Exploring K-12 Teachers' and School Counselors' Beliefs about Engineering in High School: A Case Site in Virginia (Fundamental)

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Introduction

The importance of engineering education in K-12 has been substantially articulated in multiple reports and publications. For example, Brophy et al. [1] provide an overview of the state of K-12 engineering education, whereas the National Research Council report [2] moves further by providing seven recommendations to improve K-12 engineering education through research and scholarship.

As one of the expanding domains within K-12 engineering education, K-12 actors' beliefs about engineering are important areas of study because understanding how the actors (student, teacher, school counselor parents/guardians, etc.) believe, perceive, and conceive engineering can help us better design K-12 engineering education, prepare teachers and school counselors in implementing those curricula, and assess effectiveness of those curriculum design on students' learning [3]–[5]. In particular, studying teachers and school counselors' beliefs about engineering is vital as they work on the front line in engaging with and conveying knowledge to students. This knowledge can influence how students perceive and believe engineering, and eventually students' decisions whether to pursue engineering or not [6].

Therefore, in this study, we argue that because 1) K-12 engineering education has become essential in the quest of improving engineering education in the US, 2) understanding K-12 actors' beliefs about engineering can help advance engineering education in the K-12 setting, 3) literature on K-12 school counselors' beliefs about engineering is scarce, and 4) K-12 teachers and school counselors are one of the many systemic elements that can influence K-12 students' decision in pursuing engineering or not in college, it is essential to study teachers' and school counselors' beliefs about engineering. Therefore, the purpose of this qualitative study, employing Eccles' Expectancy Value Theory (EVT) socializers construct [7], is to explore beliefs about engineering of four teachers and school counselors in a Virginia high school because teachers and school counselors play significant roles in potentially influencing students' postsecondary pathways.

Literature Review

Arguments on studying K-12 actors' beliefs, understanding, conceptions and perceptions of engineering in K-12 are well articulated in the NAE report on shifting the public understanding about engineering [3]. In the report, four main arguments are presented: 1) to provide accurate representations of what engineering is, 2) maintaining US competitiveness in technological innovation, 3) broadening participation in engineering, and 4) improving literacy with technology of future citizens [3].

The constructs used to represent actors' thoughts and values of engineering (beliefs, understanding, conceptions, and perceptions) are used loosely in existing literature. Many publications use the term "perceptions", while some interchange "beliefs" and "perceptions" in their manuscripts [5], [8]. For example, one article states "Clearly, though stereotypes and perceptions are "just beliefs", they are powerful beliefs, and are worthy of investigation and analysis" [20, pg. 8]. In this manuscript, we use the term "belief" to represent any forms of actors' thinking, perceptions, conceptions and understanding of engineering to ensure clarity and consistency within the paper and the theoretical lens of Expectancy Value Theory (EVT) employed in this study. EVT will be described and explained later in this manuscript.

In terms of teachers' perspectives, there are many studies conducted on the topic, with many arguing the importance of understanding K-12 teachers' beliefs about engineering to better prepare them for K-12 engineering education [2], [4], [5], [9]. Yaşar et al. [4] develop an instrument that assesses K-12 teachers' perceptions of engineers and "design, engineering and technology" (DET) education in K-12. The instrument contains 69 items that gauge teachers' perceptions of importance and familiarity with DET, and stereotypical characteristics of engineers and engineering. With a sample of 98 K-12 teachers, the study finds that many teachers "viewed engineers to have good mathematical skills and hold a proficient science background, like to fix things, and earn good money" [19, pg. 212]. Many teachers also perceive that many people view engineers as male, combined with the perception that female and minorities lack ability to do well in engineering [4]. In addition, other studies document interventions that help K-12 teachers improve their ability in understanding the concept engineering [5], [9].

On the other hand, there is limited literature on school counselors' beliefs about engineering. As mentioned, existing publications focus largely on teachers. We argue in this manuscript it is important to include school counselors as one of the actors because school counselors play significant roles, including providing advice on college, and career, monitoring students' progress and giving support during crises, in shaping K-12 students' experience in schools and students' college pathways [10].

Larger Context of the Study

This study is located within a larger study to identify and understand the different systemic elements within Virginia high schools that can influence students' post-secondary pathways, particularly toward engineering [11]. It is a multi-year mixed-method project that aims to inform larger efforts in broadening participation in engineering. The project utilizes a state-established longitudinal student data system to explore the rates of students pursuing engineering from all high schools in Virginia [12] and qualitative interviews at selected high schools to obtain more contextual information to make sense of the data [6]. Several of the systemic elements identified include teachers, school counselors, principals, school administrators, school locations and educational policies. Teachers and school counselors stand on the front line of education in high school as they are the ones who converse with students on various topics and issues, particularly about students' postsecondary pathways. Understanding teachers and school counselors' beliefs about engineering can help situate findings of this particular project.

Purpose Statement and Research Questions

The purpose of this qualitative study is to explore teacher and school counselors' beliefs about engineering in a high school in Virginia because teachers and school counselors are the ones that converse regularly with the students about the students' academic and career future in high school. Eccles' Expectancy-Value Theory (EVT) and the following research questions guided our study.

RQ1: What are the beliefs about engineering held by teachers and school counselors in a high school in Virginia?

RQ2: What are some similarities and differences of those beliefs about engineering among the teachers and the school counselors?

Theoretical Lens

Socializers in Expectancy Value Theory (EVT)

As teachers and school counselors interact regularly with high school students, it is important to understand how their interactions about engineering with the students can be influenced by their beliefs. We employed Expectancy Value Theory (EVT) socializer construct as the theoretical lens for this study as EVT because the theory explains how socializers such as teachers and school counselors can influence students' motivation in potentially choosing engineering.

Expectancy value theory (EVT) posits that one's motivation to engage in a task or activity is dependent on two constructs: one's expectation on whether they will complete a task successfully (expectancy) and the values (attainment, interest, cost, utility) one places on the task itself (subjective task values) [13], [14]. These two constructs are influenced by many other constructs. As mentioned, the constructs salient to this study are socializer's beliefs.

EVT situates socializers (teachers and school counselors) prominently as influencing student's achievement-related decisions regarding post-secondary pathways, such as whether to pursue an engineering major in college. Socializers' beliefs (about engineering) can affect socializers' behavior (describing engineering to students), which can influence students' self-perception and interpretation of engineering. These perceptions and interpretations, in turn, can influence students' goals, identities, and possible selves, and ultimately, resulting in influencing students' subjective task values related to whether choosing to major in engineering or not [7]. Figure 1 shows how these constructs map onto ideas relevant to this study.

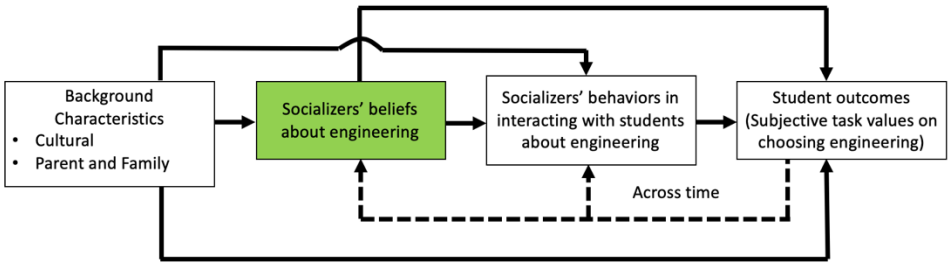

Figure 1: Modified EVT for the context of this study. This study focuses only on the green-colored box.

In this manuscript, we use the word "beliefs" because it is consistent with the EVT framework. In addition, as explained in the literature review, existing publications on beliefs or perceptions about engineering in engineering education have used the word "perception" or "belief" interchangeably. Using the word "belief" helps with consistency with the theoretical lens and the overall existing literature.

Method

Data Source and Collection

As described previously, this study is situated within a larger mixed-method project [11]. Thus, some components of the data collected for the purpose of the overarching project became the data source for this study.

As illustrated in Figure 2 below, the data source for this study is a subset (details in Table 1) of the qualitative interviews conducted for the overarching project. We selected this particular subset of interviews because all the participants worked in a single high school, which provides a unique context for the study. The interviews were transcribed verbatim and pseudonyms given to the participants and schools. Some of the most salient questions for this analysis include "Please explain your role and responsibilities in the school and how long you have been serving in that role?" (establishes socializers' role) and "How do you define engineering?, "What do you think it takes to be an engineer?", and "Do you talk about engineering with students, what do you say?" (opportunity to provide specific beliefs about engineers and engineering).

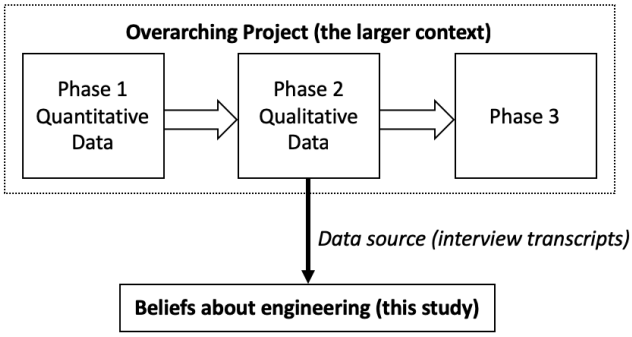

Figure 2: Overall relationship between the overarching project and this study on beliefs about engineering in terms of data source and collection.

Sample summary

Two teachers and two school counselors from a single high school in Virginia, and all four of them worked in the same high school in Virginia. Table 1 summarizes the participants' information, which became part of the context in the process of creating participant summaries and coding.

Table 1: Summary of the participants information of this study

Participant codename	Position in school	Subject taught/role	Engineering background
T1	Teacher	Robotics, electronics	Yes
T2		Physics	Yes
C1	School counselor	International Baccalaureate* (IB) counselor	Yes
C2		IB, scholarship counselor	No

*International Baccalaureate (IB) is a type of diploma offered in Virginia high school.

Data analysis

The interview transcripts were coded following steps as outlined by Miles, Huberman and Saldaña [15]. Figure 3 shows our analysis process. First, we wrote participant summaries for each interview transcript to understand each participant (teachers and school counselors) in a deeper level. Next, for the first cycle coding, we coded the entire transcripts for excerpts that imply participants' beliefs about engineering, which utilized the participant summaries to make meanings of the participants' words and responses. The coding process utilized descriptive

coding in which short word or phrases (the codes) were used to summarize the excerpts [15]. The codes (listed in Table 2) emerged from the process of creating the participant summaries and, to certain extent, the interview protocol.

Table 2: Codes and their definitions

Code	Definition
Belief	Excerpts that show or imply the participants' beliefs about engineering, regardless of the topics.
Content	Subcategory of belief; excerpts that show or imply beliefs about content in engineering. These include mention of subjects taught, type of knowledge, type of pedagogical instructions etc.
Career	Subcategory of belief; excerpts that show or imply beliefs about career in engineering, particularly on how to prepare students for postsecondary pathways and beyond. These include mention of any form of resources on career, types of postsecondary pathways students take.
Policy	Subcategory of belief; excerpts that show or imply beliefs about policy in teaching engineering in high school. These include mention of personal suggestions on policy changes.
Student Characteristic	Subcategory of belief; excerpts that show or imply beliefs about student characteristics in engineering. Characteristics of an engineer can be included.

After the first cycle coding, based on the codes in Table 2, we conducted second cycle coding in which two sub steps were involved, as shown in Figure 3. We extracted the coded excerpts and categorized them to provide a more detailed and robust characterization of the data set. Finally, we grouped the categories into themes to provide a big picture of the data set.

Reflexivity Statement

The coding process was performed by the first author. Before coding, the research team discussed and identified possible preconceived notions and biases of the coder about engineering education in high school [16]. Regular conversations with two other researchers on the team who have conducted prior research at the high school level in the Commonwealth of Virginia added additional assurance of participant understanding.

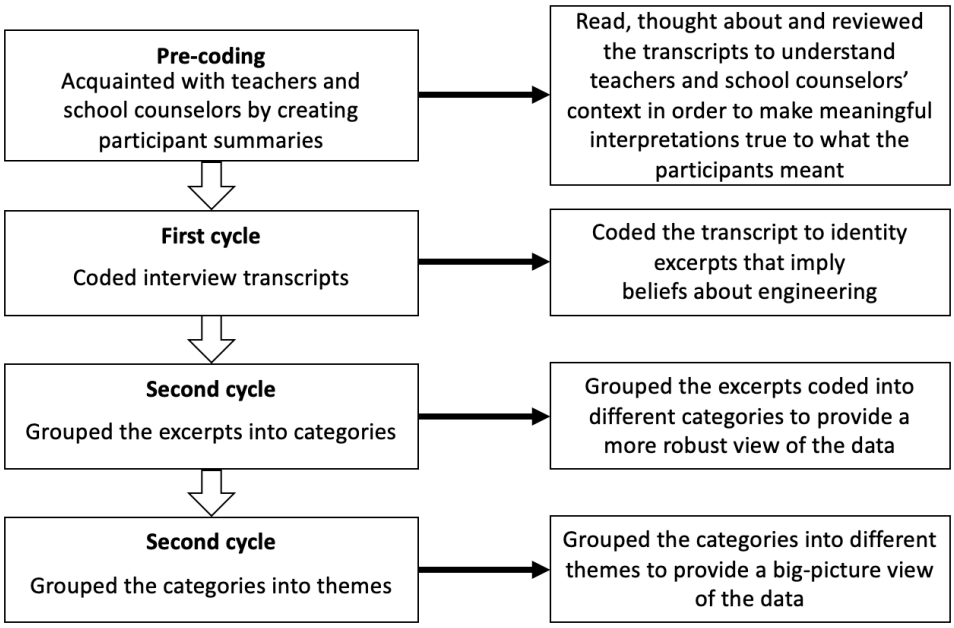

Figure 3: The data analysis steps for the study. The process was inspired by literature from [15].

Results

Table 3 provides an overview to answer what the beliefs about engineering of teachers and school counselors were in a high school in Virginia (RQ1).

Table 3: Theme, category and code assigned to the excerpt categorized.

Theme	Category	Code assigned to the excerpt grouped in these categories
Beliefs about definition of engineering	Different ideas about engineering	Content
	Build at a mechanical level	
	Engineering is broad	
Beliefs about the engineering field itself	Minority representation in engineering	Content, Career, Student characteristic, Policy
	Financial incentive	

Beliefs about definition of engineering

The first theme is the participants' beliefs about the definition of engineering, which focuses on the different perspectives the participants' definition of engineering. Table 4 shows three categories that represent this theme: different ideas about engineering, build at a mechanical level, and engineering is broad. Corresponding example quotes are also provided in Table 4. If a participant is not represented by an example quote in a category, it means the transcript was void of the category.

Table 4: Categories and example quotes under "Beliefs about definition of engineering"

Category	Example quote
Different ideas about engineering (across different participants)	*"'Engineering is, from my understanding and what I've always been, what've come to realize is* ***the ability to think and design applications that move on and other people are able to build and work with those different systems that you design****."* (T1) *"The engineering piece to me, that I convey to them, is* ***understanding the physics concept and actually making a connection with the build piece.****" (T2)* *"I mean, so there's,* ***any time you are manipulating things for a certain outcome, you are engineering something****, and so engineering can be everything from biology and chemistry up through the traditional."* (C1) *"From my perspective, I would say,* ***it's mathy, it's sciencey****. You should have exposure to physics and make sure that you really like that stuff. I don't know if that's accurate, but that's what I would say."* (C2)
Build at a mechanical level	*"It's* ***more of a mechanical engineering piece*** *where they're taking a concept and they are actually going to be building a parachute and they're going to be building a cartridge, something that contains another item in it. Or they're building a spring powered car. That's where they get to see how the spring works with the wheel and the wheel works with the axle, things like that. That's what I'm conveying to them, that engineering piece."* (T2) *'...cause there's so many. You know,* ***to be an engineer is that you are creating and fabricating at a mechanical level****, so whether that's creating and fabricating things in the cell, and doing genetic engineering, or taking out some sort of little piece of it to stimulate the autoimmune response, to building things, to making new chemicals and new products, being able to make plastic from soy, you know? To building bridges. I think there is the gamut. Even there's social engineering."* (C1)
Engineering is broad	*"Out of engineers, I think* ***chemical, and electrical engineering****, I even know are very difficult.* ***Mechanical engineering*** *is something I push all my kids towards.* ***Nuclear engineering*** *would be fine, nuclear physics would be fine, Astrophysics would be fun. UVA and George Mason are the only two that have Astrophysics programs."* (T2) *"****Yes it is, cause there's so many****. You know, to be an engineer is that you are creating and fabricating at a mechanical level, so whether that's creating and fabricating things in the cell, and doing genetic engineering, or taking out some sort of little piece of it to stimulate the autoimmune response, to building things, to making new chemicals and new products, being able to make plastic from soy, you know? To*

	building bridges. I think there is the gamut. ***Even there's social engineering****."* (C1) *"****I think they think they know what it is, but it's so broad. Do they really know what it is, and do they really know what all of the things about it are? I would say, "No," because I don't even really know****, even though I want my kid to be an engineer."* (C2) *"There's* ***so many different types of engineering****. You could go into* ***architecture and building engineering****, or you could do* ***biochemical engineering****. One wants to do prosthetic legs. I'm assuming that's engineering. Sometimes I learn from them.* ***Mechanical engineering****. I do ask when they say,* ***"Engineering," "Well, what type?"*** *Then aerospace I think has been brought up a couple of times this year with guys and girls."* (C2)

The first thing that we found is that all four participants had different general ideas about engineering. This category is defined to characterize the different perspectives on engineering from the participants on what engineering is. As shown in the quotes under "different ideas about engineering", T1 talked about engineering at the system level, while T2 talked about applying concepts to build something. In addition, each counselor also had unique ideas: C1 talked about "manipulating things for a certain outcome" and C2 mentioned that engineering is "mathy" and sciency". These show that there are differences in how the four participants thought about engineering. T1, T2 and C1 had specific definitions about engineering. These are all in contrast with C2's comments that engineering is "mathy" and "sciency". For context, both T1 and T2 were teachers that expose their students to engineering concepts, while C1 worked as an engineer before taking up the role of a school counselor. C2, on the other hand, told us they had no background in math, science, or engineering. Looking at the participants' responses with their respective context is important as we found, from this particular instance, that those exposed to math, science, and engineering described specific beliefs about engineering as compared to those who did not.

Another category under the "definition of engineering" theme is "build at a mechanical level". This category is defined to show how the different participants share their beliefs that engineering is, for example, mechanical. Both T2 and C1 implied that they believed engineering involves mechanical components while building. T2 indicated a belief that engineering "is more of a mechanical engineering piece" that involves utilizing concepts in building, adding on his previous mention that engineering is about "applying concepts of build". C1 had a similar mention, starting their definition of engineering with mention of "mechanical level". These show that beliefs that engineering is largely a mechanical endeavor exist among some of the important people that engage high school students about their post-secondary pathways. T1 and C2, on the other hand, did not mention the word "mechanical" throughout their interviews.

The next category is "engineering is broad", which characterizes participants' view of engineering as vast and diverse. Both counselors implied to believe this about engineering, as they mentioned about the broadness of definition of engineering. In particular, the quote from C2 shows uncertainty about whether they or the students knew exactly what engineering is because of how broad it is. C1 also commented that they believed engineering is broad, even though they

mentioned about engineering at a mechanical level. Particularly, when mentioned by the interviewer about how hard it was to provide a definition of engineering, C1 responded by saying "*Yes it is, cause there's so many*". T2 had also shown to believe that engineering is broad, by mentioning multiple fields of engineering.

Beliefs about the engineering field itself

The second theme is the participants' beliefs about the engineering field itself. Table 5 shows two categories that fall into this theme: minority representation in engineering and financial incentive.

Table 5: Categories and example quotes under "Beliefs about the engineering field itself"

Category	Example quote
Minority representation in engineering	*"I also work with a **summer engineering program for minorities**. It's a minority engineering program. as a minority in the [city] area. It exposes students. They put students on campus three weeks at [HBCU] and three weeks at [University]. We teach them about different aspects of engineering. They also get a chance to see people from [Power company] come in and talk to them."* (T1) *"'I get the feeling when I speak to them. Now, my classes are heavy with female students, I think there's a 60-40 ratio, girls to boys and it's been like that since [high school] days. Maybe even 65 or 70%, but it's heavy on girls. **I do notice though, fewer girls, out of that percentage, they flip when they're taking it in college. One of the reasons could be that engineering is mostly male dominated and unfortunately so, girls don't want to be in that area, I don't know, I'm not sure**. Even though I keep pushing to them that, hey current engineers have to be people who are excellent with communication skills and it just ends up being that female students are better at that than men… I don't think that's happening as much as I'd like it. **If I have 60% girls in that class, I want all of them to be in the engineering school and 40% boys should all be going to engineering school.** I notice more of the boys are, when they contact me through Facebook and they say, "I've gone to engineering school…"'* (T2) *"**I always am encouraging my female students to do that, because whereas at the high school level, and even at the undergraduate level, if you look at any honors society, if you look at colleges, there's 60% female, 40% male. But when you start going into the engineering fields, who are the engineers? They're male. And so how to get girls to go through that?** But then also, as the mother of three sons, how to make sure that boys aren't left out of the academic equation, because they're boys and they learn like boys, and they don't wanna color in the lines when they're little? And so they kinda get pushed in a path that doesn't encourage them to think and do well, in terms of academics? Academics means making pretty posters and coloring in the lines and*

	being still? And you know, as a seven-year-old boy, that's not what you're interested in, and so they get labeled and things like that." (C1) *"So it's trying to find that mix of encouraging our young women to go and like, I have a parent who, she's a Ph.D. She runs a MathScience center.* ***How do get black women into STEM fields, and so we've worked with that, to encourage our black girls to go on and to push through what they may see as barriers, but then also, to encourage our young men to hold the path, get that master's degree, go on and do, and so it's both****."* (C1) *"****'I think there's a big emphasis ... We get a lot of, I don't know, emails or somehow information about STEM careers and women****.* ***I guess when we're given out options, we do share all of that. I don't think we try to keep it a secret.*** *I don't know that we specifically say, engineering, but probably STEM, science, all that stuff. We do that in the classroom, and we meet individually with every one of our students."* (C2)
Financial incentive	*"...because the kids want to understand why. "Why should I care? Why is it important to me?" A lot of time it might be a monetary gain, but kids are kids are kids and they want to know, "How would it help me?"* ***Well, for one is money. To a lot of kids that might be a nice motivating factor****."* (T1) *"...even though I want my kid to be an engineer. It just sounds good. "****I think you'll make a lot of money****. You're smart. You should do that.""* (C2)

Minority representation in engineering is defined as participants' beliefs about minority presence in the engineering field. The category includes comments related to both gender and ethnicity. Regarding gender, one assertion is the male-dominant nature of engineering. Both T2 and C1 mentioned that the engineering field is male dominated. T2 talked about the male-dominant nature of engineering might have discouraged female students from pursuing engineering majors, though T2 suggested to hope that was not the case. C1 also wondered the same thing, asking "how to get girls to get through that", with that being the male-dominant nature of engineering. These show that, among the four participants, there are some who believed engineering is dominated by male. On the other hand, C2 commented on STEM and women, though they did not talk about the male-dominant nature of engineering. These instances show that, within this high school, there were teachers and counselors that described beliefs on the male-dominant nature of the engineering field.

Regarding ethnicity, comments about encouraging African-American students into engineering are present. T1 talked about working in a summer minority program that exposed students to engineering, while C1 mentioned about part of their work in encouraging black girls in pursuing STEM fields. C2 talked about some of her female students joining the summer minority program. To provide context, T1, who was African-American, strived to show minority students, particularly those from underrepresented communities, that there was value to post-

secondary pathways, regardless of whether it was four-year college or vocational schools. This explains T1's involvement in the summer minority program.

Finally, some of the participants commented at their beliefs of financial incentives of the engineering field. Both T1 and C2 talked about the possibility of earning a lot of money with an engineering career. As stated by T1, "well for one is money. For a lot of kids that might be a nice motivating factor."

Discussions

From the study, we identified three major takeaways. Considering the context of the interviews, the takeaways can expand the literature on beliefs about engineering at the high school level.

Different beliefs about engineering can lead to different messages sent to students

As mentioned previously, all four participants were from the same high school in Virginia. The results above show that all four participants had different beliefs about engineering in general. For example, the three participants who had experience with math, science and engineering gave more specific definitions of engineering, and the one school counselor who had no previous experience in STEM said engineering was "mathy" and "sciency". The belief that engineering involves those who like math and science is typical when discussing about the engineering field based on existing literature [3], [4], [17]. This is important to note because teachers and school counselors, who are potential gatekeepers to students' postsecondary pathways, might inadvertently limit access of engineering to a portion of student population who may not show strong passion and love for math and science because of their beliefs that engineering is "mathy" and "sciency". This is explained through the socializers construct of the EVT framework as the teachers and school counselors' beliefs about engineering can influence how and who they talk to about engineering.

These results provide us several important lessons. First, there is still work to do in exposing more teachers and school counselors in high schools about engineering after the report on public understanding about engineering by developing, discussing, and disseminating a consistent message about engineering [3]. The findings show that beliefs that engineers love math and science still exist among K-12 teachers and school counselors. In addition, the different messages found in this study show we in the engineering education community should continue striving for promoting consistent representations and characterizations of engineering, particularly educators in the K-12 space as they can be the first gateways in terms of children pathways to engineering [18]. Second, the findings strengthen the existing arguments of the need for a standard in high school engineering education [2]. Findings from this study show that lacking a standard in K-12 engineering education may have resulted in different beliefs about engineering among the teachers and school counselors in the same school. With multiple teachers and school counselors engaging with students on their post-secondary pathways, it is important to have a standard in helping teachers and school counselors learn more about engineering, which subsequently, can assist teachers and school counselors providing a more complete and accurate information about engineering to high school students. Finally, there is a need to provide training for P-12 teachers and school counselors to improve their understanding about engineering, particularly in addressing the different beliefs about engineering as found in this study. Such call has been present in multiple reports [2], [19], and we assert that messaging about engineering should be part of the training to promote better understanding of engineering and, subsequently, allow a more consistent messaging to P-12 students.

Broadening participation in engineering is a focus in these beliefs

Some of the participants discussed their beliefs about the male-dominant nature of the engineering field. Such beliefs have long existed in the field and it is consistent with existing literature on the general perception of the engineering field as a male-majority domain [4], [20], [21]. These beliefs led to three of the participants discussing about their efforts in improving female representation in engineering, with the action word "push" used to encourage their female students to choose engineering as a post-secondary pathway. This shows that, at least in this particular high school, the idea of broadening participation to close the gender gap in engineering is alive and well. This is also consistent with the claim that high school is an important local context to address the gender gap in engineering [22].

Existing literature has shown that there is a low representation of those from the African-American, Hispanic and Latino, Indian American, and other underrepresented communities in engineering [17], [23]. Compounding the low minority representation in engineering phenomenon with the economic and competitiveness arguments that lead to the need of engineering education in P-12 [1]–[3], broadening participation to close the racial gap in engineering becomes crucial. Findings from this qualitative study show that, in this high school, the teachers and school counselors believe in the encouraging more minority students to pursue engineering. In addition, some act on their beliefs, illustrating the possible impacts of research and scholarship on broadening participation to close the racial gap in engineering.

School Counselors' Beliefs about Engineering can be Different

Another important takeaway from this study is the preliminary observations on how school counselors perceive and believe about engineering. As described early in this manuscript, school counselors play significant roles in students' academic and career selection [10], and there is scarce literature on the topic of beliefs about engineering among the K-12 school counselor population. This study can start to potentially fill that literature gap.

In this study, findings show that school counselors' beliefs about engineering can be different depending on several factors. One of them is exposure to engineering. Between the two counselors, one of them worked as engineer in their previous job, while one had no exposure to math, science and engineering. This can potentially explain why their beliefs about the definition of engineering are different, as the one without any experience in engineering gave the definition that engineering is "mathy" and "sciency", which, as explained in the first takeaway, can affect how that particular school counselor's decision in how and which type of students to describe engineering to. This supports the claim that research and scholarship should be advanced to understanding the differences in beliefs about engineering among this important yet understudied K-12 population.

Limitations

Although the study has provided us many learnings and findings, there are limitations to it. One limitation is the small sample size. As presented, four participants from one high school were studied. The context of being in one high school provides a unique perspective in looking at the different teachers and school counselors' beliefs about engineering. However, it also leads to limited transferability of findings to other high schools and states in the U.S. as different high schools have different local contexts and different states have different educational policies. Even with this limitation, we argue that the findings can serve as a starting point for the pre-college engineering education community to further research and scholarship in the domain of P-

12 actors' beliefs about engineering.

Another limitation is that this is an emergent study from an existing mixed-method project. The interview protocol, though includes some questions that can lead to participants sharing their beliefs about engineering, does not require follow up with the participants on those questions. It is possible this may result in the participants not completely sharing their beliefs and thoughts about engineering. In the near future, we will look into coding transcripts from participants from other high schools with the coding framework we established for this preliminary study to see potential similarities and differences in beliefs about engineering across different case sites. Future studies, we argue, can use findings from this study and existing literature to design more studies on K-12 actors' beliefs about engineering.

Conclusion and Implication

Multiple arguments, whether they are economic- or equity-based, have been made to improve U.S. engineering education. K-12 engineering education is essential to that effort, and part of the process of improving K-12 engineering education is to understand the K-12 actors' beliefs about engineering. Teachers and school counselors are two of the many types of actor that engages the students, and they play a significant role in possibly influencing students' decision to whether pursue engineering or not.

This study has provided a specific view of beliefs about engineering of two teachers and two school counselors in a Virginia high school. We find that the four different participants have different beliefs about engineering and characteristics of engineers and engineering students. In addition, we also find that the different participants have made broadening participation in engineering one of their focuses, with many of them mentioned the male-dominant nature of engineering the need of improving minority representation, whether in terms of gender or ethnicity, in engineering. These findings are consistent with existing literature in the K-12 domain.

The findings of this study contribute to the expanding literature on K-12 actors' beliefs and perceptions about engineering, particularly on those from the teachers' perspectives. The findings also start to address the lack of literature of school counselors' beliefs about engineering, and we think this study can serve as one of the starting points to further research and scholarship in this topic, possibly on the similarities and differences school counselors' beliefs about engineering as compared to those of teachers. Additionally, the findings provide a deeper dive into some of the systemic elements (teachers and school counselors) in Virginia high school system that can influence students' post-secondary pathways, particularly in engineering.

Exploring teachers' and counselors' beliefs about engineering, from a single high school, is not generalizable. However, when taken in context with school and community characteristics, our findings, we argue, provide a basis to support important future work. First, our findings provide a starting point to assist research aimed at understanding and explaining the relationship between teachers and counselors, and students regarding students' perceptions of engineering as a career choice. Second, though socializers are a big part of the EVT framework, existing literature from the socializer's perspective in general is scarce, thus our findings can expand the EVT socializer literature by providing a different context (high schools and engineering post-secondary pathways) in how socializers in the EVT framework are studied.

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