Maybe I am Interested in Engineering, Does that Matter?

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Maybe I am Interested in Engineering, Does that Matter? (Research to Practice)

Strand: Other (None of the Above)

Abstract

Interest is often cited as one, if not the key, reason for why students chose a career or college major, including engineering. However, research has also shown that interest is not necessarily the primary reason for career choice within underrepresented groups. The purpose of this paper is to present how interest relates to engineering as a career choice for a group historically underrepresented in engineering. Using the Social Cognitive Career Theory as a frame work, high school and college engineering students from Appalachia were interviewed concerning career choices to answer the research questions: What role(s) does interest play in engineering career choices of Appalachian students? How do such roles differ for high school and college students? To answer the research questions, qualitative data from a total of 36 junior and senior high school students from multiple counties in Appalachia Virginia and 12 college engineering students from the same counties were interviewed. The interview protocol was developed using SCCT as the framework and included questions concerning interest, goals, supports/barriers, parental jobs and education, and expectations of their future. Results show that interest was the primary reason for planning on an engineering career by the high school participants. Likewise, interest was the primary reason for choosing engineering given by the college engineering participants. The students planning on engineering had exposure to engineering in high school, however not all students exposed to engineering plan to pursue an engineering career. Additional findings include 1) many high school students being unfamiliar with engineering and not knowing any engineers and 2) students who are considering a career in engineering (but not decided) not reporting an interest in engineering as a career choice. Recommendations for stakeholders are provided based on the findings.

Introduction

Research on persistence in Science, Technology, Engineering, and Math (STEM) fields suggests that factors such as role models, exposure to STEM careers, and interests in STEM fields influence K-12 students toward career choices in these fields. Of these, interests have been broadly cited as a particularly important influence on STEM career choices (e.g., [1, 2]). However, research focused specifically on underrepresented groups often reports other constructs, such as cultural milieu, as more important than interest in influencing career choices (e.g., [3, 4]). The idea that interest might be of different importance to different groups of people is worthy of further exploration. Therefore, in our study, we focus specifically on the role of interest in choosing engineering careers to help us better understand how interest emerges and translates into engineering career choices. We focus on Central Appalachians as a group underrepresented in engineering degree programs and careers. Central Appalachia is defined as portions of southwest Virginia, West Virginia, northeast Tennessee, and eastern Kentucky[5]. Central Appalachia is located in the mountainous, rural, coal mining region of Appalachia and has the highest rates of poverty and lowest rates of post secondary education within Appalachia[6]. Our sample includes high school and college students from Central Appalachia enabling us to examine the role of interest at two different time points on the pathway to becoming an engineer.

Why Study Appalachia as an Underrepresented Group?

People from Central Appalachia are both similar to and different than other underrepresented groups. Central Appalachians are similar to other underrepresented groups, such as inner city youth, with respect to having low socioeconomic status (SES) and low post secondary education achievement[7]. In contrast, Central Appalachians are different from other underrepresented groups in that they are predominantly white, live in more rural areas and are culturally different. The counties used in this case study are rural Central Appalachian counties in Virginia. Table 1 provides a comparison of the Central Appalachian region of interest with Virginia, Appalachia, and the U.S.

Table 1 Statistical Data of Sample Population

Location	Poverty, % US Ave. 2006 - 2010	Per Capita Income (2010)	Population Density	Population (2010)	College Completion (% of US Ave., 2000)	Engineers, % by B.S. degree
U. S.	100%	$39,937	87.4	308,745,540	100%	
Virginia	74.5%	$44,267	202.6	8,001,020	120.7%	9.1%
Appalachia	113.2%	$32,645	123.5	25,243,460	72.2%	NA
Buchanan	157.6%	$30,099	47.9	24,100	32.6%	NA
Dickenson	138.5%	$28,871	48.1	15,900	27.3%	NA
Lee	153.2%	$27,258	58.8	25,590	39.0%	4.0%
Russell	124.1%	$27,995	61.0	28,890	38.4%	2.8%
Scott	133.3%	$26,989	43.3	23,180	34.2%	2.1%
Smyth	138.5%	$27,381	71.4	32,210	43.5%	3.8%
Tazewell	122.5%	$32,424	86.9	45,080	45.1%	5.1%
Washington	121.9%	$32,084	96.8	54,800	67.0%	6.5%
Wise	148.7%	$31,285	102.3	41,450	45.6%	3.5%

Sources: Appalachian Regional Commission, Virginia Department of Education, and U.S. Census Data. U.S. rate of poverty = 13.8%; U.S. College Completion = 24.4%

Historically higher poverty rates, lower SES, and a higher percentage of a blue collar workforce compared to the Unites States as a whole are associated with Central Appalachia. These factors could directly influence the development of career interests. For example, within Central Appalachia the lack of white-collar and technical jobs[8] may have an impact of perceived employment possibilities (and associated interests) of youth making career decisions. In 2010, the four major employment sectors were mining (#1), manufacturing (#2), farming and natural resources (#3), and utilities (#4)[6]. The absence of "white-collar" sectors within the region may limit awareness of these jobs and their associated opportunities. Awareness of job opportunities has been previously linked to career choice predictions; students from advantaged (higher SES) backgrounds tend to aspire to higher status jobs than students from disadvantaged backgrounds[9].

Low SES is also linked to lower educational achievement[10] as a whole. Yet, most research suggests that education is paramount to individual, economic, and social growth[5, 8, 11]. Though low educational attainment in general is common across groups underrepresented in STEM, reasons for the lagging educational attainment in Appalachia revolve around factors related to rural settings. Based on prior research, factors associated with lower educational attainment include the small schools, isolationism, and outmigration of persons who achieve a post secondary education[4, 12-15]. In addition, the percentage of people reporting an engineering degree is below that of Virginia as a whole, as shown in Table 1. As the engineering community continues to promote increasing diversity in engineering, we argue that a version of diversity includes those who are from Central Appalachia. Based on the Appalachian culture and the history of people working with their hands and developing an aptitude to fix items, engineering students from Appalachia have the potential to both expand cultural diversity and challenge the status quo for Caucasian engineering students. Therefore, this region is of particular importance for understanding the role of interest in choosing engineering as a career choice and particularly with regard to the interplay with low educational achievement in general.

Though similar with regard to low SES and low educational attainment factors, Central Appalachia is different from urban areas that are often studied as underrepresented with respect to ethnic diversity, population densities, and crime rates[4, 16]. Overall, Appalachia, and in particular Central Appalachia, has distinguishing characteristics such as a higher percentage of Caucasians, and a lower population density. Less tangible are factors such as loyalty to family, proximity to relatives, and a connection to the community. In general, Appalachians do not fit the typical cultural profiles for affluent or poor Americans; the majority of Appalachia shares ethnicity characteristics of many affluent Americans – predominantly white, largely Anglo-Saxon ethnicity, predominantly Protestant, and roots tracing back several generations to the region[4, 16-18]. However, Appalachian people are often negatively stereotyped and marginalized in similar ways as ethnic minority groups[14, 19, 20].

In summary, people from Central Appalachia share similarities with other groups that are underrepresented in engineering (e.g., low SES, low educational attainment) yet different in terms of rurality, and Appalachian culture. These are all factors (similarities and differences) that could impact interest. Consequently, Central Appalachia provides an appropriate region for understanding the role of interest in the career choices to expand our understanding of underrepresented groups in engineering.

Framework

Lent, Brown, and Hackett's Social Cognitive Career Theory (SCCT)[21] was chosen as the framework for this study for several reasons. First, there is strong research-based evidence for SCCT as an appropriate framework for career choice decision making among K-12 students (e.g.,[22, 23]). Second, there is relevant research using SCCT with respect to Appalachia, engineering, and underrepresented groups more broadly (e.g.,[3, 24, 25]). Figure 1 depicts SCCT with the boxes showing the constructs and the arrows representing relationships between constructs. Of particular importance for this study is the box labeled "interest". Lent & Brown[26] define interest as "People's pattern of likes, dislikes, and indifferences regarding different activities."(p. 17) Within SCCT, interest items typically address interests in activities that relate

to the career and consider the age and experience appropriate level for the participants, i.e. high school versus college. In addition, interests can be assessed as a continuum, for example, from strongly dislike to strongly like an activity. SCCT posits that interests directly influence career goals and are mediated by one's self-efficacy (perceived ability to perform a task or negotiate an obstacle) and outcome expectations (e.g. consequences of trying a career choice). Environmental, or contextual, influences are divided into background (distal) and proximal within SCCT. The background context is modeled as an eventual influence of interests and the proximal is modeled as directly influencing career goals. While the intent of this section is not to review all relevant literature on SCCT, important findings and gaps in the literature are addressed herein.

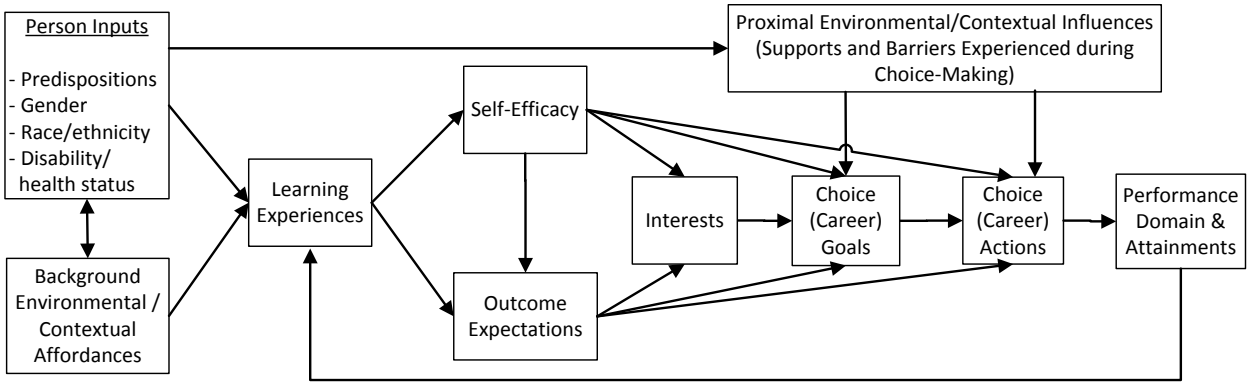

Figure 1 SCCT Model (Lent & Brown, 2000)

Within Appalachia, research on career choices has identified key factors that influence career choice in general and include wanting to remain local, desiring job stability, and the recognizing the importance of family as part of the culture[4, 16, 17, 20]. Research specifically looking at how interests affect the career choices of Appalachian youth, however, is more limited. For example, Ali & McWhirter[20] list not including interest in their statistical model as a limitation to their research and Bennett[4] reported that widely used interest instruments have not been used with Appalachians. Others report reasons why interest may not be a key factor within Appalachia, such as Tang & Russ[17], who postulate that career choices based primarily on an individual's interests may not occur due to the strength of the perceived family benefit over the individual. Note that much of this research examines career choice in general and little to no research specifically focuses on engineering.

Considering interest more broadly than Central Appalachia, research findings are mixed and dependent upon what variables, careers and participant groups are considered, SCCT literature related to underrepresented groups more broadly shows some agreement with Appalachian literature in that cultural and environmental factors are important to career choices and that interest may not be the dominant influencer toward career choice reasons[25, 27]. Research with these underrepresented groups considers cultural factors (e.g. family and location) as well as SES. However, other literature using SCCT with participants that are not distinguished by SES or other environmental factors support the primary influence that interest plays in career choice decision making. For example using a large and diverse sample of students and colleges, Lent et al.[28] reported a strong positive relationship between interest and goals in computing disciplines. Likewise, Morgan et al.[29] concluded that the anticipated experience of interest was a critical

influence on career choice for both men and women when they studied physical/math science, medicine, education, and social careers. SCCT engineering literature also support the primary influence interest has in career choices[28, 30, 31]. However, the engineering research does not tend to report on participant' economic or SES background. Though some of the engineering literature does distinguish participants by gender, ethnicity (e.g. African American, Caucasian), or type of university (e.g. HBCU, predominantly white institutes), the articles do not tend to report on analysis by socio-economic backgrounds. The gap in current literature then is considering interest in combination with SES and other environmental (i.e., contextual) factors particularly for underrepresented groups.

To address this gap, we aligned our methods with the SCCT framework in terms of the interview protocols and analysis approaches to consider context and interest. As anticipated, SCCT proved appropriate and useful for this study particularly with regard to facilitating a deeper investigation into the role of interest in engineering career choices. In addition, qualitative analysis was chosen for this exploratory work due to the lack of prior research on the topic of engineering as a career choice in Appalachia. By using a qualitative approach findings are able to emerge from the data and not be restricted to pre-determined categories or themes. In this way we did not limit our research analysis or findings to "fit" prior work conducted in different settings.

Method

This study is part of a larger project researching barriers to engineering as a career choice for Appalachian youth. The project used an exploratory qualitative methodology and employed in-person semi-structured interviews and maximum variation sampling[32]. In this section we describe the data collection, participant characteristics, and qualitative analysis (coding) used to answer the research questions: What role(s) does interest play in engineering career choices of Appalachian students? How do such roles differ for high school and college students?

Data Collection

The primary data source was semi-structured interviews with high school and college students from Central Appalachia. Approval to conduct research using human subjects was obtained through the appropriate Institutional Review Board(s) (IRB) prior to data collection. The interviews were conducted in person with two researchers (one male and one female) for all high school interviews and in person or over a phone for all college participants. Interviews were audio recorded and transcribed verbatim.

The interview protocols were developed through a series of steps to ensure the quality of the research was not compromised. The interview protocols were developed with an intent of allowing for 1) an open conversation so that unanticipated information relative to career choices would be captured, 2) multiple researchers could conduct interviews, 3) and to be conducted in approximately one hour (to support the high school students' schedules). In addition, the college student and high school student protocols were designed to gather similar information to enable both analyses by participant group and comparison between the groups. To ensure quality protocols, guidelines for the interviews followed published recommendations for semi-structured interviews[32, 33]. The interviews revolved around a few open-ended questions with multiple

probes[33, 34]. The open ended questions were developed to allow rich, deep descriptions of participant's experiences and beliefs[35, 36]. Distinctions between the protocols included ensuring the questions were appropriate to capture participants' perspectives relative to high school experiences (either current or reflection). The final protocols captured information on the participants' experiences during high school including reasons for choosing their career goals as well as information related to the other constructs of the SCCT model. Detailed information on the protocol development was previously documented[37].

Participants

All high school and college participants were from one of nine counties located in the southwestern most portion of Virginia. The counties represent a variety of economic conditions, populations, college completion percentages, and percentage of people completing college reporting an engineering degree. As a reminder, Table 1 shows the statistical variation of the counties represented by the participants.

The high school interviews occurred during the 2012 – 2013 academic school year and the 24 high school participants were from four counties and six different high schools. The mixture of high school participants represents the variety of school sizes, population densities, socio-economic statuses, and students considering and not considering engineering as a career choice. None of the participants had a parent working as an engineer, though one reported that her father has an engineering degree but changed fields in practice. Overall, a diverse sampling of participants was obtained with respect to variables common in literature about Appalachia (e.g., rural populations, prospective first generation college, low SES, and smaller schools). The participant interviews reached a point of redundancy within each school and the information gained. In addition, participants from the final high school fit the anticipated patterns, suggesting saturation of participants[35]. However, based on literature about college completion versus students entering the workforce directly from high school, the participant sample was limited; more students in the data plan on college than expected. This was an unintended consequence of the sampling process. Though a limitation of the study, it did not impact our ability to develop outcomes or answer our research question. Table 2 shows the breakdown of the 24 high school participants. More females than males volunteered to participate at the high school level (2:1 ratio, roughly half of the students had at least one parent with a 4-year degree (according to the participant), the majority (3:1) had not participated in an engineering activity. We thought this last criterion might be important as contributing to exposure to and interest specifically in engineering.

Twelve college engineering students were interviewed during the 2012 – 2013 academic year; they ranged from freshmen (first year) to seniors and included students at community colleges and four year universities. The students represented a variety of engineering majors. A snowball approach was used to obtain college participants; the initial participants were known to the lead author who lives in one of the counties included in this study. All of the college students were enrolled in an engineering program, three of the 12 were female (a 1:3 ratio), just under half had at least one parent with a 4-year degree, and half commented on participating in an engineering activity during high school.

Table 2 Participant Variation

Participant	Total	Gender		FGC (4-yr)	Engineering Activity Participant	
Virginia		M	F		No	Yes
High School	24	8	16	13	18	6
College	12	9	3	5	6	6

Qualitative Analysis

The analysis process involved using a combination of field notes, researcher log books, and MAXQDA software. A variable centered approach[38] was used and included aggregation of initial codes followed by pattern making from the aggregated variables. A priori codes were established using a combination of literature on Appalachian student career choices and SCCT literature. For example, categorical codes such as gender, plan to attend college, at least one parent having a 4-year degree, wanting to remain local, year in school, and knowing at least one engineer were used to help sort and locate patterns within and across participants both within high school or college and between high school and college. Table 3 contains the codes, sub codes, and comments on how the code was operationalized. Note that although drawn broadly from literature on Appalachia, many of these codes fit within SCCT constructs helping us to examine the intersection of context and interest. For example, gender is a person input and the parental educational level is a background environmental factor (contextual affordance). Though demographics are not always coded in qualitative research, they were important in our study with regard to characterizing context and therefore were used to facilitate pattern making and in analyzing the data for findings and are thus shown in Table 3.

Table 3 Qualitative Codes

Code	Sub Codes	Comments
Sex	Male or Female	From name, appearance and comments in the interviews.
Education Level	H.S. or College	Known prior to interview.
Year in school	Freshman – Sr	Direct question asked to participants.
Remain Local	Yes or No	Participant comments on where they want to live when they start their career. Directly asked, but also discussed in additional places of some interviews.
FGC	Yes or No	Yes if neither parent has a 4-yr degree.
Know any Engineers	Yes or No	Direct question asked. If mentioned in multiple places, all tags were included.
Interest	School-related	May be related to courses of extracurricular school activities.
Interest	Outside of School	This category included organized and personal activities. Organized activities included items such as non-school related sport or church activities.

In addition to the categorical coding, we focused on reasons participants gave for their current career plans. Of particular importance for this paper was the coding for interest as a career choice reason. Interests refer to a person's likes and dislikes or a person's "liking and willful engagement in a cognitive activity"[39]. Interest was defined for specific situations, as recommended by Lent and Brown [26] to include specific types of activities. The individual interest

activities identified throughout the interview texts were then aggregated into the categories of school-related or outside of school. Note that participants were directly asked about their interests but the entire interview was also coded for interest-related comments. Areas of interest coded included at school (classes and school related extracurricular activities) and outside of school (e.g. hobbies and jobs). In addition, college student interviews were coded for current interests as well as their reflection of high school interests.

Quality of the research was strengthened through several steps of the research process including protocol development, interview data collection, data analysis, and synthesis of the findings [32]. Methods used to ensure credibility included having the interview protocol reviewed for clarity and content of the questions and conducting pilot interviews. Credibility was also improved by audio recording the interviews and transcribing them verbatim. The reliability of the data analysis was improved by employing the assistance of an additional engineering education researcher to analyze interviews using the codebook. The interview coding was compared, differences discussed, and the codebook modified until agreement on coding and definitions was obtained [32]. After collection and analysis of the data, the information was reviewed to ensure the analysis was scoped adequately to answer the research question.

Results

Our research questions focus on understanding the role of interest in engineering career choices of high school and college students from Central Appalachia. To answer our questions, we first summarize patterns across participants with regard to the salience of interest. We then provide details about the role of interest using quotations from high school students and then likewise from college students.

The Salience of Interest in Career Choices

As previously described, we coded all reasons participants gave for their present career choices (details of the career choices are available in previous work by the lead author[40]). In this paper, we focus on interest-related reasons. Note that only 4 out of 24 high school participants were even considering careers in engineering while all 12 college students were already enrolled in an engineering program. Only two of the four high school students and 8 of the 12 college students gave interest-related reasons as the primary reasons for considering engineering as a career choice. It should be noted that interest was the primary reason for the two high school participants that are certain they will pursue engineering. Table 4 shows the breakdown of reasons for choosing engineering as a career choice with regard to the sub-code of interest or if another reason (Other Reason) mattered more. Of the four college participants listed under "other" in Table 4, three specifically had a person or activity motivate them toward an engineering careeer and spoke of the influencer's persuasion toward engineering more than the participant relaying a personal interest in an engineering career.

Note that the count of participants is provided for discussion purposes and is not intended to suggest the qualitative interviews are sufficient to represent percentages in a statistically acceptable manner. Also note that in all cases we let participants determine what is meant by engineering or engineering-related activities, i.e., the research team did not provide a definition

of engineering (as a person or a career choice) nor did the research team re-identify any comments as engineering or not engineering.

Table 4 Career Choice Reasons

Participants	# Participants	Interest School-Related	Interest Outside of School	Other Reason
H. S. Considering Engr.	4	2	0	2
College Considering Engr.	12	3	5	4

We have previously noted the lack of literature specifically examining context and interest. Therefore, we believe it is important to situate our findings regarding interest relative to the context of the participants. Characteristics of the high school and college participants are shown in Table 5 by participant and grouped by participant category in Table 6 to assist in the comparison of results. The person characteristics chosen are based on contextual factors that matter according to existing literature, e.g., being a first generation college student (FGC) is a characteristic of the participant that represents the context in which they are making choices. In addition, a factor of being a continuing generation Appalachian (CGA) emerged as a salient characteristic. CGA participants are those who have at least one parent from the region included in this case study research.

Table 5 Participant Findings

Pseudonym	Career Field	Primary Reason	Engr. Activity in HS	CGA	FGC	Prefer to Remain Local	Income Important
High School Participants Considering Engineering as a Career Choice							
Ashley	Engineering	Interest School	Yes	No	No	No	No
Debbie	Engineering	Interest School	Yes	Yes	No	Yes	No
Kyle	Unknown	Other	Yes	Yes	No	Yes	Yes
Gary	Unknown	Other	No	Yes	No	Yes	Yes
College Engineering Participants							
Hannah	General	Interest School	Yes	Yes	Yes	Yes	Yes
Shane	General	Interest Hobby	Yes	Yes	Yes	Yes	Yes
David	Industrial	Other	Yes	Yes	No	Yes	No
Jacob	Mechanical	Interest School	Yes	No	No	No	No
Dave	Mechanical	Interest Hobby	Yes	Yes	No	No	No
Tyler	Mechanical	Interest Hobby	Yes	Yes	Yes	Yes	Yes
Mark	Biological	Other	No	Yes	Yes	Yes	No
Nicholas	Chemical	Interest Hobby	No	No	No	No	No
Richard	General	Other	No	Yes	Yes	Yes	Yes
Bob	General	Interest Hobby	No	Yes	Yes	Yes	Yes
Sharon	Industrial	Other	No	Yes	No	Yes	No
Marie	Mechanical	Interest School	No	Yes	No	Yes	No

Literature on career choice indicates that parental education correlates to post secondary education aspirations and that students with parents who have a post secondary degree are more likely to attend college (e.g.,[14, 23]). For the participants of this study, however, the majority plan to attend college regardless of parental education. The comparison of being FGC showed differences between the high school and college students however. Roughly one half of the college students are FGC (see Table 6), though several of those are currently attending 2-year colleges (which have an A.S. in engineering technology and articulation agreements to 4-yr universities). For the high school students planning on or considering engineering as a career choice, none of them will be FGC. Considering the low percentage of college graduates in the region (Table 1), it was unexpected for all participants of one category of career choice to not be FGC. For the high school participants considering engineering as a career choice, though all of them have at least one parent with a four year degree, none of the parents are engineers. For the college engineering students, one (a non-CGA participant) has a parent who is an engineer and one has a sister who is an engineer.

With respect to a preference to remain local, several college participants indicated a preference to remain local, but indicated they will move to a different location (and believe they will need to move) in order to get an engineering job. Overall, all participants have a preference to remain local which agrees with literature on Appalachia[3, 4, 8].

Three of the four high school participants planning on or considering engineering as a career choice had exposure to engineering in school (e.g., via project lead the way classes). However, not all students exposed to engineering careers in high school or taking engineering classes are planning to pursue an engineering career.

The primary factor for choosing engineering as a career choice for the high school and college participants was interest, though the majority of high school students were choosing a career based on reasons other than interest. Many of the high school students who were not choosing engineering were also unfamiliar with engineering as a career choice and engineers.

Table 6 High School and College Participant Comparisons

Characteristic	College Engr. Participants	H.S. Participants Considering Engr.	H.S. Participants not Considering Engr.
CGA	Majority	Majority	Majority
FGC	One-half	None	Majority
Prefer to Remain Local	Majority	Majority	Majority
Income or Job Stability Important	One-half	One-half	One-half
Interest Reason for Career Choice	Majority	Majority (planning on engr)	Minority
Exposure to Engineering in School	One-half	Majority	Minority

In summary, the results showed that the total participant sample intends to go to college (or are in college) and is a blend of potential or first generation college, preference to remain local, career choices, and reasons for career choices. However, when segregated for planning on engineering as a career choice, none of the high school students are potential first generation

college, all chose a career in engineering based on interest, and all had exposure to engineering. Likewise, the high school students considering engineering had exposure to engineering, but did not convey a specific interest in engineering. Finally, the college engineering participants primarily chose engineering as a career because of an interest in engineering.

High School Participant Career Choices

To describe the role of interest in career decisions, we look to the participants' words. We provide quotations from the high school participants relative to why they were planning on (Ashley and Debbie) or considering engineering as a career (Gary and Kyle) to show how an interest in school classes or activities developed into a personal interest to pursue engineering as a career choice.

When asked what made her want to be an engineer, Ashley responded:

> In my middle school we had a robotics team and a science fair team, and it was very fun, and what we did was we had a thing called Lego robotics where we made robots with Legos, and I really liked that. And, um, when my teacher said, you know, there are people out there which actually do this for a job, and I was like, I would love to do this for a job. And, after I started researching what jobs out there had the same things around that, then I realized I wanted to go into an [chuckles] engineering major.
>
> - Ashley, High School Senior

Unlike Ashley, Debbie did not recount a single incident where she realized she wanted to be an engineer. Instead, Debbie commented throughout the interview that several items have contributed to her liking engineering; that she likes the math, science, problem solving, and engineering classes and that they are all easy for her. When specifically asked what it was about engineering that was causing her to choose it, she replied:

> It's [engineering] just the hands-on, like, it makes you think and it's just, that just interests me, like the problem-solving and stuff.
>
> - Debbie, High School Junior

Kyle, on the other hand, has moved away from thinking engineering was his primary career choice to it being one of several items on his list and, in fact, is considering a liberal arts school that does not offer engineering. Kyle commented that when he saw some "higher level math" from a friend he did not think he could do the math and so was also considering architecture because architecture requires creativity and "probably uses geometry;" Kyle reported he excelled in geometry. In his discussion, he did not talk about his original interest level or describe how interest had changed; interest in engineering was just absent.

Gary was similar to Kyle in that he was considering several options: medicine, law, architecture, and engineering. Gary, like Kyle, commented on moving away from engineering as a career choice because his math (calculus) was harder than he expected; Gary was considering the other career choices because of personal interests and comments from others. For example, people

suggesting he would be a good lawyer because of his speaking skills. Both Gary and Kyle said they were considering engineering, but neither related detailed or specific information on why engineering would be an interesting career for them.

Though four of the 24 participants were considering engineering as a career, several were not only NOT considering it as a career choice, but indicated they knew very little about engineering. For example, Karen's recommendation is to increase information about engineering as a career choice:

> I think, the engineering thing, maybe, to get that out, there could be, if there's, some engineer school maybe come and talk to people about what it is and what they do and because everyone knows what a, doctor does, what a nurse does, everyone knows. But, I mean, I know that I haven't really heard of engineers, and a lot of people are confused about what they do and what, what things you need in college to be that, and what exactly they do, so maybe just some, like some schools getting more information about [engineering].
>
> -Karen, High School Senior

College Engineering Student Participant Career Choices

Several of the college participants (all enrolled in engineering) discussed an interest in courses related to engineering as their reason for pursuing an engineering career. An example is given by Marie, who knew she wanted to do something related to math, science (e.g., physics and chemistry), and to have a technical job. Marie indicated that, as she went through high school, math took a prominence and she started thinking engineering would be a good path. Marie also compared engineering to medicine and said she took biology, but it did not "grab her" like she expected and that she, "liked the general spectrum of engineering classes" more than for medicine. Reflecting back, Marie indicated that while in high school she looked into careers where she could combine her interests and an engineering career appeared to meet her requirements. As Marie said:

> I got the course plan and started looking at it and it's got your core math classes, and it's got your physics, and it's got your chemistry. And even if I didn't know if I wanted to do engineering, I was like, well, I'm probably, there's a, like a 95% chance I'm going to do something technical.
>
> - Marie, Engineering College Sophomore

As a sophomore, Marie is pleased with her decision to pursue an engineering career, a decision that was reinforced after a summer internship as an engineer at a local company. Thus, Marie was continuing to deepen and internalize her interest in engineering.

However, not all of the college students reflected on high school classes as providing their interest to pursue an engineering career. In fact, nearly half of the college participants cited hobbies as their main reason for pursuing an engineering career. Several of the engineering students commented on working on vehicles or doing mechanical work as their hobby and what spawned their interest in engineering. As stated by Tyler:

> I did a lot of carpentry and uh, machining work actually and I did just a tiny bit of welding …(Dad's) a journeyman machinist, journeyman toolmaker, so he had mills and lays and saws and everything at home and that's what he did as hobbies, so naturally, when I was young, I just went with him and did that and working with my hands became pretty much my biggest hobby other than sports. Uh, I guess that's the biggest outside thing that I did that led me towards being an engineer because I just felt like, well, it's, you know, you're kind of already on track.
>
> *- Tyler, College Sophomore in Engineering*

Dave was similarly influenced by his hobby of working on cars in high school. Throughout the interview Dave continues to discuss his interest in cars and motorcycles and wanting to continue working with them as an engineer.

> Through high school I was also doing a lot of work with cars too. I mean I grew up with [friend] and he always had his head under, you know, in a car bay. And so we were always building his car up and, and then I had that—well that came during college, I had that uh, a really intense car project… I pretty much built the car and so I've done all of the electrical work and mechanical work and so that that definitely sparked my interest like figuring things out was something that I wanted to keep doing you know. And it was just, it wasn't a whole, I, I wasn't around a lot of people who, who were like mechanically minded I guess in high school. It was me and [friend] and you know people who were car fanatics.
>
> *- Dave, College Senior in Engineering*

Additionally, within Dave's interview he comments on having some exposure to engineering via a high school calculus class and a robotics class. However, Dave said that the calculus class contributed "a little" to his decision, but he did not remember the robotics course very well and was not very engaged in it.

Both Debbie and Ashley convey not just an interest in subjects (e.g. math and science) that are associated with engineering, but an interest in doing engineering as something they were interested in continuing to do. Karen, representing participants who did not know about engineering careers, recognized a need for students to know more about what an engineer does. Contrary to Debbie and Ashley, Kyle and Gary related engineering specifically with math and may not pursue engineering as a career. Similar to Kyle and Gary, Marie (college student) spoke of liking math, but also elaborated that she liked the whole spectrum of engineering related courses. Marie was also like Debbie and Ashley in that after specific exposure her interest in engineering increased. Though Dave and Tyler did not develop their interests through engineering classes, they did have hobbies that they related to being engineering hobbies and what they liked and wanted to continue doing as part of their career.

Discussion

Research results on career choices of people from underrepresented cultural groups, including Appalachians, reveal that cultural factors other than interest are of primary importance. However, career choice research specific to engineering often report interest as a primary factor. This gap in the literature prompted our research questions: What role(s) does interest play in engineering career choices of Appalachian students? and How do such roles differ for high school and college students? In answering these questions, our research, specific to career choice reasons for engineering of Appalachians, found that interest is a primary factor.

Engineering as a career choice was distinct from other professions because of the prominence of interest as the defining reason. Within the high school participants, Ashley was exposed to an engineering situation that provoked an interest in engineering which was strengthened with continued exposure to engineering related courses. Debbie, on the other hand, developed her interest through continued exposure to engineering related school activities which she now reports as a long term interest of hers. Both Ashley and Debbie represent what motivational literature generally discusses as two types of interest: situational interest and individual interest (e.g., [41, 42]). Situational interest refers to a person's liking or engagement that is triggered "in the moment by environmental stimuli"[41](p. 113). On the other hand, individual interest is a person's liking or engagement triggered by internal factors [41]. Situational interest is not necessarily long-term and individual interest is more lasting[42]. Hidi and Renninger[41] developed a four phase approach to interest that begins with situational interest (initiated by an external factor) which eventually becomes an internally focused fully developed interest. Several of the college participants, such as Marie and Dave, also described their progression from a situational interest to an internally focused long-term interest.

For the two high school students who are moving away from engineering and toward other careers, they not only did not mention specific interests in any engineering related activities, but also commented on recent difficulties with math and assumptions about a necessity of being good at "hard" math and engineering. This is consistent with SCCT which suggests self-efficacy (ability beliefs) can mediate interests. This coupled with many other high school students indicating they are unfamiliar with engineering and/or do not know any engineers suggests that students' knowledge of engineering is limited, perhaps making it even harder to understand abilities with regard to engineering careers. Moreover, as Karen suggested, increasing students' exposure to engineers and engineering careers may increase the number of students interested in engineering.

Based on the college engineering student stories, the way that students are exposed to engineering careers (e.g. in school or outside of school) are important; this may be due to students having a different propensity for the "classroom" or subjects related to engineering careers versus activities related to engineering careers. Interestingly, none of the high school students interviewed were planning on engineering based on an interest outside of school, though some of the schools activities were "hands-on".

Overall, this research shows the importance of providing students with opportunities to learn about and experience engineering for engineering to be considered as a career choice. In

addition, the research exposed that many Appalachian high school students have not had such an opportunity. The research also shows that not all students exposed to engineering consider engineering as a career choice.

Limitations

Several limitations exist for this research and are a combination of those known going into the study and as a result of data collected. First, the majority of high school participants both indicated being in the top ten percent of their graduating class and or intend to attend college. At the onset of the research our intent was to interview a broad sample of high school students from each location. However, based on comments by some participants are consent and ascent forms may have inadvertently restricted participation by having the word “engineering” in the research title (some participants indicated they and others wondered if detailed engineering questions would be asked). Secondly, the college engineering students were all attending public in-state universities and thus may not represent all college engineering students as some number may attend out-of-state or private institutions.

Conclusions, Implications and Future Work

Interviewing a combination of high school students and college engineering students from the Central Appalachian region of Virginia allowed findings to emerge related to engineering as a career choice that are useful for several stakeholder groups including school administration, high school students, college engineering students, and colleges that offer engineering degrees.

Though students in Appalachia choose careers for a variety of reasons, engineering was primarily chosen because of an interest in engineering. Therefore, it is important for students to learn about engineering at a time when they are considering career choices (i.e., high school and even earlier). Parents, teachers, counselors and school administrators in areas, such as Central Appalachia, with a relatively small number of engineers and few schools offering engineering classes at the school, might need to make a concentrated effort to introduce students to engineers and engineering careers. In addition, because students in Appalachia have a preference to remain local, these efforts could further concentrate on using engineers and engineering examples specifically from the region.

Though our sample is too limited to make sex-based generalizations, we noticed that no women expressed hobby-related interests in engineering; their interests tended to be school-related. Moreover, the hobbies that were cited by men were described with a “hands-on” or fixing component as the connection with engineering. This begs further research regarding the implications for how engineering, or even if, engineering is presented to high school students as a career choice. The research could include what the teachers and guidance counselors know about engineering as a career choice; what engineers do, who they are, and where they work. Opportunities for students to participate in engineering (or STEM that emphasizes engineering) interventions and or hobbies might be too localized and/or gendered; better understanding such programs and how students become aware of them might also help raise interests in engineering.

Future research could focus on the role of interest and specifically why interest seems to matter more for engineering as a career than for other careers. In addition, future work using the existing data set could continue to "peel the onion" on why interest mattered by requesting follow-up interviews with the existing participants. Additional interviews would allow a more in-depth examination on the roles of career-related interventions in developing interest in specific careers.

Finally, follow-on research with a longitudinal component is also recommended specifically to examine how and why professed intentions become actual higher education and career pathways Because the SCCT model accommodates plans to actions and contains a loop for actions and results to feedback as learning experiences, the longitudinal work can be framed within SCCT. Future research should make a focused attempt to include additional high school students who are not in the top of their class (as a lesson learned from the current research's limitations) and/or include more students taking vocational education tracts. Likewise, expanding the information from college students who elected to attend out-of-state or private colleges will provide an additional dimension to the participant base acting on their career goals by being in an engineering degree program.

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