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Examining Moderator Factors Influencing Students' Interest in STEM Careers: The Role of Demographic, Family, and Gender

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Abstract

This study investigates the characteristics that influence rural high school students' interest in jobs in Science, Technology, Engineering, and Mathematics (STEM). It focuses on the impact of socioeconomic class, family background, and gender on their ideas and desires for STEM jobs. The findings show that socioeconomic factors have a major impact on rural students' interest in STEM subjects. Due to enhanced access to resources, educational opportunities, and exposure to STEM-related activities, students from higher socioeconomic backgrounds in rural areas display greater interest and drive for STEM. Furthermore, parental education and occupation have a significant impact on rural children' perceptions of STEM vocations and self-confidence in these domains. The report also emphasises the impact of gender dynamics, with gender preconceptions and a lack of diverse role models contributing to rural students' underrepresentation of girls and marginalised genders in STEM jobs. It is critical to develop inclusive learning settings, challenge gender prejudices, and offer equal access to STEM education for rural children in order to increase interest and participation in STEM. By addressing these concerns, educators and politicians can encourage rural kids to pursue STEM careers, resulting in a more diversified and skilled STEM workforce and propelling rural areas forward in the face of technological breakthroughs.

Keywords: STEM, Interest, Socioeconomic, Family Background, Gender

Introduction

STEM education is defined as the teaching and learning of science, technology, engineering, and mathematics (Idris & Bacotang, 2023). STEM education is about equipping students with the skills they need to solve complex issues, think critically, and create, rather than simply teaching certain courses or preparing students for specific vocations. It is all about empowering students to apply their knowledge and abilities to make a difference in the world (National Academies of Sciences, Engineering, & Medicine, 2018). Despite efforts to promote STEM education, generating high interest and involvement in STEM areas among secondary

school students remains a difficulty (Idris et al., 2023b). Socioeconomic status, especially the distinctive setting of rural pupils, family background, and gender status, are important determinants influencing STEM interest.

Families can provide the necessary support, encouragement, and resources to overcome societal barriers and gender stereotypes, fostering confidence and determination in their children to excel in these fields. The significance of family and work-life balance in understanding job choices (Baneerjee et al., 2018). Female students appear to exceed their male counterparts in STEM academic success when their parents work in non-manual employment (Ho et al., 2020). The family plays a significant role in encouraging female students to pursue and prosper in STEM fields by providing the necessary support, motivation, and resources.

While numerous programmes and methods have been implemented to increase student interest and participation in STEM fields. However, student involvement in STEM, particularly in schools, has been falling, which has alarmed many stakeholders (Idris et al., 2023d). There have been different polemics and obstacles in accomplishing the goals in the implementation of STEM in schools (Idris et al., 2023a).

Female students, in particular, are frequently subjected to cultural prejudices and preconceptions that represent STEM as a male-dominated area, resulting in a decrease in enthusiasm and confidence in pursuing STEM jobs. It is critical to address and challenge these gender preconceptions in order to promote gender equity and diversity in STEM education and careers. Encouragement of female students to acquire a growth mindset, resilience, and self-confidence can assist them in overcoming these preconceptions and pursuing STEM disciplines with enthusiasm (Idris et al., 2023b).

Simultaneously, the existing scenario for children from rural areas in terms of STEM application highlights a need for increased access to resources, educational opportunities, and exposure to STEM-related activities in order to fully unlock their potential and engage them in STEM disciplines. Rural and small-town pupils were much less likely than their suburban peers to enrol in postsecondary STEM degree programmes (Saw & Agger, 2021). Rural students were less likely to enrol in STEM and non-STEM university programmes (Hango et al., 2018).

Gender on STEM Interest Career

The gender gap in STEM fields is of paramount importance, particularly in the context of the talent pool required for the Fourth Industrial Revolution (IR 4.0) and Society 5.0, as it hinders the full utilization of diverse perspectives, skills, and innovation necessary for tackling complex challenges and driving sustainable societal progress (Idris & Bacotang, 2023).

Malaysia Woman Policy 1989 was renamed Malaysia Woman Policy 2009 in 2009. This Policy continues the purpose established by the MWP in 1989 while also addressing current constraints and difficulties. The MWP 2009 seeks to build human capital by encouraging women to be competent, resilient, knowledgeable, imaginative, creative, and inventive while upholding moral standards. This Strategy also includes steps to prepare for increased female labor-force participation, as women make up half of the national workforce (Curriculum Development Division, Malaysian Ministry of Education, 2016).

Providing comprehensive and equitable STEM training options for women is critical not just for gender equality, but also for releasing the full potential of human capital, encouraging

economic growth, and driving innovation in the twenty-first century and beyond. According to Buffington et al (2016), when a number of criteria for their career in STEM fields are evaluated, women earn 10% less than men. The motivation to analyse the current condition of STEM over girls and women originated from ongoing concerns about the profession's poor progress towards SDGs 4 and 5, which aim for gender parity as well as encouraging all women and girls (UNESCO, 2020). Female student empowerment is critical for establishing a more egalitarian and varied society.

Gender disparities in K-12 education remain a serious issue, with male students receiving more encouragement and opportunity in STEM disciplines than their female peers. Gender gaps in this area are visible from the start of a child's educational experience in grades K-12 (Ahmed et al., 2020). Gender disparities in STEM fields are evident at both the educational and labour market levels (Garcia-Holgado et al., 2020). Women's underrepresentation in the IT business is a social and economic concern (Gonzalez et al., 2018).

Gender influences people's participation in STEM education and careers, and the impact on a country's economy and innovation cannot be overstated. The sensitivity of the female group to STEM themes is outstanding (Olmedo-Torre et al., 2018). Women account for only 29.3% of all scientific researchers globally, according to a UNESCO Institute of Statistics (2019) estimate. Women had 18.5% of research jobs in South and West Asia, 23.9% in East Asia and the Pacific, and 48.2% in Central Asia in the Asia-Pacific region (UNESCO, 2020).

Despite growing efforts to bridge the gender gap in STEM subjects, significant challenges remain to be overcome in order to provide equitable opportunity for both genders. Evidence-based policies and programmes have the potential to enhance female and female STEM involvement (Dagupta & Stout, 2014). Furthermore, as a result of increased attempts to diversify science, technology, engineering, and mathematics education, the number of studies providing insight into the experiences of women in STEM programmes in education has increased (Blackburn, 2017). Gender influences STEM interest significantly (Siregar & Rosli, 2021).

Gender differences in STEM have consequences for practises, policy, and future perspectives. The gender gap in maths course enrollment and performance has narrowed in recent decades (Wang & Degol, 2017). STEM education is crucial in empowering female students to reach their full potential and seek employment in traditionally male-dominated industries, resulting in a more varied, inventive, and inclusive workforce. Girls' and women's interest in STEM education and jobs can be encouraged through the school sector. Furthermore, the well-known fact that women's career advancement in the academic hierarchy is slower than men's is the fundamental gender inequality mechanism in academia (Alibhai et al., 2017).

Table 1
Gender Issue on STEM Education

Researcher	Results
Idris & Bacotang, 2023	The gender gap in STEM fields is important for societal progress and innovation.
Curriculum Development Division, Ministry of Education Malaysia, 2016	Malaysia Woman Policy aims to increase women's participation in the workforce, including STEM.
Buffington et al., 2016; UNESCO, 2020	Providing equitable training in STEM is crucial for economic growth and gender equality.
Ahmed et al., 2020; Garcia-Holgado et al., 2020; Gonzalez et al., 2018	Gender disparities exist in K-12 education and the technology industry.
Olmedo-Torre et al., 2018; UNESCO, 2019, 2020	Women's participation in STEM impacts a country's economy and innovation.
Dagupta & Stout, 2014; Blackburn, 2017	Efforts are being made to increase girls' and women's participation in STEM through policies and programs.
Wang & Degol, 2017; Alibhai et al., 2017	Education plays a critical role in empowering women in STEM and reducing the gender gap.

The Influence of Family Socioeconomic Background on STEM Education

The family element has a significant impact on students' participation and enthusiasm in STEM education. Parents' roles are critical in cultivating children's enthusiasm in science learning and encouraging their pursuit of science-related occupations. According to Halim et al. (2018), parents' academic expectations might assist stakeholders create effective educational interventions that involve parents' cooperation in enhancing children's enthusiasm in science learning careers.

Creating a 'family-friendly' environment in STEM areas can have a significant impact on how people regard science occupations as suitable with family life. We can positively impact the perception of science careers as viable options for individuals with family responsibilities by implementing policies and initiatives that support work-life balance, provide flexible work arrangements, and offer family-oriented benefits, leading to increased participation and diversity in STEM professions. According to Weisgram and Diekman (2017), science occupations are seen as being unlikely to allow for the pursuit of family aspirations.

In the context of STEM commitment, the relationship between work-family balance and self-efficacy has received increased attention. Understanding how people's capacity to manage

work and family duties affects their self-efficacy beliefs in STEM subjects might provide valuable insights into how to build long-term commitment and success in these domains. Men had a greater association between work-family balancing self-efficacy and STEM engagement than women (Myers & Major, 2017).

Parental influences have a significant impact on the professional aspirations and choices of persons pursuing a STEM career. According to research, parental encouragement, support, and educational background have a substantial impact on students' interest, self-efficacy (Idris et al., 2023d), and motivation in STEM subjects (Idris et al., 2023c). Parents also play an important impact in developing their children's goals for higher education (Lloyd et al., 2018).

The role of parental socialising behaviours in the development of student interest in STEM jobs has received attention in two categories. According to research, parents' behaviours such as sharing information, participating in STEM-related activities, and expressing positive attitudes have a substantial impact on their children's interest and aspirations in STEM subjects. In the case of the sons, parents reported more STEM-specific practises than in the case of daughters (Simunovic & Babarovic, 2020).

Individuals considering majoring in STEM disciplines may be put off by their perceptions of future career and family flexibility. Concerns about work-life balance, the rigours of STEM employment, and the perceived difficulties of juggling family duties and STEM careers may influence students' decisions to seek non-STEM disciplines instead. Concern about future job inflexibility is connected with a lower likelihood of majoring in hard STEM disciplines (Valentino et al., 2016).

The influence of parents on undergraduate and graduate students' decisions to pursue STEM fields has long been acknowledged. According to research, parental influences such as parental encouragement, support, and role modelling have a major impact on students' interests, motivations, and decisions regarding STEM education and career paths. Students enter STEM subjects and STEM-related occupations by different channels, in addition to the anticipated pipeline, after being nurtured by their mothers and/or fathers (Craig et al., 2018).

Understanding the early development of science interest in low-income children, including variance in interest patterns and the influence of parent-child interactions, is critical. According to research, early infancy is a vital era for developing curiosity, inquiry, and a favourable attitude towards science. Fostering preschool children's development of science-related interests in traditionally underprivileged groups has long-term repercussions for involvement and learning (Pattison & Dierking, 2018).

Table 2
The Factor of Family Socioeconomic on STEM Education

Researcher	Results
Halim et al., 2018	Parents' academic expectations influence children's interest in science learning.
Weisgram & Diekman, 2017	Creating a family-friendly environment in STEM fields can impact career perceptions.
Myers & Major, 2017	Work-family balance and self-efficacy affect STEM commitment, more pronounced for men.
Idris et al., 2023c, 2023d; Lloyd et al., 2018	Parental encouragement and support impact students' interest and motivation in STEM.
Simunovic & Babarovic, 2020	Parental behaviors and attitudes influence children's interest and aspirations in STEM.
Valentino et al., 2016	Concerns about work-life balance and family flexibility affect decisions to pursue STEM majors.
Craig et al., 2018	Parental factors shape students' interests, motivations, and decisions in STEM education and careers.
Pattison & Dierking, 2018	Early childhood and parent-child interactions are crucial for fostering science interest.

Empowering Rural Student Through STEM Education

Increasing STEM education and participation among high-achieving children in economically disadvantaged rural regions has become a critical priority in assuring equal opportunity and closing the educational opportunity gap. Despite their promise, kids in these communities frequently lack access to resources, effective STEM programmes, and hands-on learning opportunities. High-achieving students in economically disadvantaged rural schools lack access to advanced curriculum required to pursue highest-level science, technology, engineering educational and employment aspirations (Ihrig et al., 2018).

Motivating students from rural areas to pursue STEM careers is a critical endeavour that necessitates the implementation of effective practises that promote student engagement in rural schools. Students in rural locations may confront unique hurdles, such as limited resources, geographical isolation, and a lack of STEM exposure. To promote student engagement in STEM, the four rural schools used a diverse set of practises (Murphy, 2020).

STEM talent development in rural areas is an important endeavour with enormous potential for stimulating innovation, economic growth, and community development. More research addressing rural STEM education is required (Harris & Hodges, 2018). Rural communities frequently confront particular obstacles in terms of providing access to high-quality STEM education and chances for children to pursue their interests and abilities in science, technology, engineering, and mathematics. Teachers with potential in science, technology, engineering, and mathematics confront unique challenges in realising their potential in rural schools (Lakin et al., 2021).

Adopting drone technology in STEM education for rural communities represents a game-changing chance to improve learning experiences, engage students, and overcome the technological divide. Drones have a wide range of applications in STEM areas such as physics, engineering, and computer science. The drone-based STEM learning strategy increased the interest and excitement of rural children (Jemali et al., 2022).

A collaboration between a small STEM university and a network of school districts spread over a physically isolated region with the primary purpose of supporting STEM teaching and learning (Kavanagh et al., 2021). Using rural students as a model for improving diversity in STEM education is a strategic strategy that attempts to improve inclusivity, tap into underutilised talent pools, and encourage equal access to opportunities in science, technology, engineering, and mathematics disciplines. The recruitment efforts for this programme may serve as a model for other schools seeking to diversify their STEM student body (Jones & Cleaver, 2020).

Student ethnographies that investigate the impact of people and place on STEM career aspirations provide important insights into the complex interplay of personal experiences, social context, and career development. Researchers can acquire a better understanding of the elements that support or inhibit STEM career aspirations by evaluating students' narratives and lived experiences, such as role models, community resources, and cultural norms. Students' desired careers as farmers, according to Mills et al. (2021), are related to their connections to people and belonging to place.

Table 3
Rural Student on STEM Education Issue

Researcher	Results
Ihrig et al., 2018	Limited access to resources and quality STEM programs in economically disadvantaged rural communities.
Murphy, 2020	Effective practices to improve student engagement in STEM in rural schools.
Harris & Hodges, 2018; Lakin et al., 2021	Need for more research on rural STEM education and obstacles faced by teachers.
Jemali et al., 2022	Drone-based STEM learning approach enhances enthusiasm and excitement in rural students.
Kavanagh et al., 2021	Partnership between small STEM university and school district network to support STEM education.
Jones & Cleaver, 2020	Recruiting rural students to enhance diversity and equitable access to STEM opportunities.
Mills et al., 2021	Student ethnographies provide insights into the influence of people and place on STEM career aspirations.

Discussion

According to Halim et al (2018), the family component is critical in moulding students' engagement and enthusiasm in STEM education. Parental participation, support, and academic expectations all have a substantial impact on children's enthusiasm in scientific learning and career choices. According to Weisgram and Diekman (2017), creating a family-friendly environment within STEM professions can significantly impact individuals' perceptions of science occupations as suitable with family life. Parents found it difficult to relate their children's school experiences with the government-mandated curriculum or with their own (Marotto & Miler-Bolotin, 2018).

Furthermore, Myers and Major (2017) emphasise the link between work-family balance and self-efficacy in STEM fields, whereas Idris et al (2023d, 2023c) and Lloyd et al. (2018) emphasise the importance of parental influences on students' interest, self-efficacy, and motivation in STEM. Valentino et al (2016) examine the possible disincentive of career family flexibility in STEM professions, whereas Simunovic and Babarovic (2020) underline the role of parental socialising behaviours. Furthermore, Craig et al (2018) acknowledge the influence of parents on students' inclinations to pursue STEM jobs, while Pattison and Dierking (2018)

emphasise the necessity of understanding the early development of science curiosity among low-income children.

The gender gap in STEM professions is a major barrier to driving innovation and societal progress (Idris & Bacotang, 2023). Malaysia's Woman Policy 2009 intends to improve women's competency and promote gender equality (Curriculum Development Division, Malaysian Ministry of Education, 2016). Equity in STEM opportunities is critical for unlocking human potential and economic prosperity (Buffington et al., 2016; UNESCO, 2020). Gender discrepancies in K-12 education and STEM sectors continue to exist (Ahmed et al., 2020; Garcia-Holgado et al., 2020; Gonzalez et al., 2018).
Underrepresentation of women in STEM fields impedes global scientific research (Olmedo-Torre et al., 2018; UNESCO, 2019, 2020). Gender equality can be achieved by evidence-based policies and inclusive education (Dagupta & Stout, 2014; Blackburn, 2017; Siregar & Rosli, 2021). Closing the gender gap in STEM is critical for progress towards diversity and inclusion (Wang & Degol, 2017; Alibhai et al., 2017).

In order to close the educational opportunity gap, it is critical to increase STEM education and participation among high-achieving children in economically disadvantaged rural communities (Ihrig et al., 2018). Rural students confront distinct hurdles and have limited access to high-quality STEM materials (Murphy, 2020; Harris & Hodges, 2018). Drone technology use in rural STEM education shows potential in terms of improving learning experiences and student interest (Jemali et al., 2022).

STEM university-school district collaborations can support STEM teaching and learning in geographically remote areas (Kavanagh et al., 2021). Exploring the impact of people and place on STEM career goals through student ethnographies gives important insights for aiding students in rural settings (Mills et al., 2021). Rural student recruitment and enrollment in STEM programmes can enhance diversity and equal access to STEM opportunities (Jones & Cleaver, 2020).

Table 4
The Moderator of STEM Interest among Student

Factor	Result	Researcher
Gender	The findings suggest that the gender gap in STEM professions is important for societal advancement and creativity. The Malaysia Woman Policy aims to increase women's participation in the workforce, including STEM, while also recognising the importance of gender diversity. Equitable STEM education is regarded as critical for both economic growth and gender equality. Gender differences are prevalent in K-12 schooling and the technology business. Furthermore, active participation by women in STEM subjects has a direct impact on a country's economy and stimulates innovation. To overcome these gaps, initiatives and	Idris & Bacotang, 2023; Curriculum Development Division, Ministry of Education Malaysia, 2016; Buffington et al., 2016; UNESCO, 2020; Ahmed et al., 2020; Garcia-Holgado et al., 2020; Gonzalez et al., 2018; Olmedo-Torre et al., 2018; Dagupta & Stout, 2014;

	programmes are being implemented to increase girls' and women's participation in STEM. Education is widely acknowledged as an important aspect in empowering women in STEM and closing the gender gap.	Blackburn, 2017; Wang & Degol, 2017; Alibhai et al., 2017.
Family	The findings reveal that parents' academic expectations have a major impact on their children's interest in science studies. A family-friendly workplace in STEM disciplines might improve job perceptions. Work-family balance and self-efficacy are factors in STEM commitment, with men having a bigger impact. Parental encouragement and support have been demonstrated to have an impact on students' interest and motivation in STEM. Furthermore, parental behaviours and attitudes influence children's interest and goals in STEM. Concerns about work-life balance and family flexibility influence decisions to pursue STEM majors. Parental variables, such as support and involvement, influence children' interests, motivations, and career choices in STEM education and careers. Early childhood experiences and parent-child interactions are critical in developing a child's interest in science.	Halim et al., 2018; Weisgram & Diekman, 2017; Myers & Major, 2017; Idris et al., 2023c, 2023d; Lloyd et al., 2018; Simunovic & Babarovic, 2020; Valentino et al., 2016; Craig et al., 2018; Pattison & Dierking, 2018.
Demographic	A summary of the findings, economically disadvantaged rural communities have limited access to resources and high-quality STEM programmes. However, effective practises for increasing student involvement in STEM in remote schools have been established. There is an acknowledged need for additional study on rural STEM education and the obstacles that teachers confront in these settings. Implementing a STEM learning approach based on drones has been found to raise passion and excitement among rural pupils. STEM education has benefited from collaborations between small STEM universities and school districts. It is critical to recruit rural students in order to increase diversity and provide equitable access to STEM programmes. Furthermore, student ethnographies provide important insights into how people and place influence STEM career aspirations.	Ihrig et al., 2018; Murphy, 2020; Harris & Hodges, 2018; Lakin et al., 2021; Jemali et al., 2022; Kavanagh et al., 2021; Jones & Cleaver, 2020; Mills et al., 2021

Conclusion and Future Agenda

Finally, this study demonstrates the importance of socioeconomic class, family history, and gender on youngsters interest in STEM fields. The findings emphasise the need of resolving gaps and providing equitable chances for kids to participate in STEM education, regardless of socioeconomic status, family environment, or gender. Future research should concentrate on developing targeted interventions and strategies that promote STEM interest among students from diverse socioeconomic backgrounds, provide support and resources to students from low-income families, and challenge gender stereotypes in STEM fields. Longitudinal studies that track students' career paths and evaluate the impact of interventions will be critical in determining policies and programmes that promote a more inclusive and diverse STEM workforce. Furthermore, investigating the impact of other elements such as educational content, teacher support, and peer networks can provide additional insights into increasing students' interest and perseverance in STEM careers.

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