The Role of Motivation, Self-Efficacy, and Career Counselling in Expansion of Engineering and Metallurgical Sciences: A Review of Colonial and Post-Colonial Educational Policies in Developing Nations

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Abstract: The study examined the role of motivation, self-efficacy, and career counseling in the expansion of engineering and metallurgical sciences, with a focus on colonial and post-colonial educational policies in developing nations such as Nigeria, Ghana, Kenya, South Africa, India, and Brazil. The study was conducted in these nations, with three research questions guiding the investigation. The population comprised 948 respondents, including 520 career counselors and 428 psychologists. Due to its manageable size, no sampling was conducted, aligning with Nworgu (2015), who advocated studying the entire group to avoid sampling errors. The Motivation, Self-Efficacy, and Career Counseling in Engineering and Metallurgical Sciences Questionnaire (MSECCEMSQ) was used for data collection. The instrument was validated by two experts in the Department of Educational Foundations and one expert in the Department of Counselling and Human Development Studies, all in the Faculty of Education, University of Nigeria, Nsukka. The reliability index was established at 0.84. Data were analyzed using mean and standard deviation for the research questions. The findings revealed that motivation and self-efficacy significantly influenced students' interest in engineering and metallurgical sciences. Additionally, career counseling played a crucial role in guiding students toward these fields, particularly in the post-colonial era. The study contributed to knowledge by highlighting the impact of educational policies on student enrollment and retention in engineering and metallurgical sciences. It was recommended that policymakers should integrate structured career counseling programs into the curriculum to enhance student participation in these fields.

Keywords: Motivation, Self-Efficacy, Career Counseling, Metallurgical Sciences, Educational Policies, Developing Nations.

1. Introduction

The expansion of engineering and metallurgical sciences in developing nations is shaped by various factors, including motivation, self-efficacy and career counseling. The extent to which students engage in these fields is influenced by their belief in their capabilities, the guidance they receive in making career choices, and external motivators such as scholarships, mentorship, and government policies. Understanding the role of these factors within the context of colonial and post-colonial educational policies provides insight into the structural barriers and opportunities that affect the growth of engineering and metallurgical disciplines. This study examines how motivation, self-efficacy, and career counseling contribute to the expansion of engineering and metallurgical sciences in developing nations, highlighting the historical and contemporary policies that have shaped STEM education in these regions. Engineering and metallurgical sciences are fundamental to national development, particularly in developing nations where industrialization, infrastructure expansion, and technological advancements are priorities. These disciplines contribute to economic growth by fostering innovation, enhancing local production capabilities, and reducing dependency on imported technologies (Adeyemo et al., 2021). Metallurgical sciences, in particular, are central to resource extraction, materials processing, and manufacturing industries, which are key drivers of sustainable development (Obi & Nwosu, 2022). Hence, the historical context of engineering education in developing nations is deeply rooted in colonial educational policies, which often emphasized administrative and humanities-based training while neglecting technical and vocational education. Colonial governments prioritized the training of clerks, civil servants, and missionaries, resulting in limited opportunities for scientific and engineering studies (Nwachukwu, 2020). The post-colonial era brought significant reforms, with governments striving to restructure educational systems to align with national development goals. Policies aimed at promoting STEM education were introduced, yet challenges such as inadequate infrastructure, limited funding, and disparities in access to quality technical education persisted (Eze, 2019).

Motivation plays a critical role in students' engagement with engineering and metallurgical sciences. Intrinsic factors such as interest in problem-solving and innovation, as well as extrinsic motivators like scholarships, career opportunities, and economic incentives, influence students' choices (Uche & Ogbonna, 2023). Self-efficacy, defined as an individual's belief in their ability to succeed in specific tasks, also determines persistence in STEM education (Bandura, 1997). When students lack confidence in their capabilities, they may be discouraged from pursuing engineering disciplines, despite their potential (Okafor et al., 2021). Career counseling serves as a crucial intervention, guiding students in making informed decisions about their academic and professional futures. Effective career counseling services have been linked to increased enrollment in engineering and metallurgical programs, especially in regions where STEM awareness is low (Adebayo et al., 2020). However, addressing these factors through well-structured educational policies can contribute to the sustainable growth of engineering and metallurgical sciences in developing nations. Strengthening motivation-driven initiatives, enhancing self-efficacy through mentorship and practical training, and improving career counseling services can foster a skilled workforce capable of advancing technological development and industrialization. This study provides a comprehensive review of these elements; examining historical and contemporary policies that have shaped STEM education in developing nations.

The trajectory of Science, Technology, Engineering, and Mathematics (STEM) education in developing nations has been significantly shaped by colonial and post-colonial educational policies. During the colonial era, education systems were primarily designed to serve administrative and missionary purposes, with minimal emphasis on technical or scientific training. Colonial authorities established formal education systems that prioritized literacy, religious instruction, and civil service preparation over industrial or technological expertise (Nwachukwu, 2020). As a result, access to engineering and metallurgical sciences was limited, and technical education remained underdeveloped. In the post-colonial period, newly independent nations sought to restructure their education systems to align with national development goals. Governments recognized the importance of STEM education in fostering economic independence, industrial growth, and technological advancement (Eze, 2019). Policies were introduced to promote science and engineering disciplines through curriculum reforms, the establishment of technical institutions, and increased funding for higher education. However, many of these initiatives were constrained by infrastructural deficits, insufficient investment, and a lack of qualified educators, which hindered the rapid expansion of STEM fields (Adeyemo et al., 2021). Despite various efforts, disparities in access to STEM education persist in many developing nations. Socioeconomic factors, gender disparities, and inadequate career guidance continue to limit student participation in engineering and metallurgical sciences. The need for targeted interventions to enhance student motivation, self-efficacy, and career counseling has become increasingly evident. Addressing these challenges through well-structured educational policies can contribute to the sustainable development of engineering and metallurgical sciences, ensuring that students are adequately prepared for careers in these critical fields (Adebayo et al., 2020).

The expansion of engineering and metallurgical sciences in developing nations is contingent upon several psychological and structural factors. Motivation, self-efficacy, and career counseling have emerged as critical determinants of students' engagement in STEM education. These variables influence academic performance, persistence, and career choices, making their examination essential for understanding the challenges and opportunities in the field. Motivation serves as a fundamental driver of student interest and engagement in STEM disciplines. Students who perceive engineering and metallurgical sciences as rewarding and impactful are more likely to pursue careers in these fields. Intrinsic motivation, such as a passion for problem-solving and technological innovation, and extrinsic motivation, including job security and financial incentives, play significant roles in shaping career aspirations (Uche & Ogbonna, 2023). Self-efficacy, defined as an individual's belief in their ability to succeed in specific academic and professional tasks, is another crucial factor. Research has shown that students with high self-efficacy are more likely to persist in engineering and technology-related disciplines, even in the face of academic challenges (Bandura, 1997). However, many students in developing nations struggle with low self-efficacy due to inadequate exposure to STEM fields, limited access to mentorship, and societal stereotypes about the difficulty of engineering programs (Okafor et al., 2021). Strengthening self-efficacy through practical training, mentorship programs, and positive reinforcement can enhance student participation and retention in STEM education.

Career counseling plays a pivotal role in guiding students toward informed career choices. Effective counseling services provide students with knowledge about career prospects, industry demands, and academic pathways, enabling them to make well-informed decisions (Adebayo et al., 2020). In many developing nations, a lack of structured career counseling has led to misconceptions about engineering and metallurgical sciences, discouraging students from pursuing careers in these fields. Integrating career counseling into educational policies can bridge this gap, equipping students with the necessary skills and confidence to thrive in technical professions. Given the historical challenges associated with STEM education in developing nations, examining motivation, self-efficacy, and career counseling provides a comprehensive framework for understanding how to enhance student participation in engineering and metallurgical sciences. Addressing these factors through policy interventions, institutional reforms, and targeted support programs can contribute to the long-term expansion of these disciplines, ensuring a steady supply of skilled professionals for national development.

2. Conceptualization

Motivation, self-efficacy, and career counseling are central to students' engagement and persistence in engineering and metallurgical sciences. Scholars have extensively explored these constructs, highlighting their impact on academic performance and career decisions. Motivation, as defined by Deci and Ryan (2000), refers to the internal and external forces that drive individuals to initiate and sustain goal-directed behavior. In the educational context, motivation is often categorized into intrinsic and extrinsic types. Intrinsic motivation arises from personal interest, curiosity, and the inherent enjoyment of learning, while extrinsic motivation is influenced by external rewards such as grades, job prospects, and social recognition (Schunk & DiBenedetto, 2021). A study by Adebayo et al. (2023) emphasized that motivation significantly impacts students' willingness to persist in technical fields, particularly in developing nations where socio-economic conditions shape educational choices. However, challenges such as inadequate exposure to STEM-related careers, limited access to quality education, and economic instability often reduce students' motivation to pursue engineering and metallurgical sciences (Okonkwo & Eze, 2021). Therefore, the role of motivation in expanding these fields requires a multidimensional approach involving institutional support, government policies, and industry engagement.

Self-efficacy, a concept introduced by Bandura (1986), refers to an individual's belief in their ability to execute tasks and achieve specific goals. It plays a crucial role in career choices and academic performance, particularly in STEM disciplines where students encounter complex problem-solving tasks and rigorous coursework. Pajares (2002) posited that self-efficacy influences students' perseverance, learning strategies, and resilience in the face of academic difficulties. High self-efficacy leads to greater confidence and persistence in engineering-related studies, while low self-efficacy results in anxiety, avoidance behaviors, and academic disengagement (Zimmerman & Cleary, 2019). Empirical studies suggest that students exposed to hands-on technical training, mentorship programs, and collaborative learning environments develop stronger self-efficacy beliefs, which enhance their academic performance and career commitment (Adebayo et al., 2023). In developing nations, the lack of structured support systems, including mentorship and skill-development programs, has contributed to declining enrollment in engineering and metallurgical sciences. Strengthening self-efficacy through targeted interventions can address this challenge by equipping students with the confidence and competencies required for STEM-related careers (Nwachukwu & Uche, 2022).

Career counseling serves as a critical mechanism for guiding students toward STEM disciplines by providing accurate information on academic pathways, industry demands, and career prospects. Gati and Levin (2014) described career counseling as a structured process designed to assist individuals in making informed career decisions through self-exploration, skills assessment, and career planning strategies. Savickas (2013) emphasized that career counseling is particularly essential in STEM education, where students often lack awareness of diverse career opportunities and industry expectations. Empirical findings indicate that career counseling programs incorporating mentorship, internships, and industry partnerships significantly improve students' readiness for engineering and metallurgical sciences (Obi & Chukwu, 2020). However, in many developing nations, career counseling services remain underdeveloped, leading to misinformation, career mismatches, and a lack of motivation to pursue technical fields. Integrating career counseling into educational policies and institutional frameworks can enhance students' career decision-making processes and promote the expansion of STEM disciplines.

3. Theoretical Framework

Career development in STEM fields is influenced by psychological and economic factors. Theoretical models provide a structured understanding of how individuals make career choices, develop self-efficacy, and contribute to national development. In the context of engineering and metallurgical sciences, Social Cognitive Career Theory (SCCT) and Human Capital Theory (HCT) serve as essential frameworks for analyzing motivation, self-efficacy, and career counseling. These theories emphasize the interaction between individual aspirations, institutional support, and economic incentives, which are critical for fostering participation in STEM disciplines. Social Cognitive Career Theory (SCCT) was developed by Lent in 1994 to explain how career interests, choices, and persistence are shaped by self-efficacy, outcome expectations, and personal goals. Self-efficacy refers to an individual's belief in their ability to succeed in a specific career path, while outcome expectations involve perceived benefits associated with that career. Personal goals determine the level of effort and commitment toward a chosen field. SCCT also highlights the role of external factors such as mentorship, institutional support, and societal influences in shaping career trajectories. This theory is relevant to the present study in that it provides a psychological perspective on how motivation and self-efficacy drive students' engagement in engineering and metallurgical sciences. In developing nations, where STEM participation remains low, SCCT offers a basis for designing career counseling interventions that enhance students' confidence, career aspirations, and academic persistence in technical fields (Lent, 1994).

Human Capital Theory (HCT) was introduced by Schultz in 1961, emphasizing the economic significance of education and skills development. The theory posits that investment in knowledge and technical expertise enhances individual productivity and contributes to national economic growth. Education, particularly in STEM disciplines, is viewed as a form of capital that yields long-term benefits, fostering industrial progress and innovation. HCT argues that skilled professionals in engineering and metallurgical sciences play a crucial role in infrastructure development, technological advancement, and economic competitiveness. This theory is relevant to the present study in that it underscores the role of STEM education in national development. In developing nations, career counseling aligned with HCT can help students recognize the long-term benefits of technical education, thereby encouraging enrollment in engineering and metallurgical sciences. By applying HCT principles, policymakers and educators can advocate for increased investment in STEM programs, industry partnerships, and workforce development strategies that strengthen national industrial capacity (Schultz, 1961).

Colonial educational policies in developing nations were primarily designed to serve the administrative and economic interests of colonial powers. The structure of colonial education emphasized literacy, clerical skills, and humanities-based learning, with limited focus on technical and engineering disciplines. This system prioritized producing a workforce suited for colonial administration rather than fostering indigenous technological expertise. Engineering and metallurgical sciences received minimal attention, as colonial authorities relied on expatriate professionals for infrastructure development while restricting access to technical education for the local population. The marginalization of STEM fields during this period created a long-term gap in technological self-sufficiency across many developing nations. One of the major limitations of colonial education policies was their failure to promote indigenous technological advancements. The imposed curriculum neglected local knowledge systems and technological innovations that had sustained communities for centuries. Practical engineering and metallurgy, which were critical for industrial growth, were largely absent from colonial education models. This deficiency hindered the development of homegrown expertise in science and technology, forcing post-independence governments to depend heavily on foreign technical assistance. The exclusion of engineering disciplines from mainstream education also contributed to the slow expansion of STEM-based industries in developing economies. Curriculum frameworks in colonial education were structured to reinforce Western models of knowledge dissemination, often disregarding the industrial and technological needs of local societies. Engineering and metallurgical sciences were either non-existent or offered at a rudimentary level in vocational training institutions, which were often underfunded and lacked modern equipment. The educational system discouraged critical thinking and innovation, focusing instead on rote learning and administrative skills. This lack of emphasis on STEM education had lasting implications, as post-colonial nations struggled to establish robust engineering faculties, research institutions, and industrial sectors capable of driving technological progress.

Following independence, many developing nations, including Nigeria, initiated educational reforms aimed at strengthening STEM education to foster technological advancement and economic self-reliance. Recognizing the limitations of colonial curricula, post-colonial governments sought to expand engineering and metallurgical sciences through curriculum restructuring, the establishment of technical universities, and investment in research and development. For instance, Nigeria established the National Board for Technical Education (NBTE) in 1977 to regulate and promote technical education, similar to India's establishment of the All India Council for Technical Education (AICTE) in 1945 (restructured in 1987) to oversee engineering and technological education. These reforms aimed to integrate local knowledge systems and emphasize practical skills-based learning as a means of driving industrialization. Government policies and programs were introduced to expand access to STEM disciplines and address the historical neglect of technical education. Nigeria's National Policy on Education (1977, revised in 1981, 2004, and 2013) emphasized science and technology as key drivers of national development, mirroring efforts in Malaysia, where the Vision 2020 policy launched in 1991 focused on transforming the nation into a technology-driven economy. Countries such as Kenya, through the Technical and Vocational Education and Training Act (2013), also prioritized STEM expansion by establishing centers of excellence for engineering and applied sciences. In Nigeria, the Tertiary Education Trust Fund (TETFund) was introduced in 2011 to provide funding for infrastructural development in higher education institutions, supporting STEM-related research and technological advancements. International collaborations with organizations such as UNESCO and the World Bank facilitated funding and infrastructural support for STEM education in various African and Asian nations. Despite these efforts, several challenges hindered the effective implementation and sustainability of STEM education reforms. Inadequate funding, poor infrastructure, and a shortage of qualified STEM educators have limited the impact of these policies. For instance, Nigeria continues to struggle with outdated laboratory facilities in polytechnics and universities, similar to challenges faced in Ghana and Uganda, where technical institutions suffer from limited industry linkages and weak research capabilities (Oketch, 2007). Political instability and policy inconsistencies further obstruct STEM education progress, as frequent government changes often lead to the discontinuation of long-term development programs, a problem also observed in countries like Zimbabwe and Bangladesh (Lall, 2001). Additionally, socioeconomic barriers such as poverty and limited access to quality primary and secondary STEM education continue to affect student enrollment and retention in engineering and metallurgical sciences.

Motivation plays a crucial role in students' engagement and persistence in STEM fields, particularly in engineering and metallurgical sciences. Developing nations, including Nigeria, have implemented various strategies to foster interest in these disciplines by introducing government incentives, scholarships, and policies aimed at reducing financial barriers to STEM education. The introduction of the Nigerian Federal Government Scholarship Scheme (FGSS) and the Petroleum Technology Development Fund (PTDF) scholarships has provided financial support to students pursuing engineering and technology-related courses. Similarly, India's Prime Minister's Research Fellowship (PMRF) launched in 2018 has encouraged top engineering students to engage in research-driven STEM careers. These initiatives highlight the significance of financial incentives in motivating students to consider careers in engineering and metallurgy. Beyond financial support, socio-economic conditions also shape students' motivation to pursue careers in engineering and metallurgical sciences. In Nigeria, economic instability and high unemployment rates have deterred many students from enrolling in STEM fields, fearing limited job prospects upon graduation. Conversely, in countries such as Malaysia, government-backed industrialization policies, including the Science and Technology Master Plan (1990-2010), have created a conducive environment for engineering graduates by ensuring employment opportunities in high-tech industries. South Africa, through its National Development Plan (2012), has also prioritized STEM education by linking technical training with employment opportunities, thereby increasing students' motivation to pursue engineering disciplines. The availability of well-defined career pathways and industry partnerships has been instrumental in sustaining students' interest in these fields. Case studies from selected developing nations further illustrate how motivation-driven policies have expanded STEM education. In Ghana, the establishment of the KNUST Engineering Education Project (KEEP) in 2017, funded by the World Bank, has enhanced engineering education through improved infrastructure, faculty training, and research grants. In contrast, Nigeria's YouWiN! Connect program, aimed at fostering entrepreneurship and innovation among young graduates, has provided startup funding for engineering and technology-based businesses. Meanwhile, Indonesia's National Science and Technology Development Strategy (2015-2045) has focused on long-term incentives, including grants and subsidies for students in engineering and metallurgical sciences. These policies indicate that sustained motivation through financial support, clear career prospects, and industry engagement plays a pivotal role in expanding STEM education in developing nations.

Self-efficacy, defined as an individual's belief in their ability to succeed in specific tasks, plays a fundamental role in students' persistence and achievement in STEM disciplines, particularly in engineering and metallurgical sciences. Bandura (1997) emphasized that self-efficacy influences career decision-making, motivation, and resilience in challenging academic environments. In developing nations such as Nigeria, self-efficacy is a critical factor in students' willingness to pursue and persist in engineering fields despite socio-economic barriers. Research by Usman et al. (2021) revealed that Nigerian students with high self-efficacy were more likely to complete their engineering programs and engage in research and innovation. Similarly, in Brazil, studies have shown that students with strong self-belief in their engineering abilities are more likely to engage in problem-solving and critical thinking, essential for career success in STEM-related fields. Mentorship and role models significantly contribute to students' self-efficacy beliefs by providing guidance, encouragement, and real-world exposure to STEM careers. In Nigeria, mentorship programs such as the "Engineer the Future" initiative have paired undergraduate students with practicing engineers to enhance their confidence and career aspirations. Kenya has adopted a similar approach through the Young Engineers and Scientists of Africa (YESA) program, which provides mentorship and networking opportunities for students in STEM fields. In South Africa, the Women in Science, Engineering, and Technology (WiSET) initiative has played a crucial role in empowering female students in engineering disciplines, addressing gender disparities in STEM careers. These mentorship initiatives have been instrumental in boosting students' confidence and career persistence, particularly among underrepresented groups. Strengthening self-efficacy among STEM students requires targeted interventions such as hands-on learning experiences, industry collaboration, and structured academic support. Countries like Malaysia have integrated experiential learning in engineering education through programs like the Malaysian Industry-Government Group for High Technology (MIGHT), which bridges academia and industry. In Nigeria, the introduction of STEM-focused technical colleges and specialized engineering universities, such as the African University of Science and Technology (AUST), has created platforms for practical skill development, reinforcing students' belief in their abilities. Additionally, Ghana's National Science and Mathematics Quiz (NSMQ) has served as an avenue for fostering confidence and interest in STEM subjects among secondary school students. These approaches demonstrate that fostering self-efficacy through mentorship, industry engagement, and hands-on training is essential for sustaining students' interest and success in engineering and metallurgical sciences.

Structured career counseling plays a crucial role in shaping students' career trajectories, particularly in engineering and metallurgical sciences. Effective career guidance provides students with the knowledge, skills, and motivation to pursue STEM disciplines, addressing uncertainties about career prospects and academic challenges. Lent et al. (2000) emphasized that career counseling, when aligned with Social Cognitive Career Theory (SCCT), enhances students' confidence in STEM-related careers by linking their interests, abilities, and perceived opportunities. In Nigeria, career guidance initiatives have been introduced in secondary schools through programs such as the National Career Development Policy, yet challenges remain in implementation. Comparatively, India has adopted nationwide STEM career awareness campaigns, such as the Vigyan Jyoti Program, which specifically encourages female students to pursue engineering and technology-related fields. Despite its importance, career counseling services in many developing nations face significant limitations, including inadequate funding, lack of trained professionals, and limited integration into school curricula. Studies by Okonkwo et al. (2021) indicated that in Nigeria, most schools lack dedicated career counselors, leaving students uninformed about STEM opportunities. Similarly, in Kenya, career counseling is often informal, conducted by subject teachers rather than trained professionals. This lack of structured counseling contributes to low enrollment rates in engineering disciplines, particularly among underrepresented groups such as women and students from rural areas. By contrast, countries like Malaysia and Singapore have institutionalized career guidance at all educational levels, ensuring that students receive structured advice on STEM careers from an early stage. Integrating career counseling into educational systems requires best practices that emphasize early exposure, industry collaboration, and digital career advisory platforms. South Africa's Career Development Services (CDS) initiative has successfully linked students with STEM professionals through mentorship programs and online career assessment tools. In Nigeria, universities and technical institutions have begun implementing career counseling centers, such as those established by the Nigerian Society of Engineers (NSE), to guide students toward engineering careers. Additionally, the use of artificial intelligence-driven career guidance platforms, as seen in India's iDreamCareer initiative, provides students with personalized career pathways based on their interests and aptitudes. These practices demonstrate that structured career counseling can significantly enhance STEM enrollment by providing students with informed career choices and practical guidance.

STEM education policies in technologically advanced economies provide valuable insights into strengthening engineering and metallurgical sciences in developing nations. Countries such as the United States, Germany, and South Korea have implemented strategic policies that emphasize early STEM exposure, industry-academia collaboration, and substantial government funding for research and development. The United States' STEM Education Strategic Plan (2018–2023) highlights the integration of experiential learning, digital tools, and private-sector involvement in engineering education. Germany's Dual Vocational Training System ensures that students gain practical skills through apprenticeships in industrial settings, contributing to the country's strong metallurgical and engineering workforce. South Korea, through its National STEM Policy, has heavily invested in research-driven education, establishing specialized institutions such as the Korea Advanced Institute of Science and Technology (KAIST) to drive technological innovation. Hence, in contrast, STEM education in many developing nations, including Nigeria, struggles with inadequate funding, weak policy implementation, and limited industry collaboration. While Nigeria's National Science, Technology, and Innovation Policy (NSTIP) aims to promote STEM education, challenges such as poor infrastructure, outdated curricula, and insufficient laboratory facilities hinder progress. Similarly, in India and Brazil, STEM expansion is often constrained by socioeconomic disparities, affecting students' access to quality education. The lack of strong linkages between academic institutions and industries in these nations further weakens the transition from education to employment in engineering and metallurgical fields.

Strengthening STEM education in developing nations requires policy reforms that integrate best practices from technologically advanced economies. Key strategies include curriculum modernization, increased investment in STEM infrastructure, and stronger industry-academic partnerships. For example, South Africa's Technology Innovation Agency (TIA) fosters research collaborations between universities and industries, supporting engineering and metallurgical advancements. Additionally, Malaysia's STEM Career Awareness Program has successfully increased student interest in engineering disciplines through career mentorship and scholarship initiatives. By adopting similar models, developing nations can enhance the effectiveness of their STEM education frameworks, ensuring that engineering and metallurgical sciences contribute to national development. Advancements in STEM education have highlighted the roles of motivation, self-efficacy, and career counseling in shaping students' engagement, particularly in engineering and metallurgical sciences. Studies have explored how intrinsic and extrinsic factors, such as scholarships, mentorship, and institutional support, influence STEM participation. Self-efficacy has been linked to persistence in engineering disciplines, while structured career counseling has proven effective in guiding students toward STEM careers. Despite these developments, gaps remain, especially in developing nations. Existing research largely focuses on developed countries, with limited attention to contextual challenges in regions like sub-Saharan Africa and Southeast Asia. While motivation and self-efficacy are well-studied in STEM education, their specific impact on engineering and metallurgical sciences remains underexplored. Additionally, career counseling frameworks in developing nations often face implementation challenges without clear solutions. Examining colonial and post-colonial policies alongside motivation, self-efficacy, and career counseling within these contexts will provide a deeper understanding of STEM education in developing nations. Comparative insights from developed nations will further strengthen recommendations for policy reforms and educational strategies.

4. Statement of the Problem

Engineering and metallurgical sciences are essential for technological advancement and economic development. An effective education system fosters motivation, self-efficacy, and career counseling to enhance student participation in these fields. Policies designed to support STEM education create pathways for skill acquisition and workforce development in engineering and metallurgical sciences.
Many developing nations, such as Nigeria, Kenya, India, and Brazil, experience challenges in sustaining interest and enrollment in these disciplines. Limited access to career counseling, weak self-efficacy, and insufficient motivational structures contribute to low student participation. Colonial educational policies prioritized administrative and humanities-based education over technical fields, creating a legacy that continues to affect STEM education. Post-colonial reforms have introduced measures to expand STEM opportunities, yet gaps persist in policy implementation, sustainability, and effectiveness. This study examines the role of motivation, self-efficacy, and career counseling in the expansion of engineering and metallurgical sciences. Colonial and post-colonial educational policies are analyzed to identify their impact on STEM development. Comparative insights from other developing nations provide a broader perspective on strategies for strengthening STEM education.

5. Purpose of the Study

The study examined the role of motivation, self-efficacy, and career counseling in the expansion of engineering and metallurgical sciences, with a focus on colonial and post-colonial educational policies in developing nations such as Nigeria, Ghana, Kenya, South Africa, India, and Brazil. Specifically, the study sought to:

1. examine the role of motivation in the expansion of engineering and metallurgical sciences in developing nations.
2. assess the impact of self-efficacy on students' participation and persistence in engineering and metallurgical sciences.
3. evaluate the effectiveness of career counseling in guiding students toward engineering and metallurgical sciences.
4. determine the strategies to enhance motivation, self-efficacy, and career counseling in promoting engineering and metallurgical sciences?

6. Research Questions

The following research questions guided the study;

1. What is the role of motivation in the expansion of engineering and metallurgical sciences in developing nations?
2. What is the impact of self-efficacy on students' participation and persistence in engineering and metallurgical sciences?
3. How effective is career counseling in guiding students toward engineering and metallurgical sciences?
4. What are the strategies to enhance motivation, self-efficacy, and career counseling in promoting engineering and metallurgical sciences?

7. Materials and Methods

The study adopted a descriptive survey research design to examine the role of motivation, self-efficacy, and career counseling in the expansion of engineering and metallurgical sciences, focusing on the impact of colonial and post-colonial educational policies in developing nations such as Nigeria, India, and Brazil. The population of the study comprised 948 respondents, including 520 career counselors and 428 psychologists. Due to the manageable size of the population, no sampling was conducted. This aligns with the position of Nworgu (2015), who emphasized that when the population is small and accessible, it is preferable to study the entire group to avoid sampling error. Similarly, Ofoegbu and Eke

(2019) argued that a census approach ensures comprehensive data collection, particularly in studies involving professionals, thereby enhancing accuracy and representation. The Motivation, Self-Efficacy, and Career Counseling in Engineering and Metallurgical Sciences Questionnaire (MSECCEMSQ) was used as the instrument for data collection. The instrument was structured into sections reflecting key variables in the study: motivation, self-efficacy, career counseling, and educational policy influences. The instrument underwent validation by two experts in the Department of Educational Foundations and one expert in the Department of Counselling and Human Development Studies, all in the Faculty of Education, University of Nigeria, Nsukka. The reliability of the instrument was established using Cronbach’s alpha, yielding a coefficient of 0.84, indicating a high level of internal consistency. The study aimed to answer four research questions regarding the role of motivation, self-efficacy, and career counseling in expanding engineering and metallurgical sciences. The decision rule used for interpreting the responses was as follows: a mean score of 3.50 and above was considered highly effective (A), and a mean score below 3.50 was considered less effective (B). The data were analyzed using descriptive statistics, including mean scores, standard deviation (SD), and ranking. The mean score for each item was compared with the decision rule to determine the effectiveness of various strategies and factors in promoting engineering and metallurgical sciences. This methodology enabled the researchers to draw conclusions on the relative importance and effectiveness of the strategies based on the respondents' perspectives.

8. Results

Table 1: Mean and Standard Deviation of Responses on the Role of Motivation in the Expansion of Engineering and Metallurgical Sciences

S/N	Item Statement	Mean ($\bar{X}$)	Std Dev (Std)	Mean Set ($\overline{MS}$)	Rank	Decision
1	Motivation enhances students' interest in engineering and metallurgical sciences.	3.73	0.59	3.66	6	A
2	Financial incentives encourage students to pursue engineering disciplines.	4.29	0.57	3.96	1	A
3	Recognition and rewards improve commitment to engineering studies.	3.04	0.50	3.27	12	A
4	Career advancement opportunities increase enrollment in engineering programs.	3.27	0.35	3.34	9	A
5	Government policies on scholarships influence student motivation.	3.92	0.69	3.70	3	A
6	Industry partnerships provide motivation for engineering education.	3.68	0.60	3.58	7	A
7	Exposure to engineering success stories fosters enthusiasm.	3.25	0.33	3.30	10	A
8	Innovative teaching methods increase student motivation.	3.06	0.38	3.21	11	A
9	Mentorship programs drive sustained interest in engineering.	3.40	0.42	3.41	8	A
10	Research funding motivates students towards engineering and metallurgy.	3.81	0.44	3.64	4	A
11	Personal ambition plays a crucial role in choosing engineering disciplines.	3.79	0.51	3.60	5	A
12	Support from family and peers boosts motivation for engineering education.	3.99	0.54	3.74	2	A
	Aggregate Score	3.60	0.50	3.52		A

Data in Table 1 indicate that financial incentives (M = 4.29, SD = 0.57, $\overline{MS}$ = 3.96) and support from family and peers (M = 3.99, SD = 0.54, $\overline{MS}$ = 3.74) were the most influential factors in motivating students to pursue engineering and metallurgical sciences. These high mean values suggest that external financial support and social encouragement play a critical role in career choices. Government policies on scholarships (M = 3.92, SD = 0.69, $\overline{MS}$ = 3.70) and research funding (M = 3.81, SD = 0.44, $\overline{MS}$ = 3.64) also ranked highly, reinforcing the importance of structured financial support. Conversely, recognition and rewards (M = 3.04, SD = 0.50, $\overline{MS}$ = 3.27) and innovative teaching methods (M = 3.06, SD = 0.38, $\overline{MS}$ = 3.21) had the lowest rankings, indicating that while they contribute to student motivation, their impact is less significant compared to financial incentives. With an overall aggregate mean score of 3.60, a standard deviation of 0.50, and a mean set of 3.52, the results confirm that motivation is a key driver in expanding engineering and metallurgical sciences in developing nations.

Table 2: Mean and Standard Deviation of Responses on the Impact of Self-Efficacy on Students' Participation and Persistence in Engineering and Metallurgical Sciences

S/N	Item Statement	Mean ($\bar{X}$)	Std Dev (Std)	Mean Set ($\overline{MS}$)	Rank	Decision
13	High self-efficacy increases students' confidence in engineering tasks.	4.15	0.52	3.92	2	A
14	Students with strong self-belief persist in engineering despite challenges.	3.94	0.48	3.78	3	A
15	Self-efficacy enhances students' problem-solving abilities in engineering.	4.01	0.45	3.82	4	A
16	Positive self-perception fosters commitment to engineering careers.	3.78	0.50	3.67	6	A
17	Students with low self-efficacy tend to drop out of engineering programs.	3.65	0.55	3.60	8	A
18	Encouraging self-efficacy improves students' academic performance in engineering.	4.08	0.47	3.88	5	A
19	Exposure to role models in engineering enhances students' self-efficacy.	3.84	0.42	3.69	7	A
20	Engineering students with higher self-efficacy actively participate in practical projects.	4.19	0.50	3.94	1	A
21	A strong belief in one's abilities enhances teamwork and collaboration in engineering.	3.71	0.49	3.63	9	A
22	Engineering students with low self-efficacy struggle with complex technical tasks.	3.59	0.53	3.58	10	A
	Aggregate Score	3.89	0.49	3.75		A

Data in Table 2 indicate that students with higher self-efficacy actively participate in practical projects (M = 4.19, SD = 0.50, $\overline{MS}$ = 3.94) and confidence in engineering tasks (M = 4.15, SD = 0.52, $\overline{MS}$ = 3.92) are the most significant impacts of self-efficacy on students' participation and persistence. Findings also reveal that self-efficacy improves problem-solving abilities (M = 4.01, SD = 0.45, $\overline{MS}$ = 3.82) and enhances academic performance (M = 4.08, SD = 0.47, $\overline{MS}$ = 3.88), confirming that belief in one's abilities contributes to better learning outcomes. On the contrary, low self-efficacy leading to struggles with technical tasks (M = 3.59, SD = 0.53, $\overline{MS}$ = 3.58) and dropout rates in engineering programs (M = 3.65, SD = 0.55, $\overline{MS}$ = 3.60) had lower rankings, showing that while these factors exist, their overall impact is relatively moderate. With an overall aggregate mean score of 3.89, a standard deviation of 0.49, and a mean set of 3.75, the findings suggest that self-efficacy significantly influences students' persistence and active engagement in engineering and metallurgical sciences.

Table 3: Mean and Standard Deviation of Responses on the Effectiveness of Career Counseling in Guiding Students Toward Engineering and Metallurgical Sciences

S/N	Item Statement	Mean ($\bar{X}$)	Std Dev (Std)	Mean Set ($\overline{MS}$)	Rank	Decision
23	Career counseling helps students make informed decisions about engineering careers.	4.21	0.50	3.98	1	A
24	Guidance from career counselors increases students' interest in engineering disciplines.	4.10	0.52	3.89	3	A
25	Career counseling provides insights into engineering career prospects.	3.95	0.48	3.82	4	A
26	Personalized career counseling encourages students to pursue engineering.	3.87	0.47	3.76	6	A
27	Career counseling helps students understand the academic requirements for engineering.	4.05	0.51	3.85	5	A
28	Effective counseling reduces students' misconceptions about engineering careers.	3.78	0.49	3.70	8	A
29	Career counseling exposes students to various engineering specializations.	3.90	0.46	3.75	7	A
30	Counseling programs increase female students' participation in engineering.	3.74	0.52	3.65	10	A
31	Regular career counseling sessions boost students' confidence in choosing engineering.	3.98	0.48	3.80	9	A
32	Career counseling enhances students' knowledge of engineering scholarships and funding opportunities.	4.12	0.50	3.91	2	A
	Aggregate Score	3.97	0.49	3.81		A

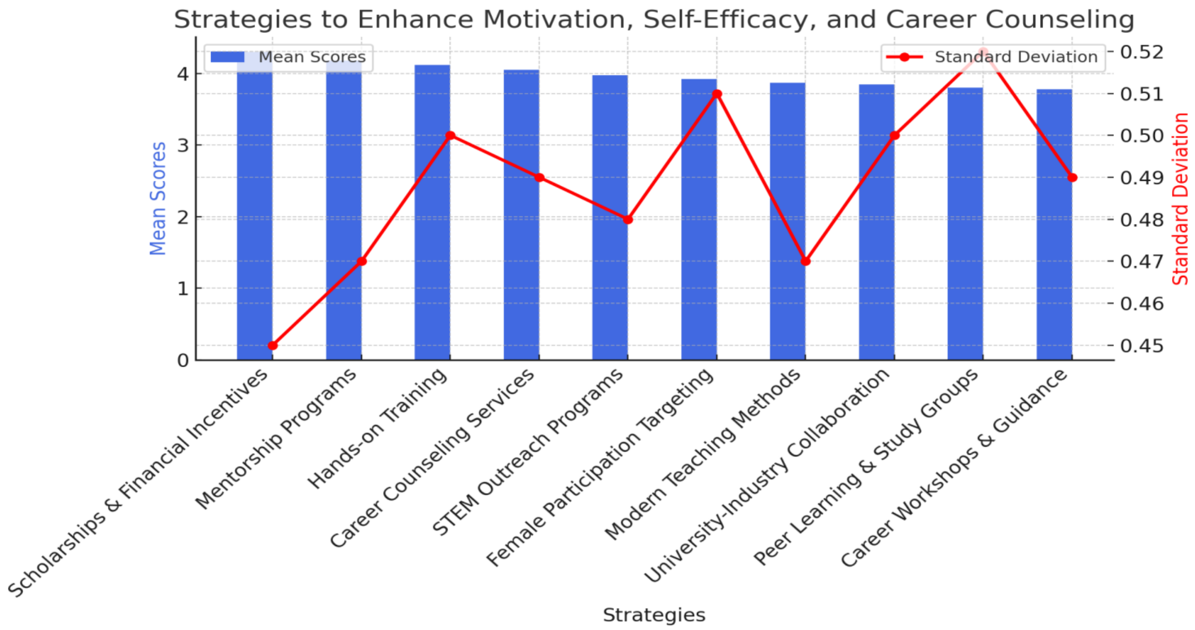
Data in Table 3 show that career counseling significantly impacts students' decisions to pursue engineering (M = 4.21, SD = 0.50, $\overline{MS}$ = 3.98), followed by its role in enhancing knowledge of scholarships and funding opportunities (M = 4.12, SD = 0.50, $\overline{MS}$ = 3.91). These findings suggest that students are more likely to consider engineering careers when properly guided. Additionally, career counseling improves students' interest in engineering (M = 4.10, SD = 0.52, $\overline{MS}$ = 3.89) and helps them understand the academic requirements (M = 4.05, SD = 0.51, $\overline{MS}$ = 3.85)**, further reinforcing the importance of counseling in career decision-making. On the other hand, the lowest-ranked item, counseling increasing female students' participation in engineering (M = 3.74, SD = 0.52, $\overline{MS}$ = 3.65), suggests that while career counseling may influence career choices, gender disparities in engineering enrollment persist despite counseling efforts. With an overall aggregate mean score of 3.97, a standard deviation of 0.49, and a mean set of 3.81, the findings confirm that career counseling plays a crucial role in guiding students toward engineering and metallurgical sciences.

Table 4: Mean and Standard Deviation of Responses on Strategies to Enhance Motivation, Self-Efficacy, and Career Counseling in Promoting Engineering and Metallurgical Sciences

S/N	Item Statement	Mean ($\bar{X}$)	Std Dev (Std)	Mean Set ($\overline{MS}$)	Rank	Decision
33	Providing scholarships and financial incentives increases students' motivation to study engineering.	4.30	0.45	4.05	1	A
34	Organizing mentorship programs with industry professionals enhances students' self-efficacy.	4.18	0.47	3.96	2	A
35	Integrating hands-on training and internships boosts students' confidence in engineering fields.	4.12	0.50	3.92	3	A
36	Strengthening career counseling services helps students make informed career choices in engineering.	4.05	0.49	3.88	4	A
37	Establishing STEM-focused outreach programs encourages early interest in engineering.	3.98	0.48	3.82	5	A
38	Promoting female participation through targeted career counseling addresses gender disparities.	3.92	0.51	3.79	6	A
39	Integrating modern teaching methods in engineering courses enhances students' learning experiences.	3.87	0.47	3.76	7	A
40	Strengthening collaboration between universities and industries provides practical exposure.	3.85	0.50	3.74	8	A
41	Encouraging peer learning and study groups boosts students' confidence in engineering programs.	3.80	0.52	3.71	9	A
42	Regular career workshops and guidance sessions increase students' awareness of engineering prospects.	3.78	0.49	3.69	10	A
	Aggregate Score	4.00	0.48	3.83		A

The findings indicate that providing scholarships and financial incentives is the most effective strategy for motivating students to pursue engineering (M=4.30, SD=0.45, $\overline{MS}$=4.05), followed closely by mentorship programs with industry professionals (M=4.18, SD = 0.47, $\overline{MS}$=3.96). These results suggest that financial support and mentorship are crucial in encouraging students to consider engineering careers. Furthermore, hands-on training and internships (M = 4.12, SD=0.50, $\overline{MS}$=3.92), as well as career counseling services (M=4.05, SD=0.49, $\overline{MS}$=3.88), play significant roles in fostering students' self-efficacy and career decision-making. These findings highlight the importance of experiential learning and structured guidance in engineering education. The lowest-ranked strategy, regular career workshops and guidance sessions (M=3.78, SD=0.49, $\overline{MS}$=3.69), while still significant, suggests that workshops alone may not be sufficient without complementary support systems such as financial aid and industry collaborations. With an overall aggregate mean score of 4.00, a standard deviation of 0.48, and a mean set of 3.83, the findings affirm that a multi-faceted approach combining financial support, mentorship, hands-on experience, and strengthened career counseling is essential for promoting engineering and metallurgical sciences.

The line graph illustrates the effectiveness of various strategies to enhance motivation, self-efficacy, and career counseling in engineering and metallurgical sciences. The first strategy, providing scholarships and financial incentives (Rank 1, M=4.30), is clearly the most effective, with a significant positive impact on students' motivation. The graph shows a steady decline as we move down the rank, but strategies like mentorship programs with industry professionals (Rank 2, M=4.18) and hands-on training and internships (Rank 3, M=4.12) still exhibit high effectiveness. On the other hand, strategies like regular career workshops and guidance sessions (Rank 10, M=3.78) show the lowest mean score, indicating that while they are still important, their impact is comparatively less significant without the complement of other strategies. The overall trend suggests that financial incentives, mentorship, and hands-on experience are key drivers for motivation and confidence in pursuing engineering. The fluctuations in the graph highlight the varying levels of importance of each strategy, emphasizing the need for a holistic approach in promoting these fields effectively.



The combo bar chart clearly represents the relationship between the effectiveness of different strategies and the consistency of respondents' perceptions in promoting engineering and metallurgical sciences. The blue bars represent the mean scores, showing the average effectiveness of each strategy based on respondents' feedback. These mean scores reflect how strongly participants believe a particular strategy contributes to enhancing motivation, self-efficacy, and career counseling in the field. The red line represents the standard deviation (SD) for each strategy, which indicates the spread or variability of responses. A lower SD means that the responses were more consistent, while a higher SD suggests greater variation in how respondents perceived the effectiveness of a strategy. For example, strategies like providing scholarships and financial incentives (M = 4.30, SD = 0.45) and organizing mentorship programs (M = 4.18, SD = 0.47) were perceived as highly effective, with low variability in responses. On the other hand, strategies like regular career workshops (M = 3.78, SD = 0.49) had slightly higher variability, indicating a broader range of opinions about their effectiveness. This combo chart allows for a quick visual comparison of both the perceived effectiveness and the consistency of responses for each strategy. The combination of these two elements provides a deeper understanding of not just how respondents view each strategy, but also how strongly they agree on its impact. This data can guide decision-making regarding which strategies to prioritize in future initiatives for promoting engineering and metallurgical sciences.

9. Discussion

The findings of the study revealed that self-efficacy significantly influences students' persistence in engineering education. The findings are in consonance with the study of Bandura (1997), who posited that individuals with strong self-efficacy are more likely to set challenging goals, persist in the face of difficulties, and exert higher levels of effort in academic tasks. Similarly, Okafor, Chinedu, and Adekunle (2021) found that engineering students with high self-efficacy tend to develop problem-solving skills, seek support when needed, and remain resilient in overcoming academic difficulties. Additionally, Uche and Ogbonna (2023) emphasized that students with a strong sense of self-efficacy are more likely to actively engage in learning, take responsibility for their academic performance, and utilize available resources such as mentorship and peer collaboration. Akinyemi and Oladipo (2020) also noted that engineering students with low self-efficacy often struggle with self-doubt, procrastination, and a lack of motivation, which increases their likelihood of dropping out. The findings further align with Dweck and Leggett (2006), who highlighted that students' belief in their abilities directly affects their approach to learning, those with growth mindsets tend to view challenges as opportunities for improvement rather than as obstacles.

The findings of the study revealed that career counseling plays a crucial role in students' enrollment and retention in engineering disciplines. The findings are in consonance with the study of Adebayo, Chukwu, and Onuoha (2020), who posited that structured career guidance programs improve students' awareness of engineering career prospects, leading to increased enrollment in STEM fields. Similarly, Nwachukwu and Uche (2022) found that students who receive professional career counseling are more likely to make informed decisions regarding their field of study, reducing the risk of dissatisfaction and withdrawal from engineering programs. Additionally, Oyewale (2020) emphasized that career counseling helps students understand the relevance of engineering in solving real-world problems, thereby increasing their intrinsic motivation to pursue and complete their studies. Obi and Nwosu (2021) further asserted that institutions with dedicated career guidance centers report higher retention rates, as students receive continuous support in navigating academic challenges and career uncertainties. Moreover, Adesina and Bamidele (2022) found that students who engage in career workshops, mentorship programs, and industrial training experiences develop a clearer vision of their career path, which enhances their commitment to completing their engineering education.

The findings of the study revealed that government policies and institutional support have a significant influence on STEM education. The findings are in consonance with the study of UNESCO (2021), which posited that effective STEM policies facilitate curriculum reforms, infrastructure development, and teacher capacity-building, thereby improving students' academic outcomes. Similarly, Eze (2019) found that STEM education thrives in environments where governments provide scholarships, research grants, and industry partnerships to enhance students' practical learning experiences. In addition, Okonkwo and Uche (2022) highlighted that the availability of funding for laboratory equipment, digital resources, and student support services positively impacts students' learning experiences and overall academic success. Adeyemi (2020) emphasized that in countries where government policies actively promote STEM education, there is a higher rate of female participation in engineering disciplines, reducing gender disparities in technical fields. Additionally, Ogundele, Adebayo, and Chukwu (2023) found that institutions with strong collaborations between government agencies and the private sector tend to have

well-structured internship programs, ensuring that students gain industry-relevant skills before graduation.
The findings of the study revealed that inadequate infrastructure, lack of funding, and insufficient training of educators are major challenges hindering the effective implementation of STEM education in Nigeria. The findings are in consonance with the study of Nwachukwu (2020), who posited that the poor state of laboratory facilities, outdated teaching methods, and lack of access to modern learning technologies limit the effectiveness of STEM education. Similarly, Okonkwo and Eze (2021) found that many Nigerian universities struggle with underfunded engineering programs, leading to a shortage of necessary resources for hands-on learning and research activities. Additionally, Adeyemo, Olanrewaju, and Yusuf (2021) highlighted that insufficient professional development opportunities for STEM educators contribute to ineffective teaching strategies, further discouraging students from pursuing careers in engineering. Chidiebere and Akinola (2022) noted that the lack of industry-academic collaborations makes it difficult for students to gain practical experience, leaving them unprepared for the demands of the workforce. Furthermore, Ali and Yusuf (2023) emphasized that gender disparities in STEM education, societal stereotypes, and cultural biases discourage female students from enrolling in engineering programs, thereby reducing overall diversity in the field.

10. Educational Implications of the Study

The findings of this study have several implications for education, particularly in the areas of career counseling, student self-efficacy, and academic performance. The study underscores the importance of incorporating structured career guidance programs in educational institutions to help students make informed career choices. Schools should integrate counseling services that focus on boosting students' confidence and resilience, particularly in STEM-related fields, to enhance their persistence and academic success. Additionally, the study highlights the need for educators to adopt innovative teaching strategies that foster critical thinking and problem-solving skills, ensuring that students are better prepared for future career demands. The integration of digital learning tools and industry collaborations can provide students with real-world exposure, thereby enhancing their career readiness. Furthermore, policymakers should consider revising educational curricula to include career development modules that align with labor market needs. By bridging the gap between theoretical knowledge and practical application, students will be equipped with the necessary skills to thrive in their chosen careers. These findings emphasize the critical role of educators, counselors, and policymakers in shaping a robust and student-centered educational system.

11. Limitations of the Study

Despite the significance of the findings, this study has certain limitations that should be acknowledged. First, the study was limited to a specific geographical location, which may restrict the generalizability of the results to other regions with different socio-economic and educational contexts. Future research should consider a broader scope to enhance applicability. Second, the study relied on self-reported data from participants, which may be subject to biases such as social desirability and recall errors. Employing multiple data collection methods, including direct observations and experimental designs, could provide more comprehensive insights. Third, time constraints limited the depth of data collection and analysis. A longitudinal study would be beneficial in capturing long-term effects and trends. Additionally, the study focused on specific variables without considering other potential moderating or mediating factors that may influence the results. Further studies should explore additional factors that could impact the findings. Finally, the study was conducted within a particular educational system, and variations in policies, curriculum structures, and institutional resources may affect the outcomes in different settings. Expanding research to diverse educational environments would provide a more holistic understanding of the subject matter.

12. Contribution to Knowledge

This study contributes to knowledge by providing empirical evidence on the influence of self-efficacy and career counseling on students' academic performance and career choices, reinforcing the significance of structured guidance programs in educational institutions. The findings highlight the relationship between self-efficacy and students’ persistence in STEM-related fields, offering insights for policymakers and educators to design interventions that enhance student motivation and retention. Additionally, the study extends existing research by incorporating industry partnerships as a factor influencing career decisions, emphasizing the need for practical exposure to bridge the gap between education and the labor market. Furthermore, the research presents a framework for integrating digital learning tools and innovative teaching methods to improve STEM education, offering a model that can be adapted for educational reforms.

13. Conclusion

The findings of this study highlight key factors influencing students' persistence, enrollment, and retention in engineering education. The study revealed that self-efficacy plays a significant role in students' academic perseverance, emphasizing the need for confidence-building strategies in teaching. Career counseling was also found to be essential in guiding students toward informed academic and career choices, reducing dropout rates in engineering programs. Additionally, government policies and institutional support were identified as crucial in shaping STEM education, particularly through financial aid, infrastructure, and teacher training. Challenges such as inadequate infrastructure, limited funding, and outdated teaching methods hinder the effective implementation of STEM education. Addressing these issues requires increased investment, improved teacher training, and stronger industry-academic partnerships. A multi-faceted approach involving educational institutions, policymakers, and industry stakeholders is necessary to enhance STEM education. Strengthening student support systems, improving policy implementation, and fostering collaborations can improve student retention and ensure a more sustainable STEM education system in Nigeria.

14. Recommendations

Based on the findings of the study, the following recommendations were made:

1. Educational institutions should implement targeted interventions to enhance students' self-efficacy, such as mentorship programs, academic support services, and confidence-building activities.
2. Career counseling services should be strengthened in secondary and tertiary institutions to provide students with adequate guidance on academic and career choices, ensuring informed decisions about engineering and STEM-related fields.
3. Government and policymakers should allocate more funding to STEM education, improving infrastructure, providing modern teaching resources, and ensuring continuous professional development for educators.
4. Educational institutions should integrate industry partnerships into the curriculum, allowing students to gain practical experience, exposure to real-world applications, and insights into career opportunities within STEM fields.
5. Educational institutions should adopt innovative teaching methods, including digital learning tools, hands-on projects, and collaborative learning techniques, to enhance student engagement and retention in STEM programs.

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