

FACTORS INFLUENCING FEMALES' PARTICIPATION IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) AMONG UNDERGRADUATES IN ENUGU STATE, NIGERIA

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Abstract:

STEM stands for Science, Technology, Engineering and Mathematics. STEM has been identified as the bedrock or foundation of wealth and consequently an imperative for national development. It has been argued that in this era of globalization, any persons with appreciable skills, knowledge and abilities in STEM are required in the job market. Female gender discrimination is also said to be evident in the school system (at all levels), of any developing countries including Nigeria. A descriptive survey study was designed to investigate the factors influencing females' participation in STEM in tertiary institutions in Enugu State, Nigeria. The study focused on females' interest levels in studying STEM education, the causes of poor participation of females in STEM and the female student's attitudes towards STEM. Four hundred and fifty (450) undergraduate students constituted the population for the study. Five tertiary institutions were selected from Enugu State, Nigeria. A simple random sampling technique was used for the selection. The instrument for data collection was questionnaire having three sections to reflect the three areas of focus of the study. Data collected were analyzed using descriptive statistics and percentages. It was found among others that; the STEM courses textbooks are very expensive; Females aspirations and ambitions are always affected by some religious beliefs and practices; and that females upbringing is more to domestic sciences than physical sciences. Based on the findings of this study, recommendations were made to enhance females' participation in STEM in Enugu State, Nigeria.

Keywords: Gender discrimination, National development, Sciences, Technology, engineering and mathematics (STEM)., interests, causes and attitudes.

Introduction

Education has been recognized in Nigeria as in many other countries as a vital and powerful tool for political, economic and social change. According to national policy on education (1981:5) the 'Federal Government of Nigeria has adopted education as an instrument per excellence for effective National development', Women as well as men have great roles to play in National development and for effective performances of these roles, both gender need education as such, gender should not be considered a barrier to education. Science, Technology, Engineering and Mathematics (STEM) have been identified as the bed rock for national development. It has been stressed out that in this era of globalization, only persons with appreciable knowledge, skills and abilities in STEM are required in the job market. It has been argued that he who educates a boy

educates a single person and he who educates a girl educates a nation, but female gender discrimination is said to be evident in the school system of many developing countries.

This study aimed at addressing the broad issue of females' participation and underrepresentation in Science, Technology, Engineering and Mathematics (STEM). The study was motivated by the historical underrepresentation and participation of females' in the domain of STEM particularly in Nigeria. This can be seen within higher education, where women receive only a small fraction of undergraduate degrees in Physics (19%), Engineering (20%) and Computer Science (18%), (National Science Foundation [NSF]-2015). Disparities continue in the workplace, with women constituting 12% of physicists/ astronomers, 15% of engineers and 24% of computer and information Scientists (National Science Foundation [NSF]- 2015). Female education in STEM includes child and adult female represented in the field for science, Technology, Engineering and Mathematics (STEM). In 2017, only 33% of students globally were women in STEM fields. (UNESCO, 2016). It is disheartening that despite the relevance and utilitarian purpose of STEM, it has been observed that participation of females in the field is relatively low. Bandekale (2003) reported that women in Africa are greatly underrepresented in science and technology related courses/occupations. In the same vein, the international conference organized by UNESCO in Bamako, Mali in July 2009 assessed the participation of girls and women in science and Technology in Africa to be the lowest of all the regions of the world (Nnaka, 2009). Alutu & Eraikhuemen, [2004] investigated the involvement of females in mathematics in South Western Nigerian Universities. The study showed that the ratio of Male to female lecturers was approximately 16: 1 and the ratio of males to females enrolled at the undergraduate level was 2:1, while at the postgraduate levels, the ratio of male to female on roll was 6:1.

The state of Science, Technology, Engineering and Mathematics in the country is now a matter of great concern to all. This concern arises from the increasing realization that Nigeria cannot develop as rapidly as she aspires to without creating an adequate pool of scientific and technological manpower at all levels in her working population, Aghadinuno (1987). However, it is being speculated that enrolment and performance of females in the hard Sciences, Technology, Engineering and Mathematics have been relatively low in Nigeria. Ajayi (1989) pointed out that "the enrolment of girls/women in science-based training program and profession is very low. For a country to develop progressively and rapidly, there must be an involvement of both sexes in the field of science and technology. The low proportion of women in science and Technology has philosophical, social and economic implications. It has been estimated that women constitute more than 50% of the Nigerian population, and as such their low representation in any aspect of the education program would amount to losing the contribution of more than one half of the population. In short, development of the country would be incomplete without women. Nigerian women have made and are still capable of making decisive contributions to national development as workers, mothers, initiators and socializing agents therefore, low representation of women in science, Technology Engineering and Mathematics would cause the country to lose the benefit of economic potential of them.

Science, Technology, Engineering and mathematics can be seen as a cord of four stings which are interwoven and interdependent. Advances in one field result in development in the other. According to US Department of Commerce, STEM occupations are growing at 17% while

other occupations are growing at 9.8%, STEM degree holders have a higher income even in non-STEM career. STEM workers play a key role in the sustained growth and stability of the US economic and are critical component to helping US win the future (NSF 2015).

The question of whether there are differences in cognitive ability between men and women has long been a topic of debate among researchers and scholars (UNESCO, 2017). Loss of interest has been the major reason cited for girls opting out of STEM. However, some have stated that the choice is influenced heavily by the socialization process and stereotyped ideas about gender roles, including stereotypes about gender and STEM. Gender stereotypes that communicate the idea that STEM studies and careers are male domains can negatively affect girls' interest, engagement and achievement in STEM and discourage them from pursuing STEM careers. (PISA, 2015). Females have been considered just as even they also consider themselves as the weaker sex which cannot do anything, and are also dependent upon males (Ajayi, 1989). Boys (males) usually receive more encouragement and support from their teachers and parents to do science than girls (females). Females are protected and prevented from engaging in risk-prone activities which may be at variance with the qualities that enhance the doing of science such as curiosity, independence, risk-taking and freedom to disagree or differ (Aghadinuno, 1989). Again, Maduka (1989) reported that, "Many of the girls in fact do not want to exert themselves studying for any course at all, let alone engineering and technology". On the other side, parents contribute to girls' lack of involvement in science and technology there are some girls who might even want to stay in school and offer science and technology courses but were withdrawn by their parents pre-maturely for marriage or to help out at home. In other word, parents are also responsible for low enrolment and participation of female in STEM. Aghadinuno (1987) further points out that, certain cultural and religious practices adversely affect the access or prevent girls from obtaining formal education which automatically eliminated them from the chances of study as well as participating in science.

These practices include the second-rate status traditionally ascribed to women, the enforcement of girls into early marriage as a means of avoiding moral and sexual contamination and mandatory solution of married women from public glare. Culture and social norms influence female' precipitations about their abilities, role in society and career as well as life aspirations. The degree of gender equality in wider society influences females' participation and performance in STEM. Gender mainstreaming legislation or policies such as quotas incentives among others can increase females' participation in STEM education and career PISA [2015]. This trend of female low enrolment, participation and achievement in STEM is worrisome, if females are not participating in STEM how can they contribute their quota to national development. Non participation of females in STEM will eventually culminate in being a misfit for the job market and consequently in economic development. This must not be allowed to happen, therefore, both the government and society as well as parents and teachers should work together in order to develop and implement strategies to improve females' enrolment, participation and achievement in STEM.

Statement of the Problem

It has been stressed out that in this era of globalization, only persons with appreciable knowledge, skills and abilities in STEM are required in the job market. It has been argued that he who educates a boy educates a single person and he who educates a girl educates a nation, but

female gender discrimination is said to be evident in the school system of many developing countries. Gender differences in STEM education participation are already visible in early childhood care and education in science and mathematics related play, and become more pronounced at higher levels of education. Girls appear to lose interest in STEM subjects with age, particularly between early and late adolescence, this decreased interest affects participation in advanced studies at the secondary school level and in higher education (UNESCO, 2017). Female students represent 35% of all students enrolled in STEM – related fields of study at higher level globally, differences are also observed by disciplines with female enrolment lowest in engineering, manufacturing and construction, natural science, mathematics and statistics and ICT fields women leave STEM in disproportionate numbers during their higher educational studies, in their transition to the world of work and in their career cycle. (PISA, 2015). STEM has been identified as the foundation of wealth creation and an imperative for national development, and anybody who wants to be relevant in this regard must be STEM compliant. It has been established that the participation of females in STEM, particularly in Africa (Nigeria inclusive) has been very low. Thus, what are the interest levels of female students in studying STEM? What are the causes of poor participation of female students in STEM? and what are the female students' attitudes towards STEM? These constitute the problem of this study.

Purpose of the Study:

This study is aimed at identification of the factors that influence females' participation and their underrepresentation in Science, Technology, Engineering and Mathematics [STEM]. It also aimed at finding out the following;

1. The interest levels of female students in studying STEM, in Enugu State, Nigeria.
- 2.. The causes of females' poor participation in STEM in Enugu State, Nigeria.
3. The female students' attitudes towards STEM in Enugu state, Nigeria.

Research Questions:

The study was guided by the following research questions:

1. What are the interest levels of females in studying STEM?
2. What are the causes of poor participation of females in STEM?
3. What are the attitudes of females towards STEM?

Methodology:

The study adopted survey research design. It was restricted to five [5] Tertiary institutions in Enugu state, Nigeria. A total of four hundred and fifty [450] undergraduate students of the selected institutions constituted the population of the study. The study used random sampling in the selection. Instrument for data collection was questionnaire which comprised of twenty [20] items with three [3] sections, the items were designed to elicit information from the respondents concerning; the females' interest in STEM; the causes of females' poor participation in STEM, and the females' attitude towards STEM. Four hundred and fifty [450] questionnaires were distributed by the researcher who made personal visit to the five selected tertiary institutions, the researcher also waited and collected all the distributed questionnaires from the respondents. The

instrument made a reliability index of 0.71 after the trial test. The data collected were analysed using descriptive statistics and percentages.

Result:

Research Question 1: What are the interest levels of females in studying STEM?

Table 1: The Interest Levels of Females in Studying STEM.

S/N	Statements	Agree		Undecided		Disagree	
		Freq	Pec[%]	Freq	Pec[%]	Freq	Pec[%]
1.	STEM courses textbooks are very expensive.	350	77.8	11	2.4	89	19.8
2.	STEM courses textbooks contain so many ambiguous words and are very difficult to understand.	267	59.4	15	3.3	168	37.3
3.	The course contents of all STEM courses are too wide.	254	56.4	14	3.2	182	40.4
4.	STEM courses lectures are always boring.	160	35.6	22	4.8	268	59.6
5.	Our STEM lecturers make STEM lessons very interesting and easy to understand	217	48.2	25	5.6	208	46.2
6.	I am studying STEM course because my parents forced me to.	12	2.7	12	2.7	426	94.6
7.	I am studying STEM course because my friends are studying it.	12	2.7	03	0.7	435	96.6

On the interest level of the undergraduate female students, 77.8% of the students agreed that the STEM courses textbooks are very expensive, and 59.4% of the students agreed that the STEM courses textbooks contains so many ambiguous words and are very difficult to understand. 56.4% of the students accepted that the course contents of all STEM courses are too wide. 94.6% of students disagreed that they are studying STEM courses because their parents forced them to, while 96.6% of students disagreed that they are studying STEM courses because their friends are studying it. 59.6% of the students disagreed that STEM courses lectures are always boring while 48.2% of the students agreed that their STEM lecturers make STEM lessons very interesting and easy to understand.

Research Question 2: What are the courses of poor participation of females in STEM?

Table 2: The Causes of Poor Participation of Females in STEM.

S/N	Statements	Agree		Undecided		Disagree	
		Freq	Pec[%]	Freq	Pec[%]	Freq	Pec[%]

1.	Females are afraid of coping with the demand of STEM courses as a married women and mothers.	182	40.4	14	3.2	254	56.4
2.	Females are not favorably considered when it comes to employment in the field of STEM	264	58.7	06	1.3	180	40.0
3.	Females do not like long period of training which characterizes most of STEM courses and jobs	186	41.4	06	1.3	258	57.3
4.	Females normally have reduced marriage opportunities if they study STEM courses	74	16.4	14	3.2	362	80.4
5.	Females go along with societal values and expectations in all their endeavors	256	56.9	19	4.2	175	38.9
6.	Females aspirations and ambitions are always affected by some religious beliefs and practices.	290	64.4	14	3.2	146	32.4
7.	Females are not encouraged to study STEM courses by their parents and teachers	85	18.9	10	2.2	355	78.9
8.	Females are motivated to study STEM courses through the gift of rewards, incentives and free education.	146	32.4	05	1.1	299	66.5

On the causes of females' poor participation in STEM; 64.4% of the students agreed that, Females aspirations and ambitions are always affected by some religious beliefs and practices, 58.7% of the students agreed that females are not favorably considered when it comes to employment in the field of STEM, 56.9% of the students agreed that females go along with societal values and expectations in all their endeavors. 80.4% of the students disagreed that females normally have reduced marriage opportunities if they study STEM courses, 78.9% of the students disagreed that females are not encouraged to study STEM courses by their parents and teachers, 66.5% of the students disagreed that females are motivated to study STEM courses through the gift of rewards, incentives and free education, 57.3% of the students disagreed that females do not like long period of training which characterizes most of STEM courses and jobs, and 56.4% of the students disagreed that females are afraid of coping with the demand of STEM career as a married women and mothers.

Research Question 3: What are the attitudes of females towards STEM?

Table 3: The Attitudes of Females towards STEM.

S/N	Statements	Agree		Undecided		Disagree	
		Freq	Pec[%]	Freq	Pec[%]	Freq	Pec[%]
1.	Females are not serious in studying let alone studying STEM courses.	26	5.8	10	2.2	414	92.0
2.	Females often have lower level of belonging while in STEM.	79	17.6	13	2.8	358	79.6
3.	Females always feel unaccepted and unfit within STEM.	100	22.2	16	3.6	334	74.2
4.	Female's upbringing is more to domestic sciences than physical sciences.	258	57.4	06	1.3	186	41.3
5.	Females sees studying STEM as a waste of time, energy and resources	89	19.8	04	0.9	357	79.3

From Table 3 above, 57.4% of the students agreed that female's upbringing is more to domestic sciences than physical sciences. 92.0% of the students disagreed that females are not serious in studying let alone studying STEM courses; 79.6% of the students disagreed that females often have lower level of belonging while in STEM; 79.3% of the students disagreed that females sees studying STEM as a waste of time, energy and resources; while 74.2% Of the students disagreed that females always feels unaccepted and unfit within STEM.

Discussion of Findings

On the interest levels of females in studying STEM; students were in agreement that, the STEM courses textbooks are very expensive, contains so many ambiguous words that are very difficult to understand, the course contents are usually too wide. The textbooks and its ambiguous words are in agreement with some researchers' findings, Akanbi [2003], argued that poor performance in physics [which is a core science subject] is due to factors like textbooks, most of the languages used in the textbooks are complex and ambiguous, hence, it becomes difficult for students to comprehend. Akinola [2006] also argued that most of the textbooks used in sciences are written by foreign authors who use complex languages which is difficult for students to follow. The students disagreed that they are studying STEM course because their friends are studying it, and that, they were forced by their parents to study STEM course. They disagreed that STEM lectures are always boring, while they agreed that their STEM lecturers make STEM lessons very interesting and easy for their understandings. This is not in agreement with some researchers' findings; Among the factors that contributed to students' poor performance in sciences were shortage of qualified and devoted instructors [teachers/lecturers] and the teaching methodology used by the instructors. [Akinola, 2006]

On the causes of females' poor participation in STEM; Students agreed that, females' aspirations and ambitions are always affected by some religious beliefs and practices, and that females go along with societal values and expectations in all their endeavours. This findings is still in agreement with that of Aghadinuno, [1987], who stressed that certain cultural and religious practices adversely affects the access or prevent girls [females]from obtaining formal education

which automatically eliminated them from the chances of studying as well as participating in sciences, these practices includes, the second-rated status traditionally ascribed to women, the enforcement of girls into early marriage and the mandatory separation of women from public glare; Culture and social norms influence females' perceptions about their abilities, role in society and career as well as life aspirations. Students agreed that females are not favorably considered when it comes to employments in STEM fields. Mari [2005] believed that gender discrimination in employment is one of the factors contributing to gender inequality in pursuit of STEM. even women also find it difficult to employ their fellow women because of one reason or the other. Recently on social media, a woman refused to employ a woman engineer, her reason being that she doesn't want someone that will be pregnant very soon. Students disagreed that, females are afraid of coping with the demand of STEM courses as a married women and mothers, females normally have reduced marriage opportunities if they study STEM, females do not like long period of training which characterizes most STEM courses and jobs. This is not in agreement with Ajayi [1989] who pointed out that, females are been considered, just as they, also consider themselves as the weaker sex which cannot do anything. Students disagreed that, females are not encouraged to study STEM courses by their parents and teachers. This did not agree with Maduka [1989]'s findings, "teachers do little or no guidance on the career choice of students, and parents contributes to females lack of involvement in science and technology". Aghadinono [1987] also pointed out, Males usually receive more encouragement and support from their teachers and parents to do science than females. Students disagreed that, Females are encouraged to study STEM through the gift of rewards, incentives and free education. Gender mainstreaming legislation or policies such as quotas, incentives among others can increase females' participation in science education and career. [PISA 2015].

On the females' attitudes towards STEM; Students agreed that, Females upbringing is more to domestic sciences than physical sciences. Aghadinuno [1987] reported that females are encouraged to conform to home activities and are prevented from engaging in risk-prone activities, they undergo some trainings at home under their mother, and they were taught to take care of children, prepare food, wash utensils and take care of the dwelling places. Students disagreed that females are not serious in studying let alone studying STEM courses. This is not in support with Maduka [1989], who reported that many girls do not want to exert themselves studying for any course at all let alone Engineering and Technology. Students also disagreed that, females see studying of STEM as a waste of time, energy and resources; females often have lower level of belonging while in STEM; and that females always feels unaccepted and unfit within STEM. One critical social factor implicated in students' performance and participation is their feeling of acceptance and fit within STEM, women often report lower levels of belonging than men [Lewis &Hodges, 2015].

Conclusion

STEM is very important because it pervades every part of our lives. Science is everywhere in the world around us. Technology is continuously expanding into every aspect of our lives. Engineering is the basic design of roads, bridges, houses etc., but also tackles the challenges of

changing global weather and environmentally-friendly changes to our home. Mathematics is in every occupation and every activity we do in our lives. By exposing students [both males and females] to STEM and giving them opportunities to explore STEM-related concepts, they will develop a passion for it and hopefully pursue a job/career in STEM fields. STEM education creates critical thinkers, increase science literacy, and enables the next generation of innovators. To succeed in this new information-based and highly technological society, students [both males and females] need to develop their capabilities in STEM to levels much beyond what was considered acceptable in the past [NSF, 2015]. In order to compete in a global economy, STEM education and career must be a national priority since each and every decision made uses an aspect of STEM to understand the implications. It is disheartening that despite relevancies and utilitarian purpose of STEM, females are still underrepresented and their participations in the field is still relatively low. The findings of this study revealed the following:

On the interest levels of females in studying STEM; Females are not studying STEM courses because their parents forced them to, and either were they studying it because their friends are studying it. Their STEM course lecturers are doing their best, making the lectures interesting, easy to understand, and making the lessons lively and not boring. But the major thing that weakens their interest in STEM is the cost effectiveness of the textbooks, the ambiguity of the words or languages used in the textbooks and the wideness of the course contents of STEM.

On the causes of females' poor participation in STEM; Females were not afraid of coping with the demand of STEM career as a married women and mothers, neither do they have reduced marriage opportunities if the go into STEM careers and jobs, they were always encouraged by their parents and teachers to study STEM courses, and they actually like long period of training which characterized most STEM careers and jobs. The causes of their poor participation in STEM were the fact that, their aspirations and ambitions are always affected by some religious beliefs and practices, they are not favorably considered when it comes to employment in STEM fields, they go along with societal values and expectations in all their endeavours, and they are not motivated to go into STEM careers through rewards, incentives and free education.

On the females' attitudes towards STEM; females believed that they are actually serious in studying all courses including STEM courses, they do not feel unaccepted or unfit within STEM, neither do they have lower level of belonging while in STEM, and they do not see studying of STEM courses as a waste of time, energy and resources. Their attitudes have to do with their upbringing, which is more to domestic sciences than physical sciences.

Recommendations:

A careful analysis of these findings points to the fact that, concrete steps need to be taken by the government and other stakeholders in order to increase females' participation in STEM. Based on the findings and conclusions reached in this study, the following recommendations were made:

1. Government should make STEM textbooks available in libraries, in quantity and quality too, and also make them affordable through relieve grants. The publications of STEM textbooks with simpler words and languages should be encouraged.

2. There should be no gender discrimination in terms of employment in STEM fields, and females should be encouraged to go into STEM careers through the gift of rewards, incentives as well as free education, especially to females that excel in STEM.
3. Parents and teachers should continue to encourage females to move out of their normal upbringing ways which is more to domestic sciences and go into STEM fields, which is more of physical sciences.

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