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High School Student Outcome Expectations on Postsecondary Pathways in Two Regions of Virginia (Fundamental)

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Perceived Outcome Expectation of High School Students' in Two Virginia High Schools (Fundamental)

Introduction

Despite efforts to broaden participation in engineering, ranging from deep scholarship to program implementation, recent literature has shown that historically minoritized students are still trailing behind dominant groups (White, Asian, male) in engineering in terms of representation and participation (Harper, 2010; Lichtenstein et al., 2015; Pawley, 2019; Su, 2010). Thus, there is a need for continuous efforts in increasing representation of those who have been historically marginalized in engineering. Pre-college serves as an important platform for such efforts (Madsen & Tessema, 2009). In this analysis, we contribute to the existing pre-college literature in general by raising the idea of understanding teacher and principals' perception of their students' outcome expectations in terms of postsecondary career choices, and to a certain extent, engineering pathways. Understanding how those who interact with the students perceive their students' outcome expectations can inform the process of improving pre-college learning environments toward broadening participation in engineering. For example, teachers can leverage student outcome expectations to design a better engineering classroom experiences for students, which can subsequently motivate students to think more about engineering (Jones, 2009). Also, principals, can make better policy and implementation decisions within their high schools to support their students' outcome expectations.

Accordingly, the purpose of this qualitative study is to explore teachers' and principals' perceptions of students' postsecondary career outcome expectations in two Virginia high schools. This study stems from a National Science Foundation (NSF) funded project on studying systemic gatekeepers and how they may influence students' decision to pursue engineering. We ground this particular study within the Social Cognitive Career Theory (SCCT) (Lent et al., 1994) to answer the following research question (RQ)**:** *How do teachers and principals in two Virginia high schools perceive their students' postsecondary outcome expectations and how those expectations are influenced?* The larger study guiding this work is a mixed methods study and this analysis focuses on a qualitative examination of two of the case sites.

Literature Review

Pre-college literature in engineering education is abundant. The seminal Journal of Engineering Education (JEE) article by Brophy et al., (2008) outlines ways to introduce engineering into the pre-college space, arguing the need for the use of "design, troubleshooting and analysis activities" to expose pre-college students to problem solving through the lens of engineering. A year later, the National Research Council (2009) published a comprehensive report that detailed arguments for the need of extending engineering education into the pre-college space, and provides recommendations in doing so. The Council especially provides seven recommendations, which include the calls to funding scholarship in pre-college engineering education implementation, focus on professional development programs for pre-college teachers, and defining what STEM literacy is. This report essentially proposes different directions that engineering education research community can take to better pre-college engineering education, and potentially has inspired subsequent studies in the domain.

Specifically with regard to broadening participation, recommendations include the need for considering diversity and inclusion in pre-college engineering education (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce

Pipeline, 2011; National Research Council, 2009), and current literature addresses such need. For example, there is literature on using robotics as an opportunity in pre-college to introduce engineering (Ludi, 2012); Rusk, Resnick, Berg, & Pezalla-Granlund (2008) argue for robotic-based lessons that are contextualized to engage broader group of students toward broadening participation. Other pre-college literature argues that maker spaces contribute to broadening participation (Hira & Hynes, 2015), and the authors present "engineering design challenges within classroom makerspaces as a means to improve the inclusion of women and underrepresented minorities in pre-college engineering and design learning" (pg. 1) using an interest-based framework. This, and literature like it, demonstrates the considerable effort towards broadening participation in engineering starting at the pre-college level.

Although teachers, principals, counselors and others are critical in enacting efforts to broaden participation in engineering, less research has focused on this perspective. Literature is not void in this area though, much research has focused on teacher and school counselor's beliefs about teaching engineering (Ming-Chien Hsu et al., 2011), and teacher engineering self-efficacy (Yoon et al., 2014). More recently has been the turn to a focus on teachers and counselors' beliefs about engineering itself (Redacted for blind review, 2019; Pleasants & Olson, 2019). We argue that it is important to continue to study those who interact and socialize with the students to better the learning environments and overall engineering experiences of pre-college students and specifically the outcomes they anticipate students could have relative to engineering. Such research can have substantial effects on the students' perception of engineering as those perceptions may act as gatekeepers to students who may have different cultural backgrounds in thinking about what engineering is (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2011).

Conceptual framework

We use the Social Cognitive Career Theory (SCCT) by Lent, Brown, & Hackett (1994), as illustrated in Figure 1. This theory provides a framework to understand a student's academic/career choice goals ("goals") and action development through person-environment interactions. The framework argues that there are many factors that can influence student's interest, goals, and performance, which include environmental influences, learning experiences, self-efficacy, and outcome expectations (Lent & Brown, 2006). SCCT posits that self-efficacy and outcome expectations mediate interests, and all three of these constructs mediate career choice goals while proximal influences may mediate or moderate career goals and actions. In this study, we especially focus on outcome expectations in the context of high school students from the perspectives of those who interact with the students. Thus, our data contain perspectives from those who may mediate or moderate students' goals and actions as proximal influencers and who may mediate a student's goals via providing learning experiences.

Career choice goals are "the intention to engage in a particular activity or to produce a particular outcome." (Bandura, 1986; quoted from Lent 2006) In this study, we focus on perceived intentions of students to pursue a career. Furthermore, because our context is high school students, we include goals associated with a job, a career, or an education in route to a career (e.g., attending a university for an engineering career). SCCT has a feedback mechanism from choice actions to learning experiences and because our data is from a single point in time, what may be considered an action toward a career goal, may also be a goal for the high school student. For example, attending a university may normally be considered a choice action toward a career goal; however, that may be a goal for the high school student.

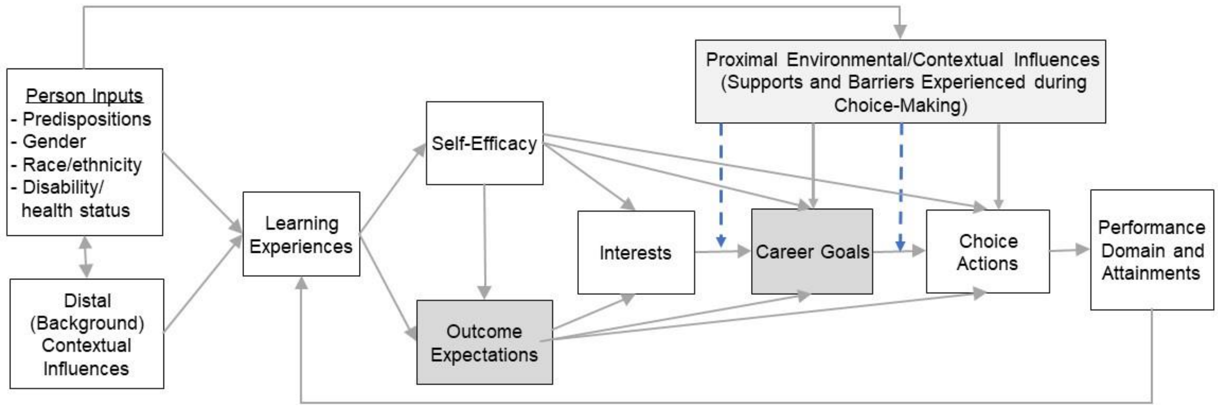

Figure 1: The SCCT framework. The diagram is modified from Lent et al. (1994). Dashed lines represent a moderating affect.

Outcome expectation, a key construct in SCCT, is one's "beliefs about the consequences or outcomes of performing particular behaviors." (Lent & Brown, 2006, pg. 17) Bandura (1977) introduced the idea of efficacy expectations (self-efficacy) and outcome expectations and argued that both influence "initiation and persistence" of one's behavior (pg. 193). This is illustrated in SCCT (Figure 1) as both self-efficacy and outcome expectations can influence a student's academic/career interest development. There are educational studies that study outcome expectation in various contexts, such as understanding high school students' physics career choices (Hazari et al., 2010), mathematics-related interest and performance (Lopez et al., 1997), and outcome expectations among underrepresented minority students (Gushue, 2006; Gushue & Whitson, 2006). Research by Carrico, Matusovich, & Paretti (2019) also reveals that students with different backgrounds (e.g., first generation college) may have different outcome expectations and influences mediating those expectations. Many of these studies are predicated on the idea that outcome expectations can influence one's interest on a certain career choice. In addition, Fouad & Guillen (2006) summarized past research on outcome expectations and recommended future research direction for the construct, strengthening its importance in education settings. In this study, we focus on outcome expectations as this construct can influence interest and choice actions of high school students in the context of postsecondary career development, arguing that SCCT is an appropriate framework to ground the study.

Finally, it is important to acknowledge that our data contain "gatekeepers" or proximal influencers' perspectives of students' outcome expectations. Proximal contextual variables are in part "environmental supports and barriers that people anticipate will accompany their goal pursuit." (Lent 2006) Contextual supports can be documented (e.g. parental income) or perceived environmental aspects (e.g. role models, gender bias) and this perspective is important to understand how they may moderate students' choice career goals and actions. Note that proximal refers to temporal proximity not necessarily geographic proximity. As an example, a proximal influence may be current financial considerations perceived necessary to afford a post-secondary education, which may mediate a student's action to attend college as a means to obtain a goal of becoming a degreed engineer.

Method

This qualitative study is part of a larger mixed method study that explores and discovers the systemic gatekeepers, supports, and barriers that can influence Virginia high school students to pursue engineering in their postsecondary pathways, which subsequently can influence efforts in broadening participation in engineering. The qualitative data collected was informed by a quantitative analysis of a population-level data set that tracks each student's high school records and postsecondary pathways. The data set is managed by the Virginia Department of Education, known as the Virginia Longitudinal Data System (VLDS).

Data sources

In this study, we explore the phenomenon of perception of student outcome expectations in two high schools, with one situated in the suburbs (271) and the other in an urban area (272). We selected these two high schools because the percentage of students who pursue four-year engineering degrees is above (271 with 7.9%) the Virginia's average (6.4%) and the other is below (271 with 3.2), as shown in Table 1. The schools, however, are in relative proximity (20 miles) from each other. Table 1 also shows several distinctions between the schools. 272 had a higher average rate of economically disadvantaged students than 271. "Economically disadvantaged" students are those who are eligible for free or reduced meals, Medicaid, or receives Temporary Assistance for Needy Families (TANF) (Virginia Department of Education, 2009). 272 also had a higher yearly rate of underrepresented minority (URM) students, showing that 272 had a large number of students who historically have been underrepresented in engineering. The yearly rate of four-year going and engineering/computer science (CS) enrollment of 272 shown in Table 1 corroborates this observation, with 272 having lower rate of four-year and engineering going than 271. The location of these schools, and the observable differences on engineering enrollment and other important demographic variables strengthen the selection of these two schools for this study. We argue that a comparison of perceptions of outcome expectations may provide insight into how gatekeepers may be influencing students' outcome expectations toward, or away, from engineering, particularly in relation to contexts of the schools.

It is important to note that our primary interest of the larger project was related to engineering as a career choice, and in particular, we bounded our quantitative data by pursuit of an engineering career via a four-year engineering degree. We acknowledge that there are engineering paths which do not require a four-year degree and, in fact, our qualitative data intermingled career goals and post-secondary education. Note that SCCT has a feedback loop where choice actions result in attainments which become lessons learned. Within this research paper, our data are based on a point in time (not longitudinal), and thus comments by participants regarding students' outcome expectations related to a career goal or post-secondary education (as a means to a career goal) were analyzed together.

Table 1: Demographic information for both schools from analysis of VLDS data (2007-2014).

School	Completers	Economically disadvantaged students	URM students	Four-year going students	Engineering/CS enrollment
271	659	13.4	17.5	70.2	7.9
272	334	52.7	51.0	50.3	3.2

Note: Table 1 shows the yearly average of number of high school completers for each school, and yearly average rate/percentage of the variables based on the average number of completers.

Participants

Four participants, two from each school, form the interview data for this study. Table 2 provides the summary of the participants and the contexts. This is a subset of the data gathered from these two cases.

Table 2: The summary of the participants included in this study.

Participant	Position	High school
T1	Technology and engineering education teacher	271 (High engineering)
T2	Engineering teacher	
P1	Assistant principal	272 (Low engineering)
T1	Technology education teacher	

We sampled these four participants through snowball sampling as we asked our participants to recommend teachers, principals or school counselors who could provide us insights on the research topic (systemic gatekeeper in engineering education).We designed the interview protocol based on the SCCT framework, and some of the questions that led to salient findings on outcome expectations include "What postgraduate 4-year pathways do you see students taking?", "Why do you think students choose a 4-year university?", and "Beyond those factors that you already mentioned, what do you think are the barriers or supports to pursuing engineering as a career for your students?". These questions particularly parsed out the salient perspectives on students' outcome expectations.

Data analysis

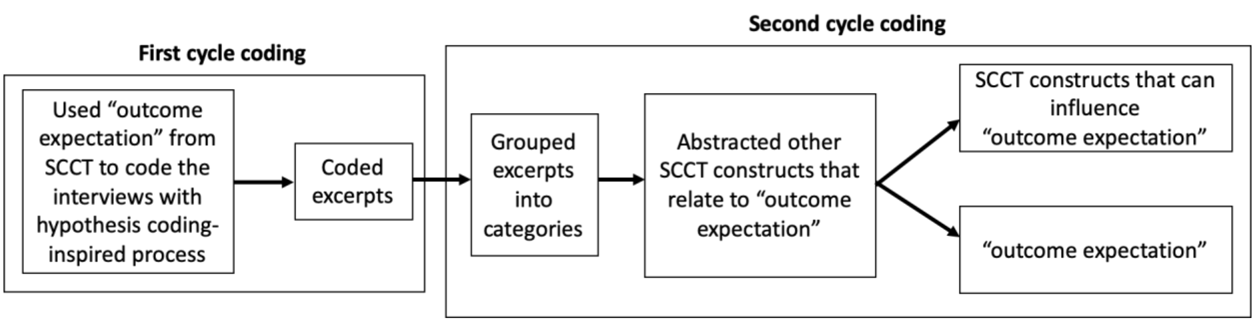

Figure 2: The coding process employed for this study.

Figure 2 illustrates the data analysis process for the study. We employed Miles, Huberman, & Saldana (2013) qualitative coding strategies for the study. Particularly, we conducted coding with a process inspired by Miles, Huberman, & Saldana "hypothesis coding" in the first cycle coding phase. In hypothesis coding, one uses predetermined codes from a theory or prediction to assess a hypothesis. In this study, we applied a similar process in that we used a predetermined code from a theory to analyze the interviews (codebook shown as Table 3 below). However, we did not generate a hypothesis as the study is exploratory in nature. The predetermined code is specifically the outcome expectation construct from the SCCT framework, and we used the definition of Lent & Brown (2006) for outcome expectation to frame our thinking when coding, "beliefs about the consequences or outcomes of performing particular behaviors" (pg. 17). In this study, we considered outcome expectation in terms of the students' postsecondary pathways. First cycle coding led to a collection of coded excerpts for further analysis.

Table 3: Summary of the categories that describe the students' outcome expectations as perceived by the teachers and principal.

SCCT Construct	Category	Explanation
Proximal Influence	Financial consideration	May influence expectation of being able to attend college.
Outcome Expectation	Job outlook/ Job security	Perceived likelihood of getting a preferred job and/or geographic location of job.
Outcome Expectation	Prestige	Students considering university prestige as a choice factor for attendance.
Outcome Expectation	University proximity	Remaining local outcome expectation or proximity of a university to home.
Learning Experiences	Course influences	Postsecondary outcome expectations that involve participants discussing how certain courses influencing students' postsecondary decisions.
Proximal Influence	People influences	Postsecondary outcome expectations that involve participants mentioning certain people that influence students' outcome expectations.

The second cycle coding phase involved two steps: 1) grouping the coded excerpts into several categories, and 2) abstraction of other SCCT constructs to provide nuances to the interpretations. We examined the coded excerpts and grouped them into categories to help explore participants' perceptions of what student outcome expectations are and what influences those expectations (Step 1). From these categories, we abstracted further to obtain 1) SCCT constructs that can influence students' outcome expectations, and 2) "outcome expectation" that influence perceived students' career choice goals. This distinction provides a more nuanced interpretations to the data (Step 2). For Step 2, how, or if, these other constructs acted as potential influences was irrelevant during the first-cycle coding. In addition, an outcome expectation excerpt might not have included or implied an additional SCCT construct and was grouped as a "stand-alone" outcome expectation excerpt during first-cycle coding. This process answered the research question.

Results

Our results revealed connections between the constructs of outcome expectations, proximal influences, and learning experiences. Importantly, the connections were from the perspective of teachers and principals who are themselves proximal influences on students and people in positions of power over students.

Financial considerations and Outcome Expectations Related to Engineering Degrees

Financial considerations were related to outcome expectations in several ways. In 271 (high engineering) high school, both participants considered the cost of an engineering degree as part of the perceived choice process related to choosing an engineering degree pathway. 271T1 specifically discussed the affordability of college, explaining a particular student going into community college before heading to a four-year institution, as illustrated in the following quotes.

"*So, I have one student in particular that pops into mind where he eventually wants to go onto a four-year college**, but his family is not in a position right now where he can afford it, so he's doing the {Regional Pathway} progra**m.*"

271T2, suggested that it is important for students to know whether they like engineering before spending large amount of money on an engineering degree, which can influence the students' financial future.

"***the goal of the class is not to make people engineers. It is to help you find out if you want to be an engineer and, do you have what it takes to be an engineer**? So, at the end of my first level one class, if a student says, "Wow, I found out I really don't want to go into engineering," well that's a win. Here they are at a high school level. **They did not pay any money to go to an engineering college and find out they didn't like it then.** I've had a number of students say, "Well, I now want to go into photography. "Okay, great. That's a wonderful thing. You found out now rather than spending all kinds of time and money doing something that you wouldn't end up doing anyway*."

At 272 (low engineering going) high school, the perceived financial considerations focused on the idea of earning money as a main reason to pursue postsecondary pathways. P1 talked about "*students go to a four-year college because they, obviously, **wanna get out of high school to make money,***" showing a different perspective on students' outcome expectation in terms of financial considerations. 272T1 supported such perception as shown in the following quotes.

"***Students will come to me and they want to get into engineering of some type. Usually they just know that it's engineering because they know that engineers make money,** they can travel, they can go just about anywhere. I think that a lot of the four-year universities, the programs and things like that, are a way for the students to escape or just get to a better life.*"

It is possible that the differences in views on financial considerations between the two schools are associated with demographics, but more data and analysis would be needed.

Proximal Influence of People Related to Outcome Expectations Regarding Engineering Careers

271T1 perceived that family and teachers themselves can influence their students' postsecondary outcome expectations regarding engineering:

"*I see students interested in architecture and starting to have a shift of that being okay to go into, but over the last I would say 10 years after the recession, the 2008 recession, **there was a shift where I had a lot of students who said they were interested in architecture but their parents were pushing them more towards engineering... because they were afraid, they wouldn't be able to get jobs, I guess.***"

271T1 also expressed similar sentiment about teachers themselves:

"[teaching team] *really tried to look at who he was and what he was good at, **and tried to steer him in the direction that would give him a promising career,** I guess, but would allow him to be* *in something that he is good at and enjoys. So, tried to show him in addition to what he was getting from his high school, other career paths, wiser options, major options, and things*."

This shows that family and teachers can shape their students' outcome expectation, but with different forms of influences. 271T1 perceived teachers to leverage students' interests in shaping the students' outcome expectations. On the other hand, 271T1 described parents "moving" their children from the children interested field to a job field perceived with more employment opportunities, showing the different dimensions of proximal influence of people.

Proximal Influences of Family and Financial Considerations and Outcome Expectations Related to Specific Colleges

272T1 implied perceived intersections between proximal influences of family and financial considerations associated with students' postsecondary outcome expectations such as proximity of a college or university. 272T1 said:

"*I think that if there's a good four-year university within four hours of them, they would see that as, "I'll be able to go to that school," or maybe it's more possible than if the university was eight hours away or something like that.* ***Some of these kids too, have to work to take care of their families as well. So I think that being close to home is a definite advantage to them. I think that having a good university nearby with a really high-ranking program or a program that they see as really good is a benefit to the area and it does encourage them more to look for those opportunities and try and apply for those opportunities***."

The need to support family and financial implications of doing so are perceived to have an impact on postsecondary plans.

Proximal Influence of Prestige and Outcome Expectations Related to Specific Colleges

Prestige of universities came out as a factor in terms of perceptions of students' postsecondary outcome expectations. 272T1 mentioned that some of their students had prestige as a factor in considering their postsecondary pathways. 272T1 said that:

"*I was actually talking to them about that yesterday during my robotics club meeting.* ***Social status and clout is very important to this generation coming up right now****. It's like their aesthetic, their clothes that they wear. Their message that they convey to others is extremely important to them. It's everything to some. It's their identity. So just getting into a four-year university in an engineering program isn't enough for some of them.* ***They have to have the extra thing of, "Well, I got into this university that has a 10% or less admission rate."*** *They can't just be happy to get into a university.*"

This shows that, for some, going into four-year colleges and majoring in engineering may not be sufficient, but the prestige of some universities may align with proximal influences such as what is important to peers, in this case prestige.

Learning Experiences Influence Outcome Expectations Related to Engineering Careers

In high school 271, both 271T1 and T2 talked about influences of courses or programs on their students' postsecondary outcome expectations. T1 mentioned that "*taking these classes* *[basic drawing classes] in high school is good because it's* ***helping them narrow their focus and see if it's something that they are interested in and if they're good at it,*** " implying that classes that students take can influence their postsecondary outcome expectations, particularly on their interest in certain fields. This is further supported by a T1's example:

"*she's [one of her students} taken my basic technical drawing class as a freshman, my architecture class as a sophomore, my engineering drawing class as a junior, and now is in my advanced drawing class.* ***She took architectural drawing first and then took engineering drawing because she didn't know which of the two she was more interested in. She's come to realize she doesn't still know, so she is applying to colleges for architectural engineering***"

271T2, on the other hand, assumed that their students have career goals related to engineering and four-year colleges, since "***if they're taking the class [engineering class], they have some inkling about engineering***, *and they know they have to go to a four-year college*". This is an instance, we argue, of perception of courses (learning experiences) influencing students' career choices.

Discussion

To answer our research question, "How do teachers and principals in two Virginia high schools perceive their students' postsecondary outcome expectations and how those expectations are influenced?", we analyzed our data using SCCT as the framework. Our resulting codebook contained six categories, in three SCCT constructs, enabling patterns to emerge. Of particular importance for this work is the recognition that High School teachers and principals, acting as proximal influencers, can moderate (influence the strength and direction of a connection) students' career choice goals and mediate (provide student learning experiences, strengthening their role as Gatekeepers. As shown in Figure 1, these Gatekeepers can both influence outcome expectations and moderate the impact of outcome expectations on academic/career choice goals. For example, the participants have perceptions based on a combination of understanding students' course interests, financial considerations, college considerations, and interest in becoming an engineer.

As an example of these gatekeepers influence as a mediator is their role of providing learning experiences for students. This category captured teacher perspectives regarding how different course experiences directly influenced outcome expectations, and can serve as a mediator between outcome expectations and person input and distal (background) contextual influences (Lent & Brown, 2006). Within the data we noted that teachers are interested in their courses providing opportunities for students to determine if they like engineering, or not. In addition, at the high engineering going school a teacher noted students' ability to compare courses, such as engineering versus architectural drawing to assist in their goal selection.

Regarding the role as a proximal influence, the participants are in a position to talk with students individually and in a group (class or club) setting about career goals. Thus, perceptions on the importance of attending a regional college or one based on prestige emerge as do the perceptions of financial constraints and outcome expectations (e.g., earning money). In this manner, the participants act as both mediators and moderators for the students. They are a variable within a student's pathway of determining career goals, such as engineering or not, and influence the strength of a student's decision toward that career goal. By understanding the Gatekeepers' perception of students' outcome expectations, and their role in influencing them, we become better positioned to understand the nuances of students' career goals and how and why they may vary between high schools. It must also be noted that family/parents also act as proximal influence, and potentially as Gatekeepers to students participating in engineering, though our data only provide glimpse of family's roles in the process. Overall, as part of a mixed method study that combines quantitative and qualitative components, these findings provide richness and nuances to the quantitative findings that characterize these two high schools engineering going rate.

These categories, taken from a Gatekeeper's perspective, strengthen SCCT as an appropriate framework to understand students' outcome expectations, which can inform efforts to improve pre-college classrooms for broadening participation in engineering. Existing literature has shown efforts in improving pre-college learning experiences toward broadening participation (Hira & Hynes, 2015). However, the findings can expand the engineering education community viewpoints in such efforts by focusing more on leveraging students' background and contexts to improve their learning experiences, which subsequently can influence the high school students' postsecondary outcome expectations. This is consistent with some literature that calls for a more expansive view on students' backgrounds in broadening participation (Brown, 2011).

Understanding how our participants, who can act as "gatekeepers" to students, perceive the development of students' outcome expectations and career choice goals is important with regard to broadening participation in engineering. As gatekeepers, teachers, principals, and school counselors have both insight into what students are thinking and their actions, as well as influencing students' thinking and actions. Knowledge about these insights and actions can help pave way for future research on how to improve the messages the gatekeepers can convey to the students regarding their career choices. Subsequently, such knowledge can potentially help inform practice in pre-college learning environments, particularly on how teachers or school counselors can interact with students about their career choices, especially engineering-related careers.

Future Work

Recall that our schools are in a single school district, within 20 miles of each other, but have different demographics. Though limited information, a comparison of the participants' perceptions of their students' outcome expectations and career choice goals suggests a "one size fits all," or fits all of this "type" of student approach to broadening participation in engineering, even within a geographical region is limited. Future work should continue to parse out differences between schools with an above average rate of engineering going students and below average (perhaps by state) going rate, especially on different Gatekeeper and their perceptions, policies, and school resources. How these Gatekeepers compare to policies and school resources compared to other schools may be of particular importance. In addition, future work should also examine family/parent's influence on student's outcome expectations and choices on engineering. Research findings on this topic can further advance our understanding of how students make choices in pursuing engineering degrees, potentially informing efforts to broaden participations of minoritized students in engineering.

Limitation

This is a qualitative study, and generalizability of findings is not the goal. Instead, this article has provided descriptions and information that can potentially lead to transferability of findings here to similar contexts by the readers (Tracy, 2010). Ultimately, we conducted this study and analysis to explore deeper how high school teachers or principals perceive their students' outcome expectations and influences on those expectations. Presented findings can provide additional perspectives on how pre-college educators perceive their students, and contribute toward efforts in broadening participation in engineering in pre-college setting.

Conclusion

Understanding how high school gatekeepers, such as teachers, school counselors or principals, perceive their students' outcome expectations, can help pave the way to advance research in the topic of pre-college engineering gatekeepers' perceptions. Findings from such research can potentially inform practices in pre-college learning environments, such as messaging about engineering career choices, in the context of broadening participation. In this study, we find that, using SCCT, teachers and principals of two high schools perceived a variety of connections between proximal influences and learning experiences and their students' outcome expectations. In short, these findings can provide perspectives on how teachers or principals perceive their students' outcome expectations, and such knowledge can be helpful in informing future research on how to provide a level playing field for all high school students in terms of discussing about engineering-related career choices. In addition, findings can potentially inform practice improvement in pre-college learning environments on engineering.

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