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A Portrait of the Gender Gap in STEM: A Focus on Identity Formation Among Final-year Undergraduate Students in Tanzania

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Abstract

This study investigates whether male and female students differ with respect to their STEM identity, and how female students negotiate between being female and being students pursuing careers that are perceived as masculine. The study uses a sequential explanatory mixed method design. A total of 749 final year STEM students from three Tanzanian universities participated in a survey that investigated STEM identity using six sub-scales: identity prominence, gender identity, stereotype endorsement, self-efficacy, persistence intentions, and positive feedback. Also, 19 females were interviewed as a follow-up exploration. Findings indicated a significant difference on stereotype endorsement only, where males significantly held negative stereotypes about females' abilities to succeed in STEM. However, there were a few variations across universities and specific STEM programmes. Qualitatively, the findings indicated that as a result of social and cultural constructions, meanings associated with some STEM careers such as engineering were in conflict with meanings associated with being a woman. Consequently, females in STEM must find a negotiating space by balancing the two conflicting identities. Interestingly, females used different strategies such as deliberate efforts to outperform males in examinations as a means to resist male domination in STEM. Finally, the implications for policy and future research are discussed.

Keywords*: gender, negative gender stereotypes, STEM identity, underrepresentation.*

1. Introduction

Females' underrepresentation in science, technology, engineering and mathematics (STEM) is a problem that has persisted over years. Even though the problem varies across geographical borders, generally females tend to be underrepresented in STEM (Etzkowitz, 2008; Mishkin et. al., 2016; Sassler et al., 2016). Notably, research has shown that although the gender gap in STEM performance is declining, females are still underrepresented, especially in the hard sciences (Francis, 2000; Francis et al., 2017; Legewie & DiPrete, 2014; Wang & Degol, 2013). With respect to specific STEM fields, general trends seem to suggest that females tend to be many in STEM fields that are considered feminine (e.g., nursing), but are enormously underrepresented in fields that are perceive masculine (e.g., engineering) (Burke, 2015; Diekman et al., 2017; Legewie & DiPrete, 2014; Stout et al., 2016). This trend has contributed to a shift from gender differences in terms of abilities to the socialization processes as foci for understanding females' underrepresentation in STEM. Regional disparities have also been noted. For instance, while the gender gap in STEM performance is closing in developed nations (Contini et al., 2017; Dasgupta & Stout,

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2014), there are studies (Dickerson et al., 2015; Masanja, 2010) showing that it still persists in Africa. In Tanzania, Kabote et al. (2014) have shown that the gender gap prevails in mathematics performance.

Despite numerous efforts being taken to address the issue of females' underrepresentation in Tanzania, including the formulation of affirmative policies in STEM, the problem still persists. For instance, while the number of females attending higher education have soared to 40% over the past ten years, the proportion of females in STEM has remained almost stagnant (Bipa, 2010; Kasembe & Mashauri, 2011; Lihamba et al., 2006). Furthermore, according to Lihamba et al. (2006), for seven years (1996 to 2003), various affirmative programmes at the university of Dar es Salaam (UDSM) have led to slight increases in the enrolment of females. Nevertheless, as shown in Table 1, recent data from admission records of one comprehensive university in Tanzania indicates that, for the past fourteen years, females' proportions in engineering programmes have not improved much.

Table 1: Final-year Students in the College of Engineering and Technology of University 1

Engineering programmes	Males	Females	Percentage (female)
Telecommunication	47	7	13.0
Computer	36	12	25.0
Electrical	49	6	11.0
Civil	176	19	9.7
Mechanical	40	2	4.8
Textile	10	4	28.6
Petroleum	17	5	22.7
Mineral processing	12	3	20.0
Mining	23	5	17.9
Chemical processing	30	18	37.5
Industrial	25	5	16.7
Total	**465**	**86**	**15.6**

Source: 2017 UDSM admission records

The records also indicate variation between programmes, with less than 5% of females in mechanical engineering programmes, but more than 37% in chemical processing engineering.

Despite the problems of females' underrepresentation and lack of persistence in STEM, the subject of gender in STEM is an under-researched topic in Tanzania. Only a few studies (Bipa, 2010; Chuwa, 2014; Kasembe & Mashauri, 2011) have looked into why females are underrepresented in the country. They reported factors such as having less confidence in succeeding in STEM and overall underperformance in STEM among female students as reasons for female's underrepresentation in STEM. Nonetheless, none of these studies has investigated the experiences of the few females who have managed to persist in STEM.

Meanwhile, as a consequence of underrepresentation, females' sense of belonging to STEM has been affected. Additionally, how females in STEM define themselves and how they are defined by others influence their persistence in STEM (Bisin et al., 2011). As a

result, females who persist in STEM must actively engage in an identification process. Based on this understanding, recent studies (e.g., Ahlqvist et al. 2013; Bisin et al., 2011; Stets et al., 2017) have focused on how females in higher education form STEM identities within male-dominated contexts. Generally, these studies conclude that one's identity influences his/her performance and choice (Ahlqvist et al., 2013; Bisin et al., 2011; Carter, 2013; Smetackova, 2015). Unfortunately, most of these studies were conducted in developed countries, thus it was deemed necessary to undertake this study. Furthermore, as science and technology are increasingly becoming important indicators of economic development (Kellner & Share, 2007), maximizing the chances of females to participate in STEM is very vital. Nonetheless, economic development should not be the only justification for improving females' participation in STEM, but also to improve their happiness and sense of belonging to STEM and the society at large by being offered full opportunities to participate in societal functions without being faced by unjust barriers.

2. Research Purpose and Questions

Given the circumstances discussed above, the purpose of this study is to investigate STEM identity formation among final-year undergraduate students who persist in STEM. Two research questions guided this study:

(a) Do undergraduate male and female students who persist in STEM differ with respect to their STEM identity? *Hypothesis:* There is a significant difference between males and females with respect to their STEM identity.
(b) How do undergraduate female students negotiate their identities in the context of a male-dominated field?

3. Theoretical Framework

The role that the identification process plays in influencing individuals' choices cannot be underestimated. This is because human beings tend to identify themselves as belonging to certain groups, or having certain attributes. That is to say, individuals engage in "an active process of categorizing, classifying or naming" themselves in relation to others (Stets & Burke, 2000: 224). For instance, according to the identity theory, one may identify herself as a woman, a nurse, a kind person, a sportswoman, or a mother. According to Carter (2013), an individual defines him/herself as a unique individual (person identity), a role occupant (role identity), or a group member (social identity). Furthermore, the identity theory informs that each identity represents a cluster of meanings that are both personally and socially constructed. Thus, when the meanings of an identity are compatible with those of a social situation, the identity concerned is said to be activated (Carter, 2013). Further, identities have been known for their volatility (Ibrahim & Heuer, 2016; Lile, 2013; Makhubela, 2015; Toyoki & Brown, 2014); thus, new ones can emerge while the existing ones may get forgotten, and the forgotten ones may recur. In other words, identities (e.g., being as student) can be forgotten at one point in time.

Turning to effects, identities influence individuals' choices and behaviours through a process called 'identity verification' (Carter, 2013: 205). That is to say, an identity is verified when individuals are informed by others that they have demonstrated the meanings associated with an identity (e.g., being a STEM student). Additionally, identity verification is associated with positive feelings in a sense that individuals feel good on

getting informed that they have demonstrated attributes that are associated with a positive identity. Therefore, the desire to feel good motivates an individual to prove the extent to which his/her actions are consistent with the meanings associated with that identity. As such, identity verification explains the motivational components of identity. With regard to the STEM identity, Stets et al. (2017: 3) have distinguished between how an individual views him/herself as a good STEM student/professional, and how s/he perceives the way others view him/her as a good STEM student/professional. They further posit that the incongruity between the two impacts identity verification, motivation, and choice of STEM.

4. Methods

4.1 Research Design

The study employed a sequential explanatory mixed method design (Creswell, 2014). This design permitted the researcher to explore the participants more so as to explain the quantitative results. For instance, after analysing quantitative data, the researcher found that while there was no significant difference with regard to STEM self-efficacy and grade point average (GPA), male students significantly held negative gender stereotypes regarding females' abilities in STEM. Thus, it was necessary to explore how female students negotiate their identities in such a stereotypical environment.

4.2 Sample

The study sample comprised of 749 final-year undergraduate students majoring in STEM. These students were randomly sampled from three public universities in Tanzania. Final-year students were chosen because it was assumed that they had persisted enough in STEM. Additionally, being in their graduation year, it was assumed that they had a strong sense of belongingness to STEM already. In other words, they were assumed to have clear decisions regarding whether they should continue with a postgraduate STEM course, or careers in STEM. A total of 1200 questionnaires were physically distributed across the three universities at a ratio of 6:3:3, proportional to the population size. Out of that number, 749 questionnaires were successfully returned, making a response rate of 62.4%.

Table 2: Demographics (Quantitative)

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
University		
University 1	377	50.3
University 2	192	25.6
University 3	180	24.1

As shown in Table 2, descriptive statistics revealed diverse demographic characteristics of participants. For instance, of the 749 students who filled the questionnaires, 506 (67.6%) were males, and 243 (32.4%) females.

To explore more on the subject, 19 females who filled the questionnaire were also purposively selected to participate in interviews. These females were purposefully sampled so as to attain a representative sample from all the participating universities, and from different STEM programmes in those universities. The demographic characteristics are summarized in Table 3.

Table 3: Demographics (Qualitative)

S/N	Name (Age)	Major	University
1	Nditonze (24)	Industrial engineering	University 1
2	Lea (23)	Civil engineering	University 1
3	Ndilabhuye (24)	Mechanical engineering	University 1
4	Rulenge (24)	Mechanical engineering	University 1
6	Ntahondi (22)	Physics	University 1
7	Ndemeye(22)	Physics	University 1
8	Ngelinna (23)	Physics	University 1
10	Ukubhela (24)	Environmental engineering	University 2
11	Pau (23)	Environmental engineering	University 2
12	Tulimo (24)	Municipal and industrial engineering	University 2
13	Nyiza (23)	Municipal and industrial engineering	University 2
14	Mpongo (24)	Municipal and industrial engineering	University 2
15	Jetu (23)	Metallurgy and mineral processing engineering	University 1
16	Musole (24)	Nursing	University 3
17	Velada (23)	Chemical processing engineering	University 1
18	Juri (23)	Environmental science	University 3
19	Nyina (25)	Environmental science management	University 2

4.3 Instruments

4.3.1 Measuring STEM Identity

Quantitatively, the STEM identity was measured using six sub-scales: identity prominence, gender identity, stereotype endorsement, persistence intention, self-efficacy, and positive feed-back. The questionnaire items were adopted from two studies: Jones et al. (2013) and Stets et al. (2017). These studies are among the few that have studied engineering and science identity among undergraduate students, respectively. Since the instrument used by Stets et al. (2017) did not provide a comprehensive measure of gender component, it was deemed important to adopt other items from Jones et al. (2013 who incorporated gender aspects (e.g., gender stereotype endorsement). Two kinds of scales were used to measure STEM identity. In this case, a four-point scale (1 = strongly disagree, 4 = strongly disagree) was used to measure the sub-scales of identity prominence, stereotype endorsement, gender identity, and persistence intention; whereas a seven-point scale (from 1 = not good at all, 7 = very good) was used to measure STEM self-efficacy and positive feedback. After a pilot study using interviews with 20 students who filled the questionnaire, the items were modified to match the Tanzanian research context. For instance, the term 'engineering' was replaced with 'science' and/or 'mathematics'.

Additionally, to improve reliability, items of the persistence intention sub-scale were increased from two in the original scale to four. For content validity reasons, the modified questionnaire was sent to two experts in the field of STEM for review. The final version of the instrument used in this study consisted of 29 items.

4.3.2 Definitions and Theoretical Relationship Among Sub-scales

With regard to the relationship among the sub-scales, research has produced mixed results. For instance, while ample evidence exists to associate self-efficacy (beliefs that something can be done) with performance, choice of activity, efforts one devotes to an activity. and persistence (Duffin et al., 2012; McLennan et al., 2017; Siwatu et al., 2017), little is known about sub-scales such as identity prominence (sense of belongingness to STEM), and gender identity (the level of importance one attaches to his/her gender). Nonetheless, researchers can logically make connections between these sub-scales. Identity prominence—or the measure of a sense of belonging to STEM—has been found to influence choice and performance. Higher levels of identity prominence in STEM are linked to high confidence and self-efficacy (Stets et al., 2017). Furthermore, for both males and females, self-efficacy is positively associated with persistence in STEM (Mishkin et al., 2016; Stets et al., 2017). Thus, along with the fact that the sense of belonging improves confidence and well-being (Carter, 2013), identity prominence and self-efficacy in STEM may be positively related.

Moreover, the compatibility between gender and identities ascribed to STEM influences associations among the rest of the sub-scales. For instance, STEM is associated with masculinity, implying that females are more likely to experience gender-STEM incompatibility and negative stereotypes (Ahlqvist et al., 2013; Cadaret, Hartung, Subich, & Weigold, 2017; Francis, 2000; Phipps, 2007; Smetackova, 2015). With that in mind, gender stereotype endorsement might negatively affect STEM persistence for females than their male counterparts. Nevertheless, it is worth noting that females vary with regard to gender stereotype endorsement. According to Bisin et al. (2011), stereotype endorsement is mediated by the importance people ascribe to their gender—gender identity. Thus, it was hypothesized that high gender identity will be positively associated with gender stereotype endorsement. Also, when mediated by gender-STEM compatibility, gender identity for females will be negatively associated with self-efficacy, identity prominence, and persistence in STEM (Jones et al., 2013). For males, gender identity will be positively associated with gender stereotype endorsement, although the association might be weak or non-existent for persistence and self-efficacy (Wang & Dovidio, 2017).

Positive feedback—people's perceptions about how others view them as good STEM students—has been found to affect both choice and motivation (Settles, et al., 2016). With regard to this, Stets et al. (2017: 3) have differentiated "… between how individuals see themselves as science students (their science identity) and how they think others perceive them as science students (reflected appraisals)." Thus, they concluded that inconsistency between the two affects choice, identity verification, and motivation.

Along with the six sub-scales, the final-year GPAs of students' STEM were included as an important dependent measure. The purpose was to establish the relationship between

students' GPAs and the STEM identity sub-scales. Thus, it was hypothesized that male and female students will differ with regard to their STEM identities and GPAs.

4.3.3 Interviews

The researcher conducted face-to-face interviews with 19 female students. This number of respondents was decided upon after reaching a theoretical saturation (Strauss & Corbin, 1990). Semi-structured interviews were preferred so that the subject matter of identity formation and negotiation could be fully explored. The purpose was to explore how female students negotiate their identities in a male-dominated field. In particular, the interviews were meant to explore their sense of belonging to STEM, and the factors influencing it. All interviews were audio-recorded; and ranged between 51 minutes to 77 minutes.

4.4 Data Analysis

With the help of the SPSS (version 22), reliability tests were conducted for each sub-scale to decide on the items to be retained for each sub-scale. For instance, the item "For one to become a great scientist or engineer, being a man/woman counts a lot" was removed from the sub-scale of stereotype endorsement to improve the reliability score. In this case, only three items were retained. For other sub-scales, all items were retained (see details in Table 4).

Table 4: Reliability Scores

Sub-scales	Number of Items	Cronbach's Alpha (Original Study)	Cronbach's Alpha (Present Study)
Adopted from Jones et al. (2013)			
Gender identity	4	.95	.76
Stereotype endorsement	3	.91	.59
Persistence intentions	4	—	.66
Self-efficacy	7	.87	.84
Adopted from Stets et al. (2017)			
Identity prominence	4	.92	.68
Positive feedback	6	.89	.83

To attempt the first research question, descriptive statistics, correlations and independent samples t-test were conducted. By employing a thematic analysis approach, qualitative data were transcribed and coded so as to generate relevant themes. For instance, if a participant stated how a home environment is related to specializing in STEM, his/her statement was coded as 'family roles'. Further, a constant comparison and contrast were conducted so that similarities and differences could be spotted among the participants. This resulted to the formulation of the main themes related to identity—such as the social construction of STEM and gender—influence of socialization processes, and resisting dominant hegemony.

4.5 Research Ethics

For the purpose of protecting the participants, the researcher applied for a research clearance letter from the Research Review Board of the University of Dar es Salaam. The clearance letter helped the researcher get access to the institutions. Further, the

researcher prepared informed consent forms to be filled in and signed by individuals who consented to participate in the study. These forms contained information on the study purpose, and the participants' rights (for instance, the right to withdraw from participation any time). More importantly, the names of the participants (especially those who participated in the interviews), and their respective universities, were not revealed (see Table 3) so that the personal information of those participants could not be traced back to their respective universities. Finally, to minimize misinterpretation, the participants' voices from interviews were quoted as frequently as possible.

5. Results

The study aimed at investigating the differences between males and females with respect to STEM identity. Additionally, it explored how female students negotiate their identities in the context of a male-dominated field. In the first step, the researcher computed descriptive statistics and Pearson correlation (Muijs, 2004) to describe data and determine the interrelations among the STEM identity sub-scales and GPA. Descriptively, generally students had higher mean scores on all sub-scales (Table 5).

Table 5: Descriptive Statistics

Items	Mean	SD
Identity prominence		
Belonging to science is something very special to me	3.42	.708
In general, being a scientist/engineer is an important reflection of who I am	3.13	.789
I feel prestige to belong to the current degree program	3.29	.711
I have a strong sense of belonging to the community of scientists	3.34	.663
Gender identity		
Being a woman/man has a lot to do with how I feel about myself	3.26	.794
Being a woman/man is important to a sense of what kind of person I am	3.04	.841
Being a woman/man matters a lot to me	3.15	.917
It is very important in this life that I was born a woman/man	3.29	.837
Stereotype endorsement		
In general, men may be better than females at science, technology and mathematics	3.06	.834
For one to become a great scientists or engineer, being a man/woman counts a lot	2.35	1.070
Many people believe that men have more ability in science and mathematics than women	2.76	.968
I don't think there are any gender differences in science and mathematical abilities	3.07	.905
Persistence intentions		
I would accept a job that is completely unrelated to my current degree program	2.90	.887
I would pursue a post-graduate study in social sciences and humanities courses if I get a chance	2.49	.918
It is always my wish to pursue post-graduate course related to my current degree program	3.06	.834
It is always my wish to work or pursue a career related to my current degree program	3.28	.780

Self-efficacy of STEM		
All in all, how do you rate your academic abilities to succeed in this degree program?	5.80	1.025
How confident are you in carrying out scientific practical involved in your degree program?	5.62	1.060
How confident are you in solving problems that involve mathematical and/or scientific thinking in your current degree program?	5.64	1.063
How do you rate your mathematical and/or scientific abilities?	5.75	1.085
How good were you in mathematics during your years in secondary school?	5.91	1.146
How good were you in science subjects during your years in secondary school?	6.05	.976
In general, how good are you in completing your course assignments for this degree program	5.69	1.011
Positive Feedback		
How did other students rate your mathematical abilities during your years in secondary school?	5.88	1.195
How confident are you in carrying out scientific practical involved in your degree program?	5.89	1.174
How do you think your classmates rate you as a good student in your degree program?	5.49	1.008
How do you think your friends rate your scientific abilities?	5.46	1.086
How do you think your lecturers rate you as a good student?	5.32	1.106
During secondary school, how did your teachers rate your abilities in science subjects?	6.02	1.054

Also, the findings (Table 6) showed that the sub-scales of STEM identity and GPA were correlated with one another. The highest correlation (r = .714) was between positive feedback and self-efficacy of STEM; while the lowest was observed between GPA and identity prominence (r = .095). Also, some sub-scales did not show significant correlation with others. For instance, gender stereotype endorsement did not show any significant correlation with other sub-scales, except gender identity (r = .162).

Table 6: Correlations Between Sub-scales of STEM Identity and GPA

	1	2	3	4	5	6	7
1. GPA	—						
2. Identity prominence	.095*	—					
3. Gender identity	.057	.378**	—				
4. Persistence intentions	.075	.432**	.174**	—			
5. Stereotype endorsement	-.043	.021	.162**	.010	—		
6. Self-efficacy	.216**	.398**	.188**	.212**	-.067	—	
7. Positive feedback	.326**	.400**	.208**	.231**	-.071	.814**	—

Notes: * Pearson correlation is significant at the .05 level (2-tailed).

** Pearson correlation is significant at the .01 level (2-tailed)

To establish the effect of gender on STEM identity, independent analysis of the correlations was done on separate data sets by gender. Results (Table 7) indicated some differences between males and females. For example, the correlation between self-efficacy and STEM GPA was significant for all students. However, the correlation was stronger for females (r = .345), than it was for males (r = .161).

Table 7: Correlations Between Sub-scales of STEM Identity and GPA by Gender

	1	2	3	4	5	6	7
1. GPA	—	**.090**	**-.100**	**-.026**	**.008**	**.345****	**.458****
2. Identity prominence	.092	—	**.333****	**.445****	**-.060**	**.366****	**.343****
3. Gender identity	.039	.399**	—	**.193****	**.040**	**.108**	**.139***
4. Persistence intentions	.113*	.426**	.166**	—	**-.018**	**.167***	**.257****
5. Stereotype endorsement	-.032	.083	.228**	.046	—	**-.100**	**-.127**
6. Self-efficacy	.161**	.416**	.226**	.234**	-.069	—	**.834****
7. Positive feedback	.266**	.432**	.243**	.221**	-.053	.806**	—

Notes: *. Pearson correlation is significant at the .05 level (2-tailed).
** Pearson correlation is significant at the .01 level (2-tailed)
Male (below the diagonal), Females (above the diagonal, bold)

A similar difference was observed between STEM GPA and positive feedback, whereby the correlation was stronger for females (r = .458), than for males (r = .266). This implies that female students are more likely to perform well if they receive positive feedback from important people. In the findings, several variables showed a significant correlation for males only. These included STEM GPA and persistence intentions (r = .113), gender identity and gender stereotype endorsement (r = .228), and gender identity with self-efficacy (r = .226). In other words, the correlation among these variables is not statistically significant for females.

5.1 Gender Differences in STEM Identity

To respond to the first research question, a t-test was performed. The t-test enabled the researcher to determine the statistical differences between the two groups. Results (Table 8) indicated that, with respect to STEM identity, there was no significant difference between males and females in all the sub-scales, except for stereotype endorsement (p < 0.01). Thus, the hypothesis was retained for the sub-scale of stereotype endorsement only. The findings showed that females (M = 2.00, SD = 0.517) were less likely to endorse gender stereotypes than males (M = 2.47, SD = 0.619). In other words, males believed that females have less ability in STEM compared to males.

Table 8: Descriptive Statistics and T-Test Scores

	Sex	N	Mean	Std. Deviation	*t*-test
Identity prominence	Male	480	3.2786	.48499	p-value = 0.133
	Female	233	3.3348	.45846	
Gender identity	Male	484	3.1865	.65364	p-value = 0.871
	Female	235	3.1947	.62968	
Persistence intentions	Male	491	3.1446	.70960	p-value = 0.155
	Female	237	3.2173	.61085	
Stereotype endorsement	Male	486	2.4717	.61873	p-value = **0.00****
	Female	235	1.9989	.51707	
Self-efficacy	Male	444	5.8098	.74717	p-value = 0.585
	Female	215	5.7754	.76225	
Positive feedback	Male	453	5.6806	.79841	p-value = 0.861
	Female	222	5.6922	.80991	

Some differences could be observed among universities and among specific STEM programmes. In all cases, stereotype endorsement remained significantly related with gender, indicating that males held negative stereotypes about females' abilities in STEM. Several differences were noted. For instance, in university 3 (which teaches life sciences and medicine courses), males and females significantly differed ($p < .05$) with respect to their gender identity. In this case, males ($M = 3.124$, $SD = .575$) had higher mean scores of gender identity compared to their female counterparts ($M = 2.900$, $SD = .614$). For the rest of the sub-scales, males and females did not significantly differ.

In terms of differences across specific STEM programmes, stereotype endorsement remained significant, with males more likely to endorse negative stereotypes. With guidance from literature and the study context, STEM programmes were categorized into three groups as shown in Table 9.

Table 9: Categories of STEM Programmes

Codes	Examples of programmes
Engineering	Mechanical, electrical, civil, chemical processing, environmental, textile engineering, design, architecture etc.
Physical sciences	BSc. Geology, BSc. Chemistry, BSc. Environmental sciences, BSc. With Education etc.
Life sciences & Medicine	Bachelor of Medicine, BSc. Nursing, BSc. Midwifery, BSc. Pharmacy, Botanical sciences, etc.

The findings showed that, for engineering majors, females ($M= 5.960$, $SD = .631$, $p < .01$) significantly perceived positive feedback from important others compared to males ($M = 5.700$, $SD = .765$). For students majoring in physical sciences, males ($M = 5.878$, $SD = .627$) reported significantly higher self-efficacy than females ($M = 5.390$, $SD = .911$). Additionally, males and females differed significantly with respect to their gender identities as related to life sciences and medicine. Males majoring in life sciences and medicine had higher scores on gender identity ($M = 3.194$, $SD = .565$, $p < .01$), compared to females ($M = 2.866$, $SD = .614$)

5.2 Negotiating Identities in a Male-dominated STEM Field

The results from interviews indicated that the identities that female students form in relation to the pursuit of STEM careers were shaped by three institutions: family, religion, and school. In other words, the meanings that are circulated within these institutions regarding what it means to be a woman (or a man) influence not only females' choices of STEM careers, but also their sense of belongingness to the STEM field. Not only did these females cite religious books, such as the Bible, as a source of gendered discourses, they also perceived family roles to be the genesis of gendered patterns in STEM.

> *Most of the boys in our class, you know… they say I cannot marry an engineer…they think you cannot be good wife material… you know for our African society, a woman is expected to take care of the husband and you will do everything for him like you will wash clothes and do other domestics* (Ndemeye, 17/01/2018).

For example, as Ndemeye's above quote implies, family roles are assigned based on sex. Additionally, during the schooling years, the participants felt that both male students and few teachers viewed them as less capable of succeeding in STEM. Although these females acknowledged the contribution of teachers in encouraging them to specialize in STEM, they also perceived some kinds of negative stereotypes while at school. Further, data from interviews indicated that females' aspiration to become 'wife materials' (Ndemeye, 07/02/2018, interview) and beautiful were in contradiction with the meanings associated with some STEM careers. For instance, they felt that a career in STEM is too demanding in terms of time, while a good 'wife material' should have much time to take care of her kids and husband. The majority of females also believed that people view careers such as engineering as involving too much muscular energy, which seems to be against what females should be doing.

> *…and of course, in many remote places most of them regard engineering as a career that involves a lot of muscular energy. … that's why if you take it (engineering) they will be wondering if you can really do it… because you're a woman! They are wrong…I agree there is some works that involve muscles but not many of them. Nowadays there a lot of machines (technology) to help lift or do muscular work* (Velada, 07/02/2018, interview).

As Velada expressed, these females experienced an identity conflict between what women are supposed to do and the meanings or identity ascribed to some STEM careers. With respect to the aspiration to remain beautiful, Rulenge wondered, "Imagine a woman climbing a tall electric pole!" (02/02/2018, interview), referring to how people might view an electrical engineer. As a response, these females would try to avoid being seen in public wearing laboratory coats since they feel they will not look beautiful while in them.

> *…when we go to workshops, we wear lab (laboratory) coats and boots. 'How do you feel about it?' (Follow-up question) …Everyone in the lab is wearing them…so it is normal. 'Do you put them from home?' (Follow-up question) … No, no, no, (laughter). I bring them in my bag…'Why?' (Follow-up question) (laughter) … No, even a* daladala konda *(public bus conductor) wear it...so it has no prestige.* (Rulenge, 02/02/2018, interview)

> *… it is simply because of the kind of jobs we do…you need to wear clothes in the manner of being at a site … you cannot wear high heels (type of shoes) on the site, but these people (women in the social science) they can... you know sometimes no matter which job we are doing we are all using mental energy during studies but it is different from when we are on the site* (Mpongo, 14/02/2018, interview)

These are just few examples of how females must negotiate between two conflicting identities—being an engineer working on a site, versus being a beautiful woman. Moreover, there is also a feeling among these females that no matter how they try to see things as normal, others will still view them (females) as unfit to pursue STEM careers.

> *There is no one to blame, I can say. It is the ladies themselves who are not interested to study science because they feel it is hard. Even when we were in secondary school, we used to hear that it is hard to succeed in science. For example, my mathematics teacher discouraged me from taking PCM (Physics, Chemistry and Mathematics). He wanted me to take EGM (Economics, Geography and Mathematics). He thought that I would face trouble by choosing it myself….* (Pau, 13/01/2018, interview)

> *No, I do not think so. I think it is women themselves that are not interested in industrial engineering!* (Ndilabhuye, 15/01/2018, interview)

> *Mhhh…I don't know. It just happens…nobody to blame…may be the women themselves... but we should also not blame them (women); instead we should encourage them. Most women don't have interest and they just don't like hard stuff. They have to be encouraged. 'What do you mean by hard stuff?' (Follow-up question) …Mhhh you know many women don't like physics and mathematics; but biology and chemistry they do very well... and I don't know why…maybe it is just how we girls are... (laughter)...maybe we (women) don't like things that involve a lot of things…you know, for example, like biology needs high cramming capacity, and women are very good at cramming capacity* (Musole, 17/01/2018, interview)

Additionally, interview data indicated that stereotyping has become so strong to the extent that even females themselves are trapped in the tendency of supporting negative stereotypes by believing that STEM is hard and uninteresting to them. In this regard (see the transcripts above), they feel that no one but the social arrangement should be blamed for that. At the same time, some of them felt that males are the ones to be blamed since they tend to underrate females when it comes to pursuing STEM careers. With regard to STEM being hard, these females seem to have a gendered definition of what constitutes hardness. For instance, Musole (see transcript above) believed that physics and mathematics are harder, compared to chemistry and biology, and this why girls are good at chemistry and biology.

Nonetheless, these female students were not slavishly accepting the identities ascribed to them. Instead, as can be evidenced in the transcripts below, they were resisting male dominance using many strategies, including ignoring all discourse that associate females with inability to succeed in STEM. For instance, they were very articulate, as Masole expressed below, on what is expected of them as STEM professionals.

> *According to my career, something must differentiate me from others. For example, an engineer must be inventive… it doesn't need to be inventing something new but at least to invent or modify something new that people will see and be able to say that you attended an engineering programme…* (Masole, 19/01/2018, interview)

> *I was asking myself, ohhh, why are they (males) doing better? .... Is it because they are guys (males) that's why they are doing better? Then I was telling myself, yeah, I have to study hard like I must prove it… prove to them (males at a nearby school) that I can do it… yeah, there was that feeling… a feeling due to inferiority complex, just built among us… 'How did you overcome inferiority complex yourself?' (Follow-up question) ...mhhh…. (deep thinking) ...I was just focused yeah, I was focused to do better, yeah…* (Nditonze, 04/01/2018, interview)

In other words, these females were articulate when it comes to understanding the meanings associated with being STEM professionals. They also felt that since even males were struggling with STEM during examinations, there was no point for males to feel superior over females. Interestingly, females majoring in STEM deliberately devised a strategy of outperforming males in examinations as a way of regaining respect from males, or as another form of resisting male dominance.

6. Discussion

Demographic data showed that the proportion of female students majoring in STEM was 32.4%, which is not surprising given females' underrepresentation in STEM. Further, these findings imply that negative gender stereotypes are commonplace in STEM education in

Tanzania. Consistently, across universities and specific STEM programmes, males held negative beliefs about females' abilities in STEM. Indeed, as interviews have indicated, negative gender stereotypes begin during the early years as a result of influence from family roles and religion. On one hand, the quantitative findings support Jones et al. (2013), who also found a significant difference between males and females with regard to their stereotype endorsement of engineering. However, the presence of a mean difference between the two studies suggests that males in the present study held stronger negative stereotypes. On the other hand, contrary to Jones et al. (2013), males and females did not differ in terms of their self-efficacy in STEM. Surprisingly, despite the fact that negative stereotypes have been found to influence females' choices and performance in STEM (Ahlqvist et al., 2013; Cadaret et al., 2017; Francis, 2000; Phipps, 2007; Smetackova, 2015), the overall findings from this study indicated that negative stereotypes affect neither their STEM GPA nor any other sub-scale of the STEM identity. However, an exception was observed among physical science majors, where female students had significantly lower self-efficacy of STEM. One possible explanation for this observation could be that females in the physical sciences experience a stereotype threat, which lowers their self-efficacy in return. However, this explanation is challenged by the fact that lower self-efficacy was not observed among females majoring in engineering, a field where females are supposed to experience more stereotype threats (Carli et al., 2016; Stets et al., 2017). Given these uncertainties, further research is needed to account for these results.

Moreover, while further research might be needed to account for the observed overall females' resilience despite being exposed to negative stereotypes, one possible expatiation could be that these women are actively resisting the identities ascribed to them. Indeed, research (e.g., Bisin et al., 2011; Stets et al., 2017; Wang & Dovidio, 2017) has shown that there is a possibility for marginalized groups to resist negative identities. This claim is also supported by the qualitative data, where females who were interviewed employed different strategies to resist the dominant hegemony. Interestingly, males majoring in the life sciences and medicine had significantly higher gender identities as compared to females. In other words, males in the life sciences and medicine perceived being male as an important identity. This can partly be explained by the fact that life sciences and medicine are programmes that are associated with femininity (Burke, 2015; Diekman et al., 2017; Legewie & DiPrete, 2014; Stout et al., 2016). This might have either raised males'—and/or lowered females'—sense of gender identity.

Finally, the fact that females majoring in engineering reported significantly higher feelings of positive feedback from important others compared to males is not surprising. Given that engineering is widely considered as hard and masculine (Simon et al., 2017; Francis et al., 2017), females majoring in that career tend to receive admirations as heroes. Nevertheless, while such admirations help these females to feel appreciated as special persons, they should also be deconstructed since they are sometimes given as forms of negative stereotypes. In other words, females majoring in engineering might be admired less for being successful in their engineering career but more for having managed to succeed in a career associated with masculinity. Overall, the findings indicated that female students had high self-efficacy and performed well just as males. Nonetheless, to make the university a happier place for female students, policy intervention is needed to deal with negative gender stereotypes

surrounding university campuses and beyond. Specifically, the socialization process, which is the driving force of the reproduction of these stereotypes, should be thoroughly scrutinized. That is to say, the ascription of STEM careers to masculinity (Francis et al., 2017; Legewie & DiPrete, 2014; Wang & Degol, 2013) is a social construction that needs to be deconstructed if females' sense of belongingness to STEM is to be improved.

7. Limitations and Suggestions for Further Research

Although the study used a mixed method approach to study STEM identity in an area where little research has been done, it was not free from limitations. First, the study did not include many independent variables, thus missing an important aspect of establishing factors influencing STEM identity. Therefore, future research could go beyond by establishing how factors such as socio-economic background affect STEM identity. Second, the sub-scales of stereotype endorsement and persistence intentions recorded the lowest reliability scores in terms of Cronbach's alpha, implying a less dependability in their ability to measure the construct they were supposed to measure in the Tanzanian context. For persistence intentions, one possible explanation could be that two items measured students' intentions to pursue a career in STEM, while the other two measured intentions to pursue a post-graduate programme in STEM. Given that intentions are influenced by many external motivators, these two sets of intentions might be perceived differently by students. Thus, further research is needed to investigate factors influencing intentions to persist in STEM, as well as establish a context-based definition of persistence in STEM.

Moreover, interviews were conducted with female students only. Although the goal was to explore how these female students negotiate their identities, interviewing male students would have enriched the study by exposing the perspective of the opposite sex. Fourth, the challenges of mixing two methods that have conflicting epistemological assumptions were evident. In this case, identity was considered both a psychological construct (quantitative), and as a cultural construction (qualitative). As a consequence, it was somehow difficult to integrate qualitative and quantitative results given that interviews could not be forced to match the sub-scales of STEM identity. Thus, given that the instrument used in the present study was originally used in a different context (US), further research is needed for cross-validation of the instrument in Tanzania. Finally, the present study involved only final-year students. Covering students from different years of study might have highlighted how identity varies as a function of time.

8. Conclusion

The findings from this study calls for immediate intervention if female students are to be helped to succeed in STEM. Although female students majoring in STEM perform well academically just as male students, they experience a stereotype threat, as well as identity conflict, which result from males undermining their chances to succeed in STEM. As a consequence, female students develop low sense of belongingness to STEM careers, such as mechanical engineering, which are associated with masculinity. That is to say, they must negotiate between being females and students in masculine programs. Therefore, career guidance programs are needed to help female students navigate through the observed identity conflict.

References

Ahlqvist, S., B. London & L. Rosenthal. 2013. Unstable Identity Compatibility: How Gender Rejection Sensitivity Undermines the Success of Women in Science, Technology, Engineering, And Mathematics Fields. *Psychological Science*, 24(9): 1644–1652.

Bipa, S. D. 2010. *Participation of women in science education trends and issues in higher education in Tanzania. An unpublished master's thesis*. University of Oslo.

Bisin, A., E. Patacchini, T. Verdier & Y. Zenou. 2011. Formation and Persistence of Oppositional Identities. *European Economic Review*, 55(8): 1046–1071.

Burke, P. J. 2015. Reducing Gender Equity to a Battle of the Sexes is Simplistic, Crude and Dangerous, pp. 14–15.

Cadaret, M. C., P. J. Hartung., L. M. Subich., & I. K. Weigold. 2017. Stereotype threat as a barrier to women entering engineering careers. *Journal of Vocational Behavior*, 99: 40–51.

Carli, L. L., L. Alawa, Y. Lee, B. Zhao & E. Kim. 2016. Stereotypes About Gender and Science: Women ≠ Scientists. *Psychology of Women Quarterly*, 40(2): 244–260.

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.

Chuwa, J. M. 2014. *Determinants of Mathematics and Science Career Choices among Secondary School Female Students in Ilala District, Dar Es Salaam Region*. A Masters dissertation submitted to The Open University of Tanzania.

Contini, D., M. L. D. Tommaso & S. Mendolia. 2017. The Gender Gap in Mathematics Achievement: Evidence from Italian Data. *Economics of Education Review*, 58: 32–42.

Creswell, J. 2014. *Research design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). California: SAGE Publications, Inc.

Dasgupta, N. & J. G. Stout. 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., S. Mcintosh & C. Valente. 2015. Do the Maths: An Analysis of the Gender Gap in Mathematics in Africa. *Economics of Education Review*, 46: 1–22.

Diekman, A. B., M. Steinberg, E. R. Brown, A.L. Belanger & E. K. Clark. 2017. A Goal Congruity Model of Role Entry, Engagement, And Exit: Understanding Communal Goal Processes in STEM Gender Gaps. *Personality and Social Psychology Review*, 21(2): 142

Duffin, L. C., B. F. French & H. Patrick. 2012. The Teachers' Sense of Efficacy Scale: Confirming the factor structure with beginning pre-service teachers. *Teaching and Teacher Education*, 28(6): 827–834.

Etzkowitz, H. 2008. Removing Barriers: Women in Academic Science, Technology, Engineering, and Mathematics. *Contemporary Sociology*, 37(1): 24–25.

Francis, B. 2000. The Gendered Subjects: Students' Subject Preferences and Discussions of Gender and Subject Abilities. *Oxford Review of Education*, 26(1): 35–48.

Francis, B., L. Archer, J. Moote, J. Dewitt, E. Macleod & L. Yeomans. 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.

Ibrahim, F. & J. Heuer. 2016. Cultural Identity: Components and Assessment. In F. Ibrahim & J. Heuer (Eds.), *Cultural and Social Justice Counselling* (pp. 15–50). Switzerland: Springer International Publishing.

Jones, B. D., C. Ruff & M. C. Paretti. 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., E. Niboye & C. I. Nombo. 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.

Kasembe, M. K. & S. Mashauri. 2011. *Assessment of Women Scientists' Participation in Science, Engineering and Technological Industries (Set) In Tanzania*. UNESCO/Government of Tanzania.

Kellner, D., & J. Share. 2007. Critical media literacy is not an option. *Learning Inquiry*, *1*(1): 59–69.

Legewie, J. & T. A. DiPrete. 2014. The High School Environment and The Gender Gap in Science and Engineering. *Sociology of Education*, 87(4): 259–280.

Lihamba, A., R. Mwaipopo &L. Shule. 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.

Lile, J. 2013. Toward A Structural Understanding of Identity Formation: A Review and Extension of Theory. *An International Journal of Theory and Research*, 13(4): 318–347.

Makhubela, M. S. 2015. Ego-Identity Formation in Black South African Young Adults. *Journal of Psychology in Africa*, 25(1): 83–85.

McLennan, B., P. McIlveen & H. N. Perera. 2017. Pre-Service Teachers' Self-Efficacy Mediates the Relationship Between Career Adaptability and Career Optimism. *Teaching and Teacher Education*, 63: 176–185.

Mishkin, H., N. Wangrowicz, D. Dori & Y. Judy. 2016. Career Choice of Undergraduate Engineering Students. *Procedia - Social and Behavioral Sciences*, 228: 222–228.

Muijs, D. 2004. *Doing quantitative research in education with SPSS*. London: Sage Publications.

Phipps, A. 2007. Re-inscribing Gender Binaries: Deconstructing the Dominant Discourse Around Women's Equality in Science, Engineering, And Technology. *Sociological Review*, *55*(4): 768–787.

Sassler, S., J. Glass, Y. Levitte & K. M. Michelmore. 2016. The Missing Women in STEM? Assessing Gender Differentials in the Factors Associated with Transition to First Jobs. *Social Science Research*, 63: 192–208.

Settles, I. H., R. C. O'Connor & S. C. Y. Yap. 2016. Climate Perceptions and Identity Interference Among Undergraduate Women in STEM: The Protective Role of Gender Identity. *Psychology of Women Quarterly*, 40(4): 488–503. *

Simon, R. M., A. Wagner & B. Killion. 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.

Siwatu, K. O., S. M. Putman, T. V. Starker-Glass & C. W. Lewis. 2017. The Culturally Responsive Classroom Management Self-Efficacy Scale: Development and Initial Validation. *Urban Education*, 52(7): 862–888.

Smetackova, I. 2015. Gender Stereotypes, Performance and Identification with Math. *Procedia - Social and Behavioral Sciences*, 190: 211–219.

Stets, J. E., P. S. Brenner, P. J. Burke & R. T. Serpe. 2017. The Science Identity and Entering a Science Occupation. *Social Science Research*, *64*(1): 1–14.

Stets, J. E & P. J. Burke. 2000. Identity Theory and Social Identity Theory. *Social Psychology Quarterly*, 63(3): 224–237.

Stout, J. G., V. A. Grunberg & T. A. Ito. 2016. Gender Roles and Stereotypes About Science Careers Help Explain Women and Men's Science Pursuits. *Sex Roles*, 75, 490–499.

Strauss, A. L., & J. M. Corbin. 1990. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Newbury Park, CA: Sage Publications.

Toyoki, S. & A. D. Brown. 2014. Stigma, Identity and Power: Managing Stigmatized Identities Through Discourse. *Human Relations*, 67(6): 715–737.

Wang, K. & J. F. Dovidio. 2017. Perceiving and Confronting Sexism: The Causal Role of Gender Identity Salience. *Psychology of Women Quarterly*, 41(1): 65–76.

Wang, M. & J. Degol. 2013. Motivational Pathways to STEM Career Choices: Using Expectancy – Value Perspective to Understand Individual and Gender Differences in STEM Fields. *Developmental Review*, 33(4): 304–340.