Effects of Role Models on Undergraduate Students' Academic Performance, Sense of Belongingness, Self-efficacy and Persistence in Science, Technology, Engineering and Mathematics (STEM)

Mjege Kinyota
Dar es Salaam University College of Education – Tanzania
E-mail: mjege.kateko@duce.ac.tz

Abstract

This study investigated the extent to which selected aspects of role modelling predict undergraduate students' performance, self-efficacy, persistence and sense of belongingness to Science, Technology, Engineering and Mathematics (STEM). The study involved a total of 749 final-year STEM students from three public universities in Tanzania. Overall, results from hierarchical regression analysis indicated no significant effects. However, few exceptions were noted. For instance, the proportion of female instructors significantly predicted academic performance for female students. Further, personal variables such as gender identification, majoring in engineering and attending a private school had significant influence on some dependent variables, with notable variations across gender. The implications of this study on policy and future research are discussed.

Keywords**:** *gender, higher education, role models, STEM, Tanzania*

Introduction

The global problem of women underrepresentation in Science, Technology, Engineering and Mathematics (STEM) is widely reported (Luong & Knobloch-Westerwick 2017; Solanki & Xu, 2018). The fact that the problem has many predictable patterns is not new either. Commonly, women tend to be more underrepresented in masculine STEM fields such as engineering, as compared to feminine STEM fields such as the life sciences (Francis et al., 2017; Simon et al., 2017). Essentially, femininity and masculinity have been associated with career choices and intentions. For example, while femininity is associated with 'people-oriented' careers such as nursing and teaching, masculinity is associated with 'things-related' careers such as engineering (Pozzebon et al., 2015; Simon et al., 2017, p. 292). Moreover, some STEM occupations and subjects such as engineering (Simon et al., 2017) and physics (Francis et al., 2017) are compatible with the cultural and social construction of masculinity. The mismatch between femininity and some of the STEM occupations or subjects is what Simon et al.

(2017, p. 385) refer to as a 'chilly climate' for women. As a consequence, women lack role models in STEM-related fields.

There is a plenty of evidence showing that role modelling has the capacity to enhance women's sense of belonging, self-efficacy, academic performance and persistence in STEM. For instance, the proportion of female instructors and students in STEM-related fields has been linked with women's sense of belonging and persistence in STEM (Bottia et al., 2015; Kasembe & Mashauri, 2011; Kier et al., 2014). Likewise, a study by Bottia et al. (2015) came up with a conclusion that, while it has no impact on male students, the proportion of female science and mathematics teachers powerfully predict women's graduation in STEM. Likewise, for all students, female professors (as compared to their male counterparts) are more positively viewed as role models (Young et al., 2013). Moreover, the presence of role models is associated with an improved sense of belonging to STEM (Herrmann et al., 2016; Young et al., 2013), reduced anxiety and stereotype threat (Luong & Knobloch-Westerwick, 2017) and high self-efficacy of STEM (Cheryan et al., 2011). Yet, there are only few studies which have established a link between role models and STEM performance. According to Solanki and Xu (2018), role modelling has generally tended to improve women's motivational processes more than their actual performance in STEM. Meanwhile, self-efficacy has been positively associated with students' persistence in STEM (Mishkin et al., 2016; Stets et al., 2017). Accordingly, based on the understanding that the sense of belonging is positively associated with self-confidence (Carter, 2013), the same must be positively associated with self-efficacy in STEM as well.

Yet, there are some other studies that have produced mixed results, some of which are not consistent with the argument that role modelling improves women's self-efficacy, academic performance, persistence and sense of belonging. For instance, Luong & Knobloch-Westerwick (2017) found that the impact was negative when female students perceived women role models as different from them. Accordingly, Cheryan et al. (2011) argue that the gender of a role model may not be important as compared to the extent to which she/he embodies stereotypes. In other words, friendly male role models can be more beneficial to female students than female role models. The fact that there are such mixed research findings regarding the impact of role models on students' academic performance, self-efficacy and sense of belonging is an apparent call for further investigation into the matter.

With respect to regional disparities, while there is a lot of research describing the nature and scope of women underrepresentation in STEM across the developed world, little has been done in developing countries. At the same time, the few studies that have investigated into regional disparities suggest that the problem of women underrepresentation in STEM may be even more serious in developing countries (Dickerson et al., 2015; Semali & Mehta, 2012). As it has been found, while the gender gap in STEM performance is almost closing in developed countries (Dasgupta & Stout, 2014), women's performance in science and mathematics still lags far behind in many African countries (Dickerson et al., 2015).

Purpose of the study

Given the presence of mixed results regarding the impact of role models, along the fact that there are only few studies that have investigated into this topic in Tanzania, the present study was deemed necessary. Thus, the study investigated the predictive power of selected aspects of role modelling in affecting undergraduate students' academic performance, self-efficacy, persistence and sense of belonging to STEM.

It was hypothesised that the selected aspects of role modelling such as proposition of female instructors, parents' background in STEM and parents' education will have significant effects on the aforementioned dependent variables.

Role modelling and other predicator variables

It has been shown by various studies that role modelling manifests itself in different forms. For instance, several studies have demonstrated the role of the family in influencing participation in STEM (Etzkowitz, 2008; Mishkin et al., 2016). That is to say, family members can serve as powerful role models. With regard to gender, Mishkin et al. (2016) have found that social pressures such as family influence tend to affect choices among engineering majors in Israel irrespective of gender. Consistent with Mishkin et al. (2016), Mungai and Velamuri (2011) have found that parents' careers predict the career choices of their children. Further, although research has yielded conflicting results, the proportion of female instructors is generally associated with female students' sense of belongingness, persistence and choice of STEM (Bottia et al., 2015; Kier et al., 2014). In this case, gender is an important personal variable when it comes to the effect of role models. Yet, some scholars have identified other forms of role modelling which effectively predict STEM persistence and performance such as mentor groups (Herrmann et al., 2016), media outlets (Luong & Knobloch-Westerwick, 2017) as well as very brief interventions such as letters from female role models (Herrmann et al., 2016). At the same time, some personal variables other than gender have been linked to STEM participation. For instance, according to Jones et al. (2013), gender identification (the significance one attaches to his/her gender) and gender stereotype endorsement (the degree to which one conforms to negative gender stereotypes) are associated with stereotype threat, thus affecting the sense of belonging to STEM especially for women (Luong & Knobloch-Westerwick, 2017). Therefore, given that the presence of role models minimizes the stereotype threat, it is important to control for these variables.

Women in STEM and higher education in Tanzania

Science, Technology, Engineering and Mathematics (STEM) is recognised in policy documents as an important aspect of education in Tanzania (Kafyulilo & Tilya, 2019). With regard to the STEM pipeline, students learn an integrated subject called Science and Technology along social science subjects in primary school. From secondary school, the curriculum is subject-based, whereby science (chemistry, physics and biology) and mathematics are learned as separate subjects (MoEST, 2021). During the first two years of secondary education (Form One and Two), all science subjects are compulsory. However, as they enter their third year of secondary education (Form Three), students are required to choose one between the social science stream, business stream and science stream. It is during this time when their perceptions towards STEM start being an issue. Generally, few students will choose the science stream. At Advanced Level, students who had been in the science stream in Ordinary level will study three science subjects, which will ultimately enable them to be enrolled into STEM programmes such as engineering, natural sciences and life sciences at the university level.

Previously, under a situation surrounded by various issues related to gender differences, girls only and boys only schools were established. Although, in recent years many newly established schools have opted for the co-education model, many old schools still maintain the single-sex education model. Given that many single-sex schools tend to be staffed with teachers of the corresponding sex, girls in single-sex schools are assumed to be under the environment where they interact with important role models.

Gender differences in STEM participation constitute a historical problem. Nearly 25 years ago, Mushi (1996) exposed that the problem of females' persistence in STEM was becoming more serious as one ascended the academic ladder. For instance, according to Mushi (1996), women constituted only 10% of all enrolments in STEM programmes at the Universality of Dar es Salaam (UDSM) and Sokoine University of Agriculture (SUA). Generally, the problem has been associated with poor performance in science and mathematics among female students. Indeed, from primary school, female students tend to perform poorly in science subjects as compared to males (Kabote et al., 2014). In dealing with the problem, especially in higher education, different affirmative programmes such as pre-entry programmes for female students who performed poorly in university entry examinations were introduced. According to Lihamba et al. (2006), these programmes improved female enrolment from 7% to 13% and 16% to 27% in the faculties of engineering and science respectively at the University of Dar es Salaam between 1996 and 2003. Although these affirmative initiatives were stopped under the claim of reducing gender stereotypes, other sensitization programmes are being used to attract women into STEM currently. For instance, the Muhimbili University of Health and Allied Sciences (MUHAS) gender policy clearly states that "the university shall review the enrolment policy in order to achieve the desired goal of a 50/50 ratio between male and female students" (MUHAS, 2013, p. 7). Generally, many universities in Tanzania have established gender units with the purpose of dealing with all forms of gender imbalance.

Furthermore, recent data (Table 1) from one public university with the largest share of STEM students indicate that women underrepresentation remains persistent in Tanzania. The data indicate that women make approximately 41% of all students and constitute an average of 28% of the students taking STEM programmes. Moreover, of the 41%, a large share comprises of women majoring in social sciences. For example, women represent 70.9% and 65.55% of all undergraduate students majoring in social work and sociology respectively. Additionally, across STEM programmes, an interesting pattern could be observed, whereby women outnumber men in programmes such as chemistry (58.3%) and microbiology (52.2%) meanwhile constituting the smallest proportions in engineering programmes such as mechanical engineering (10%) and electrical engineering (16.5%).

Table 1: *Percentage of Women in Various STEM Programmes in 2019/2020 Academic Year*

STEM Programme (duration)	**All students (% Women)**
B.Sc. in Computer Engineering & Information Technology (4 years)	110 (19%)
B.Sc. in Chemical and Process Engineering (4 years)	109 (32%)
B.Sc. in Computer Science (3 years)	137 (25.5%)
B.Sc. in Electrical Engineering (4 years)	127 (16.5%)
B.Sc. in Electronic Science and Communication (3 years)	52 (32.7%)
B.Sc. in Engineering Geology (4 years)	26 (38.4%)
B.Sc. in Geology (4 years)	44 (16%)
B.Sc. in Mechanical Engineering (4 years)	108 (10%)
B.Sc. in Mining Engineering (4 years)	86 (21%)
B.Sc. in Molecular Biology and Biotechnology (3 years)	68 (46%)
B.Sc. in Telecommunications Engineering (4 years)	123 (26%)
B.Sc. in Wildlife Science and Conservation (3 years)	57 (38.6%)
Bachelor of Architecture_ (4 years)	53 (34%)
Bachelor of Science in Civil Engineering (4 years)	407 (22.8%)
Bachelor of Science in Food Science and Technology (3 years)	81 (40.7%)

Bachelor of Science in Industrial Engineering (4 years)	84 (16.7%)
Bachelor of Science in Microbiology	46 (52.2%)
B.Sc. in Textile Engineering	40 (20%)
B.Sc. General	84 (34.5%)
B.Sc. in Chemistry	12 (58.3%)
Bachelor of Science in Aquatic Sciences and Fisheries	66 (31.8%)

Source: Extracted from Rukondo & Kinyota (2021)

Apart from females' participation in STEM in quantitative and qualitative terms, to a larger extent, sociological issues have not been linked to STEM participation and performance in the context of Tanzania. For instance, Tanzania is generally a patrilineal society, in which case educating male children is traditionally a priority. In addition, the various respected socializing agents reinforce male domination in society. For example, encouraging women to be submissive to men and/or assuming the role of family caretakers while encouraging men to explore various professions. Therefore, Tanzania provides a unique context for investigating the effects of role modelling on undergraduate students' academic performance, self-efficacy, persistence and sense of belonging to STEM.

Methodology

Sample

The sample comprised of 749 final-year undergraduate students majoring in various STEM programmes in three Tanzanian public universities. They were selected because they offer degree programmes in a wide range of fields, including STEM programmes. Being in their final-year, the students served as a purposive sample because they are assumed to have longer experiences and more concrete future career intentions. A total of 1100 questionnaires were physically distributed to the three universities at a ratio of 610: 243: 247 for university 1, 2 and 3 respectively in accordance to their study population. A total of 749 returned the questionnaires, resulting to a total yield rate of 68%. Of the 749 who returned the questionnaire, 506 were males while 243 were females. For more details, Table 2 presents the demographic characteristics of the sample.

Table 2: *Demographic Characteristics of Sample*

Characteristics	N	%
Sex (n=749)		
Male	506	67.6
Female	243	32.4
Degree programmes		
Engineering	250	33.5
Physical sciences	244	32.6
Life sciences & Medicine	253	33.9
Background in STEM (Parent(s))		
Yes	311	43.7
No	400	56.3
Background in STEM (Family member(s))		
Yes	428	64.5
No	236	35.5
School type by sex		
Lower secondary		
Single sex		
Co-education	248	33.3
High school	496	66.7
Single sex		
Co-education	547	74.1
Taught by female instructor	188	25.9
Never to very few (0-20%)		
Low proportion (21-40%)	272	36.7
High proportion (41-60%)	345	46.6
University	124	16.7
University 1		
University 2	377	50.3
University 3	192	25.6
	180	24.1

Data collection instruments

Independent variables

Literature review and study context informed the inclusion of several independent variables. Further, to explore more variables in a context where few or no study has been conducted on the subject under study, several other variables were included.

Given the intentions of this study, students were asked to indicate their gender. With regard to measures of role models, students were asked to indicate whether or not their parents and/or close family members had any background in STEM. Also, students reported the proportions of female instructors who taught them STEM courses. This was measured using a three-point Likert scale where the proportion of female instructors of 0 to 20 percent was labelled as "Never to very few", 21 to 40 percent as "Low proportion" and 41 to 60 percent as "High Proportion". A threshold of 60 percent was considered appropriate given the underrepresentation of female instructors in STEM. Single-sex secondary schools were considered to have higher proportions of same-sex students. Thus, students were asked if they had attended a single-sex or co-education school, both at lower secondary and high school levels. Furthermore, the cultural construction of STEM fields around masculinity and femininity (Jones et al. 2013) guided the grouping of STEM fields into three categories: engineering, physical sciences and life sciences and medicine (see Table 5). Other independent variables (gender identity and gender stereotype endorsement) were also included as control variables. In this case, gender identity was measured using 4 items (four-point scale, 1 = strongly disagree, 4= strongly agree). Meanwhile, gender stereotype endorsement was measured using 4 items (four-point scale, 1 = strongly disagree, 4= strongly agree). These items were also adopted from Jones et al. (2013) (See Table 2).

Dependent variables

The questionnaire items for this study were adopted from an instrument by Jones et al. (2013), who investigated the impact of engineering identification and stereotypes on females' achievement and persistence. The instrument used five scales, namely, "engineering identification, gender identification, gender stereotype endorsement, engineering ability, perception and persistence in engineering" (p. 471). Given that this study was conducted in a different context, a pilot study was carried out with 20 respondents who filled the questionnaire and were then interviewed. A modified questionnaire was then reviewed by two STEM experts in order to improve content validity. Some of the items were slightly modified to match the study context. For instance, the term engineering was replaced with science and/or current degree programme. Also, the scales were renamed: for example, identity prominence was renamed as sense of belonging to STEM while engineering ability perceptions was renamed as self-efficacy. Nonetheless, the number of items and the scales used were retained. Thus, with respect to dependent variables, self-efficacy was measured using a seven-item scale (seven-point scale, 1 = not good at all, 7= very good. The sense of belonging to STEM was measured using 4 items (four-point scale, 1 = strongly disagree, 4= strongly agree. while persistence intentions were measured using four items (four-point scale, 1 = strongly disagree, 4= strongly agree. The rest two scales of gender identity and gender stereotype endorsement were treated as predictor variables. Finally, the students were asked to indicate the Grade Point Average (GPA) they had attained in their previous year of study. The grading system for all universities is the same and the maximum GPA is five. This GPA was assumed to be a STEM GPA because during this year almost all departments were offering STEM courses for their students.

Table 3: *Reliability and T-Test Scores*

Dimensions	Number of items	Reliability in original study	Cronbach's alpha in present study	*T*-Test by gender
Gender identity	4	.95 (∝)(∝)	.76	*p* = .871
Gender stereotype endorsement	3	.91(∝)(∝)	.69	*p* = .000*
Persistence intentions	2	None (used one item only)	.71	*p* = .155
Self-efficacy	7	.87(∝)(∝)	.84	*p* = .585
Sense of belonging	4	.89	.69	*p* = .133

Data analysis

As an attempt to answer the research question, the researcher conducted descriptive statistics, T-Tests and hierarchical regression analysis using SPSS (version 22). Before recording individual items into respective scales, reliability tests were conducted to make sure that the scales were reliable. For instance, the item "I don't think there are any gender differences in science and mathematical abilities" was removed from the scale of gender stereotype endorsement as it was lowering the reliability score. In other words, only three items were retained for this scale. (See Table 3). Furthermore, before the categorical variables such as gender, degree programme, parents' background in STEM were entered into the regression models, dummy coding was conducted so as to adhere to regression analysis requirements. Further, collinearity diagnostic was conducted so that multicollinearity problems could be sorted. In this case, no serious multicollinearity problems were recorded. Later, a list of predicator variables was tested against each dependent variable. For each dependent variable, personal variables were entered in the first block, followed by the selected aspects of role modelling in the second block. Further, to interpret the findings by gender, the data were grouped by gender so that independent analysis for each group could be performed.

Results and Discussion

The purpose of this study was to investigate the impact of role modelling on students' performance, persistence, self-efficacy and sense of belonging to STEM. Hierarchical regression analysis (Table 3) was performed to evaluate the prediction of performance, sense of belonging, persistence intentions and self-efficacy in STEM from the independent variables.

Predictors of performance in STEM for females and males

For females, the results of the first block linear regression analysis revealed that the model was statistically significant (p < .001) (Table 4). In addition, the R^2 value of .196 implied that personal variables associated with this regression model explain 19.6 percent variance in STEM GPA. Specifically, there was significant positive effect for attending a private high school (B= .223, p < .01), implying that attending a private high school increased the probability of performing better in STEM. Variables of parents' background in STEM, parents' education, the proportion of female instructors and whether one attended a single-sex or co-education school were added to the second block. The results indicated the model to be non-significant (p > .05). This is contrary to the findings from the previous studies (Bottia et al., 2015; Kasembe & Mashauri, 2011; Kier et al., 2014) in which role models had significant effects on students' performance. Further, the effect of attending a private school disappeared in the second block. Additionally, although Model 2 was not significant, the proportion of female instructors significantly and positively predicted female students' performance in STEM (B= .126, p < .05). This implies that for female students to perform better in STEM, efforts to increase the proportion of female instructors should be intensified. Indeed, these findings are supported by earlier studies such as Cheryan et al. (2011), Herrmann et al. (2016) and Young et al. (2013).

Table 4 presents hierarchical regression analysis of predictors of GPA, Self-efficacy, Sense of belonging and Persistence intentions for female's sample

Table 4: *Hierarchical Regression Analysis of Predictors of GPA, Self-efficacy, Sense of belonging and Persistence Intentions for Female's Sample*

Predictor variables	**Model 1**				**Model 2**			
	GPA	Sense of belonging	Persistence intentions	Self-efficacy	GPA	Sense of belonging	Persistence intentions	Self-efficacy
Personal characteristics								
O-Level school type (1, Private; 0, Public)	.390	.334	.148	.862	.517	.386	.163	.683
A-Level school type (1, Private; 0, Public)	.033*	.543	.249	.196	.051	.814	.223	.755
Degree program								
Engineering (1, Engineering; 0, Other)	.177	.735	.729	.771	.300	.726	.550	.979
Physical sciences (1, Physical sciences; 0, Other)	.677	.770	.945	.098	.333	.693	.640	.066
University 1	.310	.687	.273	.477	.520	.640	.150	.702
University 2	.642	.390	.350	.680	.389	.439	.262	.886
Gender stereotype endorsement	.117	.514	.712	.373	.100	.497	.667	.472
Gender identity	.299	.000*	.001*	.016*	.241	.000*	.002*	.025*
Other characteristics								
Parents' background in STEM (1, No; 0, Yes)					.549	.683	.802	.769
Family members' background in STEM (1, No; 0, Yes)					.393	.438	.120	.279
Mother's education (1, Primary education; 7, Master's degree and +)					.496	.110	.574	.260
Father's education (1, Primary education; 7, Master's degree and +)					.675	.730	.778	.016*
Proportion of female instructors (1, 0-20%; 2, 21-40%; 3, 41-60%; 4, 61-Above)					.027*	.398	.003*	.388
O-Level school type (1, Mixed; 0, Single)					.771	.354	.998	.305
A-Level school type (1, Mixed; 0, Single)					.391	.511	.718	.515
R^2	.196	.158	.074	.145	.239	.187	.137	.191
ΔR^2	.196	.158	.074	.145	.043	.029	.063	.046
ΔF	.000*	.000*	.073	.001*	.064	.533	.084	.269

Table 5: *Hierarchical Regression Analysis of Predictors of GPA, Self-efficacy, Sense of belonging and Persistence Intentions for M ales' Sample*

Predictor variables	**Model 1**				**Model 2**			
	GPA	Sense of belonging	Persistence intentions	Self-efficacy	GPA	Sense of belonging	Persistence intentions	Self-efficacy
Personal characteristics								
O-Level school type (1, Private; 0, Public)	.883	.072	.024*	.205	.703	.039*	.027*	.146
A-Level school type (1, Private; 0, Public)	.028*	.925	.004*	.412	.062	.570	.002*	.515
Degree program								
Engineering (1, Engineering; 0, Other)	.000*	.955	.575	.787	.001*	.956	.264	.848
Physical sciences (1, Physical sciences; 0, Other)	.160	.588	.607	.458	.183	.652	.399	.458
University 1	.000*	.014*	.485	.288	.001*	.009*	.232	.236
University 2	.038*	.196	.857	.352	.102	.197	.514	.333
Gender stereotype endorsement	.261	.288	.778	.001*	.306	.268	.767	.001*
Gender identity	.061	.000*	.000*	.000*	.070	.000*	.000*	.000*
Other characteristics								
Parents' background in STEM (1, No; 0, Yes)					.993	.590	.489	.827
Family members' background in STEM (1, No; 0, Yes)					.748	.038*	.811	.391
Mother's education (1, Primary education; 7, Master's degree and +)					.005*	.214	.690	.968
Father's education (1, Primary education; 7, Master's degree and +)					.392	.411	.831	.495
Proportion of female instructors (1, 0-20%; 2, 21-40%; 3, 41-60%; 4, 61-Above)					.321	.184	.513	.559
O-Level school type (1, Mixed; 0, Single)					.407	.680	.002*	.498
A-Level school type (1, Mixed; 0, Single)					.352	.582	.129	.212
R^2	.124	.233	.075	.097	.164	.245	.108	.112
ΔR^2	.124	.233	.075	.097	.041	.022	.033	.014
ΔF	.000*	.000*	.000*	.000*	.064	.181	.069	.635

For the male sample (Table 5), results of the first block indicated the model to be significant. In this case, there was positive effect for attending a private school during high school (B= .190, $p < .05$) and being an engineering major (B= .383, $p < .05$). To the contrary, enrolling in university 1 (B= – .423, $p < .05$) and university 2 (B= – .164, $p < .05$) decreased the probability of performing better for male students. These predictors remained significant in the second block, except the effect of attending a private high school. This might imply that socio-economic status is not an influence of performance once students from different social background have been enrolled at a university. Further, the findings imply that being engineering major gives extra advantage to male students. This can be explained by the fact that male students tend to be more officious in masculine programmes such as engineering (Francis et al., 2017). Meanwhile, the second block regression indicated the model to be insignificant ($p > .05$). However, mothers' level of education had a significant positive effect on GPA for males (B= .062, $p < .05$).

Predictors of sense of belongingness to STEM for females and males

As indicated in Table 4, the results of the first block hierarchical regression analysis indicated that personal characteristics were significant ($p < .001$) predictors of students' sense of belongingness to STEM among female students. That is to say, the R^2 value of .158 means the personal variables accounted for 15.8 percent variance in students' sense of belongingness to STEM. The regression coefficients (B= .285, $p < .001$) of high gender identification increased the probability of having a high sense of belongingness. This is an unexpected finding, given that high gender identification has been known to weaken sense of belongingness to STEM for female students (Jones et al., 2013; Schmader, 2001). The results of the second block hierarchical regression analysis (which included variables related to role modelling) indicated the model to be statistically insignificant (p > .05), although gender identification remained a significant predictor of the sense of belongingness. In other words, female students who considered that being a woman is an important aspect of their lives were more likely to have a higher sense of belonging to STEM. Nevertheless, the findings could not explain why role modelling did not affect the sense of belongingness to STEM for female students as it has been established previously (Bottia et al., 2015; Kier et al., 2014). Nonetheless, the study was able to establish that both male and female students had higher level of belongingness, with no significant difference between them. In this case, there is a need to investigate the resilience shown by female students in these regards. One suggestion would be to investigate the factors that improved sense of belongingness among female students despite experiencing a stereotype threat.

For males (Table 5), Model 1 was significant, explaining 23.3 percent variance in sense of becomingness. In this regard, there was significant positive effects of studying at university 1 (B= .188, $p < .05$) and having higher gender identification (B= .314, $p < .001$) on sense of belongingness. In the second block, the model was not significant. However, attending a private O-Level school (B= – .113, $p < .05$) emerged in the second block as a personal characteristic negatively predicting the sense of belongingness. Also, although the model was not significant, parents' background in STEM positively predicted the sense of belonging (B=.013, $p < .01$). This is expected, considering that parents with a background in STEM are more likely to encourage their children to pursue careers in STEM. While parents' background in STEM is more likely to affect students' persistence intentions, a correlation between persistence intentions and sense of belongings has been established before (Mishkin et al., 2016; Stets et al., 2017).

Predictors of intentions to persist in STEM for females and males

Results of the first block regression indicated the model to be insignificant ($p > .05$) for the female sample (Table 4), although there was a significant positive effect for gender identification (B= .239, $p < .01$). Moreover, although there was a significant positive effect for proportion of female instructors (B= .190, $p < .01$), the second block regression analysis indicated the model to be insignificant. In the second block, gender identification remained a positive and significant predictor of persistence intentions for female students.

On the contrary, for the male sample (Table 5), model 1 was significant ($p < .01$), with the personal characteristics together accounting for 7.5 percent variation in male students' intentions to persist in STEM. Specifically, higher scores on gender identification and attending a private high school positively predicted persistence intentions. In contrast, attending a private O-Level secondary school negatively predicted intentions to persist in STEM. While the present study cannot account for differences in attending a private school at O-Level and A-Level, the findings highlight the importance of socio-economic factors in education, in this case, intentions to persist in STEM. Indeed, students coming from decent social backgrounds are more likely to continue with further studies and careers in STEM because financial barriers have been lifted up for them. In the second block regression, the model was significant although attending a co-education O-Level school positively predicted persistence intentions. The R^2 Change value of 0.33 implied that the second block improved the model by 3.3%. In addition, the personal characteristics that were significant during the first block retained their significance.

As with other dependent variables, personal characteristics in the first block indicated the model to be statistically significant for female students, accounting for 14.5 percent variance of self-efficacy in STEM. In this case, there was a positive effect for gender identification (B= .231, $p < .05$). The effect of gender identification remained significant in the second block. In other words, female students who considered that being a woman is an important aspect of their lives were more likely to have a higher self-efficacy in STEM. Therefore, these findings appear to contradict with the previous findings such as Schmader (2001) and Jones et al. (2013) which show that higher levels of gender identification are associated with higher risks of stereotype threat, thus negatively affecting self-efficacy of STEM. Also, according to Schmader (2001), higher levels of gender identification had negative and significant impact on females' performance in mathematics, as it reinforced female students' tendency to endorse negative gender stereotypes. In this case, there is a need to account for the observed deviation through research. Model 2 was not significant, although fathers' level of education seemed to be a positive significant predictor of self-efficacy.

Likewise, Model 1 (Table 5) was also significant for the male sample, explaining 9.7% variance in self-efficacy. However, in this case in addition to gender identification being a positive and significant predictor of self-efficacy, gender stereotype endorsement significantly decreased the probability of being self-efficacious. That is to say, male students with higher beliefs that women have low abilities in STEM are more likely to be less efficacious. These variables remained significant in the second model too. Also, the results indicated the second model to be insignificant and none of the aspects of role modelling significantly predicted self-efficacy in STEM for male students.

Conclusions and Recommendations

From the findings, it can be concluded that the three universities where this study was conducted have succeeded to create a learning environment in which both male and female students can excel in STEM. This is because there were no significant differences across gender with regard to their performance, belongingness and self-efficacy in STEM. Further, most of the aspects of role modelling that were tested did not emerge as significant predictors of performance, sense of belonging, persistence intentions and self-efficacy. However, the findings provide a snapshot of specific issues that must be dealt with through policy and practice. Firstly, the findings have indicated that male students hold strong negative stereotypes with regard to female students' abilities in STEM. In other words, they believe that women cannot succeed in STEM as men do. These negative attitudes should be dealt with through training and other sensitization campaigns. The fact that female students are performing equally as men does not mean they should live in an unfriendly environment where they are stereotyped. If this condition continues, it may eventually lead to lowering sense of belongingness to STEM and consequently lowering performance among female students. Secondly, the findings suggest that increasing the number of female instructors is more likely to improve female students' performance by 12. 6%. This is in support of policies to increase the proportion of female academic staff in STEM fields. However, the study demographics have indicated that women are overpopulated in health and life science-related STEM fields such as microbiology (52.2%) while enormously underrepresented in masculine STEM fields such as mechanical engineering (10%). Hence, efforts to increase the proportion of women in STEM should target those STEM programmes with serious shortages. This would somehow improve a sense of belongingness in these programmes for these women. Thirdly, the findings indicate that the level of education of a female parent predicts a future performance in STEM among their children. Thus, apart from STEM education, students of female parents who are more educated (regardless of their career orientation) are more likely to perform better in education. This implies that educating more women has a tremendous influence in the future of the society. Finally, the university only represent the highest level of education while STEM preparations begin in the lower levels. As the findings indicated, personal characteristics such as the type of school attended by students during secondary school can have influence on what they become in the later years. Thus, it necessary to promote STEM interest and participation during the lower levels of education. In the same sense, there is a need to improve students' performance in science subjects from early on so that students are well prepared for taking careers in STEM. According to the Basic National Education Statistics in Tanzania (Ministry of Education, Science and Technology [MoEST] (2021), for three successive years (2018-2020), the national average students' pass rates in the Certificate of Secondary Education Examination in physics, chemistry, biology and mathematics was 47.5, 75.2, 57.0 and 20 percent respectively, with males outperforming females in mathematics and physics. To reverse the trend of underrepresentation in STEM fields such as engineering (which require a strong foundation in mathematics and physics), there is a need to improve females' performance especially in the aforementioned subjects.

References

Bottia, M. C., Stearns, E., Mickelson, R. A., Moller, S., & Valentino, L. (2015). Growing the roots of STEM majors: Female math and science high school faculty and the participation of students in STEM. *Economics of Education Review*, *45*, 14–27.

Carter, M. J. (2013). Advancing identity theory: Examining the relationship between activated identities and behaviour in different social contexts. *Social Psychology Quarterly*, *76*(3), 203–223.

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody stem stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science*, *2*(6), 656–664.

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 21–29.

Dickerson, A., Mcintosh, S., & Valente, C. (2015). Do the maths: An analysis of the gender gap in mathematics in Africa. *Economics of Education Review*, *46*, 1–22.

Etzkowitz, H. (2008). Removing barriers: Women in academic science, technology, engineering, and mathematics. *Contemporary Sociology*, *37*(1), 24–25.

Francis, B., Archer, L., Moote, J., Dewitt, J., Macleod, E., & Yeomans, L. (2017). The construction of physics as a quintessentially masculine subject: Young people's perceptions of gender issues in access to physics. *Sex Roles*, *76,* 156–174.

Herrmann, S. D., Adelman, R. M., Bodford, J. E., Okun, M. A., Kwan, V. S. Y., Herrmann, S. D., … Kwan, V. S. Y. (2016). The effects of a female role model on academic performance and persistence of women in STEM courses. *Basic and Applied Psychology*, *38*(5), 258–268.

Jones, B. D., Ruff, C., & Paretti, M. C. (2013). The impact of engineering identification and stereotypes on undergraduate women's achievement and persistence in engineering. *Social Psychology of Education*, *16*, 471–493.

Kabote, S.J., Niboye, E. & Nombo, C. I. (2014). Performance in mathematics and science subjects: A gender perspective for selected primary schools in rural and urban Tanzania. *International Journal of Gender and Women's Studies*, *2*(3), 87–105.

Kafyulilo, A.C., & Tilya, F. (2019). Learning Technology by design: Experiences from In-service science and mathematics teachers in Tanzania. *Journal of Education, Humanities and Sciences, 8* (1), 16-29.

Kasembe, M. K., & Mashauri, S. (2011). *Assessment of women scientists' participation in science, engineering and technological industries (set) in Tanzania*.

Kier, M. W., Blanchard, M. R., Osborne, J. W., & Albert, J. L. (2014). The development of the STEM Career Interest Survey (STEM-CIS). *Research in Science Education*, *44*, 461–481.

Lihamba, A., Mwaipopo, R., & Shule, L. (2006). The challenges of affirmative action in Tanzanian higher education institutions: A case study of the University of Dar es Salaam, Tanzania. *Women's Studies International Forum*, *29*, 581–591.

Luong, K. T., & Knobloch-Westerwick, S. (2017). Can the media help women be better at Math? Stereotype threat, selective exposure, media effects, and women's Math performance. *Human Communication Research*, *43*, 193–213.

Ministry of Education, Science and Technology (MoEST) (2021). *National Basic Education Statistics in Tanzania (BEST)*. Dodoma: Government Press.

Mishkin, H., Wangrowicz, N., Dori, D., & Judy, Y. (2016). Career choice of undergraduate engineering students. *Procedia – Social and Behavioral Sciences*, *228*, 222–228.

MUHAS. (2013). *Muhimbili University of Health and Allied Sciences gender policy*. Dar es Salaam: Muhimbili University of Health and Allied Sciences.

Mungai, E., & Velamuri, S. R. (2009). Parental entrepreneurial role model influence on male offspring: Is it always positive and when does it occur? *Entrepreneurship: Theory and Practice*, 337–357.

Mushi, P. S. D. (1996). Tanzania secondary school science teachers' perceptions and reactions to gender differences in performance in science. *UTAFITI (News Series)*, *3*(2), 91–130.

Pozzebon, J. A., Visser, B. A., & Bogaert, A. F. (2015). Vocational interests, personality, and sociosexuality as indicators of a general masculinity/femininity factor. *Personality and Individual Differences*, *86*, 291–296.

Rukondo, N. & Kinyota, M. (2021). The influence of femininity and masculinity traits on participation and performance in Science, Technology, Engineering and Mathematics Education of undergraduate students in Tanzania. *Papers in Education and Development, 39* (1), 133-154.

Schmader, T. (2001). Gender identification moderates stereotype threat effects on women's math performance. *Journal of Experimental Social Psychology*, *38*(2), 194–201. doi:10.1006/jesp.2001.1500.

Semali, M.L., & Mehta, K. (2012). Science education in Tanzania: Challenges and policy responses, *International Journal of Educational Research*, *53*, 225-239

Simon, R. M., Wagner, A., & 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), 299–323.

Solanki, S. M., & Xu, D. (2018). Looking beyond academic performance: The influence of instructor gender on student motivation in STEM fields. *American Educational Research Journal*, *55*(4), 801–835.

Stets, J. E., Brenner, P. S., Burke, P. J., & Serpe, R. T. (2017). The science identity and entering a science occupation. *Social Science Research*, *64*(1), 1–14.

Young, D. M., Rudman, L. A., Buettner, H. M., & McLean, M. C. (2013). The influence of female role models on women's implicit science cognitions. *Psychology of Women Quarterly*, *37*(3), 283–292.