Investigating Association of Students' Demographics on Personal Principles Towards Engagement in STEM

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Abstract

Science, Technology, Engineering and Mathematics (STEM) has proven to be an important field of study for innovation towards economic and technological development. However, going into the field as a career requires some positive personal principles (Belief, Interest, Commitment and Values). Meanwhile, studies have shown that some genders and races are more engaged in them than some others. However, these studies have not investigated all these variables together as predictors of engagement and race with gender as moderating variables. Therefore, this proposed study aims to fill this gap by investigating the influence of race and gender on first-year university students enrolled in engineering beliefs, interests, commitments, and values towards engagement in STEM fields. The study will use secondary data collected from Pre-engineering students in Focal University. And employ a survey research design with multiple-regression analysis and gender and race as moderating variables. We expect to find the differences in the level of personal principles and engagement based on gender and race, main effects of personal principles on engagement in STEM and interaction effects of gender and race with the personal principles and engagement in STEM.

Keywords: Personal principles, STEM, Demographics, First-year university engineering students

Introduction

Science, technology, engineering, and mathematics (STEM) fields are critical for economic development and innovation and have a significant impact on society. The lack of engagement and interest in STEM among students has been a matter of concern, and various studies have explored the factors influencing their personal principles (beliefs, interests, commitments, and values) towards STEM. Indeed, the underrepresentation of certain racial and gender groups in STEM fields has been a long-standing issue in the United States. Despite efforts to increase diversity and inclusion, disparities persist, with women, African Americans, Hispanic Americans, and Native Americans being underrepresented in STEM fields (National Science Foundation, 2019).

Science, Technology, Engineering and Mathematics identity suggests an individual's idea of self and attraction to STEM field. Models of STEM identity based on personal principles draws from different theoretical frameworks and empirical studies in the field of STEM education and psychology (Hazari et al., 2010; Lent, et al., 1994; Maltese & Tai, 2010; Roberts & Grady, 2011;

Robnett, et al., 2015). Belief refers to the confidence an individual has in ability and perceived relevance of STEM to their lives and career goals (Hazari et al., 2010; Lent, et al., 1994), interest is referred to as individuals' enjoyment and curiosity in STEM field (Maltese & Tai, 2010), also commitment is an individual's intension to pursue and persist in STEM field irrespective of obstacles and challenges (Roberts & Grady, 2011; Robnett, et al., 2015) while value is the personal recognition of the importance and potential impact of STEM fields for society and themselves (Eccles, 1983).

Research has shown that student beliefs, interests, commitments, and values are key factors that influence their engagement in STEM fields (Eccles et al., 1983; Hidi & Renninger, 2006). Hazari et al. (2010) found that high school students' physics identity (i.e., how they perceive themselves in relation to physics) was a significant predictor of their physics career choice. Similarly, Yeager and Walton (2011) argued that students' sense of belongingness in STEM fields can have a significant impact on their motivation and persistence.

Studies have shown that several factors influence students' engagement in STEM. These factors include gender, parental education, socioeconomic status, school culture, and racial and ethnic background (DeWitt & Archer, 2015; Maltese & Tai, 2010). Research has also shown that beliefs, interests, commitments, and values are key factors that influence students' engagement in STEM. Students' beliefs about their abilities, interest in STEM, and perceptions of the relevance and importance of STEM to their future careers influence their engagement in STEM (DeWitt & Archer, 2015; Maltese & Tai, 2010). Additionally, students' values, such as their desire to make a difference in society or contribute to technological advancements, also influence their engagement in STEM (Maltese & Tai, 2010).

Studies have found that minority students tend to have lower self-efficacy beliefs about their abilities in STEM fields compared to their White counterparts (Niyogi & Brendefur, 2017; Steele, 1997). Steele (1997) notes that negative stereotypes can lead to a self-fulfilling prophecy, where students internalize negative stereotypes and perform poorly in STEM fields. Niyogi and Brendefur (2017) also found that African American and Hispanic students had lower STEM self-efficacy than White and Asian students.

Research has shown that communal beliefs and values play a crucial role in shaping individuals' beliefs, interests, and values towards STEM fields. According to a study by Brown et

al. (2015), communal values are defined as beliefs and values that prioritize the welfare of the community over individual interests. This study found that students who held communal values were more likely to express interest in pursuing STEM careers than those who did not. Furthermore, a study by Martin et al. (2018) found that the communal beliefs of teachers, such as emphasizing collaboration and teamwork in the classroom, positively influenced students' attitudes towards STEM subjects. The study emphasized the importance of teachers' beliefs and values in shaping students' attitudes towards STEM, which can ultimately affect their engagement and success in these fields.

In a study by Aschbacher et al. (2010), it was found that students who participated in STEM-related extracurricular activities, such as robotics clubs or science fairs, had higher communal beliefs than those who did not participate in such activities. This study highlights the role of extracurricular activities in promoting communal values, which can ultimately lead to increased interest and engagement in STEM fields. Overall, these studies suggest that communal beliefs and values can play a crucial role in shaping students' beliefs, interests, and values towards STEM. Educators and policymakers can promote communal values in the classroom and through extracurricular activities to increase interest and engagement in STEM fields.

Minority students have also been found to be less interested in STEM fields than their White counterparts (National Science Foundation, 2019). Research suggests that minority students have fewer opportunities to be exposed to STEM-related experiences and do not see STEM careers as viable options due to a lack of role models (Hurtado et al., 2010). Additionally, studies have found that minority students are less likely to participate in STEM extracurricular activities (O'Brien et al., 2013).

Students' commitment to pursuing STEM careers is also a crucial predictor of their engagement in STEM fields. Research indicates that minority students are less committed to pursuing STEM careers than their White counterparts (National Science Foundation, 2019). Hurtado et al. (2010) found that the sense of belonging to STEM communities was lower among minority students, which could impact their commitment to STEM careers.

Students' values towards STEM fields play a crucial role in shaping their engagement in STEM. Research indicates that students' values towards STEM are influenced by their perceptions of the social value and relevance of STEM fields (Eccles & Wigfield, 2002). Minority students

may have different values towards STEM fields due to cultural differences and experiences (O'Brien et al., 2013).

Research has shown that race plays a significant role in the underrepresentation of minorities in STEM fields. According to a study by Freeman and Huang (2014), minority students are less likely to pursue STEM majors in college than their white peers. The study found that African American and Hispanic students are less likely to major in STEM fields due to factors such as lack of exposure to STEM fields, insufficient academic preparation, and negative perceptions of STEM fields. Similarly, a study by Zhang et al. (2018) found that African American students have lower levels of interest and self-efficacy in STEM than white students. Other research has shown that there is a significant racial disparity in STEM fields, with certain racial groups being underrepresented. This can be attributed to a variety of factors, including societal stereotypes and biases, lack of representation and exclusion, and systemic barriers. While there have been initiatives to address these disparities, more research is needed to understand the intersectionality of race and gender and to identify effective strategies for increasing diversity in STEM fields.

Additionally, a study by Cheryan et al. (2015) showed that the lack of representation of certain racial groups in STEM fields can lead to a sense of exclusion, which can discourage individuals from pursuing these fields. Furthermore, research has shown that the underrepresentation of certain racial groups in STEM fields can be linked to societal stereotypes and biases (Estrada et al., 2016).

Meanwhile, several initiatives have been implemented to address the racial disparities in STEM fields. Such as the National Society of Black Engineers (NSBE), a professional organization that seeks to increase the number of Black individuals in engineering fields through mentorship, networking, and career development opportunities (NSBE, 2021). Other programs, such as the Meyerhoff Scholars Program at the University of Maryland, Baltimore County, have also been successful in increasing the representation of underrepresented minority students in STEM fields (Matonet al., 2000).

Despite these efforts, there is still a significant underrepresentation of certain racial groups in STEM fields, and further research is needed to understand the factors that contribute to this disparity and to identify effective strategies for increasing diversity in these fields. More research

is needed on the intersectionality of race and gender in STEM fields, as women of color face unique challenges that are often overlooked in discussions of gender or racial disparities alone (Jackson & Caldwell, 2021).

Gender disparity in STEM fields has also been a persistent issue, with women being underrepresented in STEM disciplines. Several studies have explored the factors contributing to this gender gap. According to a report by the NSF in 2020, women accounted for only 28% of the science and engineering workforce in the United States, despite representing approximately 50% of the total workforce. This gender disparity is even more significant in certain STEM fields, such as computer science and engineering.

Research suggests that several factors contribute to this gender gap, including societal stereotypes, lack of female role models, and a lack of support and encouragement for women in STEM. A study by Moss-Racusin et al. (2012) found that gender stereotypes and biases against women in STEM are prevalent, even among those who do not hold explicitly sexist attitudes. These implicit biases can affect the evaluation and treatment of women in STEM, leading to fewer opportunities and less recognition for their work.

Furthermore, a study by Dasgupta and Stout (2014) found that a lack of female role models and support systems can discourage women from pursuing careers in STEM. The study emphasized the importance of creating a supportive environment for women in STEM, including providing mentorship and networking opportunities. Also, a study by Wang and Degol (2017) found that a lack of encouragement and exposure to STEM subjects at an early age can deter women from pursuing STEM careers. The study suggested that increasing early exposure to STEM and providing opportunities for hands-on experience can increase interest and engagement in STEM fields for both men and women.

Evidently, the gender disparity in STEM fields is a complex issue with multiple contributing factors. Addressing this gender gap requires a comprehensive approach that includes addressing societal stereotypes and biases, providing mentorship and support for women in STEM, and increasing exposure and opportunities for early engagement in STEM fields.

Race and gender disparities in STEM education are complex issues that have persisted for many years. Research has shown that lack of exposure, negative perceptions, insufficient academic

preparation, gender stereotypes, and lack of role models contribute to these disparities. However, research has also shown that communal values may play a positive role in encouraging engagement in STEM fields. Addressing these issues will require a multifaceted approach that includes early exposure, improved academic preparation, addressing negative perceptions and stereotypes, and promoting communal values in STEM education.

Despite the importance of these factors, little research has explored how race and gender combined moderates the relationship between these factors and first-year university students enrolled in engineering engagement in STEM. Research has shown that racial and gender disparities exist in STEM education and career pathways, with Black, Hispanic, and Native American students being underrepresented in STEM fields (National Science Board, 2020). These disparities are influenced by various factors, including structural barriers, implicit biases, and stereotypes (National Science Board, 2020; National Academy of Sciences, Engineering, and Medicine, 2018).

Research Questions

The proposed study aims to investigate the following research questions:

i. How do first-year university students enrolled in engineering beliefs, interests, commitments, and values towards STEM fields differ based on their race and gender?
ii. To what extent do race and gender moderate the relationship between students' beliefs, interests, commitments, and values towards STEM fields and their commitment to a STEM college major?
iii. What is the interaction effect of race and gender on the relationship between students' beliefs, interests, commitments, and values towards STEM fields and their engagement in STEM?

Purpose of the Study

The purpose of this study is to examine first-year university students enrolled in engineering beliefs, interests, commitments, and values towards engagement in STEM fields, and to explore how race and gender moderates the relationship between these factors and students' engagement in STEM. The study aims to identify the factors that promote or inhibit students'

engagement in STEM fields and to inform the development of strategies to promote equity and diversity in STEM education.

The study also aims to address several gaps in the existing literature on college students' engagement in STEM fields by examining the relationships between students' beliefs, interests, commitments, and values towards STEM fields, race, gender, and their implications for promoting equity and diversity in STEM education. Overall, the study seeks to contribute to a better understanding of how students can be encouraged and supported to pursue STEM careers, particularly those from underrepresented racial and ethnic groups.

This study will address several gaps in the existing literature on first-year university students enrolled in engineering engagement in STEM fields. First, while previous studies have investigated the factors that influence students' interest in STEM fields, few studies have examined how students' beliefs, commitments, and values towards STEM fields influence their engagement in these fields, especially among first-year university students enrolled in engineering. Second, while there is evidence of disparities in STEM participation among students from different racial and ethnic backgrounds, few studies have examined the moderating effect of race on the relationship between these factors and students' engagement in STEM fields.

Third, previous studies have focused on individual factors that influence students' engagement in STEM fields, such as gender and socioeconomic status, without examining how these factors interact with race to influence students' engagement in STEM fields. Fourth, while there is a growing body of research on the role of race in shaping students' experiences in STEM education, few studies have focused specifically on first-year university students enrolled in engineering beliefs, interests, commitments, and values towards STEM fields.

Thus, this study will fill several gaps in the literature by examining the relationships between first-year university students enrolled in engineering beliefs, interests, commitments, and values towards STEM fields, race, and gender, and their implications for promoting equity and diversity in STEM education.

Methodology

The study aims to investigate the influence of race and gender on first-year university students enrolled in engineering beliefs, interests, commitments, and values towards engagement

in STEM fields. A survey research design will be used while a secondary data collected from a diverse sample of pre-engineering students from Focal University in the United States.

Engineering attitude survey was administered on students enrolled in a pre-engineering introductory course in focal university. The survey includes scales related to attitude to engineering which includes demographic items (Lakin, et al., 2019). The instructors where approached to invite students taking their course for the survey to get a representative sample for the study. The survey was carried out first two week the semester starts (Lakin, et al., 2019).

Data analysis will include descriptive statistics to examine the differences in students' beliefs, interests, commitments, and values towards STEM fields based on their race and gender. Multiple regression analysis will be used to examine the relationship between these factors and students' engagement in STEM, while also exploring the moderating effect of race and gender. Finally, an interaction analysis will be conducted to explore the joint effect of race and gender on the relationship between students' beliefs, interests, commitments, and values towards STEM fields and their engagement in STEM

Expected Results

We expect to find significant main effects of beliefs, interests, commitments, and values on engagement in STEM. Specifically, we expect that students who have more positive beliefs about STEM, are more interested in STEM, are more committed to STEM, and value STEM more highly will report higher levels of engagement in STEM. The expect to find a significant main effect of gender and race on student engagement in STEM. We also expect to find significant interaction effects of race and gender on STEM engagement, such that the relationship between the predictor variables and STEM engagement will be stronger or weaker for certain racial/ethnic and gender groups.

Discussion

The findings of this study will have important implications for educators and policymakers seeking to promote equity and diversity in STEM education. By understanding the specific needs and experiences of underrepresented groups in STEM, educators can create targeted programs and policies that help to reduce the disparities in STEM education.

Limitations

There are several limitations to this study that should be noted. First, the sample will consist of pre-engineering students from the United States, and the findings may not be generalizable to other populations or educational contexts. Additionally, the use of self-report measures may introduce bias, as participants may respond in ways that they perceive to be socially desirable. Finally, the cross-sectional design of the study limits our ability to draw causal conclusions about the relationships between the predictor variables and STEM engagement.

Conclusion

The proposed study aims to fill the gaps in the literature on the relationship between first-year university students enrolled in engineering beliefs, interests, commitments, and values towards STEM fields, race, and gender, and their implications for promoting equity and diversity in STEM education. The findings of this study will provide insights into the factors that influence students' engagement in STEM fields and inform the development of interventions aimed at promoting equity and diversity in STEM education, particularly for underrepresented groups. By understanding the specific needs and experiences of these groups, educators can create targeted programs and policies that help to reduce the disparities in STEM education.

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