

Female Role Models in Science Technology, Engineering and Mathematics and the Improvement of Female Enrolment in Stem Based Programs in Technical Secondary Schools in the Northwest Region of Cameroon

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ABSTRACT

Aim: The aim of this study was to investigate the degree to which providing STEM female role models by school administrators can improve female enrolment in STEM-based programmes in technical secondary schools in the North West Region of Cameroon.

Methods: The theoretical underpinning of this study was informed by Albert Bandura's Social learning theory, Sandra's Bem's Gender schema theory and Greg Becker's Human capital theory. The study employed the convergent parallel design whereby both quantitative and qualitative data were collected through a questionnaire for students, interview guide for principals and focus group discussion for female role models in STEM. A sample of 132 students, 14 principals and 4 female career women in STEM were purposively and conveniently selected from 14 technical high schools in the region; thus bringing the total number of participants to 150. A Spearman rho test was used to verify the degree to which providing female mentors' increased female enrolment in STEM. The hypothesis was tested at a significant level of 0.05. On the other hand thematic analysis was used to analyse qualitative data.

Findings: Spearman's rho test shows a result of $r=.763$, $p=0.05$. The implication is that the provision of female role models has a strong positive effect on the enrolment of female students in STEM. Content analysis reveals that female role models improve enrolment as the female students see them as mentors and they motivate them to become like them.

Recommendation: career women in STEM should motivate, mentor, train and advocate for more girls in STEM.

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KEYWORDS: STEM, female role models, improve enrolment, technical secondary school



INTRODUCTION

Gender disparity in STEM education remains a persistent challenge worldwide, particularly evident in the low enrollment of females in STEM-based programs. STEM, an acronym for Science, Technology, Engineering, and Mathematics, encompasses disciplines crucial for innovation, economic growth, and societal advancement (United States National Science Foundation, 2021). However, despite concerted efforts to promote gender equality

in education, female participation in STEM fields continues to lag behind that of their male counterparts. This disparity is not merely an issue of numbers; it reflects systemic barriers that hinder the full participation of women and girls in STEM education and careers. From early childhood through higher education and into the workforce, girls and women face a myriad of socio-cultural, institutional, and structural obstacles that limit their access to

STEM opportunities and perpetuate gender inequalities (Hill et al., 2010).

Globally, female representation in STEM disciplines remains disproportionately low, with women comprising only a fraction of the workforce in science and technology-related fields (European Commission, 2019). Despite advancements in women's rights and increased awareness of gender equality issues, STEM fields continue to be dominated by men. This underrepresentation of women in STEM is particularly pronounced in Africa, where cultural norms, socio-economic factors, and institutional barriers intersect to create formidable challenges for female participation in STEM education and careers (United Nations, 2020). In Cameroon, a country in Central Africa, the enrollment of females in STEM-based programs at technical secondary schools is alarmingly low, perpetuating gender inequalities in access to educational opportunities and economic empowerment (Ministry of Secondary Education, 2018). Within the North West region of Cameroon, where technical secondary education is vital for skill development and workforce preparation, the situation is exacerbated by cultural and socio-economic factors that discourage female participation in STEM fields (Fielding, 2014). The prevailing gender norms and expectations, limited access to resources and opportunities, and the lack of female role models in STEM contribute to the low enrollment of girls in STEM programs in the region (World Bank, 2017).

The consequences of low female enrollment in STEM programs are multifaceted and far-reaching. From a societal perspective, the underrepresentation of women in STEM perpetuates gender stereotypes and limits the diversity of perspectives essential for innovation and problem-solving. By excluding women from STEM fields, societies miss out on the talent, creativity, and unique insights that women bring to scientific and technological endeavors (Hill et al., 2010). Moreover, the lack of female representation in STEM perpetuates gender disparities in income and opportunities, further entrenching socio-economic inequalities. Women in STEM careers tend to earn higher salaries and enjoy greater job security than women in non-STEM fields, yet the barriers to entry and advancement in STEM professions continue to deter many women from pursuing these lucrative and rewarding career paths (United Nations, 2020).

Despite growing recognition of the importance of addressing gender disparities in STEM education, there remains a significant research gap concerning effective administrative strategies such as the employment of female role models by school

principals to improve female enrollment in STEM-based programs, particularly in the context of technical secondary education in the North West region of Cameroon (Akin, Santillan & Valentino, 2022). To address this gap, this study aims to explore whether having female mentors fosters a conducive learning environment for female students, promote gender-sensitive curriculum development, and address socio-cultural barriers to STEM participation. By conducting rigorous empirical research and utilizing mixed-methods approaches, this study aimed to generate actionable insights that could inform policy and practice aimed at improving female enrollment and retention in STEM-based programs.

Statement of the problem

Both boys and girls have the ability, potential and opportunity to study any program of their choice in technical colleges in Cameroon. Buddin (2014) stated that female students perform equally well as males on standardized tests in Mathematics and Science. Despite this, from observation, disparities continue to exist in enrolment in ((Science, Technology, Engineering, and Mathematics, (STEM) based programs and this is so glaring in our secondary schools with very few or no female students enrolled in certain options such as information and communication technology, civil engineering, mechanical engineering, air conditioning just to name a few. For example, for the 2016/2017 academic year, Government Technical High School Alabukam had 1 female student out of 37 students admitted for electricity in Form 4. Similarly, in Government Technical High School Bamenda, for the academic year 2023/2024 there is no female student offering motor mechanics in all the classes.

The gap and absence of girls in these STEM options indicates the absence of potential talents, and negatively affects the future career paths and opportunities for girls in these fields and generally slows down economic growth. There is a possibility that providing female role models in STEM can improve enrolment of girl in STEM education in technical secondary schools.

Literature review

Many empirical studies have established a connection between female role models in STEM influences on young female STEM students. A study titled “the impact of female role models leading a group of mentoring programs to promote STEM vocations among young girls” by Guenaga et al (2022) reveals that female role models have a significant effects on female students’ attitude towards technology and science Exposure to a female STEM expert, for instance, increases women’s STEM self-concept and

implicit attitudes toward STEM (Stout, 2011). Some attributions might make the role model's success seem more attainable than others, thereby boosting students' motivation to pursue this domain. The gender difference between role models and female students has shown to have no significant effect on student attitudes, whereas perceived dissimilarity with stereotypical role models showed a negative effect on self-confidence in pursuing STEM careers. Perceived similarity with non-stereotypical role models (of either gender) shows a positive effect on self-confidence to succeed in STEM occupations.

Likewise Dennely & Dasgupta (2017), contends that exposure to a positive role model may lead to a higher inclination for female learners to engage in proactive career behaviors such as career planning (e.g., setting goals and exploring options), proactive skills development (e.g., attending extra classes or practicing sessions aimed at enhancing a particular skill), and proactive networking (e.g., engaging with individuals who can advise and guide one towards a particular career). On the other hand, a lack of role models may lead to negative outcomes among the youth

Lockwood, (2006) captured an article titled "someone like me can be successful": Do college students need same gender role models? In this study, the researcher found out that female participants were more inspired by outstanding female mentors. With these role models, young individuals can readily access career information through various channels, such as direct conversations or mentorships from role models in their environment, career services, parents as career role models, role models in their extended families or communities, as well as through television and the internet.

Role models are important for motivational processes as they help indicate particular goals and suggest the path to achieve those goals. Holmes et al (2012), on "girls helping girls: assessing the influence of college students mentors in an after school engineering program", revealed that there was a significant correlation between the quality of the mentoring relationship and girls' confidence in mathematics. The author also remarks that one would expect that female engineering role models would encourage adolescents girls in pursuing careers in engineering and thereby increase the girls interest in and attitudes towards science and mathematics. In conclusion, role models play a crucial role in influencing the career choices and self-confidence of female students in STEM fields. Providing diverse and accessible role models can help mitigate the impact of societal stereotypes and increase the representation of women in STEM careers.

This study was also informed by the social learning theory by Albert Bandura. The theory rest on the idea that we learn from our interactions with others in a social context. Bandura anchored his theory on the concepts of observation, imitation and modeling. In this context, students observe, imitate and model the behaviour of successful women in STEM career. The Gender schema theory was also relevant for this study as it stipulates that though children have expectations for their careers, these careers are based on gender stereotypes that are form via observation of societies expectations for male and female. Beckers (1962), theory on human capital also gives perspective to this study. The theory argues that individual workers have a set of skills or abilities which they can improve or accumulate through training and education. Also it stimulates that education and training are investments. In this context, the theory links the importance of education to acquisition of skills. Girls need to be educated in STEM programs which are programs rich in skill formation and relevant in the job market.

Methodology

This study employed the mixed method research design, specifically, the convergent parallel design whereby both qualitative and quantitative data were collected simultaneously. The sample size of the study was 132 female students, 14 school principals and 4 STEM career women bringing the total number of participants to 150. These participants were purposively and conveniently selected from technical secondary high schools in Momo, Mezam, Ngoketunjia, Boyo and Bui divisions of the North West region of Cameroon. The research instrument used to collect quantitative data was Likert scale questionnaire for students while to collect qualitative data an interview guide was used for principals and a focus group discussion for Female role models in STEM. Quantitative data was analysed using descriptive statistics where frequencies, percentages, mean and standard deviation were used. With respect to inferential statistics, the Spearman rho test for correlation was used to establish the degree to which providing female STEM role models affects female enrolment in STEM programs. On the other hand, qualitative data was presented using content thematic analysis.

Findings

The findings on the extent to which provision of female role models improves girls enrolment in STEM based programs in technical secondary schools in the North West Region of Cameroon where as follows:

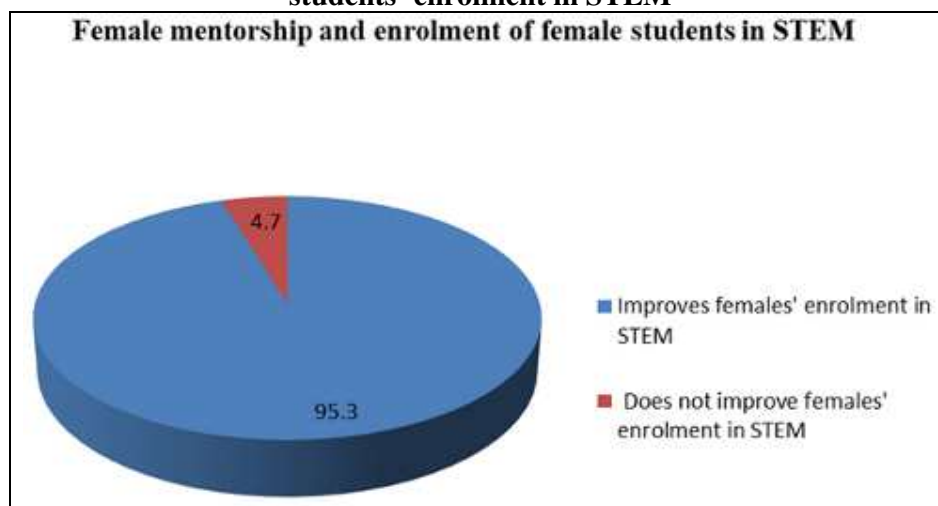
Table 1: Respondents’ opinions on whether using female models improves females’ enrolment in STEM

Items	Stretched				Collapsed	
	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly Disagree (SD)	SA/A	D/SD
I was motivated to enroll into a STEM field because I saw a woman who was an engineer	65 (49.2%)	58 (43.9%)	6 (4.5%)	3 (2.3%)	123 (93.1%)	9 (6.9%)
I enrolled in my programme because I have always admired women doing what I am studying now	50 (37.9%)	76 (57.6%)	6 (4.5%)	0 (0.0%)	126 (95.5%)	6 (4.5%)
When I see a female teacher in our trade I feel so determined to succeed in my field that is mostly dominated by men	39 (29.5%)	88 (66.7%)	5 (3.8%)	0 (0.0%)	127 (96.2%)	5 (3.8%)
I always admire senior female students around in technical education programmes such as civil engineering and motor mechanics	48 (36.4%)	80 (60.6%)	3 (2.3%)	1 (0.8%)	128 (97.0%)	4 (3.0%)
I enrolled in this programme because I have seen a lot of successful women in STEM programmes	47 (35.6%)	78 (59.1%)	3 (2.3%)	4 (3.0%)	125 (94.7%)	7 (5.3%)
Multiple Response Set (MRS)	249 (37.7%)	380 (57.6%)	23 (3.5%)	8 (1.2%)	629 (95.3%)	31 (4.7%)

Source: Field Survey, 2024

From table 1 above, female mentorship and enrolment of female students in STEM was also measured using five (5) items. In aggregate (MRS), findings reveal that majority (95.3%) of the respondents agreed that female mentorship influences the enrolment of female students in STEM while some (4.7%) disagreed. For example majority of the respondents (93.1%) agreed that they were motivated to enroll into a STEM field because they saw a woman who was an engineer while minority (6.9%) disagreed. In addition, majority (95.5%) respondents accepted that they enrolled in their programme because they have always admired women doing they are studying now while a few (4.5%) disagreed. Also, the majority (96.2%) respondents agreed that when they see a female teacher in their trade, they feel so determined to succeed in their field that is mostly dominated by men while very few (3.8%) disagreed. Similarly, majority (97.0%) respondents agreed that they always admire senior female students around in technical education programmes such as civil engineering and motor mechanics while very few (3.0%) disagreed. Again, majority (94.7%) respondents agreed that they enrolled in this programme because they have seen a lot of successful women in STEM programmes whereas few (5.3%) disagreed. This is represented on figure 2.

Figure 1: Respondents’ Opinion the use of female role models and the improvement of female students’ enrolment in STEM



As depicted on the figure 2, 95.3% of respondents indicated that the use of female mentors improves female students' enrolment in STEM while 4.7% of respondents indicated that the use of female mentors does not improve female students' enrolment in STEM.

To further determine the degree to which using STEM female role models by school administrators leads to an improvement in the enrolment of female students in STEM-based programs in technical schools, school administrators were also interviewed and results of the interview presented below.

Table 2: School administrators' opinions on whether using female mentors improves females' enrolment in STEM

Themes	Sample Quotations
Role modeling	<p>"Yes bringing success women in STEM to sensitise students will act as first hand evidence to the female students that they too can be successful in STEM"</p> <p>"Yes every young person looks up to a role model ion one way or the other so having successful women talk to them will motivate them to enroll in STEM"</p> <p>"Yes through testimonies of successful STEM women they will be convinced about the advantages of STEM for females"</p> <p>"Yes, female students benefit from seeing female professionals in STEM programs excelling hence serve as relatable role models to these female students when stereotypic ideas have kept them away from STEM."</p> <p>"Yes seeing excelling female professionals will act as a source of encouragement to enroll in STEM because they will like to be like them"</p>
Motivation and inspiration	<p>"Yes because meeting with success women in STEM can inspire and motivate female students to enroll in STEM programmes"</p> <p>"Yes and this is because in life, people are moved by role models. So such successful women will act like an inspiration to younger girls"</p> <p>"Yes because meeting someone already in the field acts as a motivation force to push them to enroll in STEM"</p> <p>"Yes because these women stand as success figures that will motivate them"</p>

Source: Field Survey, 2024

School administrators' opinions were sought to findout extent to which using STEM female role models by school administrators leads to an improvement in the enrolment of female students in STEM-based programs in technical schools. As depicted in their statements using female mentors improves female students' enrolment in STEM. This is due to the fact that they want to be like these models and they also serve as a form of motivation.

Role modeling

Majority of the respondent opined that female mentors improve female students' enrolment in STEM because they want to be like the mentors. One of the participants stated: *"Yes bringing success women in STEM to sensitise students will act as first hand evidence to the female students that they too can be successful in STEM."* Another interviewee pointed out: *"Yes every young person looks up to a role model ion one way or the other so having successful women talk to them will motivate them to enroll in STEM"* Supporting the previous opinion, another participant stated: *"Yes through testimonies of successful STEM women they will be convinced about the advantages of STEM for females"* Similarly another interviewee opined: *"Yes, female students benefit from seeing female professionals in STEM programs excelling hence serve as relatable role models to these female students when stereotypic ideas have kept them away from STEM."* Correspondingly, another participant added: *"Yes seeing excelling female professionals will act as a source of encouragement to enroll in STEM because they will like to be like them"*

Motivation and inspiration

More so, some of the respondents opined that using female mentors serve as a form of motivation an encouragement for female students to enroll in STEM. An interviewee remarked: *"Yes because meeting with success women in STEM can inspire and motivate female students to enroll in STEM programmes"* In the same light another added: *"Yes and this is because in life, people are moved by role models. So such successful women will act like an inspiration to younger girls"* In the same vain another participant stated: *"Yes because meeting someone already in the field acts as a motivation force to push them to enroll in STEM."* Likewise another interviewee remarked: *"Yes because these women stand as success figures that will motivate them."*

A focus group discussion was also undertaken with some female mentors in STEM to find out whether they were influenced by other female students' to enroll in STEM.

Table 3:Female mentors opinions on whether female mentors enhanced their enrolment in STEM

Themes	Sample Quotations
Role modelling	<p>"Yes, I had female student ahead of me and I wanted to be like her"</p> <p>"Yes I had a female senior I admired."</p> <p>"Yes there was a female student in my quarter I admire so much but I never had any discussion with them regarding technical education"</p>

Source: Field Survey, 2024

During a discussion with some female mentors, all of the respondents agreed to the fact that there was always a female senior student ahead of them in terms of class that they looked up to. However, these senior female students were not a mentor or role model per se as they did nothing to encourage the junior ones. As depicted in their statement a respondent stated: *"Yes, I had female student ahead of me and I wanted to be like her"* Similarly another mentor added: *"Yes there was a female student in my quarter I admire so much but I never had any discussion with them regarding technical education."* The effect of female mentors on female students enrolment in STEM was further appreciated by computing the Spearman correlation test as indicated on table 12.

Verification of the Hypothesis: Providing female mentors by school administrators has no significant effect on the improvement of female enrolment in STEM-Based Programs in technical schools in the North West Region.

A two tailed correlation matrix (Spearman) was done to inter-match the correlation indices of the predictor variable (female mentors) with the criterion variable (female enrolment) as shown on table 4.

Table 4:Effect of female mentors on female students' enrolment in STEM

Test	Statistical parameters	Provision of female mentors	Females' enrolment in STEM
Spearman's rho	R-value	1.000	.712**
	P-value	.	.000
	N	132	132

** . Correlation is significant at the 0.01 level (2-tailed).

Statistically, findings revealed that the use of sensitization has a strong positive effect on female students' enrolment in STEM programmes ($R = 0.712^{**}$, $P = 0.000$, < 0.05). The positive sign of the correlation value implies that both variables are increasing together. This means that, female students' enrolment in STEM is more likely to increase when female mentors are provided by school administrators to talk to students. Based on this, the null hypothesis was rejected and the alternative hypothesis that states that providing female mentors by school administrators have a significant effect on the improvement of female enrolment in STEM-based programs in technical schools in the NWR was accepted.

DISCUSSIONS

The findings arrived at from this study indicates that providing female role models by school administrators significantly improves female enrolment in STEM-Based programs in technical schools in the North West Region. The finding is in line with Guenaga et al (2022),) who argue that providing female role models in STEM education can have a profound impact on motivating and inspiring female students. The suggestion is that school administrators should actively seek out successful women in STEM fields and invite them to share their experiences and insights with students. Their view is significant as it recognizes the importance of representation and visibility in motivating female students. The implication of this view is that by providing female role models, administrators can inspire and empower female students to pursue STEM-Based programs.

Likewise, the finding is also in synergy with Denny & Dasgupta (2017), who emphasize the importance of showcasing diverse female role models in STEM education. They argue that administrators should ensure that students have access to a range of role models from different backgrounds, career paths, and areas of expertise. Baker's perspective is important as it recognizes the value of diverse representation in motivating and engaging female students. The implication of Baker's view is that by highlighting a variety of female role models, administrators can inspire a broader range of female students to enroll in STEM-Based programs.

The finding is in agreement with UNESCO (2017) which contends that school administrators should establish mentorship programs that pair female students with successful women in STEM fields. The report recommends that these mentorship

relationships can provide guidance, support, and role modeling for aspiring female students. The United Nation's perspective is important as it recognizes the power of mentorship in motivating and empowering female students. The implication of this view is that by facilitating mentorship opportunities, administrators can provide female students with the necessary guidance and inspiration to enroll and succeed in STEM-Based programs.

These findings are also in congruence with Albert Bandura's theory of social learning. People learn through observing, imitating and modeling others behaviour. When female students have a successful woman in a STEM career, they will observe what she is doing, then try to imitate the ways of the model and then put the behaviour into practice. Bem's 1981 Gender schema theory also informs this finding as it stimulates that children have expectations for their careers and the choices are usually based on gender stereotypes. Female role models are testaments that any gender can succeed in any career, hence breaking gender stereotypes in STEM.

Recommendations

Findings reveal female role models in STEM can improve female enrolment in STEM based programs in technical secondary schools in the region. Thus, it is recommended that career women in STEM fields can volunteer to mentor, train and be advocates for more females to enroll in STEM programs. They stand as role models to the female students who are rarely exposed to women in STEM careers. These women can through activities like guest tutoring, mentorship, seminar presentations, job shadowing help encourage female students in STEM that they too can have careers in male dominated fields like construction, mechanics, wood works etc.

School administrators should always invite these female role models on campus to do guest teaching, during open door days to share their experiences with the students and on the other hand encourage these women to invite students to their place of work so that they can have first hand field experience. Finally, policymakers should advocate for policies that address societal challenges and biases, promote gender equity in STEM education, and encourage the provision of female role models in STEM fields.

Consider an outline of activities below that can be carried out by successful women in STEM careers to help improve female enrolment in STEM:

Activities carried out by success STEM Female

Role Model



i) Stakeholders:

Women in STEM careers in Academia, Business, Entrepreneurship

ii) Activities:

- Magazine publications
 - Open days
 - Caravan tours
 - Interviews
- Radio/TV Documentaries
- Sporting activities

Outcome



Opportunities for girls in STEM

- ✓ Direct recruitment from school to work
- ✓ Direct admission from secondary school to university
- ✓ Scholarships
- ✓ Grants
- ✓ Entrepreneurial opportunities

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