnerable to negative emotional experiences such as loneliness (Diehl et al., 2018; Heinrich & Gullone, 2006) and low self-esteem (Santiago & Einarson, 1998) as well as associated negative outcomes such as decreased academic achievement (Bahmani et al., 2018) and attrition (Valerio, 2014), although these outcomes are certainly not unique to minorities. Negative emotions can also diminish student motivation, which may impair learning strategies and student achievement (Ramirez-Arellano et al., 2018).

The complex interplay of emotions and behaviors is especially applicable to engineering, a field in which students' self-perception, behaviors, and performances are often shaped by the context of their academic environments (Foor et al., 2007; Jackson, 2018; Pawley, 2009; Sochacka et al., 2014). Prior research identifies a range of emotional experiences as vital in social contexts, such as loneliness (Diehl et al., 2018), and in the academic settings, such as assessment anxiety and similar pressures (Bahmani et al., 2018; Parkman, 2016; Struthers et al., 2000). Emerging scholarship on students' professional socialization indicates a reciprocal relationship between students' perceptions about themselves and their environments (Vasconcelos & Almeida, 2018) and their experiences in those environments (Stansbury, 1986; Vogt et al., 2007). The environments are in turn guided by a set of academic and non-academic expectations (Furry & Sy, 2015; Schilling & Schilling, 1999; Sommerfeld, 2016) that inform the social and professional formation of students (Zoghi, 2015). Some of these broader cultural dimensions of expectations for engineering students have been explored in studies of student experiences (Foor et al., 2007) and have more recently received attention in studies of larger cultural features (Committee on Public Understanding of Engineering Messages, 2008; Godfrey & Parker, 2010; Pawley, 2009), disciplinary narratives (Sochacka et al., 2014), or metaphors (Lee, 2019) that describe and, in turn, shape the field.

RESEARCH QUESTION

Building on this prior work, the present study explores students' lived experiences of expectations in the larger cultural and disciplinary context of engineering. Aligned with the interest in potentially negative impacts on students, the study intentionally focused on experiences when students subjectively perceived not having met expectations.

More specifically, the inquiry addresses the following two research questions:

1. What are sources of expectations for engineering students that emerge from their overall educational experience?
2. How are these expectations experienced and internalized by students, in particular when students perceive not meeting expectations?

RESEARCH DESIGN

Informed by the theoretical framing around the collective, social construction of expectations, the data collection was based on an ethnographic approach (Emerson et al., 1995; LeCompte et al., 1993) in student

focus groups (Barbour, 2007; Morgan, 1988). More specifically, the data gathering as well as the subsequent qualitative analysis purposefully attended to the cultural context in which students' expectations were situated and that profoundly impacted their lived experiences of those expectations. A total of 10 semi-structured focus groups were conducted with 38 students at two different institutions (see details below). The focus groups were recorded and transcribed for subsequent analysis in the qualitative analysis software NVivo (Bazeley, 2007).

Methodology and Methods

The focus groups explored individual students' lived experiences and perceptions around expectations with a view to understanding the cultural context in which their perceptions of and reactions to those expectations were situated. More specifically, the protocol elicited individuals' experiences around expectations, and the facilitator followed up with questions that established the details and context of individual experiences. The facilitator initiated the discussion with a question about the context of expectations in the engineering program. To ground the discussion not in students' perceptions but in their lived experiences, the facilitator's follow-up questions prompted students to recall specific incidents or times when they experienced not meeting explicit or perceived expectations. This focus also aligns with the theoretical framework of shame that guided the larger study's design.

The focus group format was then conducive to uncovering the cultural dimensions as the individual's accounts took place in a safe but nevertheless public forum. In the data, we observed that students expressed their individual experiences in terms that were appropriate to the group setting and that the discussion often provided a microcosm of the collective construction of expectations. 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 around rigor and hard work in engineering.

The focus group discussions with 2-5 students took about 60-90 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 expectations and follow-up questions that guided students to elaborate on the details and context of those accounts. As a whole, the focus groups started with a broad exploration of expectations with a shared discussion that prompted further recall of experiences. Subsequent questions explored particular areas of expectations that had emerged as significant in the present or in prior focus groups.

The focus groups were audio recorded and professionally transcribed with the research-team members checking the transcripts for accuracy and de-identifying both speakers and individuals named in the discussion. The deidentified 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 (RU) and a small teaching-focused, faith-based university (TU).

The RU offers a comprehensive engineering program with about 2200 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 enrollment-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 all engineering programs 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 TU offers five engineering degree programs that enroll approximately 250 students. Although the engineering programs' curricular plan is, in many ways, similar to the programs at the RU, the institutional culture at the TU 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.

The diversity of institutional contexts allows the research to uncover robust common patterns and, at the same time, explore the richness of the ways these patterns manifest in the local context (Theoretical Validation in Walther et al., 2017).

Participants and Demographic Information

Across the two research sites, 10 focus groups were conducted with a total of 38 participants. Table 1 provides an overview of the focus groups in terms of institutional context, participants, and demographic information.

TABLE 1
PARTICIPANT DEMOGRAPHIC DATA

#	Inst.	Gender	Racial Self-identification	Majors	Year / level
1	RU	4 Men	White	Mechanical	1 freshman, 2 sophomores, 1 junior
2		4 Men	White	Mechanical	2 sophomores, 1 junior, 1 senior
3		2 Women	African American, White	Civil, Mechanical	1 freshman, 1 senior
4		4 Women	Asian, 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 freshman, 1 sophomore, 3 seniors
6	TU	3 Women	2 Hispanic, 1 White	Biological	1 sophomore, 2 juniors
7		4 Men	White	Biomedical, Electrical, Mechanical	2 junior, 2 seniors
8		5 Men	White	Computer, Electrical, Mechanical	5 sophomores
9		2 Women, 3 Men	2 Hispanic, 3 White (1 female, 2 male)	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 minority participants. We defined minority and majority status in terms of race and gender. This research design feature (Procedural Validation in Walther et al., 2017) 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 minority focus groups, students tended to be more comfortable revealing personally challenging experiences and connecting with other participants' accounts. Similarly, the discussion in groups with majority 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 our participants' identity facets (Pawley, 2019). Rather, the focus groups' composition aimed to maximize variation in perspectives and experiences while creating environments where those perspectives could be shared. Accordingly, the analysis does not aim to establish systematic

differences between the participant groups, a focus that is beyond the scope of this study and the subject of future work.

Data Analysis and Research Quality

The iterative analysis progressed from topic coding (Richards, 2005) of accounts in participants' experience-near terms (Geertz, 1973) to interpretive coding that established abstract patterns across the topic codes. More specifically, the first level captured how students described sources of their expectations in their own terms, e.g. "student clubs." In the next step, these codes were clustered and described at a more abstract level, e.g. "extracurricular influences," a higher-level category that also included perceived student expectations around the topic code of "internships."

The data analysis was conducted by three undergraduate researchers (authors 1, 3, and 4) 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., 2017). 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).

Alongside the interpretive coding, the team engaged in shared model building activities. As functional relationships between categories seemed to emerge, we attempted to capture these in multiple iterations of visual models. Where the connections between topic categories provided a sense of additional explanation or resonance, the data set was re-coded for those functional patterns. For example, the findings that capture the ways in which students internalize expectations were the product of this systematic process of model building and re-coding.

FINDINGS

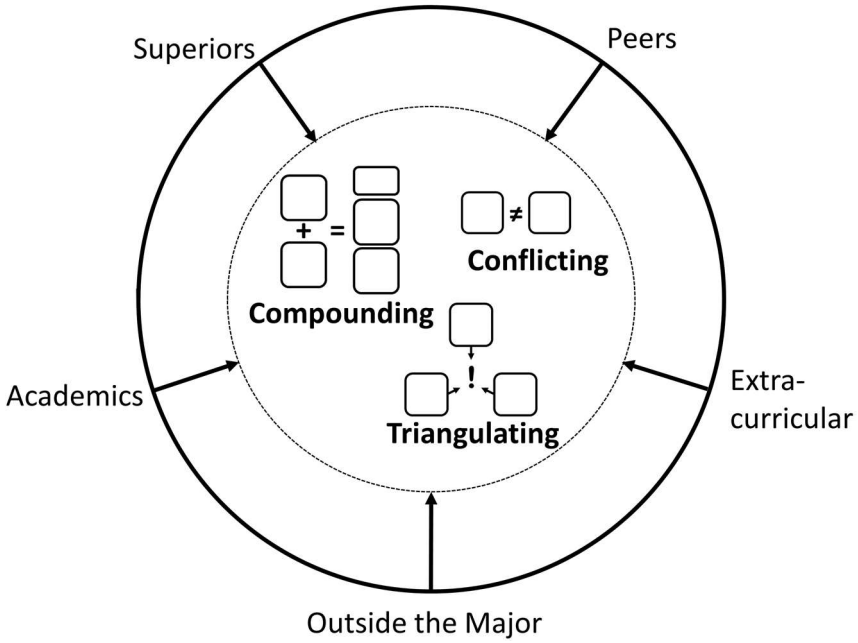
The following provides an overview of the sources of expectations described by the participants. Based on these categories, the second part of the findings identifies three distinct ways in which these expectations dynamically interact and are internalized by students as the *compounding, conflicting,* and *triangulating* of expectations. Figure 2 provides a contextual model to illustrate the analytic categories and their functional relationships.

Sources of Expectations

In our analysis of expectations through which students internalize and interpret socially constructed standards within the degree program, five major sources emerged that capture an intricate web of expectations – namely, academics, engineering superiors, engineering peers, extracurricular activities, and entities outside the engineering major.

Invariably, **academics** was a principal expectation source for many students due to its directly evaluative nature and significant implications. For our purposes, academic sources of expectations were defined as all activities, assessments, and requirements that serve as measures of engineering students' academic competence. An example of such expectations is a course exam that evaluates students' knowledge and understanding of the relevant course material.

FIGURE 2
CONTEXTUAL MODEL FOR SOURCES OF EXPECTATIONS AND WAYS OF INTERNALIZING EXPECTATIONS



The following statements from Tehzlyn, a second-year mechanical engineering major, illustrate students' academic responsibilities, specifically managing their own learning and preparing for academic evaluations.

> *"I think that what you're saying, they can't cover everything in a class, and so it's expected that we're going to have to do a lot of self-teaching and self-learning at home, and especially with classes that have pop-quizzes, and so you know, you'll have to really be on top of things, [...], so keeping up with that and balancing those classes -- the material of the classes weekly" [Tehzlyn, Focus Group #4]*

The student describes a clear expectation to independently master course material and to demonstrate mastery by performing well on quizzes. Across the data, assessments were a central theme of this category, particularly in the context of stress. On the surface, grades serve as a straightforward, quantitative measure that provides clarity about academic requirements, an element unique to this expectation source. However, that clarity is tempered by the stress of the academic expectations themselves, as well as the potential implications of failure to fulfill them. Tehzlyn, for example, describes an overarching expectation to "keep up" that emerges at a more personal level across multiple courses' seemingly well-defined levels of academic performance.

In addition to academics, expectations also resulted from the influence of **engineering superiors**, who were defined as entities within the engineering major in a position to directly and professionally impact students' grades, learning environment, career-related decisions, and other engineering experiences. These entities range from individuals such as professors to organizations or academic units such as the student advising center.

For example, if an instructor unknowingly creates a hostile learning environment with rigid expectations and methods, the learning experience can become extremely stressful, given the instructor's position of power in that context. The following exchange describes such an environment and depicts students' experiences with stress as a result of harsh learning conditions mediated by a superior's influence.

John is a second-year mechanical engineering major, while Jackson is a senior mechanical engineering major.

They articulate similarly negative experiences with the same professor, despite taking his course in different semesters.

> *"JOHN: I feel like he does that just to teach everyone a lesson (laughs), to wake up early. So that's kind of just the kind of guy he is. He assigns homework, and then doesn't ever take it up, and gives you pop quizzes that are based off the homework. So the only way of making sure you do your homework is he gives you pop quizzes, which are a significant portion of your grade.*
>
> *JACKSON: He's a very traditional engineering guy [...] You know, you shouldn't have any social life. You should be going home and studying.*
> *[…]*
>
> *JOHN: The whole way the class is run is like [...] He'll -- If you don't know the answer to a question he'll harp on you for a good five minutes.*
>
> *JACKSON: Yeah. It was a stressful class. (laughs)*
>
> *JOHN: It is really stressful." [Focus Group #1]*

Here we see students articulate experiencing stress due to the classroom conditions created by a professor. While the professor's expectations are not inherently harsh, students perceive an attempt to send a message ("teach everyone a lesson") about how developing engineers should conduct their lives even outside the classroom. Though the instructor's goal may be to encourage learning, his approach stifles the learning process and introduces stress to an extent that it may appear to students that he deliberately attempts to cause distress. The consistency of the effects of his philosophy – illustrated by statements such as "the whole way the class is run," "it was a stressful class," and "it is really stressful" – suggest that this salient experience is shared by a significant portion of his past and present students, as well as students of professors with similar approaches. Therefore, a vital element of expectations from superiors is the way these expectations are presented and may imply social or cultural norms to students.

On a more horizontal hierarchical level, **engineering peers** can serve as a prominent source of expectations for engineering students, due to proximity and shared norms and behaviors. Engineering peers were defined as other engineering students with experiences and challenges comparable to those of the student.

A common example of such expectations is female students who feel pressured to display predominantly masculine behaviors such as competitiveness and assertiveness, even when such behaviors are not aligned with their personality or values. The next two quotes work in tandem to illustrate this point, with the first quote from Vivian (junior computer engineering student) recounting some of the negative peer influences, and the second quote from Kia (first-year mechanical engineering student) describing a reactive behavior associated with such treatment.

> *"The guys in engineering make me really mad a lot of times, because they're -- (sighs) They look down on you because you're a girl, especially in one that's almost all guys. They're like oh, you're doing this, okay. I'm like okay, yeah, I'm actually trying." [Vivian, Focus Group #6]*
>
> *"Because -- I don't know, it just makes me feel like I'm a competitive person, but not oh, I'm trying to be better than everybody else, but I don't like to feel lesser or not as capable,*

or even people to assume that I am not – [that they assume] incapabilities of me. So I'm less likely to raise my hand and ask for help."[Kia, Focus Group #3]

In recounting a snide show of approval from a male student, Vivian presents a common theme in the data, that female students receive occasional but powerful comments that question their competence. Her emphatic account emphasized with a "sigh" highlights the frequency of the experience and the distress it brings. Chiefly, women perceive these comments as disrespectful and sexist and suffer threats to self-perception resembling the one Kia describes. Thus, Vivian's experience illustrates how gender-related peer expectations are constructed, while Kia explains how they are perceived from a minority perspective. While experiences of underrepresented students powerfully illustrate the role of peer influences, similar constructions and perceptions of such expectations were frequently described by other participants, indicating the significant influence of peer-related expectations on students' experiences.

Extracurricular activities were also identified as a vital source of expectations for students, especially professionally oriented ones such as internships and student organizations. They were defined as activities with no direct academic intent but are managed alongside academics in order to enhance professional development.

The expectation to obtain an internship in order to solidify one's engineering self is a common example that can severely impact a student's self-perception if not met. First-year mechanical engineering student Kassidy expresses the general awareness of this expectation in the department, as well as the personal stress she experiences as a result of it.

"Right now is the time for applying for internships. So all my friends are applying for different internships and I'm not, because I don't know where to find one, and I have looked and most of the ones that are interesting to me, they require like experience that I don't have at the moment, so I'm just putting that off for now, but I feel pressure" [Kassidy, Focus Group #5]

Principally, Kassidy discusses an inability to obtain an internship due to lacking both information and experience ("I don't know where to find one," "they require experience that I don't have"). As a result, she has postponed her internship search, likely in order to gain additional experience. However, she clearly experiences pressure, because "right now is the time for applying for internships." Here we see an element of time associated with these expectations that introduces additional pressure on students. Even though a freshman student herself, Kassidy buys into a widespread sense of urgency among engineering students, especially juniors, who often believe that they cannot fit the expected level of extracurricular activities into their overall studies.

Equally powerful for contributing engineering expectations are entities completely **outside** of engineering. This category is broadly defined as individuals or organizations who express judgments about a student's status as an engineer or what it takes to be an engineer. As a prevalent theme, these individuals tend to be family members who exert undeniable influence on students' self-perception.

For example, parents' high expectations can significantly increase a student's stress levels, particularly when they suggest that high achievement is part of their innate ability. In the following statements, fifth-year civil engineering student Jade narrates her experience with her parents who believe that her mediocre performances were entirely due to a lack of effort on her part.

"My parents were really disappointed (laughs) with my grades, -- […] Because they expected high grades out of me, and oh, well, you're not studying enough, or you know, they just thought I wasn't trying or that I was you know, maybe socializing too much and not studying enough, so -- I think that is definitely an expectation to be -- to do well in your classes and -- as an engineer. [Jade, Focus Group #3]

Jade discusses the experience of a typical engineering student, who probably excelled in earlier stages of her education but does not achieve the same level of grades in her engineering studies. Her parents believe that she has the innate ability to continue her excellence in the engineering program, so the disappointment is not just with the performance but the student herself. In their view, the only reason why Jade would not be a high achiever is a lack of effort. Jade's account serves as an effective lens for observing the distress caused by high parental expectations. There is also the general perception that engineers naturally excel ("as an engineer"), which exists beyond the program and introduces an extremely potent layer of pressure, especially for students who once excelled in school. In this way, entities outside of the major can have powerful input on the construction of expectations within engineering.

Ways of Internalizing Expectations

Each of the above sources of expectation can have varying levels of impact depending on the priority and context of the source as well as the students' own values and prior experiences. The next level of findings describes three mechanisms through which sources interact to impact a student's perception of expectations as well as their self-perception relative to those expectations. The individual mechanisms are not specific to specific expectations, but the same expectation can be internalized differently depending on the student and the context. More specifically, compounding, conflicting, and triangulating of expectations describe dynamic ways in which expectations interact with often amplified impacts on students' emotional experiences.

Compounding Expectations

Compounding expectations are defined as expectations from multiple sources that encourage a similar set of behaviors, thus amplifying the impact of those expectations. Students are generally concerned about meeting expectations from various sources and may prioritize those influences differently. Although each source contributes distinct expectations, they can combine to construct a system of expectations about engineering identity and performance. This coherence is largely due to a silent dialogue among the sources, as each source essentially presents its own interpretation of the engineering field. Each resulting expectation contributes appreciable levels of pressure, so compounded expectations are likely to induce substantial stress as students feel compelled to meet every expectation in order to maximize their chances of success. Due to the demanding nature of the engineering major, however, fulfilling compounded expectations often proves challenging as students struggle to manage various responsibilities in an attempt to establish a holistic engineering identity.

As an example, the following quote demonstrates the lived experience of Kia, a first-year mechanical engineering student. While success as a student is evidently central to her developing engineering identity, fulfilling other expectations contributes critically to her overall sense of competence as a developing engineer. While endeavoring to become a well-rounded engineering student, she experiences severe stress associated with simultaneously maintaining all aspects of her engineering identity.

> *"I'm not just a student, even though I am a student first, I'm not just a student. I work as well, and I'm in three or four different clubs, so I have to show if I'm thinking, okay, I want a job or an internship, I have to be a well-rounded person who can handle these kinds of stresses of having a job and getting your school work done, and being a part of clubs, and showing leadership, and this, and that, and […] I just need more hours in the day." [Kia, Focus Group #3]*

Kia's statements suggest that she is overwhelmed by the compounding expectations not just because they each require time and effort but also because the resulting system of expectations appears greater than the sum of its parts. In other words, instead of simply attending to a series of responsibilities, she attends to one major responsibility, which is to track and satisfy all the individual requirements necessary to become well-rounded. This system of expectations induces additional stress partly because it seems to create an interminable process of identifying and accomplishing a collection of goals, without even a clear idea of

success. Profoundly, she implies that a primary objective might be to simply demonstrate an ability to handle various kinds of stresses ("I have to be like a well-rounded person who can handle these kinds of stresses"), because in her mind that constitutes well-roundedness as an engineering student. This belief that experiencing high amounts of stress correlates to one's legitimacy as an engineering student emerges throughout the data, as does the frustration ("I just need more hours in the day") that accompanies an inability to effectively and consistently satisfy the system of expectations student experience. Compounding expectations produce such powerful reactions because they imply that a deficiency in any expectation category is a deficiency in meeting the overall structure of expectations, which indicates deficiency as an engineering student, regardless of other accomplishments. Thus, this mechanism represents a fundamental interaction of external expectations to construct a system of expectations focused on stress and activity that in itself becomes an overarching yet ill-defined meta-expectation.

Conflicting Expectations

Conflicting expectations represent an additional way that expectations interact to have significant implications for engineering students' experiences. This mechanism is defined as expectations from multiple sources that encourage opposing/conflicting norms and behaviors. While the conflicting expectations can both be positive and productive, their opposing demands on the student introduce an additional layer of uncertainty. Thus, conflicting expectations can produce a powerful dissonance as they lead students to wonder what defines a successful engineering student and the relevance of each perceived expectation for achieving this status. This dissonance exists because the expectations require students to develop competing facets of their engineering identity, so that efforts to meet one expectation decrease their ability to fulfill the other. With expectations derived from multiple external sources, students are frequently compelled to favor one aspect of their identity at the expense of another trait, behavior, or skill.

The mechanism of conflicting expectations can pull students in several opposing directions and is perhaps most evident if observed with two starkly contrasting expectations. The following statements are from Dale, a junior mechanical engineer at the faith-based institution, whose personal growth is seemingly at odds with his academic obligations. He expresses difficulty fulfilling both expectations due to the competition that exists between them.

> *"I have tried to be involved in our clubs, holding offices and positions that require us to do things outside of the engineering department, and that's been kind of hard to do with all the time that we spend in the engineering department building doing homework. Then [University] being a Christian university expects us to grow as Christians and to get ourselves in the community and do different things which are very good things, attend Bible studies, go to church, which are very good things, but when you spend every day going to bed at 1:00, 1:30 because you were doing homework, waking up at 7:30 because you have more homework to do before class starts, and then going to chapel, and then going to class until 3:00 or 4:00, and then going to the engineering building and doing homework until 1:30, it's hard to find some personal time for you and for your faith to grow" [Dale, Focus Group #10]*

Dale describes expectations whose impacts conflict almost directly with each other, as he experiences some personal and spiritual stagnation due to his academic dedication. His academic expectations (classes and homework) compete directly with vital extra-curricular expectations (personal and spiritual growth, as well as community involvement) which originate from his institution's culture. At some level, we recognize the issue of time, but more prominently the student talks about developing facets of identity that each require extensive personal investment. His current investment in academics damages his ability to develop as a Christian because progress in one area hampers progress in the other. We see that even though both identity facets are salient and positive on their own, Dale experiences a significant struggle when attempting to satisfy both demands simultaneously. Consequently, he might perceive that a thorough fulfilment of his academic expectations might detract from his community involvement and spiritual growth while the latter

would benefit from a decrease in academic obligations. Thus, the expectations are not inherently conflicting but are internalized as conflicting due to the investment required for each, escalated by differences in the facets of identity each one emphasizes, i.e., professional development and personal development. This pattern of experience was conspicuous across the data, by similar sentiments of essentially developing one aspect of identity at the expense of other positive elements.

In addition to conflicting facets of identity, students also experience dissonance with regard to academic talent and effort. The following example provides an illustration of this second strand of conflicting expectations. Tehzlyn, a second-year mechanical engineering major, describes her experiences sharing her major with non-engineers who assume that inherent intelligence is a definitional aspect of engineering. However, she expresses a conflict between those outside expectations with engineering expectations of hard work and dedication as well as an inclination toward the latter.

> *"[…] I always say mechanical engineering, and I feel you guys too, a different person would be like oh, he must be so smart, and I don't really know how to respond to that, because I'm not the best at math. I feel like in engineering you've just got to work hard and train your mind to think a certain way, but I know that -- I don't know. It doesn't mean that we're all intelligent and super smart." [Tehzlyn, Focus Group #4]*

Tehzlyn talks about the expectation to be smart simply due to her status as an engineering student. This expectation from entities outside the major is extremely common, a fact pointed out by the student herself ("I feel like you guys too"). Across the data, "smartness" emerged as a salient marker of engineering students' identity in their transition from high school, which is eventually lost as they struggle to meet the academic requirements of the engineering program. Their struggle is more due to dramatic increase in rigor and expectations for performance that may require some adjustment than an ineptitude for engineering coursework. As a result, their transition from high school is essentially followed by a transition from their "smart" identity to embracing expectations of hard work within the department. Therefore, when entities outside the major introduce expectations about "smartness," these expectations conflict with the hard-working identities the students have constructed. They experience severe dissonance as they are faced with assumptions they no longer identify with, as much as they would like to relate. This dissonance is partially aided by a common sentiment identified in the data that being intelligent means not having to work hard and working hard means that intelligence alone is not enough. Tehzlyn expresses this idea in her statements ("it doesn't mean that we're all intelligent and super smart") by implying that "smartness" and hard work are mutually exclusive. She suggests that having to work hard and not being naturally proficient at math inherently suggests some inadequacy in intelligence. Across the data, outside expectations regarding "smartness" and engineering expectations about hard work are discussed in a similar manner that presents them as conflicting expectations, with emphasis on one aspect automatically decreasing emphasis on the other, due to the implied mutual exclusivity. The result of this idea is basically a choice of one expectation to fulfill when students are faced with both expectations about hard work and expectations about "smartness."

These examples demonstrate a mechanism through which expectations from different sources are set against each other through dissonance and forced choice, even though the expectations are rarely inherently conflicting. More specifically, "being smart" and "working hard" are not mutually exclusive but are culturally constructed as binary choices. Accordingly, the data presents salient and prevalent expressions of conflict when certain expectations clash, suggesting conflicting expectations as a prominent mechanism in the way students form their perceptions of engineering expectations.

Triangulating Expectations

Triangulating expectations constitutes the third mechanism through which expectations interact. In this pattern, similar expectations from multiple sources encourage the same behavior or emphasize the same aspect of engineering formation. It is different from the compounding mechanism in that the subsequent stress overload is due to an exaggerated emphasis on a particular expectation rather than the influence of

multiple expectations. The perception of one expectation from multiple sources serves as a steady reminder that amplifies its importance in engineering, which can be extremely stress-inducing because it creates the appearance that a sole expectation is the primary marker of engineering performance, identity, or belonging. The perception of a single expectation as the defining factor for the student's success in engineering can diminishes the significance of other expectations in comparison. Through this gradual process, external sources of expectations can influence students' perception and valuing of an individual expectation—and indeed other expectations—regardless of their own preferences and values.

The following quotes illustrate how a single expectation can appear ubiquitous when reinforced from multiple sources. The students describe how the consistent input from multiple entities regarding the extracurricular expectation for students to obtain internships can establish internships as a fundamental measure of engineering success and achievement.

> *"For electrical and computer, the expectation is to get an internship, you're expected to get an internship after your junior year [...] if you don't get an internship you aren't really going to get a good job. And so [professor] is like, oh, let's -- every time you go to talk to him about anything he's like okay, so let's talk about internships" [Vivian, Focus Group #6]*

> *"I always get those e-mails from [internship coordinator] about the different internships" [Kia, Focus Group #3]*

> *"[...] when I look at all these people around me I'm like wow, that's so cool, my friend's doing this, doing that, I have to do something. I need to do that. I need to get the internship." [Elsa, Focus Group #5]*

Each statement describes one source of the same expectation, with "professor" and "internship coordinator" being both superiors and "people around me" being peers. Since the expectation itself is of the extracurricular type, a variety of sources contribute to this mechanism. We recognize that the statements represent the perspectives of different students, but they also portray common experiences which students encounter and could encounter regularly. In fact, all three students attend the same institution and imply that these experiences are not at all unique to them: Vivian states, "[…] you're expected to get an internship […]", Kia describes mass emails which nearly every student receives, and Elsa mentions "all these people around me [are getting internships]," an observation any student could make. Since these expectations are echoed throughout the engineering environment, they become definitional elements of engineering requirements, as expressed by Vivian ("if you don't get an internship you aren't really going to get a good job"). Across the data, internships are viewed as important for experience, and triangulation can cause an overload that is extremely stress-inducing for students. Other expectations have similar effects on students' perceptions, as they are echoed throughout the social and cultural environment. Prominent examples are expectations about grades, hard work, and campus involvement. Such expectations are internalized more intensely because their ubiquity would suggest a fundamental significance for students' engineering identity. In this way, certain engineering expectations gradually rise in prominence from a personal and professional perspective, which changes how they—and other expectations—are perceived.

DISCUSSION

The findings provide an overview of the sources of expectations for engineering students, some of which mirror prior research in engineering education (e.g. Hackett et al., 1992) or other educational contexts (e.g. Ang & Huan, 2006; Sommerfeld, 2016). Beyond this overview, the codes for the sources of expectations also illustrate the varied complexity of a network of expectations students experience. In other words, this landscape of expectations is dynamic, varied, and interconnected. For example, the findings show that students perceive related expectations from within the engineering context (e.g. peer, superiors)

and from outside (e.g. non-engineering friends, parents). The internal sources are often steeped in the disciplinary culture (Godfrey & Parker, 2010; Pawley, 2009) and provide specifically constructed versions of what those expectations mean. The outside sources of expectations do not have the same connotations of disciplinary culture and might in some ways diverge from internal expectations while sharing central elements. For example, within the engineering environment participants described how expectations around academic success are informed by notions of rigor and hard work (Riley, 2017; Sochacka et al., 2014) without necessarily implying top grades. For outside sources, parents' expectations might center more on high grades and frame success through notions of "smartness" that they associated with engineering as a field. This interplay of these signals that tell students what it means to be and succeed as an engineering student suggests a robust and compelling system of expectations. Common cultural threads affirm expectations and place them in context of disciplinary characteristics and narratives. The variations and tensions at the level of individual signals that students interpret create a vibrant engagement of participants in these processes of social construction.

This dynamically interconnected nature of the system of expectations also emerged as a significant factor in how students experienced and internalized those expectations. That is, students' subjective self-assessments were not based on objective academic standards but were informed by exposure to the systemic functioning of a landscape of expectations. On the level of the public discourse around engineering education, Sochacka et al. (2014) similarly describe a dynamic autopoetic system (Bednarz, 1988; Blaschke, 2008; Geyer, 1992) that discursively constructs definitions of engineering. More specifically, definitional narratives about engineering gain significance through the variations and, sometimes, tensions between the ways those definitions are articulated. The patterns around compounding, triangulating, and conflicting interactions between sources of expectations shed further light on this systemic functioning. Compounding speaks to the scope or magnitude of expectations that students perceived across the various aspects of their educational environment. The data analysis showed how the subjective perception of aggregated expectations can leave students feeling overwhelmed and discouraged. Conflicting expectations amplify the impact of expectations, particularly when the conflicting signals pit significant aspects of students' lives against the socially constructed ways of being an engineering student. Triangulation showed how variation and confirmation of expectations from different sources can similarly amplify the weight and importance of those aspects in an individual student's subjective perception.

The thick description (Geertz, 1973) from the data also illustrate the emotional significance of students perceiving that they do not meet these individually and socially constructed expectations that are often amplified by the above dynamics. While the focus of this study was on the collective construction of expectations, participants' accounts suggest profound internal emotional experiences. The focus group format of gathering data was not designed or suitable for eliciting more nuanced accounts of internal experience. However, the quotes show significant signs of students' distress in the face of subjectively not "measuring up" to the disciplinary expectations and norms. In the data, the distress was often connected to feeling overwhelmed, experiencing a sense of inadequacy, or questioning one's belonging in the major. Such empirical hints at the profound emotional impacts of expectations link this work to emerging scholarship around the role of shame in education. In the engineering context, James L. Huff et al. (2020 (in press)) conceptualize "professional shame to be 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." Their work explores the internal individual experience of students to better understand the depth and scope of emotional impacts on students (James L. Huff et al., 2018; James L Huff et al., 2016) with significant impacts for discussions of student well-being and retention. The facets of disciplinary culture that became visible in the analysis presented here suggests opportunities to further investigate ways in which perceptions or definitional narratives about engineering are shaped by the social construction of expectations. We showed that these processes can conflate academic performance standards with cultural expectations of what it means to be an engineering student or a professional engineer. A deeper study of these dynamics could help us understand how expectations, their social construction, and individual shame experiences not only impact students' learning experience and outcomes but may also lie at the heart of professional formation and socialization processes.

The above insights about the students' experiences with expectations have implications for educators in engineering and can provide interesting insights in their transfer to other disciplinary contexts. The analysis shows that when educators communicate expectations or standards of academic performance to students, we are part of and contribute to a dynamic ecosystem of expectations, whose interplay can result in significant pressures and emotional challenges for students. Prior literature in education suggests a significant role of expectation in student engagement (Collaço, 2017) and advocates for educators to establish high academic expectations to promote student learning (Chickering & Gamson, 1987; Collaço, 2017; Mahoney & Choe, 2016). While we do not disagree with the recommendations, we contend that the study presented here paints a more nuanced picture of expectation's role in education that warrants a critical examination by educators. More specifically, the culturally informed facets of the ways in which expectations are experienced by students and the role that instructors can play provide an opportunity to consider that when we communicate expectations about performance or achievement in our courses, we are also telling students something about their field of study. For example, in the engineering context, we might inadvertently reinforce cultural notions of rigor (Riley, 2017) and hard work that not only shape the student experience in our programs but also their beliefs of what engineering is, what makes a good engineer, who should be an engineer, and, ultimately, who should not (Sochacka et al., 2014). In other words, we should strive to find ways to communicate performance standards without stating or implying culturally definitional facets of engineering that might be problematic for students' experiences or exclusionary for some groups. If we realize that communicating necessary standards in a specific course is situated in a larger cultural construction of expectations, we might consider balancing these signals with other messages in the broader context. For example, an instructor might communicate performance expectations clearly in a course but also discuss their commitment to supporting students and make room to productively engage with the emotionally challenging experiences students may have.

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