Exploring the perceptions of female students on the role of gender stereotypes in the enrolment and retention of females in STEM in Nigerian universities

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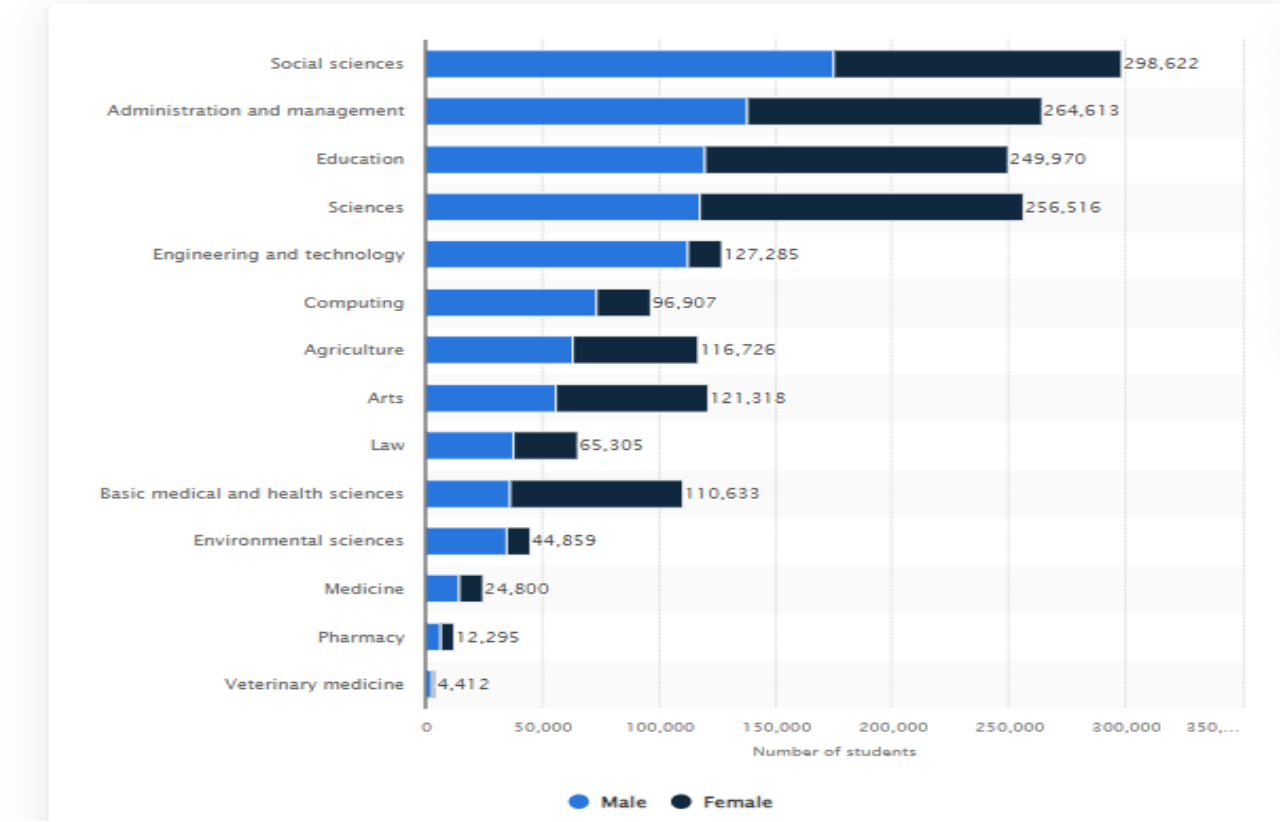
INTRODUCTION

Science, Technology, Engineering and Mathematics (STEM) are essential to every country's economic development since they are at the forefront of innovation. In many ways, a nation's capacity for development and ensuring the welfare of its citizens depends on its level of scientific and technological prowess (Onile-ere et al, 2021).

Number of undergraduate students at universities in Nigeria as of 2019, by gender and discipline



Source: National Bureau of Statistics (Nigeria), 2021

Globally, men are more represented in studying and working in the fields of Science, Technology, Engineering and Mathematics (STEM) than women. According to a UNESCO estimate (2019), women make up just 35% of all students enrolled in STEM-related higher education globally, less than 30% of scientists who do research, and less than 25% of STEM-related occupations in the US. While the Nigerian government has recently concentrated on enhancing national capabilities in science and technology, it has not yet fully acknowledged the significance of gender parity in STEM education (Ekine, 2015).

Identifying the role of gender stereotypes in the gender gap in STEM education will be helpful for policymakers in designing effective intervention programs that will encourage female enrolment and retention in STEM fields. Thus, the inquiry into the subjective role of gender stereotypes that deter females from studying and pursuing careers in STEM is beneficial in policy formulation and in achieving sustainable development in Nigeria.

Relatively few studies have focused on obtaining the viewpoints of women who are enrolled in STEM disciplines in Nigerian universities. The Q-methodology on which the study depends on, which has not been used in the Nigerian context, enables the exploration of qualitative and subjective views while doing so using quantitative methods.

Specifically, the study seeks to answer the following fundamental questions:

- What are the perceptions of females in STEM regarding the gender gap in enrolment of females into STEM fields?
- What are the attitudes of female students towards advancing in STEM education and career?

LITERATURE REVIEW

STEM education is important in addressing the challenges of the twenty-first century. It serves as a crucial national development tool that moulds people's perspectives of the world and their ability to participate in an increasingly competitive global economy (UNESCO, 2017). Widya *et al* (2019) posits that STEM education is beneficial as it helps students become more creative, rational, innovative, productive, and immediately tied to real-world situations. The goal of STEM education is to prepare students for competition and job readiness in their chosen fields.

The significant underrepresentation of girls and women in the fields of science, technology, engineering, and mathematics may be caused by a variety of societal, environmental, biological, behavioural, and psychological factors. On a global scale, women are disproportionately underrepresented in branches of science that depend heavily on mathematics, such as physics, engineering, economics, and the geosciences (Kahn & Ginther, 2017). Women's participation in STEM education has been impacted by the internalization of attitudes and beliefs about appropriate responsibilities and expectations. According to the study by Kpabep & Okora, (2013), the involvement of girls in STEM fields is influenced by socialization and the conventional roles assigned to them right from birth. Women are discouraged from studying science and technology courses, under the justification that these subjects are too challenging and demanding for women. The study of Alabi & Alabi (2013) revealed that parents' choices for specific academic disciplines, girls' apathy in math, teachers' antagonism toward their students, poor teaching methods, and a lack of attention on females' education by the government or society are all possible factors that may affect girls' involvement in STEM. Another cause of this gender disparity in STEM according to Bataineh et al. (2022) is the stereotypical portrayal of male scientists, mathematicians, engineers, and technologists in popular media and job advertisements.

According to a study by Musso et al. (2022) that simultaneously explored how adolescents' STEM gender stereotypes were related to school empowerment and involvement as well as to socioeconomic status showed that higher socioeconomic status was associated with lower STEM gender stereotypes. The study findings imply that school engagement and empowerment are important factors to combat adolescent STEM gender stereotypes. However, it is important to take into account the national context and gender.

The findings from Xu’s study reveals that the gender gap in STEM extends beyond variations in school enrolment. According to Xu's research, men and women earn significantly different income over the first ten years of employment. Additionally, the findings show that women in STEM careers had various income penalties while juggling between their career and expanding family responsibilities. Interestingly, the income and participation differences are not justified by differences in skills and abilities. Similarly, Akinsowon & Osisanwo (2014) posits that some women have chosen to forgo career advancement in favour of spending more time with

their families. Women who intend to have children in the future abandon academic research at a rate that is two times higher than that of men.

In the light of this, it is essential to capture the perceptions of female students in STEM about the gender gap in enrolment in STEM as well as their attitudes towards STEM stereotypes and how this influences their performance, satisfaction and desire to advance in STEM education and careers. Thus, to promote the participation of girls in STEM education in Nigeria, there is a need to examine the phenomenon using a subjectivity approach.

THEORETICAL FRAMEWORK

The theoretical framework of the study is buttressed by the social role theory and the social cognitive career theory. Social role theory which was developed by Eagly and Wood (1987) contends that men and women behave in ways that generally uphold and promote the division of labour as a result of socialization and the development of gender roles. The theory proposes that social expectations influence the career choices of men and women. For instance, men generally prefer careers that help them achieve agentic goals like self-assertion and independence, whereas women typically prefer caregiving roles with benefits to the family and community (Prediger, 1982).

Additionally, the social cognitive career theory proffers to identify connections between people and the situations in which they make career-related decisions, taking into consideration the environment in which those decisions are made. The theory was developed by Robert W. Lent, Steven D. Brown, and Gail Hackett in 1994 and employs Albert Bandura's general social cognitive theory as a unifying framework. The theory's underlying tenet is that individuals are motivated to accomplish things that they believe they are good at, and they are more inclined to practice and improve at things that truly interest them. However, individual choice is frequently but not always related to interests. Compromise is often caused by other environmental and personal factors. The theory emphasizes that people don't make choices that are influence-free and value-free.

The attribution of STEM academic disciplines to the masculine gender is predominant globally which informs the gender differences in the interest and choices of male and female students in science, technology, engineering and mathematics fields. Women's participation in STEM education and employment has been impacted by the internalization of attitudes and beliefs about proper responsibilities and expectations. Thus, the social role theory and social cognitive

career theory both provide a deeper insight into the impact of the gender stereotypes on low enrolment rates of females in STEM subjects and gender differences in STEM-career aspirations.

RESEARCH DESIGN

This study adopts the Q-methodology as its research methodology. Utilizing the Q-methodology allows for a systematic analysis of subjective beliefs and reflections. The Q-method was developed by William Stephenson in the 1930s as the foundation for a scientific approach to human subjectivity. The use of the Q-method is pertinent to this current study on how gender stereotypes affect the enrolment of women as the study aims to capture, categorize and interpret the diverse perceptions of the female students rather than generalizing how gender roles and stereotypes influence the self-efficacy and outcome expectations of females enrolled in STEM. According to Ward (2010), Q-method allows a researcher to identify and comprehend the many points of view held by the study population and categorize each person's opinion into cluster groups. Thus, a major advantage of Q-methodology is that it provides a method for quantitatively studying subjective phenomena. Apart from the Q-set, the post-sorting semi-structured interview guide contained specific questions paying attention to the life story approach to capture the individual trajectories of lifepath and how attitudes of respondents towards enrolment and advancing in STEM have been formed throughout their lifetime.

Creation of the Q-set

At the onset of the Q-study, the concourse is developed. The concourse is the collection of general statements made by people about the phenomenon being studied. A concourse can be developed either through a naturalistic method or ready-made method. Naturalistic concourses are often collected verbally or in writing from the participants. Ready-made concourses obtain information from published materials, such as those found in books, newspapers, journals, websites, or social media (McKeown & Thomas, 1988). This study adopts hybrid-sampling technique by utilizing some statements that were provided by respondents through an online survey and some statements gotten from secondary sources in existing literature.

An online questionnaire for female undergraduates at Nigerian universities served as the main source of the Q set items. In the questionnaire, there were four main inquiries:

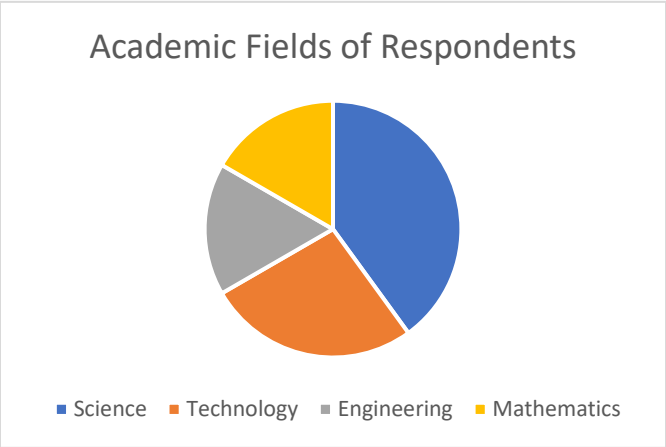
1. How do you think of females studying in STEM fields?
2. What are the challenges of females studying in STEM fields?

3. Why are there fewer women working in STEM fields?
4. What strategies will increase the enrolment of girls in STEM fields?

The naturalistic component of the hybrid sample was provided through the responses. This component is more significant because the primary aim of the study was to provide an avenue for female students in STEM fields to voice their opinions. The results from the survey were compared with those from a literature review, which produced the ready-made part of the hybrid sample. Since there is a vast body of literature on the subject of the underrepresentation of women in STEM fields, information was gathered from journal articles, analytical notes, and policy briefs that address gender inequality in STEM academic disciplines.

Sample Population (P-sets)

In the main study, 30 female students (P-sets) between ages 20-35enrolled in STEM disciplines in Nigerian universities were selected through purposive snowball sampling technique. To minimize probable biases associated with snowball sampling, quota representation was used to categorize respondents into "ages between 20-35" and "female students enrolled in STEM from the six geo-political zones of the country". Watts and Stenner (2012), provided guidance for Q researchers to select participants who will be significant to the study and have important things to contribute. Hence the sampling method was focused on the population of interest.



All the respondents (P-sets) are citizens of Nigeria and currently studying for their first degree in a Nigerian university. Participants were selected from two universities in each of the 6 geo-political zones of Nigeria, making a total of 12 universities used in the study. 18 respondents'

study in government owned universities while 12 are enrolled in private universities. Respondents were selected from various STEM academic disciplines. 12 respondents study in the faculty of pure and applied sciences, while 8 respondents study in technology and there were 5 respondents for each studying Mathematics and Engineering courses.

During the Q-sort, participants were required to sort and rank the statements in the Q-set. By sorting the statements, respondents give the statements a personal interpretation, which reveals their subjective point of view. In this study, these statements were about general perceptions and attitudes towards the subjects of the study. The Respondents (P-set) were asked to sort the statements in the Q-set into 3 categories ('Most disagree', 'Neither agree nor disagree/undecided', 'Most disagree' and rank them in the Q-grid (Appendix). They were asked to rank the statements according to their individual opinions, preferences, assessments and feelings.

The responses to the Q-sort were analysed using the Q-factor analysis. According to Moree (2017), Q-factor analysis reveals the similarities and contrasts in people's perspectives on a subject matter by correlating them. Analysing the data obtained from the study through factor analysis involved the identification of similar opinions of respondents that cluster into a theme. PQ Method software was used to investigate and compute the inter-correlation between the Q-sorts. Eight factors with eigenvalues greater than one were initially extracted using Principal Component Analysis (PCA). However, the study retained two distinct viewpoints that were validated through the Scree test (Appendix) and Kaiser-Guttman criterion (Appendix). The factor scores with the corresponding ranks are outlined as follows:

	Statement	**Factor 1**	**Factor 1**	**Factor 2**	**Factor 2**
		Z-score	Rank	Z-score	Rank
1	Being a male or female influences one's career choice	1.34	3	2.07	1
2	There are less female than male undergraduates enrolled in STEM courses in Nigerian universities due to gender stereotypes	1.47	2	1.73	2
3	STEM fields are not appropriate for women who will fulfill their traditional roles as wives and mothers	-0.01	11	0.92	4
4	STEM related fields are perceived as Masculine	1.59	1	-0.68	17
5	Females more than males experience challenges in STEM fields	-1.25	18	-1.59	19
6	Government educational policies encourage females that enroll in STEM fields	-1	17	-1.15	18

7	There are job opportunities for females more than males enrolled in stem fields	-0.75	16	-0.19	11
8	Culture influences whether a female enroll in STEM fields or not	-0.26	13	-1.6	20
9	Religion influences whether a female enroll in STEM fields or not	-1.99	20	-0.63	16
10	Enrolment of females in STEM fields is over-rated in Nigerian universities	-0.5	15	0.61	6
11	Females less than males tend to be quieter in the classroom	0.87	6	0.47	7
12	Female students are considered competitive by fellow male students	-1.49	19	-0.63	15
13	Females less than males handle specimen and experiment more during practical sessions	0.38	7	-0.08	10
14	Females are more likely than males to change their career path from STEM disciplines	1	4	1.15	3
15	Lecturers show favoritism to males than females in the classroom	0.13	8	0.02	9
16	Males are better professionals in my field in Nigeria	-0.11	12	-0.31	12
17	There are higher chances for male than female students to top the class in STEM courses	-0.36	14	-0.53	14
18	Female students are often blamed for their interest in STEM fields	0.9	5	-0.47	13
19	The media encourages enrolment of females in STEM fields in Nigeria	0.02	9	0.77	5
20	The media encourages enrolment of females in STEM fields in Nigeria	0.02	10	0.14	8

RESULT AND DISCUSSION

The summaries of respondents' viewpoints representing each factor is displayed below. A green cell in any of the two factor arrays shows full consensus, signifying agreement between both factors while a pink cell shows partial consensus, signifying both factors agrees (or disagrees) but at varying degree. The blue cell shows divergent views of both factors.

Factor 1 Array

Negative Statements Ranked Lower in factor 1 Array than in Other Factor Arrays				Neutral	Positive Statements Ranked Higher in factor 1 Array than in Other Factor Arrays			
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
7. There are equal job opportunities for females and males enrolled in stem fields	8. Culture influences whether a female enrolls in STEM fields or not	6.Government educational policies that encourage females that enroll in STEM fields	9. Religion influences whether a female enrolls in STEM fields or not	10.Enrolment of females in STEM fields is over-rated in Nigerian universities	2. There are less female than male undergraduates enrolled in STEM courses in Nigerian universities due to gender stereotypes	5. Female students experience more academic challenges than males in STEM fields	1. Being a male or female influences one's career choice	4. STEM related fields are perceived as Masculine
	19. The media encourages gender stereotypes regarding STEM in Nigeria	20. There are sufficient civil society organizations advocating for female enrolment in STEM fields in Nigeria	11. Female students tend to participate less than males in the classroom	15. Lecturers show favoritism to males than females in the classroom	3. STEM fields are not appropriate for women who will fulfill their traditional roles as wives and mothers	14. Females are more likely than males to change their career path from STEM disciplines	13. Females students tend to handle specimen and laboratory equipment less than males during practical sessions	
			18. Female students are often blamed for their interest in STEM fields	16. Males are better professionals in my field in Nigeria	12. Female students are considered competitive by fellow male students			
				17. There are higher chances for male students to top the class than female students in STEM courses				

Factor 1 described the shared viewpoint of respondents that believed the presence of stereotypical attitudes influences the choice of female students to enrol in STEM disciplines. 18 out of the 30 respondents (60%) loaded onto this factor. More than the other factor, this viewpoint claims that STEM related fields are perceived as Masculine as a result, there are less female undergraduate students enrolled in STEM courses in Nigerian universities due to gender stereotypes. The views strongly disagree that there are more jobs for female STEM graduates than males. This is attributed to the respondents within this factor who strongly disagree that culture, religion, media and civil society organizations encourages female enrolment in STEM disciplines.

This viewpoint agrees that one's gender influences his/her career choice and the presence of stereotypes is evident in the classrooms where male students are more likely to handle specimen or lab equipment during practical sessions.

Factor 2 Array

Negative Statements Ranked Lower in factor 2 Array than in Other Factor Arrays				Neutral	Positive Statements Ranked Higher in factor 2 Array than in Other Factor Arrays			
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
17. There are higher chances for male students to top the class than female students in STEM courses	12. Female students are considered competitive by fellow male students	6.Government educational policies that encourage females that enroll in STEM fields	1. Being a male or female influences one's career choice	5.Female students experience more academic challenges than males in STEM fields	4. STEM related fields are perceived as Masculine	8. Culture influences whether a female enrolls in STEM fields or not	18. Female students are often blamed for their interest in STEM fields	2. There are less female than male undergraduates enrolled in STEM courses in Nigerian universities due to gender stereotypes
	3. STEM fields are not appropriate for women who will fulfill their traditional roles as wives and mothers	7. There are equal job opportunities for females and males enrolled in stem fields	10.Enrolment of females in STEM fields is over-rated in Nigerian universities	11. Female students tend to participate less than males in the classroom	19.The media encourages gender stereotypes regarding STEM in Nigeria	14. Females are more likely than males to change their career path from STEM disciplines	20. There are sufficient civil society organizations advocating for female enrolment in STEM fields in Nigeria	
			13. Females students tend to handle specimen and laboratory equipment less than males during practical sessions	15. Lecturers show favoritism to males than females in the classroom	9. Religion influences whether a female enrolls in STEM fields or not			
				16. Males are better professionals in my field in Nigeria				

Factor 2 described the similar views of those who believe that personal interests rather than gender stereotypes determine the choice of females to enrol in STEM disciplines or not. 8 participants (27%) that loaded onto this factor are only from the southern region of Nigeria. The respondents strongly disagree that there are higher chances for male than female students to top

the class in STEM courses and STEM fields are not appropriate for women who will fulfill their traditional roles as wives and mothers. Furthermore, they disagree that one's gender influences his/her career choice and does not support the notion that female students are considered competitive by fellow male students or that the enrolment of females in STEM fields is over-rated in Nigerian universities. More than the other factor, this viewpoint perceives there are fewer female undergraduates enrolled in STEM courses in Nigerian universities due to gender stereotypes as a result of culture and religion. However, the media and civil societal organizations are perceived to encourage enrolment of women in STEM in Nigeria.

To augment the thematic interpretation of viewpoints, data was obtained from the respondents after Q-sorting and analysis. 10 respondents who closely matched each of the factor profiles, totalling 20 out of the initial 30 respondents of the Q-sort were purposefully selected. This is to ensure that their predominant viewpoints were elaborated. Participants were invited to comment on their Q sort ranking decision, giving the reasons why they strongly agreed, disagreed, or selected neutral. The interview questions were also used to capture the personal normative beliefs of respondents in enrolling in their academic disciplines. The interview which was conducted via zoom was recorded and responses were coded through NVivo software.

Respondents from Factor 1 strongly believe that gender stereotypes present in the family, media and societal organizations influence the personal interest, choice, and performance of females in STEM fields. They attributed the underrepresentation of females in STEM as a result of stereotypical attitudes. This viewpoint supports the study of Akinsowon & Osisanwo (2014) that revealed that female engagement in STEM is impacted by several factors ranging from the stereotype that males are better than females in STEM, socio-cultural factors that influence girls' interest in STEM, self-efficacy as a result of the bias that associates STEM with men. All the 10 respondents strongly believed that the greatest influence on the choice of their academic discipline was partly due to the economic benefits and the influence from family and social networks.

"I can say that I was greatly influenced by my siblings as well other people I respect exceling in the field of civil engineering, that is why I enrolled for this course as well" – Respondent 2

"I was greatly influenced by the employability rate of my course which provides the opportunity to relevant skills in today's modern world" – Respondent 5

The respondents also have a common claim that the choice of their university was largely due to their parent's preference and the influence of peers.

"I chose to study in my university because my close friends attend the school" – Respondent 7

Only 4 out the 10 respondents in this group expressed satisfaction about their course. 2 out of the remaining 6 respondents claimed they didn't have enough knowledge about their course before enrolling. Others maintain that they were facing challenges from their studies and the stereotypical attitude in the learning environment is the reason why they are not satisfied. These respondents also think there is a high possibility to change their career paths after graduation.

"It is possible I don't eventually work in an engineering firm although I'm currently studying civil engineering. There are more boys in my class than girls which speaks volume of how females have to do the extra work to fit in" – Respondent 1

"I am not satisfied with the attitude of some lecturers especially during practical sessions, where they prefer the males to operate lab equipment and prefer females to observe and take notes" – Respondent 8

8 respondents answered that their parents/guardians primarily fund their education. The remaining two respondents are scholarship recipients. When asked if they would have changed their course if they didn't get the support from their primary funders to study in STEM, 9 out of the 10 respondents replied in the affirmative, claiming that absence of the financial support from their sponsors would halt their educational pursuits.

"If my mother doesn't support my course and stops paying my tuition and other school fees, then I would have to stop my education" – Respondent 10

These viewpoints further validate the SCCT that establishes the connections between people and the situations in which they make academic and career-related decisions, taking into consideration the environment in which those decisions are made. The theory holds that individual's academic or career interests can be compromised by socio-cultural and environmental factors (Lent, 2013). Similarly, the viewpoint asserted the study of Prediger (1982), reveals that social expectations influence the career choices of men and women which is why men generally

prefer careers that help them achieve agentic goals like self-assertion and independence, whereas women typically prefer caregiving roles with benefits to the family and community.

Respondents from Factor 2 strongly share the views that personal interest influences the choice of females to enrol in STEM disciplines although there are gender stereotypes are present and can limits the performance and satisfaction of females in STEM which is why females are underrepresented in STEM fields. The perception of the respondents holds that even though the engagement of females in STEM has been impacted by the internalization of attitudes and beliefs about proper responsibilities and expectations, the choice to enrol in STEM is largely due to self-efficacy of students.

All the 10 respondents in this group strongly asserted that their personal interests were the greatest influence on their choice of academic disciplines.

"My interest in chemistry especially the love to know the composition of substances and how it affects life is the major reason I'm studying bio-chemistry" – Respondent 13

"I am studying Engineering because I love the idea of creating and recreating for humanity's benefits" – Respondent 17

When asked what was the greatest influence on their choice of university, 9 out of 10 responses showed preference for the university because they perceive it to be the best available option for them to study in Nigeria.

"I chose my current university because it is a technology school, so I feel it is a specialized school" – Respondent 15

All the respondents in this group expressed satisfaction for their course, and 8 respondents claimed they knew and understood the requirements and demands of the course but still went ahead to enol in the course of their academic interest. However, 7 respondents admitted that there are more challenges for female students in their faculties.

"I got to know about industrial chemistry since my secondary school days when I was looking for a specialized course in Chemistry. I was immediately interested and enrolled for the course" – Respondent 12

7 respondents are primarily sponsored by their parents/guardians while the remaining three are sponsored by the state government, a non-governmental organization and self-funded respectively. 5 respondents claimed that they would not re-think studying their courses if the financial support from their primary sponsor stops, rather they would apply for scholarships and/or study grants to keep them educated in the choice of academic discipline. Out of the remaining 5 respondents, 3 agreed they might have to stop schooling if they don't continue to get support from their primary sponsors. The remaining two respondents claimed they would switch to other courses outside STEM fields in order to earn a degree but will still continue to pursue their passion in their chosen fields of study.

"I have the options to apply for government scholarships if my parents stop supporting my educational pursuits financially" – Respondent 14

"I work and study which makes me capable of funding my studies. I will still choose to follow my passion to be a renowned pharmacist in the case where my parents stop funding my education" – Respondent 19

This viewpoint corroborates the interest model of the social cognitive theory that posits individuals are motivated to accomplish things that they believe they are good at, and they are more inclined to practice and improve at things that truly interest them. Although the views of these respondents depict that gender stereotypes affect the enrolment of females in STEM due to societal roles and expectations, they also strongly perceive that the media and activities of civil society organizations are encouraging the self-efficacy of females to participate in STEM.

Evidently from the study analysis, STEM academic disciplines are ascribed to males while female students are taken aback due to gender stereotypes. The study confirms that there are different stereotypical attitudes from the family, learning environment and the societal institutions towards females that study in STEM. Supporting the study of Kpabep & okora (2013), that even if a large percentage of female secondary school students enrol in science courses, a very persistent and incorrect misconception persists that women are by nature technologically illiterate and unable to absorb scientific and technological information or to acquire the essential skills, as a result, many women choose to major in humanities and social sciences in universities.

The socio-cultural barriers to the participation of females in STEM education are quite severe, and if they are not addressed, Nigerian women will continue to be unable to fulfill harness their human potentials, which is counterproductive and will have a detrimental effect on the country's future development. Gender preconceptions engendered by culture and religion are also significant in explaining why there aren't as many female undergraduates taking STEM courses in Nigerian tertiary institutions, nonetheless, the media and civil societal organizations are thought to take on advocacy roles to enhance the enrolment of women in STEM education.

The findings revealed that gender stereotypes influence the personal interests of girls in STEM fields. The discrepancies between the number of females and males that enrol in STEM is a result of the gender gap in personal interests in STEM. Even though the gender disparity in science courses is less than the extremely enormous disparities that exist in engineering courses, it is nevertheless evident that women are underrepresented in society.

According to SCCT, the self-efficacy of an individual, outcome expectations and personal goals determine the preference of the academic and career choice of the individual. However, the interest of a person could be compromised owning to socio-cultural and environmental factors. According to findings, the personal barriers to female engagement in STEM, such as a negative self-perception or attitude, a lack of self-assurance and a feeling of inferiority are the result of socialization. The majority of STEM courses are abstract, which may contribute to their perceived difficulty, especially in developing countries like Nigeria where educational materials/aid are scarce (Akinsowon & Osisanwo, 2014). Thus, girls who have been socialized to be soft and tender therefore perceive STEM as a discipline for males.

The study findings also reveal women's participation in STEM education has been impacted by the internalization of attitudes and beliefs about proper roles and expectations. From the analysis of study, it was discovered that the preference of parents and significant orders toward certain disciplines for their girl-child could also influence the personal interests of girls in STEM. 15 out of 20 respondents were primarily sponsored and received financial support from their parents/guardians. 14 responses signified that the respondents will have to stop or change their education path if their parent or guardian did not support their educational pursuits. The seeming lack of interest of girls in STEM can therefore be attributed to distinguishing feminine identities. The educational opportunities, learning outcomes and commitment of girls to study and work in

STEM are greatly influenced by formal and informal sociocultural norms and expectations regarding women's roles in society.

Gender stereotypes have a significant role on how many girls choose to study STEM-related academic fields. As a result of the misconception that women lack the aptitude to succeed in STEM disciplines, their participation has been significantly retarded. Young girls are less motivated to enrol and become professionals in STEM fields due to this position, which is detrimental to the socioeconomic development of the country. According to SCCT, the environs and circumstances of individuals that support them in pursuing their interests rather than those that limit them is the most significant influence on their academic and career choice.

Overall, a significant amount of human potential is wasted by excluding girls from the process of creating and utilizing scientific knowledge. This will endanger the economy's ability to compete and advance (Aja-Okorie, 2013). Hence, the benefits of female participation in STEM disciplines are necessary conditions for achieving Nigeria's economic and social progress by enhancing human capital, slowing population growth, and alleviating poverty.

To effectively reduce the gender gap in STEM education, the study offered the following practical recommendations for policy makers and civil society organizations in Nigeria that could be adopted in other developing countries to increase female enrolment in STEM academic disciplines thereby promoting sustainable development:

- **Debunking the myth that STEM is primarily meant for the males:** Promoting a positive image of women in STEM would be essential for reorientation and raising awareness in dispelling the myth. The entire society, especially parents, teachers, curriculum developers, school management, needs to be informed of the significance of eliminating any gender bias towards female students and understand the long-term effects of stereotypical attitudes towards a girl child from a tender young age. Through increased funding and incentives for local NGOs working in rural and marginalized communities, government institutions and agencies such as the ministry of women affairs, as well as multinational and national corporations can encourage re-orientation campaigns and gender equality advocacy programs targeted at key stakeholders such as family heads, community and religious leaders.

- **Early STEM engagement for young girls:** Female children should be stimulated in developing math interest and approach the subject with confidence right from primary school as it is crucial for achievements in STEM fields later in life. Adequately equipping students for professionalism by observing career days regularly in schools to lecture them on the different career options available in STEM could also spike up the interest of girls. An instance is commemorating the annual day of celebrating girls and women in STEM globally on February 11 every year in primary and secondary schools.
- **Gender equity in teacher education:** The majority of teachers in STEM subjects are men. This portrays the underrepresentation of females in STEM and justifies the notion that STEM fields are masculine in nature. Collaborative efforts from the government and civil societal organizations are required in Nigeria to close the gender gap and attract more women in the STEM teaching education especially because of the weighty influence teachers have in student's perception of their course and learning experiences.
- **Scholarships and Awards Competitions to encourage females in STEM:** There are a few sporadic scholarships offered to exceptional female students in STEM disciplines. Collaborations between private companies and governmental agencies in organizing recurring STEM project fairs and exhibitions, quizzes, competitions and outstanding awards at the state and national levels for elementary and secondary school students will encourage scientific project ideas and then attract the interest of girls in STEM fields from a young age. These competitions can be televised and streamed on online platforms to promote public awareness for female participation in STEM. Furthermore, there is a need for funded opportunities provided by the government, corporate organizations, NGOs and philanthropists to women in STEM for them to participate in international exchange programs, learn new and relevant skills that they can put to use in Nigeria.
- **Early exposure of girls to female role models who have excelled in their STEM careers:** Adopting role modelling and mentorship platforms are effective strategies for reducing the negative impact of gender gap in STEM. However, these strategies are underutilized in Nigeria. Women who are successful in STEM fields can significantly influence and attract young females into the industry. Such mentorship platforms can be established through organizing forums, workshops and STEM-posiums with sessions ranging from topics on new innovations, emerging discourses as well as challenges of

students enrolled in STEM in Nigeria. The practical recommendations can inform policy formulation. Additionally, corporate organizations and women empowerment organizations could leverage on organized mentorship sessions between female STEM role models and students to advocate for progress in closing the gender gap in STEM.

CONCLUSION

Using a qualitative approach, the study explores the influence of gender stereotypes on the enrolment and retention of females in STEM fields. Relatively few studies have focused on obtaining the viewpoints of women who are enrolled in STEM disciplines in Nigerian universities. The Q-methodology which is the basis of the study has not been applied in the Nigerian context. The Q-methodology enables the exploration of qualitative and subjective views while doing so using quantitative methods. Consequently, there is a good chance that this study will introduce new research areas in the exploration of socialization processes, gender gap in STEM disciplines and sustainable development in Nigeria and beyond. The findings from the study also provides insight for policy formulation and practices to boost female enrolment in STEM academic disciplines in Nigeria.

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APPENDIX

Q-SET

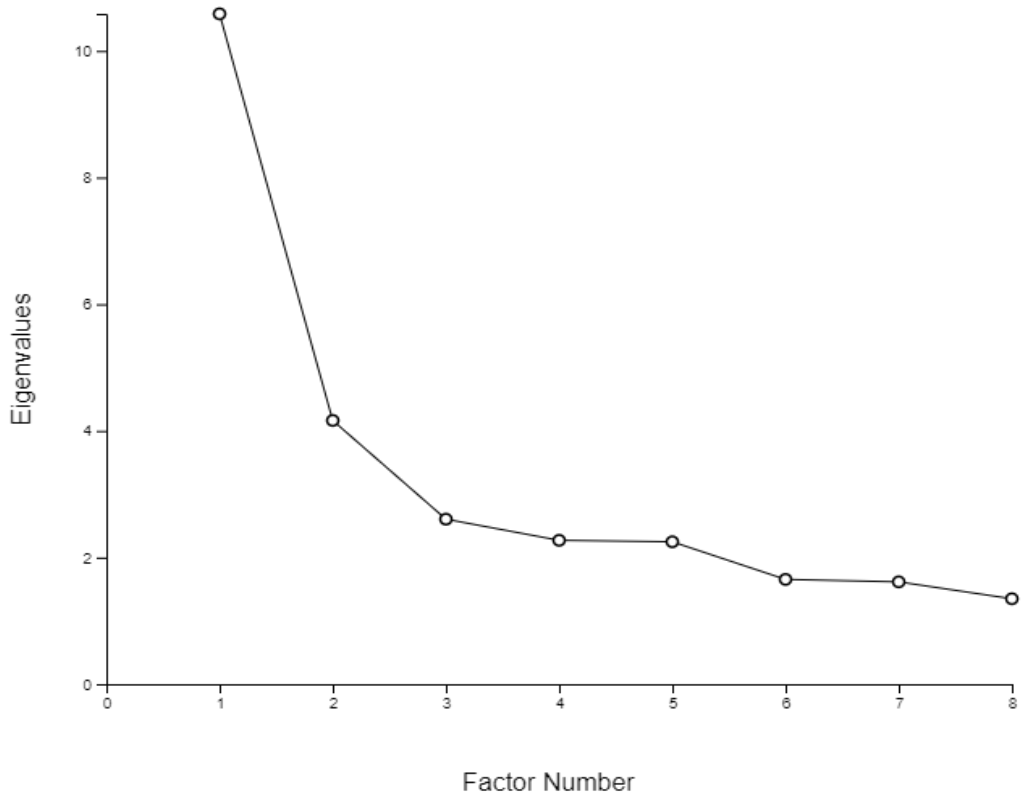
No	Statement	Question Theme
4	STEM related fields are perceived as Masculine	Personal normative beliefs
10	Enrolment of females in STEM fields is over-rated in Nigerian universities	Personal normative beliefs
5	Female students experience more academic challenges than males in STEM fields	Personal normative beliefs
1	Being a male or female influences one's career choice	Personal normative beliefs
17	There are higher chances for male students to top the class than female students in STEM courses	Personal normative beliefs
2	There are less female than male undergraduates enrolled in STEM courses in Nigerian universities due to gender stereotypes	Personal normative beliefs
6	Government educational policies encourage females that enroll in STEM fields	Personal normative beliefs
20	There are sufficient civil society organizations advocating for female enrolment in STEM fields in Nigeria	Personal normative beliefs
3	STEM fields are not appropriate for women who will fulfill their traditional roles as wives and mothers	Personal normative beliefs
16	Males are better professionals in my field in Nigeria	Personal normative beliefs
19	The media encourages gender stereotypes regarding STEM in Nigeria	Perception of socio-cultural factors
8	Culture influences whether a female enrolls in STEM fields or not	Perception of socio-cultural factors
14	Females are more likely than males to change their career path from STEM disciplines	Perception of socio-cultural factors
9	Religion influences whether a female enrolls in STEM fields or not	Perception of Socio-cultural factors
7	There are equal job opportunities for females and males enrolled in stem fields	Perception of Socio-cultural factors
18	Female students are often blamed for their interest in STEM fields	Perception of socio-cultural factors
15	I Lecturers show favoritism to males than females in the classroom	Perception of attitudes from learning environment
12	Female students are considered competitive by fellow male students	Perception of attitudes from learning environment
11	Female students tend to participate less than males in the classroom	Perception of attitudes from learning environment
13	Females students tend to handle specimen and laboratory equipment less than males during practical sessions	Perception of attitudes from learning environment

Q-SORT FIGURES

Participant	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	Mean	Standard Deviation
P1	1	3	1	4	2	-2	-4	-3	-1	0	-1	1	3	2	0	0	0	-1	-3	-2	0	2.176
P2	1	3	-3	1	0	-2	-2	2	1	-1	0	-3	-1	2	0	0	-4	4	-1	3	0	2.176
P3	-1	3	-4	4	0	-2	0	-1	2	1	-1	-3	0	2	0	-3	1	-2	1	3	0	2.176
P4	-1	3	-4	3	1	-2	-1	-1	2	1	-2	-3	0	2	0	-3	0	1	0	4	0	2.176
P5	-4	3	-3	3	2	-2	-2	1	0	-1	0	1	4	2	1	-3	-1	-1	0	0	0	2.176
P6	-3	4	-2	2	1	-2	-3	3	-1	0	0	-1	3	2	1	0	0	1	-4	-1	0	2.176
P7	-3	3	-4	1	3	-2	-2	4	0	0	-1	-1	0	2	-3	1	-1	2	0	1	0	2.176
P8	0	3	-3	2	3	-2	-1	4	-1	0	-4	0	-3	2	-2	1	0	1	-1	1	0	2.176
P9	0	3	-3	1	1	-2	-1	1	0	0	0	2	3	2	-1	-4	-1	4	-3	-2	0	2.176
P10	2	3	-4	3	1	-2	-1	0	1	-1	0	4	0	2	0	-3	-2	1	-1	-3	0	2.176
P11	1	3	-4	4	0	-2	-3	2	1	-1	-2	0	-1	2	-3	-1	1	3	0	0	0	2.176
P12	-1	3	-2	3	4	-2	-4	1	-1	0	-3	0	-3	2	0	-1	0	2	1	1	0	2.176
P13	2	3	-3	1	3	-2	-1	-2	-3	-1	0	1	0	2	0	4	-4	-1	0	1	0	2.176
P14	3	3	-4	2	4	-2	-1	-1	-3	0	1	-3	1	2	-2	0	0	-1	1	0	0	2.176
P15	-4	3	-3	3	4	-2	-2	-1	2	-1	1	1	0	2	1	-3	0	0	0	-1	0	2.176
P16	4	3	3	-3	-4	-2	2	-3	-2	1	-1	-1	0	2	-1	0	0	1	0	1	0	2.176
P17	-4	3	-3	1	-1	-2	-2	4	3	-3	-1	2	0	2	0	0	-1	1	0	1	0	2.176
P18	-3	3	-2	4	-4	-2	-3	-1	0	-1	0	1	3	2	1	1	-1	0	2	0	0	2.176
P19	2	3	-4	1	-2	-2	-3	1	-1	-1	0	0	0	2	-1	-3	0	4	3	1	0	2.176
P20	3	3	-1	4	-3	-2	-2	0	-4	-1	2	-3	1	2	0	0	-1	1	0	1	0	2.176
P21	2	3	3	1	-1	-2	0	-2	-4	-1	1	-3	0	2	1	-1	0	4	0	-3	0	2.176
P22	-3	3	4	0	1	-2	-1	0	0	-1	-4	0	-1	2	-3	1	1	3	2	-2	0	2.176
P23	-1	3	-3	-1	2	-2	-3	1	0	-4	1	0	-1	2	1	4	-2	3	0	0	0	2.176
P24	-4	3	1	-1	2	-2	4	0	-3	0	-2	3	-1	2	-1	-3	0	1	1	0	0	2.176
P25	3	3	-2	0	1	-2	0	-1	-3	-1	4	1	-1	2	0	0	-4	-3	1	2	0	2.176
P26	2	3	4	1	-3	-2	0	0	-1	0	1	3	0	2	-1	-4	-3	-2	-1	1	0	2.176
P27	-1	3	-2	1	4	-2	-3	0	0	2	-4	3	-1	2	0	1	-3	0	-1	1	0	2.176
P28	4	3	1	-1	-3	-2	-2	-4	0	2	1	-3	0	2	1	0	0	-1	3	-1	0	2.176
P29	-3	3	-2	-1	1	-2	2	4	-1	0	-3	3	0	2	-1	0	-4	1	0	1	0	2.176
P30	-2	3	3	2	0	-2	-4	1	-1	-1	0	0	1	2	-1	-3	-3	4	0	1	0	2.176

VALIDITY TESTS

- **Scree Plot**



- **Kaiser-Guttman Criterion**

Kaiser-Guttman criterion indicates that factors with Eigenvalue of 1 or above should be retained. In this data set 8 factors satisfy the Kaiser-Guttman criterion

EV 1	EV 2	EV 3	EV 4	EV 5	EV 6	EV 7	EV 8
10.584	4.1633	2.6049	2.2709	2.2476	1.6538	1.6149	1.3481