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Gender Participation in Tertiary STEM Education in Nigeria: Examining the Current Perspectives

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A B S T R A C T

There are global challenges and problems that require sound and prompt knowledge of STEM in order to seek redress. Dearth of individuals with kin knowledge in STEM fields will further pose threat to the survival of nations of the world. Hence, the study looks into gender participation of undergraduate students in tertiary STEM education. 225 (128 males, 97 females) undergraduate students undertaking STEM related courses formed the sample of this study across four Nigerian universities in Lagos State, South West Nigeria using survey design method. Data were collected through the use of self-developed questionnaire. One research question and one hypothesis were answered and tested using inferential statistics of analysis of variance (ANOVA). The findings indicate wide gender gap in participation exists among undergraduate students in tertiary STEM, especially in science, technology and engineering related courses. The finding further reveals a significant difference in gender participation of undergraduate students in tertiary STEM. The study therefore, recommends all stake holders to adopt scholarships and provision of education materials as motivation to attract boys and girls into STEM fields of study.

1. Introduction

Science, Technology, Engineering and Mathematics are veritable tools for human growth and development. This calls for adequate participation of men and women in STEM education. Hitherto, global observation has shown an indication of under participation of women and girls in STEM Education. This trend is found to extend to/ does not exclude STEM related occupation, where women participation is equally low. This denies the women from participating in high skill STEM

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fields. However, report shows that women and girls claim over half of the word population (Aguele & Agwagah, 2007). Despite the fact that women and girls' population claim half of the world population, it is recorded that percentage of female graduates with core STEM degrees and their participation in female STEM workforce with women still falls below 30% (26% and 24% respectively (Davies, 2023).

Davies (2023), in a study to explore students' and graduates' attitudes towards gender issues that are prevalent within STEM, using data garnered from autumn 2019, 2020 and 2021 reveled an increase in the percentage of respondents that see diversity initiatives as extremely or very important when accepting a job offer. The report indicated 57% of respondents in 2021 acclaimed they suffered from or experience imposter syndrome. Similar report in USA puts women participation in STEM workforce at 25% over three decades. Such report observes that women representation in STEM varies base on industries within the STEM workforce. For instance, women turned in significant gains in certain areas within STEM, especially social sciences, mathematics, and life and physical science occupation.

However, report of study shows that gender pay gap is a function of less representation of female in higher-level and higher-paying positions (Davies, 2023). Nations of the world are now at the cusp of attaining conditions needed to propel and motivate gender equality and equity in academic science (Traylor et al., 2020**).** One of the factors that determine the progress of education is what the teacher does in learning in the classroom (Bella, 2023). According to Miller et al. (2020) traditional academic science cultures portend high walls which serve as barriers to women under- representation in STEM. Literature shows that women now can enter many previously male-dominated academic fields but are still under-represented in higher positions. For instance, women are engaged in commercial driving, occupying positions in politics, banking, academics and military but with low percentage at higher level positions.

Different countries of the word have embarked on programmes and projects to increase women participation equally with men in STEM education careers and disciplines. However, women lost in ever greater proportions as they ascend the academic ladder (Maggian et al., 2020). The rapid development of science and technology has a direct impact on human life, including in the field of education (Agusti, 2023). Developed nations such as USA, UK, Ireland, Europe, and Australia have consistently made concerted efforts to bridge the gender gap in STEM education careers and workforce. STEM Women hosted numerous networking and careers events to help more women to enter STEM careers. Such events open windows of employers to the opportunity to introduce their graduate opportunities, speak on a panel, list their job roles online and reach out to the attendees immediately after an event (Dasgupta & Stout, 2014).

Responsive to the great demand for STEM fields experts to meet up with industry workforce demand in 2023 and prepared to integrate STEM into education, Turkey spurned into research action to survey the interest of students in the secondary school towards STEM careers and ready to integrate STEM into

education (Ünlü & Dökme, 2020). The research finding showed that middle school students' interest in TEM careers differed according to sex, where they lived, and grade levels. The study however, found that students' interest in STEM careers did not differ in relation to their parents' educational status and the levels of income of the family.

STEM (science, technology, engineering, and mathematics) education emphasizes the 21st century skills, integrates science, technology, engineering, and mathematics disciplines, and covers formal and informal education at all education levels. In this 21st century, individual, especially women and girls need to channel the course of scientific and technological development and acquisition to adapt to the attendant of technological changes in the world society (Hebebci & Usta, 2022; Ugras, 2019; Hanum, 2023). Glaring disparity in gender participation in STEM education careers and workforce may not be unconnected to certain factors of difficulty of nature of STEM subjects, teaching strategies, profession interests, age, attitude and self-perception of female and male students.

Ugras (2019), in a study to investigate effects of problem-based STEM activities on STEM profession interests, STEM attitudes and self-efficacy perceptions of grade eight students' long side their views on STEM education, found a significant difference between STEM profession interests, STEM attitudes and self-efficacy perceptions of the students involved in the study. The study further revealed that the participating students viewed STEM education as didactic. Adejimi et al. (2020), in their study to determine relationship between age, gender, verbal ability in biology discovered that there was significant difference in students' achievement based on age, gender and verbal ability. Therefore, age, gender and student verbal ability level are vital predictors of students' possibility to want to do or engage in STEM careers or related field.

For industries, businesses and organizations of the nations of the world to meet up with their workforce demands, grow their economies rely heavily on integrative STEM education for equitable men and women experts, to provide the needed quantity and quality personnel in STEM fields that provide optimum contribution to nation's social, technological and economic growth (English, 2016; Wang & Degol, 2016). Additionally, Sharma and Yarlagadda (2018) posit that the next generation jobs, known and unknown require highly proficient men and women in STEM and STEM-related skills. For this reason, equitable involvement of men and women, boys and girls in STEM education must be given considerable attention and utmost priority by the nations of the world especially developing country like Nigeria.

According to Jones et al. (2018) and Ring et al. (2017) bridging gender gap in STEM participation can be fostered by attracting and retaining more students to STEM programmes and enhance curriculum and instruction in STEM engender desirable performance. Reports in literature show that half of women constitute the workforce in USA, but are still found underrepresented in the science, technology, engineering, and mathematics-related STEM workforce (Davies,

2023). Such report notes that population of girls and boys who engaged in mathematics and science in elementary, middle and high school is about equal but at variance as more men opt to pursue STEM major than women in college (Davies, 2023). To this end, many countries of the world are unrelenting, embarking on producing STEM experts and professionals to take charge of providing solutions to world problems and challenges in all facets of human life (Morales et al., 2022).

As many nations of the world have observed that individuals who are keen and talented in core STEM fields, such as science, technology, engineering and mathematics are germane to contribute to nations overall competitiveness and growth (Adam, 2019). It is therefore, imperative for world nations to make concerted efforts to train and retrain STEM professionals and enhance STEM literacy (Barth et al., 2022). In line with strengthening mutual understanding and connections with highly competitive countries in the arena of STEM education, and to share experiences in STEM education, Taiwan, through the K- 12 Education Administration of the Ministry of Education pulled ten STEM educators from top 15 countries to share their experiences which metamorphosed to the publication of a book " Status and Trends of STEM Education in Highly Competitive Countries: Country Reports and International Comparison''(Barth et al., 2022).

The role of teacher in fostering equal participation of gender in STEM cannot be over emphasized. The ability of the teacher to effectively involve and engage learners in classroom instructions catalyses and fosters desirable learning outcomes. This is corroborated by studies that suggest that inadequate acquisition of teachers' content, pedagogical and content pedagogical knowledge promotes poor performance of students in STEM (Sharma & Yarlagadda, 2018). To this end, Morales et al. (2022) advocate possession of sound and adequate pedagogical and content knowledge by the teacher to encourage and propel equal gender participation in STEM education. This implies bridging gender gap in STEM demands teachers who are competent to handle technology, pedagogy and stuffed with superb content knowledge to attract and retain boys and girls in STEM (Scherer, 2014).

In Nigeria, the Africa Centre of Excellence for Innovative and Transformative STEM Education at the Lagos State University has been consistently promoting STEM professionals through its academic programmes that open doors for both national and international students. The centre through its dynamic leadership team engages STEM teachers at all levels of education with incessant workshops, seminars, conferences and training programmes. Hence, this study focuses on examining the current perspective of gender participation in tertiary STEM education in Nigeria.

2. Methodology

The study was descriptive survey deign to establish status of gender participation in STEM in tertiary institutions. Population was drawn from tertiary institutions in

Lagos State, south west, Nigeria with sample randomly selected from four universities across the state. These include three state universities owned by the Lagos state government and one Federal university run and maintained by the Federal government of Nigeria. For the purpose of the study, a peer-reviewed 4-point Likert-scale (Strongly Agree (SA), Agree (A), Disagree (D), and strongly Disagree (SD)) type questionnaire with 4 sections developed by the researchers was the main instrument used for data collection. Section A- demographic profile requires the participants to check the boxes as it applies to them, which include gender, disciplines in STEM education or course of study. Section 'B'- 25 structured items based on factors that influence or enhance gender disparity in STEM fields, requires participants to rate these items as they relate or influence the choice of STEM fields.

The instrument was validated by four experts for content and constructs validity. The instrument was administered to 255 students in the universities in Lagos state, south west, Nigeria. The respondents consisted of 128 males and 97 females (see figure 1). Of the 255 students that participated in the study, 117 students were in science related courses, 32 in technology courses, 29 in engineering and mathematics courses respectively, and 18 participated in other courses that are not within the purfew of STEM fields (see figure 2). 255 questionnaires were distributed and 248 were retrieved representing 97.25% return rate. 23 of the 248 returned were declared invalid due to inappropriate completion of the questionnaires to, representing 9.27 % of the return rate. It was thereafter subjected to Cronbach's Alpha to earn a reliability index = 0.84. Research question was answered with mean and standard deviation while the hypothesis was tested with inferential statistics of analysis of variance (ANOVA). SPSS 25.0 was employed to execute analysis of data collated at 0.05 level of significance.

3. Results and Discussion

Based on data analysis in research. The results of Bar Chart Showing the Distribution of Respondents by Gender in Figure 1.

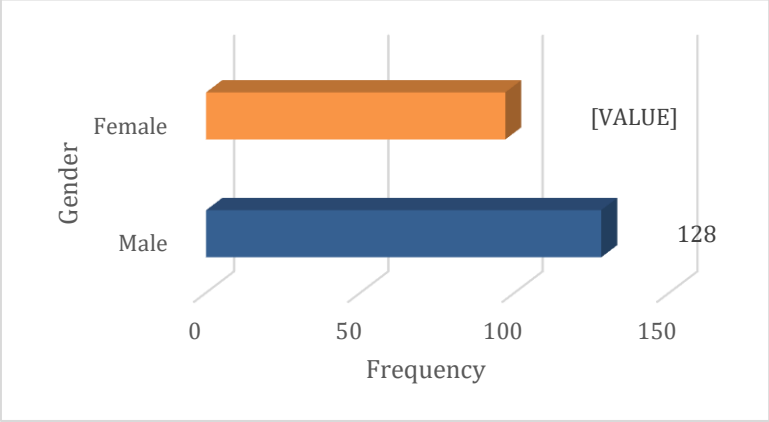

Figure 1. Bar Chart Showing the Distribution of Respondents by Gender

Figure 1 indicates that out of the 225 respondents that participated in the study, 128 were males and 97 were females. Figure 2 indicates that 117 students participated in science related courses, 32 in technology courses, 29 in engineering and mathematics courses respectively, and 18 participated in other courses that are not within the purfew of STEM fields (Figure 2).

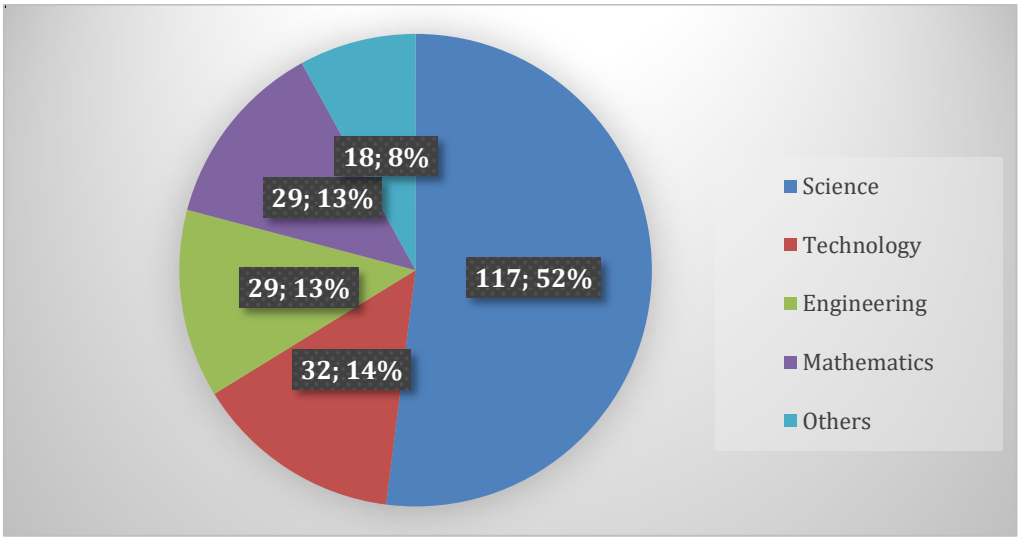

Figure 2. Bar Chart Showing the Distribution of Respondents by Course Studied

Table 1 shows gender participation of undergraduate students in tertiary STEM fields or career. 61 males against 56 females were found studying science related course, 21 males and 11 females were discovered studying technology related courses. In engineering, 23 male and 6 female undergraduate students were discovered to be studying engineering. 15 male and 14 females were found to by studying mathematics respectively with 8 males and 10 females studying other non-STEM related courses (Table 1).

Table 1. Summary of Gender Participation in STEM Careers

Career	**Male**	**Female**
Science	61	56
Technology	21	11
Engineering	23	6
Mathematics	15	14
Non-STEM related courses.	8	10

Research question: Is there a significant difference in male and female undergraduate students' participation in STEM?

To answer the research question, it was converted to the hypothesis below

Ho_1: There is no significant difference in male and female undergraduate students' participation in STEM

Table 2. Summary ANOVA of tertiary students' participation in STEM

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	406.085[a]	9	45.121	5.365	.000	.183
Intercept	30397.023	1	30397.023	3614.541	.000	.944
Gender	12.630	1	12.630	1.502	.222	.007
Career	379.310	4	94.828	11.276	.000	.173
Gender * Career	28.350	4	7.088	.843	.499	.015
Error	1808.075	215	8.410			
Total	56410.000	225				
Corrected Total	2214.160	224				

a. R Squared = .183 (Adjusted R Squared = .149)

Table 2 shows the results of analysis of variance of gender participation of undergraduate students in STEM fields. The results show that there was a significant [F (4, 215) = 11.28; $p < 0.05$)] difference in male and female undergraduate students' participation in science, technology, engineering and mathematics.

Discussion

The quest to ensure equal gender participation in STEM education, especially in tertiary institutions of learning remains the focus of this study. Therefore, the study sought to determine perspective of gender participation in tertiary STEM education in Nigeria. The finding to the research question revealed that more male and female undergraduate students were found undertaking their studies in science courses with male taken a lead. Of the 225 participants, 117 were found to study science. 61 of the 117 were males, along with 56 female counterparts studying science related courses. A total of 32 students were found studying technology courses. 21 of these 32 students were males leaving 11 female students found to be undertaking study with their male counterparts. In engineering, 23 males and only 6 female students were found, while 15 males and 14 females were found undertaking their courses in mathematics.

In all the components of STEM education, male participation outnumbered the females, with the exception of mathematics where the male topped by a difference of one. This finding attests to STEM Women report (2022) that discovered low percentage of female graduate with degree in core STEM and participation in STEM workforce. It therefore implies that gender gap exists in enrolment and participation of undergraduate students in tertiary STEM. This phenomenon may not be unconnected to their attitude and innate tendencies. However, if there are motivations and teachers adopt gender friendly pedagogy or strategies that make teaching and learning of science, technology, engineering and mathematics quite interesting to both genders, then more females will be drawn to and retained in STEM. In addition, the finding is in consonance with Chauke (2022), who discovered a number of push-pull factors were responsible for influencing both male and female choice of STEM careers. Such factors are lucrative salary,

graduate unemployment rate, aptitude for math and science, parental education, autonomy and independence, and rejecting stereotypical feminine identities.

However, male and female students differ on how each of the factors influences their choice of careers in STEM. While the female believed feminine as influencing factor to their choice of STEM careers, the male consented to passion as their motivating factor. That is the male did not believe that gender plays a role in their ability to choose STEM careers. Again, female students consented to parental education as another motivating factor to choose STEM career, but the male disagreed, rather they owned their choices. Divergence view of students on push-pull factors remains cogent reason for gender difference in participation in STEM career. It therefore implies that teachers should engage tertiary institution students with instructional strategies that would foster and motivate their interest to choose and study STEM careers.

Earlier studies have shown that use of student-centred instructional strategies is capable of bridging gender performance in sciences, and hence other components of STEM (Adam et al. 2023). Lameed et al. (2023) discovered that use of problem-solving strategy helped to foster higher-order thinking of male and female students. Similarly, the study of Akintoye et al. (2023) showed that use of culture-techno-contextual approach bridged gender performance of students in STEM subject. This suggests that one of the ways to encourage equal participation of students in STEM include exposure to experiential strategies of instruction.

Further, the study sought to determine how significant was the difference in gender participation of undergraduate students in tertiary STEM education. The finding revealed that there exist significant differences in the participation rate of male and female undergraduate students in favour of the males. This is in alignment with Adejimi et al., (2020), who discovered gender as a predictor of students' possibility to want to engage in STEM careers or related fields. The study suggests wider gap existed between male and female students studying sciences, technology and engineering. The disparity is preponderance in technology and engineering. This brings to mind the population of women engineers to find their way into industries where higher man power service is needed with higher pay.

Besides, this is an indication that women may likely remain inequitable with men counterparts. Ability to understand perspective of gender participation in STEM fields provides insight on measures to put in place to equate participation of men and women in STEM fields or careers. This will make women and females or girls to effectively take their place of role in technology and engineering workplace (Folberg & Kaboli-Nejad, 2020). In similar vein, the finding is consistent with Folberg and Kaboli-Nejad (2020), who found that women endorse communal goal orientations as predictor of their interest in female stereotypic careers, while men endorse agentic goal orientations as predictor of interest in male-stereotypic careers. Having more men in STEM than women may indicate that men accept STEM careers or disciplines as potential tool for future use,

especially in the development and growth of the society. Therefore, a continued gender gap in tertiary STEM will post threat to social, economic, political and technological growth and development of the developing nations especially Nigeria. To foster equal participation of gender in STEM, the teacher must have ability to effectively involve and engage learners in classroom instructions to foster desirable learning outcomes (Adam et al., 2022). Therefore, teachers need to acquire adequate content, pedagogical and content pedagogical knowledge to promote desirable performance of students (Sharma & Yarlagadda, 2018), and encourage equal gender participation in STEM (Morales et al., 2022).

4. Conclusion

Corroboration has emerged regarding gender participation in tertiary STEM, with specific reference to undergraduate students in tertiary institutions. The study has made it clear that gender gap exists in participation of tertiary students in STEM fields. More male students were discovered studying science, technology and engineering with narrow gap in mathematics than females. Further, the result of the study indicates significant gap exists between male and female undergraduates' participation in STEM. The study therefore beckons on stakeholders to be responsive with interventions that encourage equal gender participation in STEM.

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