Science Education Quarterly, 2025, Vol. **3**, Iss. 2, pp. 44–56 10.55056/seq.1004

Students' self-efficacy in STEM subjects: influence of career guidance support across gender

Christina Jerome Shuma, Fidel Dassan Gwajekera and Asia Mbwebwe Rubeba

The University of Dodoma, 1 Benjamin Mkapa Rd., 41218 Iyumbu, Dodoma, Tanzania

Abstract. Science, Technology, Engineering, and Mathematics (STEM) subjects are recognised as potential areas that prepare students to address the ongoing changes in the world. However, evidence shows that students exhibit low self-efficacy in STEM due to limited human resource training in these subjects. This article examined the impact of career guidance support on students' self-efficacy in STEM subjects. A multiple linear regression model, supplemented by descriptive statistics, was employed to analyse the collected quantitative data. The study revealed a significant positive influence of career guidance support on both male and female students' self-efficacy in STEM subjects, with regression coefficients of 0.552 and 0.533, respectively. Male students demonstrated higher self-efficacy in STEM subjects than their female counterparts. The study recommends that the Tanzania Ministry of Education, Science and Technology ensure access to comprehensive career guidance support for both male and female students to foster successful STEM learning.

Keywords: academic and career support, STEM subjects, self-efficacy, gender

1. Introduction

STEM is an acronym for Science, Technology, Engineering and Mathematics [52]. Its prominence in education policy can be traced back to the United States of America (USA) education reforms in 1983 [32]. STEM integrates disciplines that cultivate creativity, innovation, and problem-solving competencies essential to preparing students for the changing technological era. To further foster creativity, Arts was subsequently added to form STEAM [10]. The U.S. National Science Board (NSB) advocates improving STEM K–12 education for all, as this approach serves as the cornerstone for developing the nation's future science and engineering workforce [29]. Kalogiannakis and Papadakis [17] acknowledges that STEM education equips students with skills they will need in the future workplace. In Sri Lanka, Deshani and Hirimburegama [10] revealed that STEM education has the potential to improve economic stability, enhancing health, wealth, and social wellbeing. In Malaysia, Marzuki et al. [27] recommended increased accessibility, interdisciplinary learning, and continuous professional development for educators to ensure that STEM education remains relevant and effective.

In Africa, the United Nations underscores the importance of STEM education in promoting innovative solutions crucial for sustainable development [46]. Well-trained STEM graduates are expected to contribute to national economies and address development challenges. Research on STEM education contributes to creating STEM awareness and ensuring that individuals are appropriately engaged in science fields [46]. White [52] confirmed that students taking STEM subjects gain preparation not only for science programmes in post-secondary education but also for critical thinking and problem-solving. López, Simó and Marco [24] reported that STEM disciplines are recognised as fundamental to human capital development, characterised by favourable employment outcomes

0000-0002-3245-4379 (C. J. Shuma); 0000-0001-9693-4382 (F. D. Gwajekera); 0000-0001-7136-5486 (A. M. Rubeba)
jerochristine@gmail.com (C. J. Shuma); fidel.gwajekera@udom.ac.tz (F. D. Gwajekera); asia.rubeba@udom.ac.tz (A. M. Rubeba)
https://www.udom.ac.tz/staff/staff_profile?id=VG5wQk1BPT0= (F. D. Gwajekera);
https://www.udom.ac.tz/staff/staff_profile?id=VG5wak5RPT0= (A. M. Rubeba)

Received 2025-06-12 Accepted 2025-12-29 Published 2026-04-25 Version of record 2026-04-25

and robust economic prospects. Investigating the impact of career guidance support on students' self-efficacy in STEM subjects is therefore essential, as the findings can inform educational policies and career guidance practice to improve access to such services and foster student engagement in STEM.

2. Literature review

2.1. Self-efficacy

Lent [21] describes self-efficacy as a dynamic set of beliefs linked to particular performance domains and activities. In the present study, self-efficacy is treated as a crucial mechanism motivating students to engage in STEM subjects and achieve their educational and career goals.

Self-efficacy is recognised as a critical determinant that influences both the initiation and persistence of specific behaviours when learners face obstacles [23]. Learners with a high sense of self-efficacy in STEM subjects are expected to maintain the motivation to learn and succeed despite difficulties. High self-efficacy significantly influences individuals' affective responses, cognitive processes, self-motivation, and behavioural patterns [6]. Individuals with strong confidence in their abilities view difficult tasks as opportunities to learn and grow rather than as setbacks [6, 13, 36], whereas those who perceive themselves as lacking ability tend to avoid challenging tasks and give up readily when faced with difficulties [6].

Bandura [4], as cited in Spenner [43], affirmed that self-efficacy beliefs develop through four key sources: performance achievements, observational learning, social influences, and physiological and affective states. Social persuasion – one of these sources – can be effectively delivered through career guidance services in schools [7]. As Brown and Lent [7] noted, comprehensive career guidance services facilitate not only the attainment of educational goals but also the development of career self-awareness, guiding students toward informed choices and adjustments. To promote active participation and academic success in STEM, it is therefore crucial to help learners cultivate confidence and realise their full potential. As Sidiq, Permanasari and Riandi [39] suggested, students with high self-efficacy in STEM subjects are more likely to secure careers in STEM. Creating a supportive physical learning environment must therefore be accompanied by building students' strong sense of self-efficacy.

2.2. STEM subjects in the Tanzanian education system

According to the current curriculum for ordinary secondary education, STEM subjects include Physics, Chemistry, Biology, Computer Science, and Mathematics. Basic Mathematics and Biology are mandatory for all ordinary secondary school students [28]. In the present study, STEM subjects refer to the five science subjects that provide a foundation for further study at the college or university level. By studying STEM subjects, students are expected to demonstrate competencies including understanding of scientific concepts, theories and principles; proficiency in conducting scientific investigations; and subject-specific skills required at both lower and higher secondary levels.

In the Tanzanian education system, ordinary secondary students choose between science, arts, business, or other available subject streams during the transition from Form II to Form III [28]. This transition is a critical period during which many students struggle to define their career path [44] and require support from teachers, parents, and career counsellors. Recognising these challenges, the Tanzania Education and Training Policy (ETP) of 2014, revised in 2023, mandated comprehensive career guidance and counselling programmes to enable students to select subjects aligned with their vocational aspirations [49]. Research on career development further highlights the need for increased access to career guidance support to help students successfully navigate educational and career pathways [9, 25, 26, 34].

2.3. Students' self-efficacy in STEM subjects across gender

Self-efficacy serves as a crucial determinant of students' interest in STEM and ultimately influences career choice and performance in these fields [20]. As Bandura [5] suggested, self-efficacy is connected to individuals' motivation, engagement, persistence, and achievement. It also shapes emotional responses, cognitive processes, and decision-making, determining the pathways individuals choose to pursue [43]. For students to feel confident and motivated to engage with STEM subjects, they require a strong sense of self-efficacy to face associated challenges [11]. Self-efficacy in STEM subjects is reported to decline as students progress through secondary school, college, and university, and this decline is more pronounced among girls [11, 50], contributing to their underrepresentation in STEM programmes and careers.

At the global level, the World Economic Forum [53] reported that women remain underrepresented in STEM fields, particularly in Information and Communication Technology (ICT) and Engineering and Manufacturing. Among graduates employed in ICT-related fields, women represent 1.7% compared to 8.2% for men. In Engineering and Manufacturing, women and men represent 6.6% and 25.0%, respectively. A study by Papadakis, Tousia and Polychronaki [31] on women in computer science found that females with a Master's degree accounted for only 23.4%, compared to 76.6% among male students. This underrepresentation is also evident in Tanzania: according to TCU [45], female students enrolled in ICT across universities in the 2022/2023 academic year accounted for 44.8%, compared to 55.2% for males, while in Engineering, females accounted for 38.1% and males 61.9%. Addressing this gender gap is necessary as stakeholders work towards achieving the Sustainable Development Goals 2015–2030. Designing programmes that build students' confidence in STEM and encourage girls to develop an interest and perform well in these subjects is therefore a priority.

2.4. Career guidance support and students' self-efficacy in STEM subjects

Various scholars have demonstrated the role of career guidance support in strengthening students' confidence in STEM. In the USA, career guidance delivery in schools inspired students – many of them girls – to engage actively in STEM [19, 33, 41, 51], with Krome [19] and Robnett [33] emphasising mentoring and role-model exposure, and Simon, Wagner and Killion [41] and Wang and Degol [51] focusing on structured counselling interventions. In China, career guidance support strengthened students' confidence in STEM subject choices and academic performance by raising awareness [55]. Schulstok and Wikstrand [37] found that educational and professional counselling programmes demonstrated considerable capacity to challenge gender disparities across Nordic nations, including Sweden, Finland, Norway, Iceland, and Denmark.

Career guidance practitioners working in partnership with government institutions have strengthened girls' capabilities and challenged gender-based educational stereotypes, boosting female engagement in STEM. The WEF [53] positioned Iceland, Norway, and Sweden among the five leading countries in gender balance across economic opportunities, educational access, health indicators, and political involvement. This cooperative framework aligns with Tanzania's Gender Policy [47] and the National Strategy for Gender Development [48], both of which emphasise multi-stakeholder collaboration as fundamental to achieving gender equality.

Institutions such as the University of Dar es Salaam have introduced pre-entry courses and lowered entry qualifications for female students interested in science programmes. Despite these efforts, limited knowledge exists regarding the specific role of career guidance support in shaping students' self-efficacy in STEM subjects. This study, therefore, addresses that gap by examining the impact of career guidance support on students' STEM self-efficacy, with a focus on gender, to identify effective strategies to encourage broader participation by both girls and boys in STEM.

3. Theoretical framework

The study draws on Social Cognitive Career Theory (SCCT) by Lent, Brown and Hackett [22], which is derived from Bandura's self-efficacy theory [3, 4] and postulates a mutually influencing relationship between people and their environment [23]. SCCT proposes three interrelated segments of career development explaining (a) how vocational interest develops, (b) how career choices are made, and (c) how career performance and stability are determined [15]. Each segment centres on three core variables – self-efficacy, outcome expectations, and personal goals – which form the foundational building blocks of career development within the theory.

Self-efficacy is recognised as the central variable within SCCT and has received considerable attention in the literature [23, 43]. Bandura [3] proposes that people need self-efficacy and resilience to build a successful life and to overcome the obstacles they inevitably encounter [21]. Self-efficacy determines whether behaviour is initiated and how long it is sustained when individuals face obstacles or adverse experiences. For students to choose STEM subjects and perform well in them, they need to develop a strong sense of self-efficacy. The SCCT provides career guidance practitioners and researchers with an overarching framework to guide practice, as well as testable propositions and hypotheses [23].

3.1. Rationale for adopting SCCT

SCCT was selected for this study because its core constructs – self-efficacy, outcome expectations, and personal goals – directly address the educational and career issues relevant to STEM subject engagement and career decision-making. Among these constructs, self-efficacy has the strongest predictive relationship with academic and occupational performance [7, 23] and has been extensively examined in studies of career and educational outcomes. Integrating these psychological constructs provides a holistic framework for understanding how academic confidence develops and influences career trajectories.

SCCT is particularly appropriate here because it situates self-efficacy within a broader social and environmental context, making it sensitive to the gender-related factors that shape STEM participation. Several studies have documented girls' lower self-efficacy in STEM subjects [11, 40, 50], and SCCT provides a blueprint for designing comprehensive strategies to address this disparity – including the role of career guidance support in building confidence, providing social persuasion, and exposing students to relevant role models. Enhancing girls' self-efficacy in STEM represents a critical strategy for promoting gender inclusion in science education and laying a foundation for STEM careers.

4. Methodological procedure

4.1. Study approach and design

A quantitative research approach was employed, adopting an ex post facto design. According to Ary et al. [2], an ex post facto design is appropriate when a researcher seeks to examine existing relationships between independent and dependent variables without manipulating them. Edmonds and Kennedy [12] similarly argue that this design provides an alternative means of investigating the extent to which a specific independent variable may affect a dependent variable. In the present study, the researchers examined the relationship between career guidance support (the independent variable) and self-efficacy in STEM subjects (the dependent variable) among ordinary secondary school students in Tanzania.

Ex post facto designs have been criticised for difficulty in establishing causal inference due to limited control over independent variables, as these have already occurred prior to the study. The present study addressed this limitation through two strategies: random selection of study participants, as recommended by Ary et al. [2] and Edmonds and Kennedy [12], to strengthen the representativeness of the sample and reduce selection bias; and the use of multiple linear regression to statistically

partition the effects of career guidance support from those of confounding variables (age, school ownership, and class level), thereby isolating the relationship of primary interest and enhancing the interpretive validity of the findings.

4.2. Location of the study and participants

The study took place in Dar es Salaam, involving 10 public and private secondary schools in Ilala Municipality. Ilala Municipality was selected because its secondary school students come from diverse backgrounds and have varying exposure to STEM careers, and because the schools are located near industrial areas where STEM activities are conducted. This context was considered conducive to generating informative data on students' career-related experiences. Two groups of students participated: Form III and Form IV. These groups were selected because, having already made subject stream choices, they were best placed to reflect on their self-efficacy in STEM subjects and the career guidance support they had received.

4.3. Sample size and sampling procedures

The sample size was calculated using the Yamane formula [54] based on the known student population. Three sampling techniques were employed in combination. Criterion purposive sampling was used to select schools (mixed-sex, public and private), class levels (Form III and Form IV), science teachers, and school counsellors. Single-sex schools in Ilala were excluded. Stratified sampling was then applied to form strata based on class level (Form III and Form IV) and gender. Within each stratum, simple random sampling was conducted using numbered pieces of paper as inclusion and exclusion markers to ensure unbiased representation. A total of 464 students were selected from the ten schools.

4.4. Data collection and analysis

A self-report questionnaire (SRQ) consisting of 30 items on a five-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree), was administered to students in their respective schools. Printed questionnaires were distributed face-to-face, and students were given sufficient time to read each item and respond. To ensure content and face validity, subject experts in career guidance, gender studies, and STEM education reviewed the instrument. A language specialist from the Department of Foreign Languages at the University of Dodoma translated the items from English into Swahili to facilitate comprehension and ensure respondents' freedom of expression in their first language. A pilot study was conducted at Dodoma Secondary School, which shared relevant characteristics with the study schools, to assess the instrument's suitability, readability, and relevance.

The collected data were analysed using both descriptive and inferential statistics. Descriptive statistics were used to organise data and calculate frequencies and percentages to describe the variation in self-efficacy across gender. The influence of career guidance support on students' self-efficacy was then examined using a multiple linear regression model. In this model, age, school ownership, and class level were included as covariates to separate their effects from the effect of career guidance support, thereby enabling a cleaner estimate of the relationship between the independent variable and self-efficacy. This approach enhances the validity of findings and facilitates clearer interpretation of the effect of career guidance support. Data analysis was conducted using IBM SPSS Statistics, version 25. As Pallant [30] notes, multiple linear regression allows the researcher to predict an outcome variable from a set of predictors while statistically accounting for the influence of covariates.

4.5. Validity and reliability of research instruments

To ensure the quality of the instrument measuring students' self-efficacy in STEM subjects, item analysis and reliability analysis were conducted. The results are presented in table 1. Each item

demonstrated a positive association with the total scale score, confirming that all items were relevant and appropriate for measuring self-efficacy in science-related areas. Item-rest correlations ranged from 0.374 to 0.836, indicating strong relationships between individual items and the overall construct. The higher the correlation, the more closely the item relates to the measured construct. The scale's Cronbach's alpha reliability coefficient was 0.954, indicating very high internal consistency and confirming that the items consistently measured the same construct. Table 1 presents the full results of the item and reliability analysis.

Table 1
Results of item and reliability analysis for the instrument measuring students' self-efficacy in STEM subjects [38].

№	Item	Sign	Item-rest correlation	α
1	I can successfully finish assigned STEM activities	+	0.819	0.949
2	I feel contented doing biology, physics and chemistry practicals in the laboratory	+	0.724	0.951
3	I can schedule a studying timetable on my own for mathematics, chemistry, physics, biology and ICT, and I actively follow it	+	0.785	0.950
4	I am confident that I can excel in STEM subjects	+	0.808	0.949
5	I enjoy taking science classes	+	0.829	0.949
6	I can solve difficult mathematics questions by myself	+	0.673	0.952
7	I always perform well in STEM subjects	+	0.719	0.951
8	I willingly attend science classes	+	0.812	0.949
9	I stay focused during science lessons, even when other activities compete for my attention	+	0.836	0.949
10	I can recall science concepts taught in class and acquired through textbooks	+	0.722	0.951
11	I complete my homework on time	+	0.374	0.959
12	I receive support from my teachers and fellow students whenever needed	+	0.781	0.950
13	I am motivated to pursue a career in STEM after my studies	+	0.817	0.949
14	I feel confident taking STEM subject tests and examinations compared to other subjects	+	0.776	0.950
15	I can manage challenges in STEM lessons independently when I encounter them	+	0.680	0.952
	Test scale			**0.954**

4.6. Ethical considerations

Adherence to research ethics is central to all research endeavours, particularly in social sciences, where participants are directly involved [1]. The following ethical considerations were observed. A permission letter from the Director of Postgraduate Studies at the University of Dodoma was obtained. Permission to conduct the study in secondary schools was also sought from the President's Office, Regional Administration and Local Government (PO-RALG), and forwarded to the Dar es Salaam Regional Administrative Secretary (RAS), who granted permission for research in the selected schools in Ilala Municipality. Throughout data collection, voluntary participation was ensured by obtaining informed consent from all respondents, who were free to withdraw at any point without consequence. No financial or material inducement was used. Respondents were identified by number rather than by name to preserve anonymity and confidentiality. No physical or psychological harm was inflicted on participants, and the purpose and significance of the study were clearly communicated to all respondents.

5. Findings

5.1. Students' self-efficacy in STEM subjects across gender

To contextualise the influence of career guidance support on students' self-efficacy, it was first necessary to establish the baseline distribution of self-efficacy levels across gender. Figure 1 presents the findings.

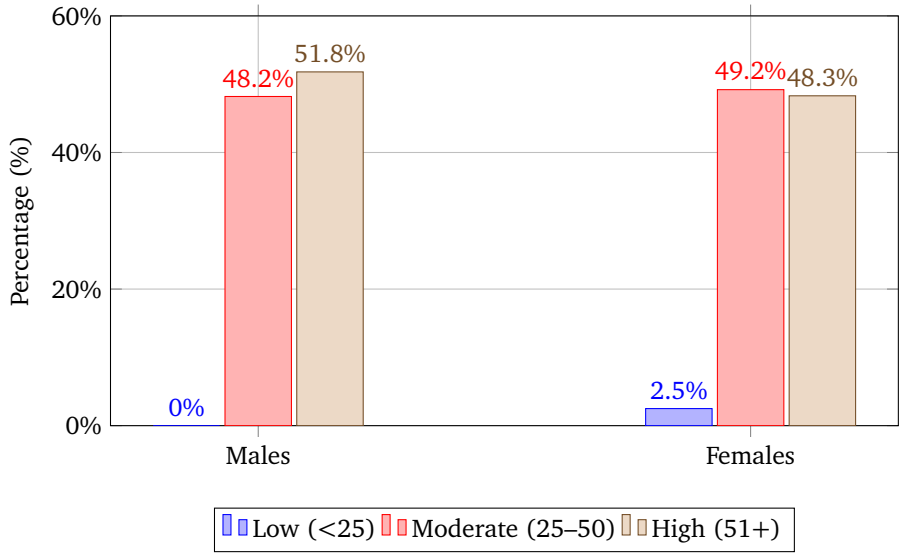

Figure 1: Male and female students' self-efficacy in STEM subjects [38].

Self-efficacy scores were categorised into three levels: low (below 25), moderate (25–50), and high (51 and above). As figure 1 shows, 51.8% of male students and 48.3% of female students scored in the high self-efficacy range, indicating that male students demonstrate higher self-efficacy in STEM subjects than female students. Among female students, 2.5% scored in the low self-efficacy category and 49.2% in the moderate category, compared to 0.0% and 48.2%, respectively, for male students. These figures indicate that female students are more represented in the lower self-efficacy categories than their male counterparts.

5.2. Influence of career guidance support on students' self-efficacy in STEM subjects

To examine the impact of career guidance support on students' self-efficacy, a multiple linear regression model was estimated separately for male and female students, with age, school ownership, and class level included as covariates. The results are presented in table 2.

Table 2
Influence of career guidance support on students' self-efficacy in STEM subjects: multiple linear regression results [38].

	Males				Females			
Effect	**Coeff.**	**SE**	***p***	**Adj.** R^2	**Coeff.**	**SE**	***p***	**Adj.** R^2
Intercept	−11.708	7.193	0.105		−14.845	6.951	0.034	
Career guidance support	0.552	0.014	<0.001		0.533	0.014	<0.001	
Age (years)	0.187	0.455	0.682	0.894	0.309	0.429	0.472	0.889
School ownership (ref: Public)								
Private	1.741	0.675	0.011		2.891	0.618	<0.001	
Class level (ref: Form III)								
Form IV	−0.218	1.005	0.828		1.395	0.939	0.139	

The regression coefficient for career guidance support was 0.552 ($p < 0.001$) for males and 0.533 ($p < 0.001$) for females, indicating a significant positive effect on self-efficacy in STEM subjects for both groups. These findings confirm that both male and female students benefited from the career guidance services available in their schools. The regression coefficients for age and class level were not statistically significant for either group, indicating that these variables did not substantially influence students' self-efficacy in STEM subjects within the observed sample. However, school ownership was statistically significant for both males (coefficient = 1.741, $p = 0.011$) and females (coefficient = 2.891, $p < 0.001$), indicating that students in private secondary schools demonstrated higher self-efficacy than those in public secondary schools.

The model-level adjusted R^2 values reported once per gender group in table 2 were 0.894 for males and 0.889 for females, indicating that the models accounted for approximately 89.4% and 88.9% of the variance in self-efficacy, respectively. These values confirm a strong overall model fit and suggest that the included predictors collectively explain a large proportion of the variation in students' STEM self-efficacy. The findings underscore the importance of increasing access to comprehensive, gender-inclusive career guidance services in secondary schools to support student engagement in STEM subjects, with particular attention to female students, who demonstrated lower self-efficacy than their male counterparts.

6. Discussion

The present study investigated the impact of career guidance support on students' self-efficacy in STEM subjects across gender. Two main findings emerged: male students exhibited higher self-efficacy than female students, and career guidance support exerted a significant positive effect on self-efficacy for both groups.

The finding that male students demonstrate higher STEM self-efficacy than female students is consistent with evidence from other contexts. Hu, Jiang and Bi [14] conducted a cross-sectional study involving 1,564 high school students in China and found that boys demonstrated greater STEM confidence than girls, with girls' confidence declining as they advanced academically. A parallel pattern is observable in Tanzania: TCU [45] data show that female graduates in science fields are proportionally fewer than male graduates. In Mining and Earth Sciences in 2022, females represented 27.7% of graduates, compared to 72.3% males; in Physical Sciences and Mathematics, females represented 28.8%, compared to 71.2% males. This gender disparity at the university level has been attributed, among other factors, to low self-efficacy associated with gender stereotypes [18]. In the USA, Chatterjee et al. [8] similarly found that female biomedical scientist trainees reported lower career self-efficacy than male trainees. Given the established relationship between self-efficacy in STEM subjects at the secondary level and subsequent engagement in science programmes and careers [20, 22], these disparities carry implications that extend beyond secondary school. Students with high STEM self-efficacy are more likely to select science programmes and pursue STEM careers; those with low self-efficacy are less likely to do so. Comprehensive intervention to build self-efficacy – particularly among female students – is therefore a matter of both equity and educational effectiveness.

The finding that career guidance support significantly and positively predicted self-efficacy for both male and female students aligns with evidence from other national contexts. Sáinz et al. [35] found that a combination of interventions, including career guidance, increased young people's participation in STEM in Spain by enhancing their self-efficacy. Dorfman and Fortus [11] established that marginalised students in Israel who had access to academic and career support became considerably more confident in science. These findings collectively point to the value of inclusive career guidance as a lever for strengthening STEM engagement. Usher et al. [50] found that students in school environments where they received consistent social persuasion regarding their STEM competence demonstrated higher self-efficacy than those in environments where such encouragement was absent. Sinring and Umar [42] similarly found that a stimulating environment – characterised by positive feedback from surrounding individuals – predicts STEM career self-efficacy.

The finding regarding school ownership – that students in private secondary schools demonstrated significantly higher STEM self-efficacy than those in public schools – warrants attention. The greater availability of resources, infrastructure, and support systems in private schools likely contributes to an environment more conducive to developing confidence in science subjects. This finding suggests that addressing the resource gap between public and private schools may be an important complementary strategy to career guidance provision.

It is also important to note that career guidance support alone will not be sufficient if foundational STEM education is of inadequate quality. As Kalogiannakis and Papadakis [16] argued, well-trained early-grade teachers who can facilitate quality science learning both inside and outside the classroom are essential. Career guidance should therefore be implemented as part of a broader strategy that includes improving the quality of STEM instruction and creating learning environments where all students – regardless of gender – feel confident to engage with science.

7. Conclusion

This study examined the impact of career guidance support on students' self-efficacy in STEM subjects, with a focus on gender. The findings demonstrate that while male students generally exhibit higher self-efficacy than female students, career guidance support exerts a significant positive effect on self-efficacy for both groups. The observed gender gap – in which girls' confidence in STEM subjects is lower and declines more markedly with educational progression – contributes to the persistent underrepresentation of women in STEM at both academic and professional levels. Addressing this disparity requires comprehensive career guidance programmes that strengthen self-efficacy and create supportive learning environments for all students, alongside high-quality STEM instruction beginning in the early grades. Career guidance provision that stands alone, without attention to instructional quality and learning environment, is unlikely to produce sustained change. The positive impact of career guidance support demonstrated in this study reinforces the case for inclusive, well-resourced guidance services as a component of equitable STEM education strategies. Investing in students' self-efficacy – particularly that of female students – can contribute to a more diverse and capable STEM workforce and, ultimately, to innovation and development.

8. Recommendations

Based on the findings, the following recommendations are made. The government of Tanzania, through the Ministry of Education, Science and Technology, should ensure that every secondary school has at least two qualified counselling professionals to provide comprehensive support for the academic development and career decision-making of both male and female students. This should be accompanied by efforts to create learning environments where students feel confident engaging with science and aspire to STEM careers. Future research should investigate the contextual factors that contribute to higher STEM self-efficacy among male students compared to female students, drawing on qualitative or mixed-methods approaches to capture the underlying dynamics. A comparative analysis of science learning environments in public and private schools is also recommended to establish an empirical basis for targeted resource and support interventions. In contexts where funding for dedicated counselling staff is limited, qualified STEM teachers with relevant training in guidance and counselling could serve in a counselling support capacity as an interim measure.

Declaration

The authors declare that this manuscript is derived from the PhD thesis of the first author, submitted to the University of Dodoma. Portions of the content presented here also appear in that thesis.

Acknowledgments

The authors express their sincere gratitude to the statistics analyst, language specialists, editorial team, and reviewers for their guidance and intellectual contributions throughout this work.

References

[1] Akaranga, S.I. and Makau, B.K., 2016. Ethical Considerations and their Applications to Research: a Case of the University of Nairobi. *Journal of Educational Policy and Entrepreneurial Research*, 3(12), pp.1–9. Available from: https://web.archive.org/web/20220621075522/https://profiles.uonbi.ac.ke/kuria_paul/files/429-825-2-pb.pdf.

[2] Ary, D., Jacobs, L.C., Sorensen, C. and Razavieh, A., 2010. *Introduction to Research in Education*. 8th ed. Belmont, CA: Wadsworth Cengage Learning. Available from: https://ebookppsunp.wordpress.com/wp-content/uploads/2016/06/donald_ary_lucy_cheser_jacobs_asghar_razavieh_bookfi-org.pdf.

[3] Bandura, A., 1977. Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), pp.191–215. Available from: https://doi.org/10.1037/0033-295X.84.2.191.

[4] Bandura, A., 1997. *Self-efficacy: The exercise of control*. New York, NY: W H Freeman/Times Books/Henry Holt & Co.

[5] Bandura, A., 1999. A social cognitive theory of personality. In: D. Cervone and Y. Shoda, eds. *The coherence of personality: Social-cognitive bases of consistency, variability, and organization*. 2nd ed. New York: Guilford Publications, pp.185–241.

[6] Bandura, A., Barbaranelli, C., Caprara, G.V. and Pastorelli, C., 2001. Self-Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories. *Child Development*, 72(1), pp.187–206. Available from: https://www.jstor.org/stable/1132479.

[7] Brown, S.D. and Lent, R.W., eds, 2021. *Career Development and Counseling: Putting Theory and Research to Work*. 3rd ed. Hoboken, New Jersey: John Wiley & Sons, Ltd. Available from: https://protean.or.id/wp-content/uploads/2025/05/Career-Development-and-Counseling-Putting-Theory-and-Research-to-Work-Steven-D.-Brown-Robert-W.-Lent-Z-Library.pdf.

[8] Chatterjee, D., Jacob, G.A., Varvayanis, S.S., Wefes, I., Chalkley, R., Nogueira, A.T., Fuhrmann, C.N., Varadarajan, J., Hubbard, N.M., Gaines, C.H., Layton, R.L. and Chaudhary, S., 2023. Career self-efficacy disparities in underrepresented biomedical scientist trainees. *PLOS ONE*, 18(3), 03, p.e0280608. Available from: https://doi.org/10.1371/journal.pone.0280608.

[9] Coetzee, M., 2022. Career agility for purposive career exploration: Role of adult learners' career orientations and digital-era world of work awareness. *African Journal of Career Development*, 4(1), p.a54. Available from: https://doi.org/10.4102/ajcd.v4i1.54.

[10] Deshani, N.A.D.K. and Hirimburegama, K., 2024. Impact of STEM education in overcoming poverty. *KDU Journal of Multidisciplinary Studies*, 6(2), pp.67–78. Available from: https://doi.org/10.4038/kjms.v6i2.130.

[11] Dorfman, B.S. and Fortus, D., 2019. Students' self-efficacy for science in different school systems. *Journal of Research in Science Teaching*, 56(8), pp.1037–1059. Available from: https://doi.org/10.1002/tea.21542.

[12] Edmonds, W.A. and Kennedy, T.D., 2017. *An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods*. 2nd ed. Thousand Oaks, CA: SAGE Publications. Available from: https://doi.org/10.4135/9781071802779.

[13] Gaylor, L. and Nicol, J.J., 2016. Experiential High School Career Education, Self-Efficacy, and Motivation. *Canadian Journal of Education / Revue Canadienne De l'éducation*, 39(2), pp.1–24. Available from: https://cje-rce.ca/index.php/cje-rce/article/view/2029.

[14] Hu, X., Jiang, Y. and Bi, H., 2022. Measuring science self-efficacy with a focus on the perceived competence dimension: using mixed methods to develop an instrument and explore changes

through cross-sectional and longitudinal analyses in high school. *International Journal of STEM Education*, 9(1), p.47. Available from: https://doi.org/10.1186/s40594-022-00363-x.

[15] Jena, L. and Nayak, U., 2020. Theories of Career Development: An analysis. *Indian Journal of Natural Sciences*, 10(60), June, pp.23515–23523. Available from: https://www.researchgate.net/publication/344414923.

[16] Kalogiannakis, M. and Papadakis, S., 2019. Pre-service kindergarten teachers' acceptance of '*ScratchJr*' as a tool for learning and teaching Computational Thinking and science education. *The Journal of Emergent Science*, (16), pp.31–34. Available from: https://www.ase.org.uk/system/files/Kalogiannakis%20et%20al_0.pdf.

[17] Kalogiannakis, M. and Papadakis, S., 2020. The Use of Developmentally Mobile Applications for Preparing Pre-Service Teachers to Promote STEM Activities in Preschool Classrooms. In: S. Papadakis and M. Kalogiannakis, eds. *Mobile Learning Applications in Early Childhood Education*. Hershey, PA: IGI Global Scientific Publishing, pp.82–100. Available from: https://doi.org/10.4018/978-1-7998-1486-3.ch005.

[18] Kimaro, A.R. and Lawuo, E.A., 2016. The Effects of Gender Stereotyping on Career Choice among Secondary School Students in Tanzania. *International Journal of Advanced Engineering, Management and Science*, 2(2), 2, pp.39–46. Available from: https://media.neliti.com/media/publications/239377-the-effects-of-gender-stereotyping-on-ca-d460e77a.pdf.

[19] Krome, R.L., 2016. *Attracting women to STEM programs: the influence of goal-orientations and the use of gendered wording in recruitment materials*. Ph.D. thesis. Kansas State University, Manhattan, KS. Available from: http://hdl.handle.net/2097/32487.

[20] Kwon, H., Vela, K., Williams, A.M. and Barroso, L.R., 2019. Mathematics and Science Self-efficacy and STEM Careers: A Path Analysis. *Journal of Mathematics Education*, 12(1), pp.74–89. Available from: https://journalofmathed.scholasticahq.com/article/89050-mathematics-and-science-self-efficacy-and-stem-careers-a-path-analysis.pdf.

[21] Lent, R.W., 2005. A Social Cognitive View of Career Development and Counseling. In: S.D. Brown and R.W. Lent, eds. *Career Development and Counseling: Putting Theory and Research to Work*. John Wiley and Sons, Inc., pp.101–127.

[22] Lent, R.W., Brown, S.D. and Hackett, G., 2000. Contextual supports and barriers to career choice: A social cognitive analysis. *Journal of Counseling Psychology*, 47(1), pp.36–49. Available from: https://doi.org/10.1037/0022-0167.47.1.36.

[23] Leung, S.A., 2008. The Big Five Career Theories. In: J.A. Athanasou and R. Van Esbroeck, eds. *International Handbook of Career Guidance*. Dordrecht: Springer Netherlands, pp.115–132. Available from: https://doi.org/10.1007/978-1-4020-6230-8_6.

[24] López, P., Simó, P. and Marco, J., 2023. Understanding STEM career choices: A systematic mapping. *Heliyon*, 9(6), p.e16676. Available from: https://doi.org/10.1016/j.heliyon.2023.e16676.

[25] Magee, M., Kuijpers, M. and Runhaar, P., 2022. How vocational education teachers and managers make sense of career guidance. *British Journal of Guidance & Counselling*, 50(2), pp.273–289. Available from: https://doi.org/10.1080/03069885.2021.1948970.

[26] Magere, G.M., 2022. *Assisting high school students with career decision-making difficulties through career construction counselling*. PhD thesis (Educational Psychology). University of Pretoria, Pretoria, South Africa. Available from: https://repository.up.ac.za/handle/2263/89170.

[27] Marzuki, O.F., Teo, E.T.Y.L., Zainol @ Abdullah, W.N.Z., Khairuddin, N., Inai, N.H., Md Saad, J.B. and Abdul Aziz, M.H., 2024. Innovating Education: A Comprehensive Review of STEM Education Approaches. *International Journal of Academic Research in Progressive Education and Development*, 13(1), pp.614–631. Available from: https://doi.org/10.6007/IJARPED/v13-i1/20490.

[28] Ministry of Education, Science and Technology, 2023. *Curriculum for ordinary secondary education, Form I-IV*. Dar es Salaam: Tanzania Institute of Education. Available from: https://www.scribd.com/document/815527495/Curriculum-for-Secondary-Education-Form-I-IV.

[29] National Science Board, 2022. *The U.S. Must Improve K-12 STEM Education for All*. Na-

tional Science Foundation, National Center for Science and Engineering Statistics. Science and Engineering Indicators, K–12 education indicator report. Available from: https://nsf-gov-resources.nsf.gov/files/k-12-indicator-2022.pdf.

[30] Pallant, J., 2020. *SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS*. 7th ed. London: Routledge. Available from: https://doi.org/10.4324/9781003117452.

[31] Papadakis, S., Tousia, C. and Polychronaki, K., 2018. Women in computer science. The case study of the Computer Science Department of the University of Crete, Greece. *International Journal of Teaching and Case Studies*, 9(2), pp.142–151. Available from: https://doi.org/10.1504/IJTCS.2018.090963.

[32] Petrosino, A.J., Sherard, M.K. and Tharayil, S.A., 2020. The Education Philosophy, Theories and Models That Enable STEM Policy Integration. In: C. Zintgraff, S.C. Suh, B. Kellison and P.E. Resta, eds. *STEM in the Technopolis: The Power of STEM Education in Regional Technology Policy*. Cham: Springer International Publishing, pp.51–63. Available from: https://doi.org/10.1007/978-3-030-39851-4_3.

[33] Robnett, R.D., 2016. Gender Bias in STEM Fields: Variation in Prevalence and Links to STEM Self-Concept. *Psychology of Women Quarterly*, 40(1), pp.65–79. Available from: https://doi.org/10.1177/0361684315596162.

[34] Roy, P., 2020. Career Guidance: A Way of Life. *Tathapi*, 19(39), pp.22–31. Available from: https://doi.org/10.2139/ssrn.3640339.

[35] Sáinz, M., Fàbregues, S., Romano, M.J. and López, B.S., 2022. Interventions to increase young people's interest in STEM. A scoping review. *Frontiers in Psychology*, 13, p.954996. Available from: https://doi.org/10.3389/fpsyg.2022.954996.

[36] Sakellariou, C. and Fang, Z., 2021. Self-efficacy and interest in STEM subjects as predictors of the STEM gender gap in the US: The role of unobserved heterogeneity. *International Journal of Educational Research*, 109, p.101821. Available from: https://doi.org/10.1016/j.ijer.2021.101821.

[37] Schulstok, T. and Wikstrand, F., 2020. Gender Equality and Career Guidance in a Nordic Context. In: E.H. Haug, T. Hooley, J. Kettunen and R. Thomsen, eds. *Career and Career Guidance in the Nordic Countries*, *Career development series*, vol. 9. Leiden, The Netherlands: Brill, chap. 4, pp.51–64. Available from: https://doi.org/10.1163/9789004428096.

[38] Shuma, C.J., 2022. Field data.

[39] Sidiq, M.N., Permanasari, A. and Riandi, R., 2022. The Analysis of STEM Career Interest of Students Aged 13-15 as an Overview for The Development of STEM Career Counseling. *Proceedings of the 3rd International Conference of Science Education in Industrial Revolution 4.0, ICONSEIR 2021, December 21st, 2021, Medan, North Sumatra, Indonesia*. EAI. Available from: https://doi.org/10.4108/eai.21-12-2021.2317329.

[40] Simamora, R.E., Saragih, S. and Hasratuddin, 2019. Improving Students' Mathematical Problem Solving Ability and Self-Efficacy through Guided Discovery Learning in Local Culture Context. *International Electronic Journal of Mathematics Education*, 14(1), pp.61–72. Available from: https://doi.org/10.12973/iejme/3966.

[41] Simon, R.M., Wagner, A. and Killion, B., 2017. Gender and choosing a STEM major in college: Femininity, masculinity, chilly climate, and occupational values. *Journal of Research in Science Teaching*, 54(3), pp.299–323. Available from: https://doi.org/10.1002/tea.21345.

[42] Sinring, A. and Umar, N.F., 2023. Other people in career choice influence career self-efficacy and individual career self-management. *European Journal of Educational Research*, 12(2), pp.1045–1057. Available from: https://doi.org/10.12973/eu-jer.12.2.1045.

[43] Spenner, K.I., 1986. *Career Choice and Development* by Duane Brown and Linda Brooks. *Contemporary Sociology*, 15(1), pp.126–127. Available from: https://doi.org/10.2307/2070975.

[44] Tesha, A.J., 2020. *Career Guidance and Career Aspiration among Students in Public Secondary Schools in Dodoma City, Tanzania*. Master's thesis. University of Dodoma, Dodoma, Tanzania. Available from: https://repository.udom.ac.tz/server/api/core/bitstreams/d94d1b94-2bfd-42f5-810c-965bf14898b5/content.

[45] The Tanzania Commission for Universities, 2022. *VitalStats on University Education in Tanzania 2021*. Dar es Salaam: The Tanzania Commission for Universities. Available from: https://tcu.go.tz/sites/default/files/file_uploads/2024-01/VitalStats%202021.pdf.

[46] United Nations, 2022. *Science, Technology, Engineering and Mathematics (STEM) as an Enabler for Development and Peace*. (Policy paper). Office of the Special Adviser on Africa. Available from: https://www.un.org/osaa/sites/www.un.org.osaa/files/docs/2116613_stem_policy_paper_web_rev.pdf.

[47] United Republic of Tanzania, 2000. *Women and Gender Development Policy*. (Government policy). Dar es Salaam, Tanzania: Ministry of Community Development, Women Affairs and Children.

[48] United Republic of Tanzania, 2005. *National Strategy for Gender Development*. (National strategy). Dar es Salaam, Tanzania: Ministry of Community Development, Gender and Children.

[49] United Republic of Tanzania and Ministry of Education, Science and Technology, 2023. *Education and Training Policy 2014*. 2023rd ed. Dodoma: Ministry of Education, Science and Technology. Available from: https://web.archive.org/web/20250109094602/https://www.moe.go.tz/sites/default/files/EDUCATION%20AND%20TRAINING%20POLICY%202014%2C%202023%20EDITION.pdf.

[50] Usher, E.L., Ford, C.J., Li, C.R. and Weidner, B.L., 2018. Sources of math and science self-efficacy in rural Appalachia: A convergent mixed methods study. *Contemporary Educational Psychology*, 57, pp.32–53. Available from: https://doi.org/10.1016/j.cedpsych.2018.10.003.

[51] Wang, M.T. and Degol, J.L., 2017. Gender Gap in Science, Technology, Engineering, and Mathematics (STEM): Current Knowledge, Implications for Practice, Policy, and Future Directions. *Educational Psychology Review*, 29(1), pp.119–140. Available from: https://doi.org/10.1007/s10648-015-9355-x.

[52] White, D., 2014. What Is STEM Education and Why Is It Important? *Florida Association of Teacher Educators Journal*, 1(14), pp.1–8. Available from: http://www.fate1.org/journals/2014/white.pdf.

[53] World Economic Forum, 2022. *Global Gender Gap Report 2022*. (Insight report). Cologny/Geneva: World Economic Forum. Available from: https://www3.weforum.org/docs/WEF_GGGR_2022.pdf.

[54] Yamane, T., 1967. *Statistics, An Introductory Analysis*. 2nd ed. New York, Evanston, and London: Harper & Row, Publishers.

[55] Zhou, X., Li, X. and Gao, Y., 2016. Career Guidance and Counseling in Shanghai, China: 1977 to 2015. *Career Development Quarterly*, 64(3), pp.203–215. Available from: https://doi.org/10.1002/cdq.12055.