

Full Length Research Paper

A study on the barriers to participation of females in science, mathematics and technology education in Imo State the way forward

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A study was carried out to ascertain the barriers to effective participation of females in surface-mount technology (SMT) in Imo State. Four purposes and four research questions guided the study. The study adopted the survey research design. The population of the study consists of all the female science students and lecturers in six tertiary institutions in Imo state. The simple random sampling technique was adopted with a sample size of six hundred respondents. A structured questionnaire was used to elicit response which was analyzed using mean. Findings revealed that domestic issues and responsibilities, culture of marginalization, stereotyping of knowledge and skills are barriers to effective participation of females in SMT. It was therefore recommended that schools should be gender responsive and females should be assertive and stand for their rights in order to move forward.

Key words: Barriers, stereotype, marginalization, science, mathematics and technology.

INTRODUCTION

In Nigeria, the government is increasingly realizing that technological development is mandatory for the country's overall development. During the introduction of formal education in Nigeria, efforts were made by parents to ensure that females did not attend formal education. This was for several reasons one of which was that it was considered wasteful as girls would eventually be married off to become housewives (Bandekale, 2003).

Thus, women formal education was not favoured by parents early enough. However traditional forms of education were available to prepare women for future roles. According to STAN (1992), a constant problem to the continued attendance of girls in school at the early period was withdrawal for early marriage and this was

common in Northern part of the country.

As a result of the foretasted setback, there is under-representation of women in education generally and especially in the field of science and technology. Harding (1987) posits that low performance of women in science, mathematics and Technology can be due to:

1. The assumption the society makes about males and females (their abilities, behaviours roles and aspirations).
2. The objectives and organization of education
3. The practice of science, mathematics and technology.

The aforementioned factors are embedded in the political and cultural context of the society. Maccoby and Jackson

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(1975) gave credence to statement that males display superior spatial skills however argued that equitable distribution and creation of science and technology is a necessary prerequisite for the development and improvement of human beings.

It is critical that the Nation's workforce in a climate of significant and global economic restructuring aims at attaining and maintaining a state of technological and scientific readiness that will enable it to thrive in the global economy. To achieve this, all the sections of the population must be fully developed. A way of achieving this is through the building and encouraging of scientific literacy.

The participation of women in science, mathematics and technology education has been and is still low around the world (Kishore, 2008; McCarthy, 2003; Ellis, 2003). United Nations has recognized the role of women in the development of any country as well as the importance of understanding the gender differentiated efforts of development plan and to this end the platform of Action of the 4th United Nations World Conference on women (1995) noted that women's empowerment and full participation are prerequisites for the achievement of equality, development and peace. Though women are underrepresented in almost every sphere of recognized scientific participation (Macathy, 2003) there is increasing participation in the 21st century (British Council, 2001).

Generally speaking, science subjects like chemistry are given masculine outlook by many educationist, such that girls in Science, Mathematics and technology Education attracts attention. Fegbesan (2010) states that curricular, pedagogic practices and classroom organization hinder the access and retention of girls in science and technology education. Gender mainstream have led to advance studies and women participation in science, mathematics and technology.

Thus, United Nations conventions such as the 1995 World Conference on Women held in Beijing and the world conference on science held in Budapest in 1999 called for the collection of gender disagreed data reflecting women's economic, science and technology contributions (UNESCO, 2014).

According to Orji (2000), some professions like carpentry, engineering, woodwork, Mental work and Automobile Engineering technology are still regarded in some quarters as a no go area for females while nursing and catering professions are seen as exclusive for women.

Technology and Science Education is very important for both men and women alike because it accelerates the pace of change in the world. Science, mathematics and Technology provides the foundation for wealth and development bringing immense improvement to the quality of life and people's ability to interpret the world. The process of Technology Education provides knowledge, develops skills and inculcates attitudes that are necessary for future occupation.

Science, Mathematics and Technology Education is an important tool in National Reforms for development and poverty reduction in the present National Economic Empowerment and Development Strategy (NEEDS) FOR Nigeria. Participation of females in science and technology is necessary, but socialization and traditional roles assigned to the girls at birth still determines the level of participation girls in science and technology, maths education, because the life of the person is influenced or affected by socio-cultural forces. The culture learned directly or indirectly to a large extent determines how the person thinks and feels, directs his or her actions and defines his or her outlook in life.

Viadero (2006) pointed out that differences in brain structure, hormone production or maturation rates may account for differential performance in school-related tasks. Furthermore, the parts of the brain responsible for processing verbal information and control of impulse mature earlier in males, thus Acker and Oathy (1993) reports that females are indifferent in science because they lack analytical and visual spatial skills needed for abstract reasoning to science. The above argument has been proved wrong with the emerging evidence which shows that ability is not a determining factor in performance because girls and boys are found to perform equally well if instructional context is fair and conducive (Campbell et al., 2002; Erinosh, 2008).

According to Johnson (2007), males are more variable on most quantitative and visuospatial ability, which necessarily results in more male at both high and low ability extremes, and achievement to communicate and comprehend abstract ideas effectively. Thus, better performance by males than females contributed to interest, specific brain and cognitive systems.

Furthermore, few females than males have innate ability to succeed in academic disciplines that requires advance mathematical abilities, hence the scarcity of females with exceptional mathematical talent, which explains the disparity in female and female and male ratio in science, mathematics and technology education.

The wide gap between males and females has expired over the years and deliberate efforts have been made by United Nations to address it, the efforts include declaration of a decade for women which culminated in the Beijing conference of 1985, Education for all and millennium Development Goals (UN, 2000; Oldham, 2000; UNDP, 2001). Fegbasan (2010) points that there is a relationship between gender role, orientations and gender stereotype with related variables.

Science plays a central role in contemporary society, with the potential to improve lives in a multitude of ways and advance national development. Access to the fruits of science at the individual and collective levels, however lies primarily with those endowed with scientific knowledge and skills. Thus Science is regarded as the cornerstone of industrial development and the link between technology and socio economic development

(Ekwe, 2014).

Hence closing the gender gap in science is of critical importance for all countries because failure to do so means the loss of vast human resources that could contribute to National development and further entrenchment of gender inequality in the society.

A country's ability to create, apply and diffuse scientific and technological knowledge is now a major determinant of its socioeconomic development and national competitiveness. This potential cannot be fully realized without making the best use of the entire population of a nation including girls and women. There are 69 million women and girls in Nigeria (United Nations Department of Economic and Social Affairs (2010). Their exclusion from the generation and application of scientific knowledge represents a tremendous waste of human potentials.

According to Garder (1984) and Ocho (1985), in Nigeria culture female children are reared differently from males. Girls are protected and discouraged from explorative and risky activities while males are encouraged to be assertive and challenge their mental powers thus socialization leads to certain personality characteristics regarded as masculine or feminine independent qualities such as initiative and assertiveness for boys; dependency, submissiveness and complacency for girls towards science as they believe that they are inferior to boys physically and mentally. Schools specifically play important role in females' access to science by the manner the school curriculum is implemented in Nigeria.

Spear (1985) posits that sex, attitude and teaching approach of teaches influences the attitude of female students, whom they believe view science to be more important to boys than girls. In support, Sadker and Sadker (1986) stated that confidence of females are low such that their ability to study science subjects like mathematics is practically unconnected with their actual ability.

According to Udeani (2012), school factors like Instructional materials, illustration, examples and applications presented in resources materials are more familiar in general to the experiences and interest of males than to those of females. In collaboration AAUW (1992) recognized the deleterious effects of such omissions on females in science. MacDonald (1985) asserts that talented girls are discouraged from advance science and mathematics courses by guidance counselors who try to convince them that the subjects are difficult and unnecessary for them. Limnus and Steveson (1990) and Baker (1983) independently opined that parents discourage their female from sciences because they believe that males perform better in maths from elementary school and throughout their academic process.

The exclusion of women from participation and high achievement in science education means limited access to jobs in these fields, which are among the fastest

growing and highest paying. Studies have shown that a student's performance in science and mathematics is a strong indicator of later earnings (Crawford and Cribb 2013). In science and mathematics subjects many cognitive and non-cognitive skills necessary for individual and national development such as higher order thinking and problem solving are expected to be taught.

Cromie (1995) posits that gender discrimination is a critical factor facing females' effective participation in every field of science. The discrimination results from combination of built in biases that make them less likely to participate in mathematical, critical and technical profession.

The family plays a vital role in selection of profession, science career requires scientists to devote most of their time to researches striving to solving problems and bringing about new innovation (Fgbasan, 2010) stereotype as a social barrier can influence individuals positively and negatively and in evaluating performance, stereotype threat is one compelling explanation that has hindered women and is a major reason why females remain under represented in science.

Closing the gaps in science is essential for ensuring that women as much as men benefit as citizens and contributors to their societies (Garden et al., 1999). Women should not be limited to be being passive users of science and technology but instead should be active participants and decision making, ensuring that science and technology but instead should be active participants in scientific development, applications and decision making, ensuring that science and technology initiatives are implemented to address the needs and preferences of both sexes (Rathgeber, 2009).

Statement of the problem

Ekpo (2004) and Ithen (2002) observed that though there has been considerable progress in facilitating women access in education lately, there is still gender disparity in performance and completion of science, and technology based programmes. It has been speculated that women shy away from science, mathematics and technology related courses giving rise to the following questions:

1. Do women have greater difficulty entering science and technology courses.
2. What are the challenges that females science and technology graduate face in and out of school.
3. What are the barriers to female pursuit of science related careers?

Purpose of the study

The general purpose of the study is to identify the barriers to effective participation of women in science,

mathematics and technology Education.

Specific purposes

The specific purposes include:

1. To ascertain the roles of the school in the low participation of females in science, mathematics & technology education.
2. To identify the impact of socialization in female participation in SMT education.
3. To ascertain the role of cognitive ability in SMT participation.
4. To identify the ways of improving the participation of women in science, mathematics and technology education for national development.

Research questions

1. To what extent does the school contribute to low participation of women in SMT?
2. To what extent does socialization affect participation of females in SMT.
3. To what extent does cognitive ability affect participation of females in SMT.
4. In what ways can female participation be increased in SMT for sustainable development?

In view of the aforementioned, there is need to investigate the barriers to effective participation of women science, mathematics and technology for sustainable development in Nigeria.

METHODS

The study was carried out in Imo State housing six tertiary institutions namely: Imo State University, Federal University of Technology, Federal Polytechnic Nekede, Alvan Ikoku Federal College of Education, Owerri, Imo State Polytechnic, Federal College of Soil Resources Oforola. The research design used was descriptive survey. The population of the study comprised of all the female science educators and female students in the six tertiary institution.

The simple random sampling technique was adopted and fifty respondents from each school was sampled given a sample size of six hundred science lecturers and students. The instrument used for gathering data was 12 items questionnaire on four Likert scale developed by researchers tagged BAFPSMT:

B = Barrier
A = Affecting
F = Female
P = Participation
S = Science
M = Mathematics
T = Technology

The items were weighted as follows:

Very high extent: 4
High extent: 3
Low extent: 2
Very low extent: 1

The mean of the scale was calculated:

$$X = \frac{4 + 3 + 2 + 1}{4} = \frac{10}{4} = 2.5$$

Any mean rating below 2.5 was rejected and 2.5 & above accepted.

RESULTS

Research question 1: To what extent does the school contribute to low participation of females in SMT education?

Table 1 revealed the role of the school in low participation of females in Science, Mathematics and Technology Education, Instructional procedure used by lecturers female exploitation by male lecturers and academic foundation of female recorded an average mean of 2.36.

Research question 2: To what extent does socialization affect participation of women in SMT education?

Table 2 unveiled the impact of socialization on participation of females in SMT, findings revealed an average of 3.36 indicating that professional gender labeling, peer group influence and family background play a crucial role in participation of females in SMT education.

Research question 3: To what extent does cognitive ability affect participation of females in SMT Education?

Table 3 analyzed the extent to which cognitive ability affects participation of females in SMT education findings revealed that IQ, lack of ingenuity and lack of critical analysis does not affect female participation in SMT education with a mean rating of 1.82.

Research question 4: In what ways can female participation be increased in SMT for sustainable development?

Table 4 results revealed that the use of successful females of SMT education as resource persons, the use of pragmatic approach in the teaching/learning process and the award of scholarship can help to increase female participation in SMT education.

DISCUSSION

Barriers to participation of females in Science,

Table 1. The role of the school in low participation of females in SMT education?

Question item	Total score	Sample size	X
Instructional procedure used by lecturers in schools contribute to low participation of females in SMT education	-1326	600	2.21
Females exploitation by male lecturers in SMT education contribute to low participation of females in SMT	1844	600	3.07
Poor SMT foundation in high school contribute to low participation of females in SMT education	1094	600	1.82
Average mean	-	-	2.36

Table 2. The impact of socialization on participation of females in SMT education.

Question item	Total score	Sample size	X
Professional gender labeling affects participation of females in SMT education	1923	600	3.20
Peer group influence affects participation of females in SMT education	1871	600	3.11
Family background affect participation of females in SMT education	2019	600	3.36
Average mean	-	-	3.22

Table 3. Cognitive ability and participation of females in SMT education.

Question item	Total score	Sample size	X
Females have low intelligence quotient (IQ) and this affect their participation in SMT education	1108	600	1.84
Poor mathematics foundation affects participation of females in SMT	1138	600	1.89
Lack of analytical and spatial skills affects female participation in SMT	1043	600	1.73
Average mean	-	-	1.82

Table 4. Strategies for increasing female participation in SMT education for sustainable development.

Question item	Total score	Sample size	X
Using successful females of SMT education as resource persons during career day in schools will increase participation of females in SMT	2096	600	3.49
Scholarships to females in SMT education will increase participation of females in SMT	1902	600	3.17
A pragmatic approach such as the use of 21st century teaching strategies in the teaching of SMT in schools will increase participation of females in SMT	1094	600	3.03
Average mean	-	-	3.23

Mathematics and Technology Education ranges from professional gender labeling, and peer group influence to family background. Findings revealed in Table 1 that instructional procedure used by lecturers, exploitation and SMT foundation of females was not a determinants on the participation rate of females and this is different with the position of Spears (1985) that attitude and teaching approach of teachers influence the attitude of females.

However, Mac Donald (1985) asserts that talented girls are discouraged from advance science and mathematics

courses by guidance counselors who try to convince them that the subjects are difficult and not necessary for them. Thus, schools play important role in female access to science by the manner in which the curriculum is implemented. Undeani (2012) and AAUW views runs contrary to the results obtained in the present study.

The Nigeria culture, socialization leads to certain personality characteristics regarded as masculine or feminine independent qualities like initiative and assertiveness for boys and dependency, submissiveness and complacency for girls, thus making them believe that

boys are superior, mentally than girls, the findings of this study collaborates the views of Limnus and Stevenson (1990) who pointed out that parents discourage their females from science because they believe that males perform better in mathematics from elementary school and through their academic process.

In the same manner, Holloway (1993) asserts that the family plays a role in the selection of profession especially science career which is believed to be tasking. The present study revealed that in the past formal education was seen as a waste for females, who are eventually married off to become housewives, hence average mean of 3.36 is not surprising because Harding (1987) reported that low performance of females in science, mathematics and education is traceable to the assumption the society makes about males and females.

Participation of females in SMT education is hindered because of the socialization and traditional role assigned to girls right from birth, this culture learned directly or indirectly determines how a person thinks, feels, directs his or her action and determines the outlook on life.

To crown it, Cromie (1995) posits that gender discrimination is a critical factor facing female effective participation in every field of science and this results from the combination of built in biases that reduces their participation in mathematical critical and technical profession. The study revealed that cognitive ability has no effect on participation of females in SMT Education with the mean rating of 1.77 and in support Viadero (2006) pointed out difference in brain structure and maturation rates may account for differential performance in school-related tasks but Erinosh (2008) poits that ability is not a determining factor in performance because males and females are found to perform equally if instructional context is fair and conducive.

In support to the aforementioned comment Marshall and Horton (2011) asserts that in teaching of SMT subjects many cognitive and no cognitive skills necessary for individual development such as high order thinking and problem solving are taught.

Thus, cognitive ability though a vital tool for retention is not a determinant for participation in SMT education. Strategies for increasing female participation had average mean of 3.23 which revealed that the incentives like scholarship, use of pragmatic approach in the teaching/learning process can increase female participation in SMT.

In support, UN (2000) and UNDP (2001) reported that the Beijing conference of 1985 played a key role in integration of women in decision making policy of many countries and their efforts have reduced the gap between males and females in decision making. Furthermore United Nations Department of Economic and Social Affairs (2010) opined that the exclusion of females from generation and application of scientific knowledge represents a tremendous waste of human potentials.

Hence, McCarthy (2003), Ellis (2003) and Kishore (2008) pointed out that participation of women in Science,

Mathematics and Technology Education though low can be remedy because United Nations have realized the crucial role of women in the development of any country as well as understanding the gender differentiated efforts of the development plan which insist that women empowerment and full participation are prerequisites for achievement of equality, development and peace.

Conclusion

The result of the study suggest that instructional procedure, gender labeling and culture are issues in participation of females in SMT education and this calls for continued efforts to enlighten the society on change of attitude to gender roles to enhance the acceptability of females into ventures that are referred to as male dominated profession. A motivating factor for some of the female respondents was the use of females who have excelled in SMT course as role models in SMT areas that are perceived male dominated environment. The study further emphasis the need to publicize and celebrate the successes of females SMT professionals as this will encourage more females to follow their footsteps.

Recommendations

The study recommends that the society should be enlighten on the need to change attitude to gender roles, and the need to initiate affirmative actions for females in SMT education. In the same view, females should be assertive and standing for their right avoid unnecessary marginalization, and the school and the curriculum should be gender responsive.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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