



STEAM EDUCATION FOR GIRLS IN DEVELOPING COUNTRIES: IMPACT ON EMPOWERMENT AND ACADEMIC PERFORMANCE

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Abstract

This study examined the role of STEAM education in promoting girls' empowerment and academic performance in developing countries in relation to Sustainable Development Goal 5 (SDG 5). Female students in many developing regions continue to face educational inequalities, limited learning resources, and socio-cultural barriers in science and technology-related disciplines. STEAM education offers interdisciplinary and innovative learning opportunities that enhance creativity, confidence, participation, and academic achievement. The study adopted a quantitative cross-sectional survey design. Data were collected from 200 participants, including 170 female students and 30 teachers through structured questionnaires and academic performance indicators. Statistical techniques, including descriptive statistics, correlation, and regression analysis, were employed using SPSS. The findings revealed that STEAM education significantly improved girls' empowerment, participation, and academic performance, contributing positively to gender equity and educational development aligned with SDG 5 Gender Equality.

Keywords: *STEAM Education, Girls' Empowerment, Academic Performance, Gender Equality, Educational Participation, Developing Countries, SDG 5,*

Introduction

Science, Technology, Engineering, Arts, and Mathematics (STEAM) education has become an important educational approach for developing critical thinking, creativity, innovation, and problem-solving skills in the twenty-first century (Belbase et al., 2021). The government and educational institutions in developing countries are increasingly advocating for the education of STEAM to equip students for technological development and economic competitiveness in the global market. Despite the lower participation of girls in STEAM education compared to boys, socio-cultural factors, resource limitations, gender bias, and gender inequality in education remain significant barriers to STEAM education for girls (UNESCO, 2020; Akinwale, 2023). There are indications that girls in developing countries may be denied access to quality science and technology education which may limit opportunities for their academic achievement and professional development (Ashioya, 2016; UNDP, 2024).

The gaps in educational attainment and participation in STEAM fields are ongoing issues that continue to impact women's empowerment and their ability to lead, innovate, and contribute to economic development (Niu & Cheng, 2022). Girls' participation in STEAM education not only boosts their academic achievement but also builds their self-confidence, digital literacy, decision-making power, and social empowerment (Halder et al., 2024; Saba & Almas, 2018). In addition, the more girls participate in STEAM, the easier it becomes to reach the goals set forth in SDG 5 – Gender Equality and Empower all Women and Girls (UN Women, 2024).

Although there are many international efforts dedicated to gender equality, many girls in the developing world continue to face obstacles in accessing quality STEAM education (Gul et al., 2024; Roy & Xiaoling, 2022). There are many factors that limit the involvement of girls in the STEM and STEAM related science and technology fields, such as lack of educational resources, lack of female role models, cultural restrictions, poverty, and gender discrimination



(UNESCO, 2020). Furthermore, there is scarce evidence of the impact of STEAM education on girls' empowerment and school performance in developing countries. Thus, this study aims to investigate the role of STEAM education in the empowerment and academic performance among the female students, concerning SDG 5. Hence, this study aims at studying the impact of STEAM education on female students' empowerment and academic performance with respect to SDG 5.

Research Objectives

1. To examine the impact of STEAM education on girls' empowerment in developing countries.
2. To analyze the relationship between STEAM-based learning and girls' academic performance.
3. To evaluate the effectiveness of STEAM education in promoting gender equity and educational participation among female students.

Research Questions

1. What is the impact of STEAM education on girls' empowerment in developing countries?
2. What is the relationship between STEAM-based learning and girls' academic performance?
3. How effective is STEAM education in promoting gender equity and educational participation among female students?

Research Hypotheses

H1 STEAM education has a significant positive impact on girls' empowerment.

H2 STEAM-based learning has a significant positive relationship with girls' academic performance.

H3 STEAM education significantly promotes gender equity and educational participation among female students.

This study contributes to gender-inclusive education research by exploring the relationship between STEAM education, empowerment, and academic achievement among girls. The results could be fed into the design of inclusive learning strategies for teachers and curriculum developers to motivate girls to engage in STEAM courses. The study further offers policy suggestions for governments and educational institutions to assist in closing the gap on gender inequality in education. Furthermore, it helps realize SDG 5 by encouraging equal educational opportunities and empowering girls through inclusive and equitable education systems.

Literature Review

Concept of STEAM Education

STEAM learning is defined as a single interdisciplinary approach that emphasizes Science, Technology, Engineering, Arts and Mathematics, with an aim to foster creativity, innovation, collaboration, and critical thinking (Niu & Cheng, 2022). STEAM is not conventional subject centered learning, it is both practical and theoretical learning experiences to solve real-world problems (Perignat & Katz-Buonincontro, 2018). The addition of "Arts" to STEM brought a new dimension to education, fostering creativity, communication and design thinking skills among students. Lin and Tsai (2020) suggest that STEAM education is able to improve students' cognitive and social skills and prepare them for future technological challenges. The transition from STEM to STEAM has also drawn focus to inclusive student-centered learning spaces for all students, particularly for girls and under-represented groups.

Girls' Education in Developing Countries



Gender disparities in education remain a significant issue in many developing countries. Poverty, cultural norms, early marriage, and lack of family support are some of the factors contributing to the unequal access to quality education faced by girls (UNICEF, 2021). Female enrollment is especially low in STEM subjects where there are stereotype images of STEM fields as male. Girls' educational attainment and career goals remain limited in developing areas by social and cultural factors, as noted by Gul et al. (2024). In addition, poor school facilities, fewer female role models and limited access to electronic devices have a negative impact on girls' engagement in STEAM education (Msambwa et al., 2023).

STEAM Education and Empowerment

Self-confidence, leadership development and independent thinking are important aspects of STEAM education that help to empower girls. Research demonstrates that STEAM involvement positively impacts girls' SE and encourages them to choose careers in science and technology (Santos et al., 2024; Banigo et al., 2017). Students develop critical thinking and problem-solving skills in project-based and collaborative learning activities to enable their empowerment for personal and social development. Moreover, STEAM learning environments foster an active learning and decision-making skill in girls (Santos et al., 2023). Girls who are engaged in STEAM programs also feel more confident expressing ideas, joining in class discussions and leadership roles in educational environments, according to additional research.

STEAM Education and Academic Performance

Several studies have reported a positive relationship between STEAM education and academic achievement. The integrated language learning strategies have been shown to enhance students' understanding of complex subjects and motivation to learn (Hsiao & Su, 2021). The STEAM approach to teaching involves using hands-on, real-world application activities that also integrate science, technology, engineering, art, and mathematics, which further contributes to the significance of classroom learning. In comparison with traditional learning, STEAM activities have been found to enhance students' creativity, innovation, and collaborative learning abilities (Cheng et al., 2024). Moreover, the use of interactive learning and technology-based learning enhances the student's academic achievement due to its ability to motivate and engage students in learning activities.

Gender Equity and Educational Participation

Gender equality in STEAM education will not be achieved without the use of inclusive educational practices. Girls' equal access to learning opportunities enables effective participation in disciplines of science and technology (Niu & Cheng, 2022; Awwalina et al., 2024). OECD (2023) states that inclusive education systems and gender-responsive curricula decrease the gender gap in participation. Further, the involvement of teachers and mentoring programs, and scholarships have a positive impact on female enrolment in STEAM careers (Sibisi et al., 2024). Involving girls in science and technology education helps to promote social inclusion, girls economic empowerment and sustainable development.

Theoretical Framework

This study is based on three theories. Bandura's social cognitive theory states that learning is through observation, interaction, and self-efficacy, which are key factors in STEAM learning environments (Stewart et al., 2020; Wong et al., 2022). Constructivist Learning Theory focuses on the active construction of knowledge for students in the process of learning by participating in practical activities and group activities (Abri et al., 2024). The key points of empowerment theory focus on the ability of education to improve people's capacity to make their own decisions, to be more confident, and to participate in society. Theories in total can help to gain



an understanding of the issues that STEAM education can impact on girls' empowerment, academic performance, and participation.

Conceptual Framework

This study's conceptual framework was developed to explore the relationship between STEAM education and the educational development of girls in developing countries. In this context, STEAM Education was used as an independent variable, and the other three variables namely Girls' Empowerment, Academic Performance, and Educational Participation were treated as dependent variables (Arshad et al., 2023; Rana et al., 2024). The framework made an assumption that if there is effective implementation of STEAM education, the confidence, leadership skills, problem solving skills and involvement in educational activities of girls is expected to be improved. It also recommended that interdisciplinary STEAM learning environments had a positive effect on the academic performance of students and that they actively engaged in learning processes inside and outside the classroom. Additionally, the framework emphasized the potential of STEAM education in fostering gender equality by ensuring an inclusive learning environment and offering opportunities for girls to engage with STEAM-related disciplines with confidence (Farooq et al., 2023). Thus, the study sought to examine the impact of STEAM educational practices on the empowerment of girls, their academic performance, and their educational engagement in relation to SDG 5 (Gender Equality). In this figure 1 shows the link between STEAM education and STEAM learning outcomes for girls in developing countries. The independent variable that had an influence on the dependent variables of empowerment, academic performance and participation in education among the girls was STEAM education. The framework is based on the assumption that quality STEAM-based learning spaces boost girls' confidence, leadership, academic performance, and engagement in learning activities and thus contribute to Sustainable Development Goal 5 (Gender Equality).

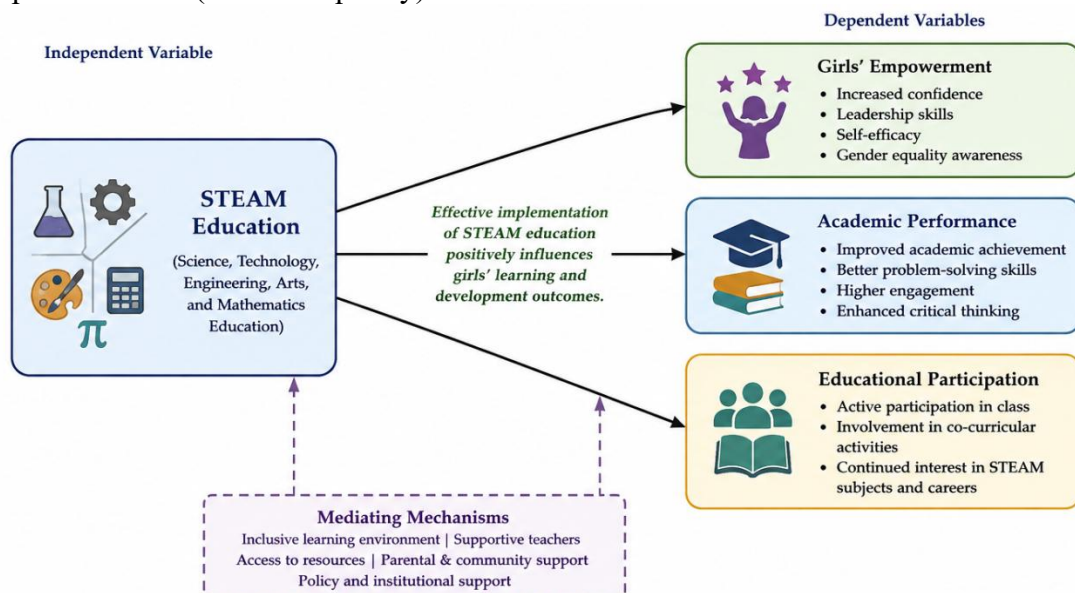


Figure 1. Conceptual Framework of the Study
Research Gap

While STEAM education and gender equality have been examined in previous studies, there is still a gap in research that needs quantitative examination in developing countries about how STEAM education affects the empowerment of girls and academic outcomes (Santos et al.,



2024; Banigo et al., 2017). Current research is largely conducted in developed countries with little research on educational participation and empowerment of girls in low-resource settings. This study, thus, aims at bridging this gap by looking at the relationship between STEAM education, empowerment and academic performances among girls in developing countries in the context of SDG 5.

Research Methodology

This study adopted a quantitative research approach using a cross-sectional survey design to examine the impact of STEAM education on girls' empowerment and academic performance in developing countries. The quantitative method was used because it allowed the researcher to gather data that could be measured and analysed statistically to identify relationships between the variables (Creswell & Creswell, 2017). A cross-sectional design was deemed appropriate as data was gathered at one point in time to illuminate the "current" attitudes and experiences of participants towards STEAM education.

Population of the Study

The study participants included female students and teachers from secondary schools in developing nations where STEAM education programmes were put into practice. The selection of female students was made due to the study being focused on the empowerment and academic performance of girls, teachers were included in the study for providing professional observation about the participation and performance of students.

Sample Size and Sampling Technique

The total number of the participants was 200. A sample of 170 female students and 30 teachers from selected secondary schools were involved. In this study, stratified random sampling method was applied to get equal number of participants in each educational background and grade level (Taherdoost, 2016). This method increased the reliability and correctness of the data that was gathered.

Data Collection Instruments

The main instruments in data collection were the structured questionnaires. Students and teachers were provided with separate questionnaires. The student survey consisted of questions relating to aspects of STEAM learning experiences, empowerment indicators, academic participation and perceptions of gender equity. The teacher questionnaire included items on teacher demographics, STEAM teaching practices, observations of girls' participation in STEAM, and academic performance indicators. Academic achievement was assessed by examination results and class grades.

Validity and Reliability

Content validity was confirmed via educational researchers and STEAM specialists. A pilot test was carried out prior to the actual data collection procedure to establish ambiguities and refine the design of the questionnaire. The internal consistency was determined by reliability analysis of Cronbach's Alpha, which a value greater than 0.70 was taken as acceptable (Taber, 2017).

Data Collection Procedure

Prior to the data collection, arrangements were made with school authorities for permission to conduct the research. Questionnaires were given out to participants while school was in session and returned and structured for analysis.

Data Analysis Techniques

The data collected were analyzed on Statistical Package for Social Sciences (SPSS). Summarization of participant responses was conducted using descriptive statistics such as mean and standard deviation. This study employed correlation and regression analysis methods



to analyze the correlation and regression between STEAM education, empowerment and academic performance.

Results and Data Analysis

Demographic Analysis

Table 1: Distribution of Participants by Age

Age Group	Frequency	Percentage (%)
13–14 Years	52	26.0
15–16 Years	94	47.0
17–18 Years	54	27.0
Total	200	100.0

Note. N = 200.

The results showed that the majority of respondents were in the age group of 15 to 16 years (47%) from the whole sample. A quarter of the participants (26%) were aged between 13 and 14 years and a third (27%) were aged between 17 and 18 years. The distribution revealed that most of the respondents were middle secondary level students who are active in relation to the educational activities involved with STEAM.

Table 2: Distribution of Participants by Grade/Class Level

Grade/Class Level	Frequency	Percentage (%)
Grade 8	38	19.0
Grade 9	61	30.5
Grade 10	71	35.5
Teachers	30	15.0
Total	200	100.0

Note. N = 200.

The outcome indicated that there were more Grade 10 (35.5%) than Grade 9 (30.5%) students in the study. The teachers comprised 15% of the sample. This distribution was based on parity in participation by educational level in order to explore attitudes towards STEAM education and girls' empowerment.

Table 3: Distribution of Participants by School Type

School Type	Frequency	Percentage (%)
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Public Schools	118	59.0
Private Schools	82	41.0
Total	200	100.0

Note. N = 200.

The results indicated that 59% of the respondents came from public schools and 41% from private schools. This variation offered wider views on the implementation of STEAM education in various institutional contexts.

Descriptive Statistics

Table 4: Descriptive Statistics of Study Variables

Variables	N	M	SD
STEAM Education	200	4.12	0.61
Girls' Empowerment	200	4.05	0.58
Academic Performance	200	3.98	0.64
Educational Participation	200	4.09	0.56

Note. M = Mean; SD = Standard Deviation.

The descriptive statistics showed higher mean score of all the study variables. The highest mean value (M = 4.12, SD = 0.61) was found for STEAM Education, indicating positive perception of STEAM learning experiences by the participants. They also showed strong positive responses regarding Girls' Empowerment (M = 4.05, SD = 0.58) and Educational Participation (M = 4.09, SD = 0.56), indicating that STEAM education built confidence, participation and engagement of female students. The mean score for Academic Performance was positive (M = 3.98, SD = 0.64), suggesting that there was a positive impact of STEAM learning on academic achievement.

Reliability Analysis

Table 5: Cronbach's Alpha Reliability Values

Variables	Number of Items	Cronbach's α
STEAM Education	10	.87
Girls' Empowerment	8	.84
Academic Performance	7	.81
Educational Participation	6	.85



Note. Cronbach's α values above .70 indicate acceptable reliability. The reliability analysis results showed good internal consistency for all study variables. The Cronbach's Alpha values were between .81 and .87, which were higher than the acceptable value of .70. These findings indicated that the questionnaire items were reliable and suitable for measuring the intended constructs.

Correlation Analysis

Table 6: Correlation Matrix of Study Variables

Variables	1	2	3	4
1. STEAM Education	—			
2. Girls' Empowerment	.682**	—		
3. Academic Performance	.641**	.598**	—	
4. Educational Participation	.655**	.621**	.584**	—

Note. $p < .01$.

The correlation analysis indicated strong positive relationships among all the study variables. There was a significant positive correlation between STEAM Education and Girls' Empowerment ($r = .682, p < .01$), which meant that when the girls participated more in STEAM education, they became more confident and empowered. Likewise, Academic Performance ($r = .641, p < .01$) and Educational Participation ($r = .655, p < .01$) were positively correlated with STEAM Education. These results indicated that positive impact of effective STEAM learning environments on female students' learning outcomes and participation.

Regression Analysis

Table 7: Regression Analysis: Impact of STEAM Education on Girls' Empowerment

Variables	B	SE	β	t	p
Constant	1.214	0.284	—	4.27	.000
STEAM Education	0.689	0.071	.682	9.71	.000

R	R ²	Adjusted R ²	F	p
.682	.465	.461	94.32	.000

Note. Dependent Variable: Girls' Empowerment.

Interpretation

The regression analysis revealed that STEAM Education had a significant positive impact on Girls' Empowerment ($\beta = .682, p < .001$). The R^2 value of .465 indicated that STEAM Education explained 46.5% of the variance in girls' empowerment. The findings suggested that increased engagement in STEAM learning activities improved female students' confidence, leadership abilities, and self-efficacy.



Table 8: Regression Analysis: Impact of STEAM Education on Academic Performance

Variables	B	SE	β	t	p
Constant	1.108	0.301	—	3.68	.000
STEAM Education	0.654	0.076	.641	8.59	.000
R	R ²	Adjusted R ²	F	p	
.641	.411	.407	73.79	.000	

Note. Dependent Variable: Academic Performance.

The results indicated that STEAM Education significantly influenced Academic Performance ($\beta = .641$, $p < .001$). The R^2 value of .411 showed that STEAM Education accounted for 41.1% of the variation in academic achievement. These findings demonstrated that interactive and practical STEAM learning approaches positively improved students' educational performance and classroom achievement.

Table 9: Regression Analysis: Impact of STEAM Education on Educational Participation

Variables	B	SE	β	t	p
Constant	1.176	0.265	—	4.43	.000
STEAM Education	0.701	0.068	.655	10.31	.000
R	R ²	Adjusted R ²	F	p	
.655	.429	.425	106.29	.000	

Note. Dependent Variable: Educational Participation.

The results of the regression analysis indicated that the STEAM Education had a significant effect on the Educational Participation of female students ($\beta = .655$, $p < .001$). The model accounted for 42.9% of the variance in level of participation. The findings indicated that STEAM learning environments led to active engagement in classroom and inclusive engagement in learning.

Interpretation of Findings

The regression results indicated that there is significantly educational participation among female students due to STEAM Education ($\beta = .655$, $p < .001$). The model accounted for 42.9% of the variance in participation levels. The findings indicated that STEAM learning settings promoted the active participation of classrooms and learning for all. The results of the study showed that STEAM education positively affects the empowerment, students' academic achievement, and educational participation of girls in developing countries. Girls who engaged with STEAM learning experiences showed increased STEAM confidence, better decision



making skills, and increased engagement in the classroom. The results were consistent with Albert Bandura's social cognitive theory, which focuses on self-efficacy and experiential learning in determining educational results.

Furthermore, the correlation and regression analyses showed that there was a significant relationship between the STEAM-based learning and academic achievement and educational participation among girls. The interactive learning environment, collaborative activities and problem solving approaches generated students' motivation and interest in subjects related to science and technology. The findings were congruent with those previous studies which revealed that STEAM education was an effective approach to enhance the creativity, critical thinking and educational inclusion of female students.

The study also showed that inclusive education practices are vital to achieve United Nations Sustainable Development Goal 5 (SDG 5). This positive effect of STEAM education on girls' participation implied that there may be a possibility to mitigate educational gaps in the developing countries by implementing gender-sensitive STEAM curricula, equal learning opportunities and supportive teaching practices. Thus, governments, teachers and policy makers need to intensify STEAM efforts to promote gender-inclusive STEAM education and greater equitable access to quality education.

Discussion

Discussion on Girls' Empowerment

The results of the study showed that STEAM education was significantly affecting empowerment of girls in the developing countries. The female students who engaged in STEAM-based learning activities showed more confidence, classroom participation and self-expression. The regression analysis revealed that STEAM education was a significant factor in the empowerment of girls, suggesting that the practical and collaborative nature of STEAM education helped to empower girls to participate actively in learning. These results corroborate the opinion that STEAM education contributes to students' self-efficacy and independent thinking skills (Santos et al., 2024). The results also indicated that project-based learning and interactive classroom practices developed girls' communication skills and promoted leadership development in the classroom discussion and group activities.

The results further corroborated the Empowerment Theory as it suggests that education builds confidence, decision making skills and involvement in society among others. Girls learnt problem-solving and critical thinking skills through STEAM activities and gained in academic and social confidence. This is also in line with the conclusions reached by M. Santos et al. (2023), who stated that STEAM learning environments help to foster an active and leadership role among female students. The study showed that inclusive STEAM education could be one of the key pillars in order to empower girls and contribute to SDG5-Gender Equality.

Discussion on Academic Performance

The findings of the study revealed that the implementation of STEAM education positively affected academic achievement of female students. The correlation and regression analyses results showed that there was a positive relationship between STEAM-based learning and academic achievement. The students involved in STEAM activities demonstrated increased engagement in the classroom, conceptual understanding, and academic motivation. The results of this study indicated that interdisciplinary learning could help students relate theory with practice, thereby achieving good learning outcomes.



The results are consistent with previous studies by Hsiao and Su (2021) and L. Cheng et al (2024) that STEAM education enhances creativity, innovation, and academic performance. The entry of interactive and technologic learning activities in the learning process enhanced students' interest in science and mathematics subject and fostered students' collaborative learning practices. In addition, the students' involvement and interest in classroom activities increased, as students were more active in discussions, projects, and problem-solving (Belbase et al., 2021). The findings were also consistent with the principles of the Constructivist Learning Theory, which focuses on active learning and building knowledge through hands-on experiences.

Discussion on Gender Equity

The study results indicated that STEAM education was found to be a strong catalyst for gender equality and educational participation for female students. Girls' participation in STEAM related activities and gender barriers to learning were minimized through inclusive classroom practices and equal learning opportunities. The results indicated that supportive instructional approaches, collaborative activities and curricula that were gender sensitive had a positive impact on the involvement of and confidence in girls in learning.

The results corroborated with the argument made by OECD (2023) that inclusive education systems can contribute to the minimization of gender gap in science and technology education. In the same way, Belbase et al. (2021) and Sibisi et al. (2024) found that mentorship programs and teacher support and equal opportunities in education have a positive impact on female participation in STEAM disciplines. The present study showed that girls' participation in educational activities is increased and their interest in science and technology related subjects are promoted in an environment that is inclusive and supportive for their education.

Discussion in Relation to Previous Literature

The results of the study confirmed with the previous literature and with the theoretical points that were linked to STEAM education and to girls' empowerment. The positive association between STEAM education, empowerment and academic achievement aligned with the STEAM education characteristics of creativity, collaboration, and critical thinking skills highlighted by Perignat and Katz-Buonincontro (2018). Likewise, Lin and Tsai (2020) defined that STEAM learning environment is conducive to student-centered and inclusive education.

The results also supported the Social Cognitive Theory proposed by Albert Bandura who said that learning takes place through interaction, observation and self-efficacy. Collaborative learning experiences fostered girls' confidence and motivation to engage in the STEAM activities. Furthermore, the results were in line with other international reports such as by UNESCO (2020) and UNICEF (2021), which emphasized the need for inclusive education to tackle gender inequalities and ensure equal access to education for girls in developing countries.

Conclusion and Recommendations

Conclusion

The study focused on the effects of STEAM education on the empowerment of girls and their academic performance in developing countries with respect to Sustainable Development Goal 5 (SDG 5). The results indicated that STEAM education positively affected the confidence, leadership skills, classroom engagement and academic performance of the girls. The correlation and regression analyses results showed that the STEAM-based learning positively influenced the empowerment of girls, participation in education and their academic performances. Female students who engaged in STEAM learning activities exhibited higher



motivation, communication ability, and involvement in classroom discussions and co-operative projects.

The study also emphasized that inclusive STEAM learning environments help to lessen gender gaps in education by ensuring all female students had the same learning opportunities. The use of pedagogical ways that were practical, and technologically based, enhanced students' scientific knowledge and active involvement in learning activities. The results corroborated the hypotheses of Social Cognitive Theory, Constructivist Learning Theory, and Empowerment Theory which state that active and participatory learning experiences increase learners' self-efficacy, knowledge building, and personal empowerment.

In conclusion, the study showed that the application of STEAM education in the field of girls' empowerment and academic achievement in developing countries is important. The research helped build the body of literature exploring gender-inclusive education and highlighted the need to continue to develop STEAM projects for gender equality and sustainable education development.

Practical Recommendations

Teacher training programmers should be organized for educational institutions on gender-inclusive STEAM teaching methods and student-centred teaching methods. Curriculum developers need to develop inclusive STEAM curriculum to create the space for girls to be actively involved in science and technology-related subjects. It is also recommended that schools make STEAM laboratories, digital learning materials, and hands-on learning experiences more available to boost girls' participation and learning outcomes.

Policy Recommendations

Financial and institutional support must be given to the education of girls in developing countries on STEAM education. The policies of educational systems should foster gender equality by providing equal access to science and technology education, scholarships, mentorship programs for female students. Policymakers must also champion reform in the education system that is more inclusive and less gendered and discriminatory.

Implications of the Study

Theoretical Implications

This study offered quantitative evidence and contributed to the literature on gender equity, educational empowerment and inclusive STEAM education by offering evidence linking STEAM learning, empowerment and academic achievement with girls in developing countries.

Practical Implications

The results informed educators, curriculum designers, school administrators and policy makers in the design of gender responsive educational approaches, which can help to encourage girls' engagement and success in STEAM education.

Limitations of the Study

The study was restricted to a small sample size and a geographic area, which may limit the generalizability of the findings to other contexts. However, as the study was a quantitative cross section, there was limited opportunity to explore participants' experiences in depth. Further, limitations in time and resources impacted the scope of the study.

Future Research Directions

Longitudinal studies should be carried out in the future to explore the long-term effects of STEAM education on girls' empowerment and academic performance. Researchers are also encouraged to use mixed research methodology to have more insights on students' experience



and perception. Gender-inclusive STEAM education practices and policies could be further improved through comparative studies across different countries of development.

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