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”Emotions can hinder Professional Experiences:” Emotional states of first-generation engineering students when introduced to hidden curriculum

Dr. R. Jamaal Downey, University of Florida

Dr. Downey has been a postdoctoral research associate in the Department of Engineering Education at the University of Florida since 2021. His current research is focused on determining how engineering students respond to hidden curriculum as well as how Latinx contingent faculty experience workplace inequities in engineering. He received his Ph.D. in Language, Literacy, and Culture in Education from the University of Massachusetts-Amherst. Dr. Downey focuses on critical qualitative inquiry with a discerning eye toward humanizing and culturally sustaining pedagogies.

Idalis Villanueva Alarcón, University of Florida

Dr. Villanueva Alarcón is an Associate Professor in the Engineering Education Department at the University of Florida. Her multiple roles as an engineer, engineering educator, engineering educational researcher, and professional development mentor for underrepresented populations has aided her in the design and integration of educational and physiological technologies to research 'best practices' for student professional development and training. In addition, she has developed methodologies around hidden curriculum, academic emotions and physiology, and engineering makerspaces.

Dr. Victoria Beth Sellers

Dr. Victoria Sellers is a postdoctoral research associate in the Department of Engineering Education at the University of Florida. Her current research is focused on determining how engineering students respond to hidden curriculum. Victoria has previousl

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Introduction

Hidden curriculum (HC) has been viewed as the unwritten, unofficial, and often unintended messages (e.g., assumptions, lessons, values, beliefs, attitudes, and perspectives) that are not openly acknowledged in a given environment [1]. HC often consists of positive (inclusive) or negative (exclusionary) systemic messages that are structurally supported and sustained [2]. HC affects everyone but people with limited access to social and institutional capital are the most prone to be affected negatively by HC (e.g., first-generation) [1],[2].

The U.S. Department of Education classifies first-generation (FG) college students as those who came from families where neither parent obtained a four-year college degree [3]. FG students are disproportionally people of color (POC) [4], therefore their disenfranchised and marginal identities are intersectional [5]. The literature suggests that FG students are not given access to important social and institutional capital specific to engineering programs that allow them to navigate their learning and working environments similarly to their non-FG peers. While Moll et al. [6] stress the importance that different funds of knowledge should be seen as assets, their different funds of knowledge are seen through a deficit lens rather than assets. Additionally, most FG students might not have obtained the institutional and social capital needed in engineering that could help them better process their emotional experience [7]. Non-first-generation students (non-FG) have a larger pool and/or community who are closer to the field of engineering which might also include how one might navigate the emotions of an engineering program [7]. Having social capital in engineering has proven to have several benefits such as higher academic achievement and academic performance, increased retention, and a stronger sense of their engineering identity [8]. This paper brings forth and identifies the emotions that FG students have while unpacking hidden curriculum in engineering education.

One FG participant stated, “emotions can hinder professional experiences.” This is a daunting reality for FG students and can lead to negative emotions, which have an impact on their success, both in school and in industry. Given the lack of social and institutional capital that FG status carries, along with the impact that negative emotions have on both teaching and learning, the researchers felt it was vitally important to understand how FG engineering students emotionally interpret HC. By neglecting the power of emotions in both engineering and engineering education, emotions could (and have, given the example above) be used to maintain HC and its subservient ways to perpetuating an uneven, unequitable, and dehumanizing system that privileges dominant identities at the expense everyone left in their wake. This paper seeks to understand the emotional self-expression of underrepresented FG (and their intersecting identities of race and gender) engineering students when asked about their previous experiences and perceptions with hidden curriculum in engineering. Additionally, this paper attempts to provide a more comprehensive understanding of the importance and power that emotions—of both the student and teacher— have on the success of the classroom and students’ success.

Background

The presence of hidden curriculum in classrooms has been well documented [9] [10]. While a large portion of the research for, and in, the area of HC has been in sociology, education, and medical science, much less focus has been given to the HC in STEM. Recently, there has been

more attention paid to the way that HC operates within engineering education [11]. While HC was originally understood to convey the learned behaviors of children in school such as manners, timeliness, and turn taking as cited above, study of HC has begun to unpack the ways that HC perpetuates and normalizes dominant narratives in schooling through the veil of professionalism, standards, and norms that are structurally supported and sustained through individuals, social groups, or systems to maintain a status quo.

Villanueva et al. [1] created a validated instrument to explore the perceptions of engineering undergraduate students, graduate students, and faculty about HC, how it is defined, received, and responded to. As explained in prior work a validated instrument (UPHEME) [1] to measure the HC in engineering was created. With this instrument, four factors were identified: Hidden Curriculum Awareness (HCA) which is a factor by which information being communicated is discerned; Self-efficacy (SE) that serves as an igniter towards behaviors and actions to counter the HC; Self-advocacy (SA) is considered an outcome of the framework where an action (negative, positive, or none) is taken; and most important for this study, emotions (EM) that illustrates how HC is received and recognized and is considered an important mediator to processes like decision-making. While the combination of these factors is important to comprehend the totality and effect that HC has on individuals, it is just as important to understand how each of these factors works independently. Previous work has been done on HCA and SE [12]. However, this is the first attempt at understanding the emotions self-reported by FG engineering students who completed the UPHEME instrument.

Theoretical Framework

"Engineers often identify their work as rational, beyond emotion, and engineering is often characterized as purely scientific, involving technical solutions to real world problems" [13]. Consequently, in the code of ethics for the National Society of Professional Engineers' (NSPE) [14] or Accrediting Board for Engineering and Technology (ABET) [15], there is no mention of emotions, what to do with emotions, how to take an emotional pulse of both teachers and students, how both positive and negative affect outcomes, nor how to engage with the emotions of society within engineering.

The lack of acknowledging emotions, much less the pervasive ways that unchecked emotions dominate our ability to both learn and teach, is unfortunate at best because "it is hard to think of an aspect of educational theory in which emotions play no part" [16]. In an oversimplified and simply not achievable attempt to remain objective, engineers subscribe to the traditional view of emotions—that being in emotional states was thought to sway people from their "rational purposes and objectives viewpoints by blind emotions" [16, p. 224]. The sciences, including engineering, are often described as "purely rational" disciplines [17, p. 3]. However, the research contradicts these assumptions by stating that "emotions are as important in science as they are in other disciplines" [17, p.4].

When we discuss emotions in education, we are talking about the state of emotions for both the teacher and student. Research suggests that emotions profoundly impact "students' and teachers' engagement, performance, and personality development" [17, p.3]. The emotional state of the teacher affects the students' emotions, which then impact either their success or failure in the classroom is documented [18]. Teachers' emotions are mirrored by the students; if teachers show enthusiasm, then their students do also. Conversely, if teachers are bored with a topic and show a lack of interest, students' emotions of boredom, irritation or anxiety surface [19, p.9]. With that, "both knowledge and emotion are inescapably matters of concern in education is one

which has been reached by generations of teachers, parents, and educationists from the time of Plato to the present day" [16, p.229].

Given the importance of emotions in education, better understanding how negative or the lack of emotions present in the classroom can help us to support all students. This is particularly salient for those with marginalized identities in engineering education often including but not limited to women, people of color, first generation students, and the intersections of these identities. Thus, as we direct much needed attention into being critical of the pedagogical practices in engineering education and thinking of innovative ways to attract, retain, and help engineering students become successful, we should ensure our decisions are sound and derived from a holistic understanding of both the way teachers teach, and students learn [20].

While this work is not particularly situated in a given theoretical framework, as described in [1], the emotions component of this work was originally derived from Pekrun's academic emotions questionnaire along with DeCuir-Gunby's work on race and emotions.

Methods

Positionality

The authors of this paper are all first-generation college graduates. The lead author is a cisgender, heterosexual biracial man. Dr. Downey's doctoral degree is in Language, Literacy, and Culture in Education, and he focuses on critical qualitative inquiry with a discerning eye towards humanizing and culturally sustaining pedagogies. The second coauthor is a cisgender, heterosexual Latina woman whose doctoral degree is in chemical and biological engineering. Dr. Villanueva Alarcón brings expertise in science and engineering, professional formation, workplace dynamics, and STEM education research. The third author is a cisgender white woman. While Dr. Sellers is not an engineer, she utilizes her previous geoscience, as well as geoscience and engineering education, experience to examine the hidden curriculum in engineering. All authors bring different perspectives to this work, which affords them the ability to see trends that might not be obvious to those coming from simply STEM or education backgrounds. The authors have transformative worldviews, which "holds that research inquiry needs to be intertwined with politics and a political change agenda to confront social oppression at whatever levels it occurs" [21, p. 9]. The authors acknowledge the potential detrimental effects that oppressive forms of communication can have on the subsequent decisions and actions of marginalized and minoritized students in disciplines like, but not limited to, engineering.

Research Question

The thread of this paper primarily focused on first-generation status and then subsequently the intersections of gender, and race (specifically Latiné/a/o/x, Black, and white participants). The research questions that drove this study was: *Does the status of FG student increase the types of negative emotions that HC would incite for white, Black or* Latiné/a/o/x *participants? Do the intersecting identities of FG participants further increase the frequency of negative emotions? Are these different than their majority counterparts*?

Participants

We excluded anyone that identified HC as positive since the scope of our project was to see how HC is negatively impacting FG students and their intersecting disenfranchised identities (self-identified women, Latino, and Black bodies). Asian identities were excluded from this study since they are statistically overrepresented in science and engineering [22]. An initial round of coding the data revealed that out of *n*984, *n*341 answered the emotion question on the survey. Of the *n*341, *n*157 answered the survey question with either a negative emotion or

lacking any memory of HC experiences. The demographics of the *n*157 participants is listed in the chart below.

Table 1: Participant Demographics

First Generation Participant Demographics	*n*	%
Gender[1]		
Women	63	40
Men	94	60
Racial/Ethnic Identity		
Black or African American	19	12
Hispanic, Latina/o, Chicana/o/[2]	45	29
White	93	59
Race and Gender Intersection		
White men	57	61
White women	36	57
Hispanic, Latina/o, Chicana/o men	27	29
Hispanic, Latina/o, Chicana/o women	18	29
Black men	10	11
Black women	9	14

Analysis

A mixed-method survey instrument (UPHEME) was disseminated between 2018/19 to explore the perceptions of engineering undergraduate students, graduate students, and faculty about HC, how it is defined, received, and responded to. Participants were asked several questions that covered their prior knowledge of HC and then introduced to two video vignettes which depicted HC in action. The participants were then asked: *Can you think about an example of hidden curriculum you experienced in engineering? Briefly explain the situation and the emotions you had in that situation*. Given this original survey question, the researchers are assuming that the responses the participants gave are speaking to their own educational experiences while in engineering programs and/or the spaces they currently operate as professors in engineering.

For this manuscript, the analysis focused on the second factor of the UPHEME instrument, emotions. In general, people cannot process an environment without feeling it first. In this instance, and factoring through the lens of HC, emotions serve to whittle down an "infinite range of variables that underpin the choices we make" [20, p.9]. Given that our hypothesis was that FG students, POC, and marginalized identities would emote more negative emotions relating to HC, we narrowed the focus down to those that felt negative emotions or a lack of identifying HC in their own lives to establish what emotions propel us to engage (or not) with whatever HC might be present. These factors could have significant importance for a sense of belonging and retention purposes of FG and/or women and POC. The reason we included an absence of HC in their own lives is because we understand HC to be active whether we are aware or not. Those that did not have any experiences that they could share most likely felt indifferent

[1] There were no self-identified transgender and/or non-binary individuals

[2] At the time of the study, Latiné/a/o/x terms were not included in the instrument

to the HC, benefited from the HC, or decided not to identify any examples for their own personal reasons. Either way, an absence of experiencing HC is seen as a privilege not afforded to all and promotes the myth of meritocracy, of which is outside the scope of this paper.

To identify negative feelings, we looked for key words which comprised our codes (see table below). Some answers were easily coded because their replies directly named their emotions when describing their previous experiences with HC like: "I was frustrated" (#468) or "I feel frustrated and angry" (#496). Other answers spoke their feelings out without naming them directly such as: "as a woman in engineering…it has not been easy" (#218) or in and amongst the engineering field, "There is a sense of superiority" (#79). For the second theme of an absence of personal experience with HC, we looked for key words such as: "can't remember," "not a situation I can think of," or "I not have experienced anything like that." The code for these answers was none detected.

A first round of coding excluded the people that had not completed the survey question. A second round of coding included only FG white, Black, and Latino/a identities. Another round of coding identified either a positive, negative, or absence of experiences with HC as defined and shown by the survey.

Table 2: List of negative emotional codes

Anger	Disturbed	Hopelessness
Rage	Condescending	Don't belong
Sad	Devalued	Dehumanized
Frustrated	Stereotypes	Shame

In order to better understand the larger ramifications of the isolated identity of being a FG participant, we felt it was vitally important to compare the findings with non-FG participants to locate any similarities and/or disparities. With that, this paper also includes some of the results of non-first-generation students. The analysis for this group mirrored that of the FG participants.

Results and discussion

The numbers below are relative ratios based on the pool of participants—relative to those that answered either negative or an absence of experience with the HC. The preliminary results suggest that of the participants which answered the short-answer question on the validated tool, 65% (n=102) of self-identified FG participants identified negative emotions when asked to reflect on their prior experiences with HC. Thirty-five (n=55) did not recall any experience with HC. These are interesting and telling data points as it suggests that a majority of FG participants have negative emotions associated to their engineering education experiences. What is also worth pointing out is that 35% of the respondents did not report having previous experiences with HC despite the research that states HC permeates across all levels of education. Breaking down the nuances of the numbers might help us determine if most negative emotions can be attributed to their FG status.

At the intersection of FG and gender, 71% (n = 45) of self-identified FG women and 61% (n=57) of self-identified FG men recalled negative emotions related to HC in engineering. Furthermore, for those intersectional FG participants who did not recall any personal experiences connected to HC, 29% (n=18) were self-identified women and 39% (n=37) were self-identified men. The salient data here is the distance between women and men (71% compared to 61%). The 10% swing solely based on the differences of gender and begs us to question how marginalized and targeted identities perceive HC in engineering. As men are dominant identities, they might

not perceive HC as directed toward them. This might indicate that their dominant identities as men mitigate their marginalized identity as a FG participant.

Results—First Generation Participants	**Negative**		**Absence of HC**	
	%	*n*	**%**	*n*
Total (*n*157*)*	65	102	35	55
Gender				
Women **(*n*63)**	71	45	29	18
Men **(*n*94)**	61	57	39	37
Race				
White (*n*93)	57	53	43	40
Latiné/a/o/x (*n*45)	87	39	13	6
Black (*n*19)	53	10	47	9
Race/Gender Intersection				
White Women (*n*36)	61	22	39	14
White Men (*n*57)	54	31	46	26
Latiné/a/o/x Women (*n*18)	94	17	6	1
Latiné/a/o/x Men(*n*27)	81	22	19	5
Black Women (*n*9)	67	6	33	3
Black Men (*n*10)	40	4	60	6

At the center of FG and race, 57% (*n* = 53) of white participants had negative emotions about their experiences with HC compared to 87% (*n* = 39) of Latinx and 53% (*n* = 10) of Black participants. Additionally, 43% (*n*=40) of FG white participants did not identify any experiences compared to 13% (*n*=6) of Latino and 47%(*n*=9) of Black participants. The difference between white and Black FG students continues to further the notion that marginalized identities feel negative emotions from HC at a far greater influence than their dominant identity colleagues. The difference of 30% between white and Latino FG participants is significant enough to understand that within the FG participant pool, race matters [23].

Finally, at the intersection of FG with gender and race, we found that 61% (*n* = 22) white women experienced HC with reported negative emotions vs 94% (*n* = 17) of Latinas and 67% (*n* = 6) Black women. Of the first gen White men, 54% (*n* = 31) had negative emotions compared to 81% (*n* = 22) of Latino and 40% (*n* = 4) of Black men. Overall, the findings suggest that intersectional women and men recall more negative HC experiences, which suggests potential detrimental consequences to their mental health and well-being [16]. The data continues to suggest that marginalized identities perceive their experiences with HC as negative. An example is, FG participant status being the same, there is a 7% difference between FG white women (61%) and white men (54%). The difference between those that hold multiple marginalized identities (FG status/race/gender) is more evident when discussing the distance between Latina women (94%) and Latino men (81%) relating to negative emotions—a swing of 13%. Lastly, the trend of marginalized identities perceiving their experiences with the HC as negative continues with Black women (67%) and Black men (40%) with a difference of 27%. This resumes the trend that the more marginalized identities you hold, the more negative experiences you remember of HC. However, the only difference in the 2 examples laid above is gender which

makes us ask the question: is the status of being a FG student as powerful of a marginalized identity as other layers of identity (race/gender)?

Comparing First-Gen and Non-First-Generation's negative emotions

When we originally conceived the hypothesis and analyze the data by looking at the negative emotions that FG participants might have, our hypothesis was that FG participants would have more negative emotions than non-FG. This is in part due to their lack of social and institutional capital upon entering an engineering program. It was vitally important to see what the baseline for emotions from the entire group was in order to see the impact of FG status. We analyzed non-FG participant answers to better understand which salient identities might have a stronger impact on participants' negative experiences of HC. However, the data suggests that the identities that have the strongest negative ramifications on emotions *is not* FG status. Overall, the numbers surprisingly upended our first hypothesis. Some noteworthy similarities and differences are explained below.

The total number of FG and non-FG participants that had negative emotions was quite similar (65% to 63% respectively). There was only a 4% swing for FG/non-FG women relating to negative emotions (71% to 75%). Contrary to our original hypothesis, you'll notice that non-FG women had more negative emotions than FG participants. There was a difference of 8% between FG and non-FG men (61% to 53% respectively) which trends differently than FG/non-FG women. When analyzing through the lens of race, the difference between white FG and non-FG was only 4% (57% to 61%). Yet again, the non-FG participants explained more negative emotions derived from their experiences with HC. However, when we compare between FG and non-FG Latinos, there was a 16% difference in favor of FG participants (87% to 71%). What is also surprising about these numbers is that in both FG/non-FG Latinos, a strong majority felt negative emotions from their past experiences with HC. Viewing Black participants and their negative emotions, there was a difference of 14% towards FG (53% to 39% respectively).

The intersection of race and gender was illuminating. Latinas, FG and non-FG overwhelmingly had negative emotions about their experiences with HC (94% to 95% respectively). This might indicate that their intersectional identity of two (or more) targeted identities (gender/race) compound to elicit an almost total negative experience with HC. However, for Black women, both FG and non-FG participants, this does not seem to be the case. Only 29% of non-FG Black women had negative emotions while 67% of FG Black women recalled negative experiences with HC. In this case, we cannot attribute the difference to gender or race, since FG status was the only other salient identity that wasn't similar.

Concluding thoughts/future implications

While these results might be contrary to the authors' original hypothesis, they do shed light on the nuances that different identities contribute toward negative emotions surrounding personal experiences with HC—which can lead to negative impacts on the learning and teaching experience. By questioning our original hypothesis, we found that even though FG status is important, it does not have the large impact on negative emotions that we envisioned. One of the reasons that FG status might not have as much of an impact on participants emotions is simply due to visibility. Looking at students doesn't automatically reveal their FG identity in the way that gender and/or race are easily detected. Some participants might try to hide their FG status as they might see it as a hinderance or something that might hold them from obtaining a more respectable status. The connections and networking opportunities that non-FG students have

might help form their engineering identity [7], but does not necessarily shield them from experiencing negative emotions about HC in engineering/education.

Future Implications

"Educators need to critically evaluate and oppose the conditions under which certain human lives are perceived as vulnerable and therefore in need of psychologize and therapeutic interventions" [24]. These words begin to isolate the core issues that need to be addressed in engineering education which will propel the next several generations of diverse engineering students with multiple marginalized identities to solve our world issues with amore equitable, humanizing, and empathetic heart. With this critical evaluation, is the effect that negative emotions has on both students and teachers. As authors, we can only imagine an engineering education program and world that better understands the vital role that emotions play in our ability to teach, learn, and problem-solve which would ultimately benefit society as a whole.

Future implications of this research allow the reader the ability to understand that, while FG status matters, other salient marginalized identities might matter more when thinking of the impact negative emotions has on teaching and learning. This is not to discount FG status. Rather, to understand its importance acts more as an exponent—an addition to other identities—and an identity that can be concealed by the host. FG status might not easily show itself through the lens of negative emotions about a program or HC that they encounter. Deeper qualitative, and potentially ethnographic, means of research could better understand the complex and layered thought process that occurs in the mind of FG students that makes them over/compensate for their intersectional status within a field that promotes the myth of meritocracy, professional norms and standards which perpetuate patriarchy and white supremacy.

Limitations

Due to the nature of the questionnaire, and more specifically, the short-answer question on emotions (see above), some critical qualitative scholars would not consider this as true qualitative research. The authors, instead position themselves with Creswell [25] and argue that open-ended short answers are indeed qualitative in nature, scope, and results. They serve the purpose capturing a more in-depth snapshot and understanding of previously unknown social phenomenon [26]. While we understand that open-ended short answers are not as detailed as other forms of qualitative methods (ethnography, participant observation, etc.), the creators of the survey placed a heavy emphasis on capturing a large set of data to compensate for the perceived lack of detail.

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