

Understanding Barriers to Engineering as a Career Choice for Appalachian Youth: Investigating the “heart” of the region

Matthew Boynton,¹ Cheryl Carrico,² Dr. Marie C. Paretti,³ Dr. Holly Matusovich,⁴

Abstract –Literature provides common barriers students may face related to entry and success into engineering and STEM fields. Students within the Appalachian region of the United States often experience a lack of learning experiences, role models, below average economic conditions, and other factors that limit their full range of career options. Research specific to Appalachia can inform relevant interventions by taking geography and culture into consideration to help students gain a full understanding of engineering career pathways. As part of a National Science Foundation (NSF) grant, the authors will conduct a three phase mixed method project to research influencing factors specific to Appalachia. This paper provides background on the research project and reasons for beginning the project in the Central Appalachian region. In particular, information on ethnicity, education, economics, and population migration patterns within the Central Region of Appalachia, as defined by the Appalachian Region Commission(ARC), is provided to show the uniqueness of the region.

Keywords: Appalachia, Youth, Engineering, Education, NSF

INTRODUCTION

Engineering in particular, and STEM fields in general are often viewed as a culture in which the white, Christian, heterosexual, middle class male has the greatest chance of entry and success [12]. This success comes from a combination of many historical factors in our educational system that continue to create barriers or students considered to be at a disadvantage. Factors that have been identified that impact students’ choices to pursue, and ability to succeed in, STEM fields include, but are not limited to, gender, sexual orientation, race, socioeconomic status, geographical region, school experiences, access to mentors, and parental support[3, 13, 14, 19, 31, 33]. Particularly within the Appalachian region, a lack of learning experiences, role models, and below average economic status may inhibit students from choosing engineering and other STEM career fields. Research specific to Appalachia is important so that interventions are designed in context (e.g. with respect to culture and geographic considerations); student learning, and therefore interventions, in context are key as they help students to gain a relevant understanding of the career [7].

To address this gap, our research explores how regional culture impacts Appalachian students, using several established motivation theories as our primary lens. Our multi-phased mixed method project begins with interviews designed to capture factors unique to Appalachian students and how regional socio-economic factors interact. The

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initial interviews will inform surveys to collect data from a broader sampling. Using this qualitative and quantitative data, we will develop an empirical theory to explain the gap in engineering as a career choice. We anticipate that this theory will combine and extend existing motivation theories to leverage strengths and overcome weaknesses of each theory individually for explaining career choice in this region. Finally, we will lay the groundwork for interventions to help students understand engineering as a career choice. The initial focus of our project is on Central Appalachian students. Within Appalachia, the region of labeled Central Appalachia by the Appalachian Regional Commission (ARC) contains the greatest discrepancies compared to national averages for socio-economic factors such as education and income. This region also has an outward migration pattern which may further increase these gaps. This paper discusses the unique combination of ethnicity, education, economics, and population migration patterns within Central Appalachia to provide justification for focusing on Central Appalachia with the initial research project.

Educational Challenges in the Appalachian Region

Prior Research on Appalachian Youth is examined in an effort to understand barriers to engineering as a career choice for Appalachian high school students. Detailed information on the region in terms of defined boundaries, education, economics, and migration helps to demonstrate why students in Appalachia are at a disadvantage in pursuing higher education or engineering, even though those disadvantages are not always visible when looking at the student. For example, existing research describes Appalachian individuals as having a strong sense of self-reliance, leading researchers to believe that helping students to maintain high levels of self-efficacy beliefs is crucial in the achievement of their educational goals [4]. Lack of self-efficacy is apparent, for example, a study by Ali [5] found that students who choose to enter the workforce directly after high school, rather than pursuing higher education, do so as a result of perceptions of obstacles, lack of confidence in their ability to obtain postsecondary education, and low vocational/educational confidence and outcome expectations. Lack of self-efficacy is also linked to exposure: students in Appalachia often lack a full range of career models[8] so they do not fully understand career options. Therefore, while parents may be supportive of higher education, students are not likely to pursue a career which they have not experienced leaving self-efficacy as a key support mechanism for students[8, 28].

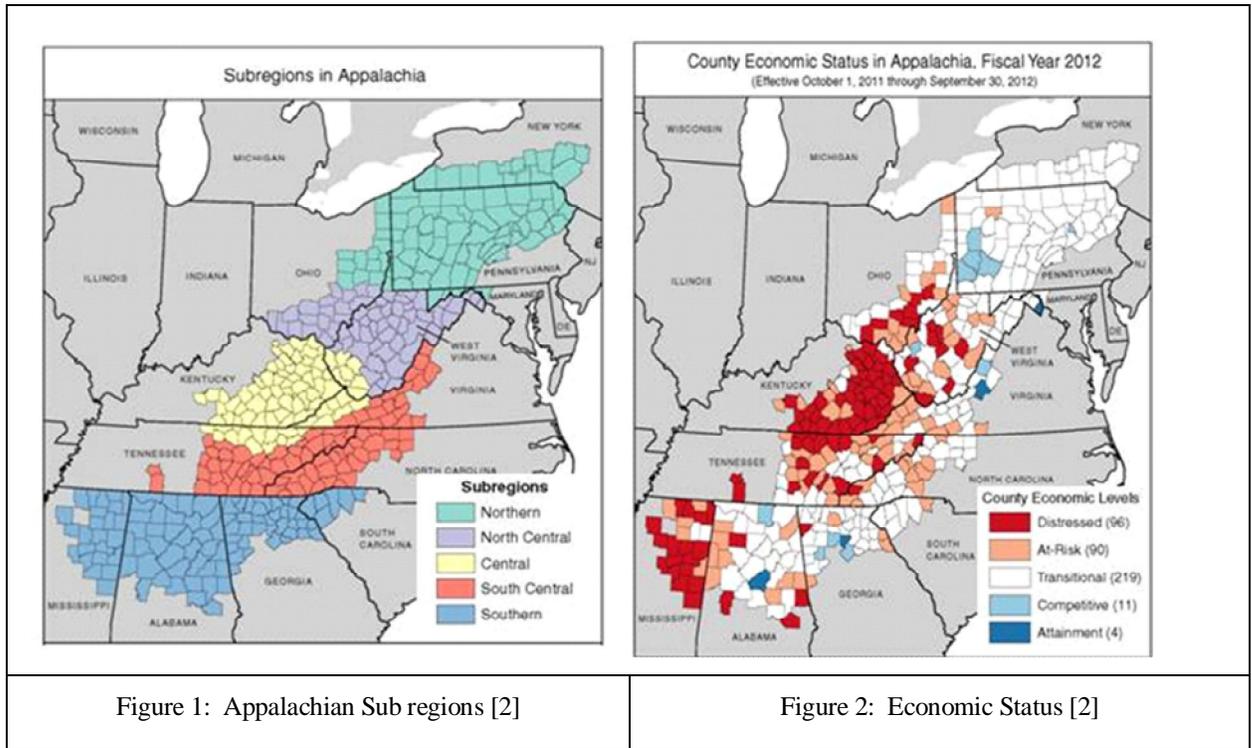
Importantly, these researchers also demonstrate that efforts to address these critical areas have positive results. Ali[6] found that students with high levels of vocational/educational self-efficacy showed strong expectations to attend college. Building high levels of self-efficacy is an important direction for practice, students rely on the influence of parents, peers, and teachers for support[6, 28]. Students perceptions of their own intelligence, preparedness for college, and comfort in school settings were highly associated with college plans, but these aspirations were higher for students who were exposed to college preparatory curriculum, role models who attended college, and parental and peer support[8, 10]. Bennett[8] found that regardless of the source of encouragement, students who experienced greater educational and occupational support were likely to have higher efficacy and outcome expectations, more educational choices, and were more likely to follow these opportunities.

Although studies of Appalachian high school students and higher education are limited, those that do exist highlight common themes and illuminate the need for additional research from a broader range of frameworks, coupled with a deeper connection to contextual factors specific to the Appalachian region, to support effective interventions. Toward that end, the remainder of this paper provides greater detail about the location/regional boundaries, education, economics and migration that are potential barriers to students pursuing higher education and work in STEM fields.

Location and Regional Boundaries

Though Appalachia's culture is not dictated by man-made state or county boundaries, it is important to have an understanding of the approximate cultural boundaries. We use the boundaries defined by the Appalachian Regional Commission (ARC). As shown in figure 1, Central Appalachia is divided into North Central, Central, and South

Central. Central Appalachia is an area defined as portions of four states and includes southwest Virginia, West Virginia, Tennessee, and eastern Kentucky [26].



An identifiable feature of much of Appalachia is its rural setting. Within Appalachia, less than half of the counties have a population at or above the nation’s average. There are Appalachian metropolitan areas such as Atlanta, Birmingham and Pittsburgh which contribute to the skewing of the mean population density of the entire Appalachian region. Smaller cities, such as Knoxville and Winston-Salem, that are located in the central region, also skew the population density higher. Even with these smaller cities, the areas of Central Appalachia tend to have a density of 87.3 or less people per square mile which is below the national average [21].

Information on Appalachian identity suggests that the extensive geographical definition by ARC is too broad. For example, the inclusion of Eastern Mississippi and parts of Alabama show little evidence of identifying as Appalachia [11]. The area of Mississippi was added to the ARC 1967 boundaries of Appalachia, as was a portion of New York State. The areas of Central Appalachia have been part of the defined boundaries since the geographical boundaries were drawn by Campbell in 1921[32]. A survey of college students revealed that inhabitants of the ARC defined Appalachia use a variety of vernacular (directional and topographical) to describe their regional names though the term Appalachian was primarily used by those in Central Appalachia and the Southern Highlands areas [22].

This information on location/regional boundaries contributes to our argument as to why we should start our research project focusing on central Appalachia. First, this region tends to share a rural characteristic. Second, this is often the region most often conceived of as “Appalachia” by people who identify as Appalachians.

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Educational Profile

Education is another important factor because it relates to a student’s ability to have role models that are college educated and to have learning experiences of jobs requiring a college education. These experiences help students to understand what they can expect from certain jobs as well as improve their ability to see themselves in such a job.

Historically, low education levels and chronic unemployment have been contributing factors to poverty in the Appalachian region[18]. The educational attainment in Appalachia lags behind the national average [15, 26]. The gap with the Central Appalachian region is the greatest and data from the American Community Survey (ACS), shows the comparison between the United States, Central Appalachia, and other regions within Appalachia. Research shows that education is paramount to individual, economic, and social growth[16, 25, 27]

Education	H.S. Grad No Postsecondary Degree	Bachelor's Degree or More
United States	49.6	27.9
Appalachian Region	54.8	20.7
Sub regions		
Northern Appalachia	57.9	21.6
North Central Appalachia	59.5	17.3
Central Appalachia	54.2	12.1
South Central Appalachia	52.9	21.3
Southern Appalachia	51.2	22.8
County Type		
Rural	55.0	13.9
Figure 3: Educational Attainment Data[1]		

As shown in Figure 3, numbers for Central Appalachia, including North and South Central regions, show over 50% of the population over 25 years having a high school diploma, but only generally less than 20% of individuals hold a college degree. Figure 4 shows the diversity of locations with high school diplomas in Appalachia. The Northern regions, including West Virginia, have very strong percentages of high school graduates. Kentucky and Virginia, which are in the central region, represent the lowest averages. College attainment in the Appalachian region is different than the high school profiles. Based on data presented by the ACS, only 19 % of Appalachians hold a minimum of a Bachelor’s Degree. Data shows that the Northern, South Central, and Southern Appalachian regions have the highest percentage of college graduates leaving North Central and Central trailing behind. The maps shown in Figures 3 and 4 are indicative of statements made by Lichter[18]. An overlay of Figure 1 (showing the ARC boundaries by region) with Figures 4 and 5 shows a clear correlation of lower educational attainment in Central Appalachia.

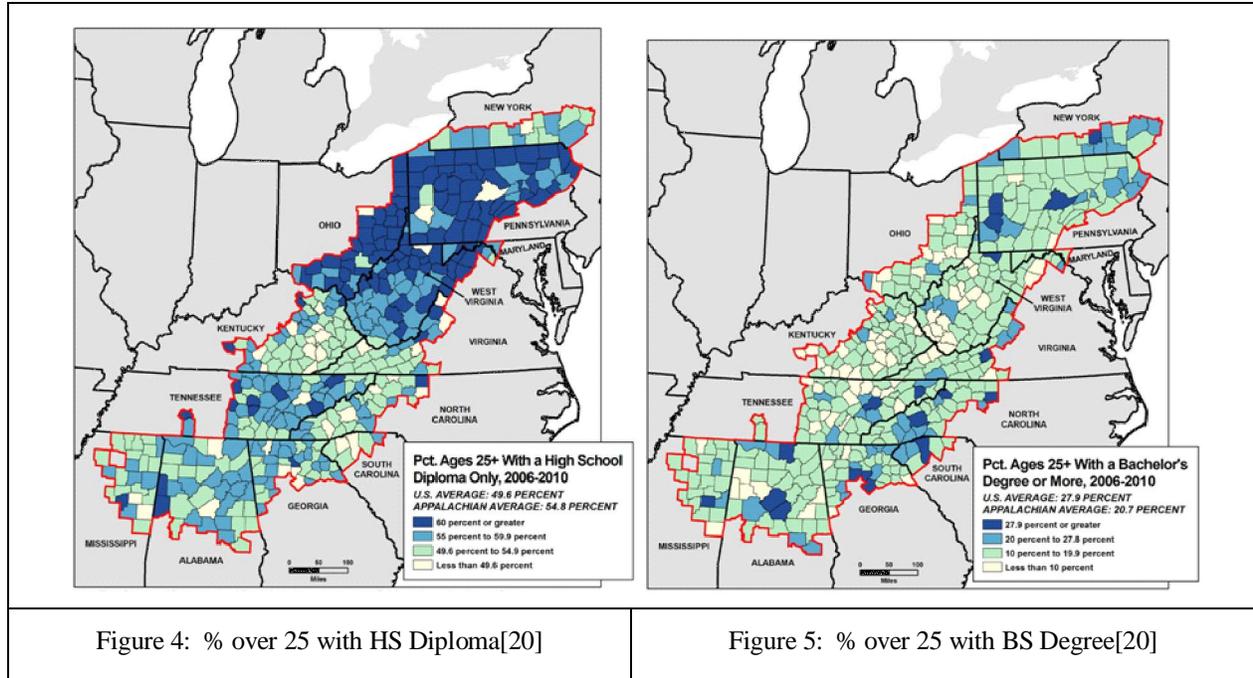


Figure 5 shows that more metropolitan areas and areas containing a four year university account for a higher percentage of college graduates. In rural areas the distance students’ travel to schools can be greater in spite of their being more schools per student in rural areas, requiring students to spend more time going to and from school and greater travel times between schools. In addition, rural schools tend to be smaller with the majority having less than 400 students [17]. A positive impact of smaller school sizes is a greater sense of community. However, a limitation is the number of course offerings (e.g., calculus) and reduced extra-curricular activities (such as gifted and talented programs and athletics) [17]. Having, on average, a higher level of education in the urban areas is counter-intuitive to other situations where inner-city educational completion rates are lower than the surrounding suburban areas.

The number of Appalachian’s holding a Bachelor’s degree may not properly reflect the number of students attending college. Appalachia is at the losing end of migration patterns as often college graduates move to areas with more economic vitality[18]. Education, however, seems to be a direct link to eradicate poverty in any region of the country. Lichter[18] shows that only 3.4% of the nations people with a college degree are considered poor as compared to 22% of high school dropouts. Remote rural counties in Appalachia display higher rates of poverty and lower rates of education level than their more populated counterparts[18]. Lichter[18] states that this does not prove the benefits of higher educational attainment but does clearly identify that poverty levels are higher in areas with low education levels.

Educational data shows that a large portion of individuals residing in the Appalachian region do not hold college degrees. Migration patterns also show that educated individuals relocate to areas with more economic opportunity. These patterns leave rural areas within Appalachia without the role models and experiences necessary to see themselves pursuing career pathways involving college preparation. With education shown as an important link to eliminate poverty, it is important to fully understand how education levels interact with engineering as a career choice in Appalachia.

Regional Economics

Economic wellness correlates with people’s educational attainment in Appalachia. Poverty in Appalachia has historically been a major problem. Figure 2 shows the ARC county classification. The classification is based on

unemployment, per capita income, and poverty levels within each county[2]. Comparing economic classification with region boundaries shows the large number of distressed and at-risk counties within Central Appalachia. In 1964 President Johnson launched the war on poverty in West Virginia where many parts of the state exceeded the national average by up to three times[18]. Lichter[18] notes that statistical measure of income may not tell the entire story of poverty in the region as it often runs in families and is passed on through generations. Some, such as Harrington in his 1962 book *The Other America*, have referred to Appalachia as a “culture of poverty”, suggesting that the poverty in Appalachia is systemic. Harrington argued that poverty in Appalachia is unique because it does not stem from discrimination of minority status, the poverty continues regardless of the United States strength of economy, and there is an assumption that people raised in Appalachia would not want to disseminate into urban areas [23]. Others, however, have discredited the claims that Appalachians are lazy and unwilling to work as discriminatory and victim blaming. Central Appalachia contains some of the deepest poverty levels equaling or exceeding urban areas and central city ghettos[29].

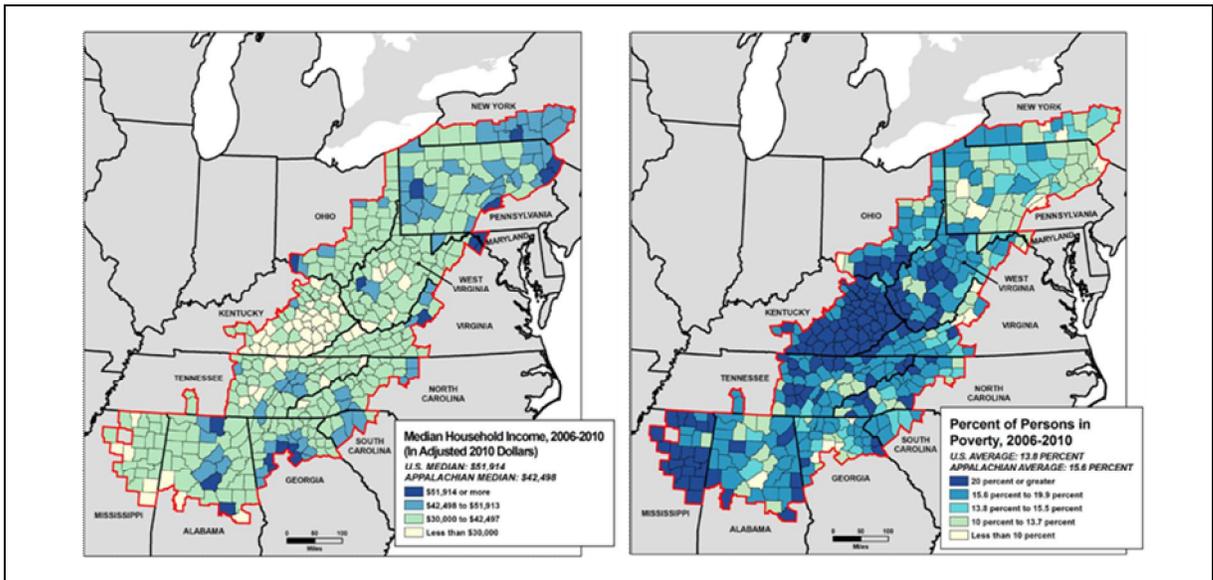


Figure 6: Median Household Income[20]

Figure 7: % below the poverty level[20]

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Income Level	% Persons Below Poverty Level	Median Household Income
United States	13.8	51,914
Appalachian Region	15.6	42,498
Subregions		
Northern Appalachia	13.5	44,001
North Central Appalachia	17	40,089
Central Appalachia	23	32,278
South Central Appalachia	16.4	40,537
Southern Appalachia	15.2	45,784
County Types		
Rural	22	33,387

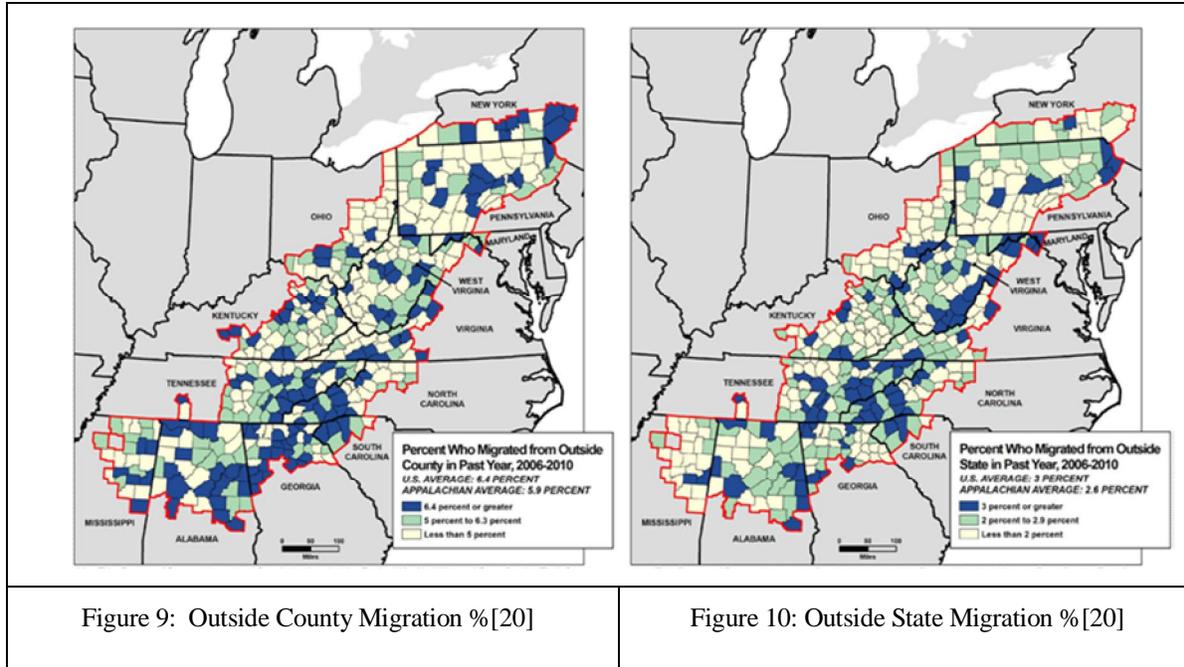
Figure 8: Income Data[1]

Lichter[18] discussed the variation of poverty throughout the region. In his report, Lichter[18] shows that the northern and southern sub regions of Appalachia had significantly lower rates of poverty than the central region. The central Appalachian region continues to have the highest levels of poverty in Appalachia with levels at 23% in 2010 which is a rise of 1.9% since 2000. Appalachia differs from other areas of the U.S. in that poverty resides in rural areas within Appalachia yet centers around more metropolitan regions elsewhere in the nation[18]. This phenomenon can be seen in Figures 6 and 7 by looking at more populated areas around cities where lower poverty rates and higher median incomes are predominant. Comparing the poverty maps to education level maps shows the correlation discussed by Lichter[18] displaying areas of high poverty and low income being the same areas with low levels of education. This creates a negative feedback loop indicating that these may be traits passed down through generations.

Engineering as a career choice decision is influenced by learning experiences, role models, a motivation to pursue careers requiring a college education, and an ability to believe barriers such as financial ones, can be overcome. However, students living in areas with high unemployment and low median incomes are less likely to have the experiences, role models and more likely to have barriers than other students. How these influences are reacted to by Appalachian students, needs to be understood.

Migration Patterns Into and Out of Appalachia

Migration patterns in Appalachia have added to the poverty levels in the region[18]. Appalachia has typically been on the losing end of migration patterns with many college educated persons leaving the area to seek employment[18]. Lichter[18] notes that in the 90's the Appalachian region had an increase in migration, but many were not college educated individuals seeking employment in the region. This migration pattern only feeds the negative feedback loop for education. The current outlook of the region benefiting from higher education does not look good. As educated students seek employment outside the region, fewer employers see the area as a good location for future industry. Migration patterns were down slightly in the 2006-2010 data from previous years. This leads Pollard[20] to believe that the economic downturn may have slowed these patterns.



CONCLUSION

Obstacles come in many forms and are experienced by students of all backgrounds. While rural Appalachians appear to be a part of the dominant white culture, students from this region often struggle due to lack of role models, low social capital, lack of exposure to STEM careers, and a low socioeconomic background. These struggles stem from low education levels, poor economic conditions, and rural and isolated living conditions. Although the entire Appalachian region has a number of variations in education and economic conditions, the central region of Appalachia in particular includes the geographical and cultural conditions most typically associated with the Appalachian Mountains. Individuals from this area often face obstacles associated with poverty and lack of exposure to a full range of career options. Central Appalachia is the area that comprises the core of Appalachia and remains the area with the largest number of low income counties, high percentage of rural counties, and fits the geographical description of the Appalachian Mountains. Historically, the Central Appalachian region has been the most affected by poverty and is identified as having a unique social and cultural identity [30]. In addition, with the overall low attendance in and completion of college degrees, Central Appalachia is an underrepresented group for college. The low educational attainment, low median income, and high rate of blue-collar jobs support the claim of a low percentage of students becoming engineers [9, 24].

That said, Appalachians often display a strong sense of self reliance and have historically had access to blue collar employment, and such employment has been a major economic driver for the region. Shifts in the U.S. economy, however, have undercut that economic stability, making it critical for students from the region to explore other employment opportunities. Literature shows that exposure to multiple career options, college preparatory curriculum, and efforts to raise students' self-efficacy have been shown to have positive results. Without studies in the region identifying barriers students may face associated with choosing engineering as a career choice, a valuable population may be left without the full knowledge of this career. By using participants from Central Appalachia as the basis for phase 1 of our project researching barriers to engineering as a career choice, the ways in which critical factors are uniquely influencing Appalachian students can be explored in context. This exploration will ensure a solid foundation for the overall research project.

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