# GENDER IMBALANCE IN PHYSICS: THE ROLE OF SOCIALIZATION

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## Abstract

*Gender imbalance in terms of enrolment performance and the number of professionals in physics has been an issue of concern for stakeholders in physics education. The purpose of this paper is to advance some sociological reasons why females are underrepresented in physics and what can be done to address this gender imbalance in physics; particularly in the classroom. In this paper it was argued that the gender imbalance in physics is not necessarily due to gender brain-difference model as believed by some researchers but rather it may be due to gender-role socialization through some conscious and unconscious socialization activities in the environment. Recommendations were made on how to bridge this gender imbalance in physics; one of such recommendations include that counselors should encourage female students' to be actively involved in physics or its related activities instead of running away from the subject.*

**Keywords**: Gender, Gender Imbalance, Socialization, Socialization Factors.

## Introduction

Gender Imbalance in physics has been an issue of concern for physics education researchers for decades. Gender Imbalance in science according to Bello (2002) is characterized by female underrepresentation and underachievement in science (physics inclusive).This gender imbalance is noticeable in enrollment, performances and the numbers of professionals in physics. According to Baird (1997) there seems to be a natural gender role distribution all over the world which has created gaps in opportunities (physics inclusive) between males and females; this identified gap has constituted what is generally regarded as gender imbalance among gender advocates. Gender imbalance is that wide separation, the unfilled space, gap between male and female in various endeavors; this includes physics education. The issue of gender balance in physics education is important particularly with the emphasis on finding ways of increasing the manpower in the scientific and technological field (Ogunkola & Bilesanmi-Awoderu, 2000). In other words since the country is short of manpower in the science and technical fields; thus allowing and encouraging women to participate in physics will definitely increase the manpower in the field of science and technology.

Historically, this gender imbalance in physics was thought to be as a result of differing brain structures and functions between males and females. Indeed some theorists and researchers still hold on to that view; however recent explanations based on gender-specific socialization have largely displaced the brain difference model in the mind of some physics researchers. The socialization theories hold that girls are directed away from physics as a result of their interaction with peers (both male and female), parents, teachers and others in the society because such study are considered unfeminine. This theory further suggest that girls themselves select out of physics because issues involved in these fields do not match with the issues with which the girls are encouraged to be concerned (Beyer & Reich, 1987). Socialization involves the lifelong process of

inheriting and disseminating norms, customs, ideologies; providing an individual with the skills and habits necessary for participating within his or her own society. For this article; socialization will be viewed as the effects that interaction with peers, parents, teachers and others in the society have on the school student.

Several sociological factors within the environment and not necessary the brain difference model can promote or cause gender imbalance in pursuing a career in physics or other physics related courses. Some of these sociological factors include: stereotype threat, interest, masculine image of physics, social barriers, role models and teacher/classroom interaction factor. A brief explanation of these factors is discussed below:

**Stereotype Threat**

Baird (1997) argues that stereotype threat may be inhibiting female performance in physics. He defined stereotype as personifications which are widely accepted and shared among members of a given society and are handed down from generation to generation. Fung & Ma (2000) asserted that stereotype is a subjective perception which may be an intuition, a prejudice, an imagination or past impression of what a person has been. From these viewpoints gender stereotype is a subjective perception of what a man or woman should be and how people should behave. Most of these stereotypes often described men as intellectually, competent, strong and brave while women as homely, warm, expressive, incompetent and passive. They portray the male as strong, dominant person with leadership trait (Fausto-Sterling.1985).

Stereotype threat is the threat of being viewed through the lens of a negative stereotype or the fear of doing something that would inadvertently confirm that stereotype. The fear of confirming the stereotype can negatively impact members of a stereotyped group and result in worse performance. Spencer (2008) as cited in Udeani (2012) demonstrated the effect of stereotype threat by looking at females' performance on difficult standardized physics test. The study reveals that when students were told that the physics text generally produced gender differences; females performed worse than equally qualified males. However when students were told that the test generally did not show gender differences (alleviating females concerns that their poor performance would confirm the stereotype that girls can't do physics) females performance increased matching that of the males. Several studies have found that stereotype threat can be alleviated through self affirmation. Self affirmation is a process through which a person affirms their overall sense of self worth and integrity. Work on self affirmation assumes that people are motivated to maintain a positive sense of overall integrity, identity and worth; for instance individuals can affirm a more general sense of worth and integrity ( i am a good person, i am not afraid of physics and so on). A study by Kost-Smith et.al (2010) found that females with self affirmation were able to do well in physics achievement test like their male counterpart.

**Interest**

Interest is a critical factor that influences the choice of a subject. Results from studies such as Hill, Pettus & Hedin(1990); Stadler, Reinders and Benke (2000), Udeani (2012) all reported that majority of female students lack interest in physics and as a

result of this it affects their participation and performance in physics therefore negating their further pursuit in physics and other related technological courses.

**Masculine Image of Physics**

Masculine image of physics is the perception of science being masculine as major barriers of females pursuing careers in physics and other related physics courses. Erinosho (2005) argued that the physics curriculum texts and the physics learning environment are being dominated by masculine activities. The male domination of physical science often results into hostile environments for females in physical science classroom. In Nigeria, female scientists (particularly in physics) have had very low visibility; only the male scientist are distinctly visible thus making individuals in the society to perceive the subject as being solely for men. The masculine image of physics is conveyed in the way in which the physics curriculum is packaged, taught and assessed. According to Udeani (2012) he argued that physics textbooks have helped project the masculine image of physics in schools; in the sense that until recently their illustrations were almost entirely male related and work problems generally dealt with male-oriented mechanical and outdoor examples. Where women are portrayed, they were usually shown in stereotypical roles such as housewives, helpers or spectators. According to Stadler, Reinders and Benke (2000) they argued that boys and girls tend to take certain roles in mixed gender groups when carrying out experiments; the boys dominate, they run the show so to speak while the girls often take the role of writing down the results. They further stated that at times the statements, illustrations, examples or questions in the physics classrooms tend to be male oriented. To support this claim; in a study by Erinosho (1995) in Erinosho (1997) he analyzed 76 science textbooks; his study reported a great disparity in gender representation. Out of the 2995 pictorial illustrations; 63.2% were male while 36.8% were for female. A total of 13.506 generic words (noun/pronoun) found in the textbooks 10211 (75.6%) of these were males and 3296 (24.4%) of these words were female. Luckwood (1995) argued also that males were cited in greater number than females in the use of the generic words, pictorial illustration and in occupational role. She observed that females were portrayed as traders, hairdressers and secretary while males were depicted in skillful profession like doctors, scientist, engineer and the likes. All these tend to portray the physical science (physics inclusive) as masculine in nature and this tends to discourage female in pursue a career in these areas.

**Social Barriers**

Udeani(2012) viewed social barriers to female representation in physics careers from three perspectives; these are:

- Environmental (urban and rural setting)
- Socio economic status
- Societal expectations.

In terms of environmental factors; Okebukola and Jegede (1990) argued that the general environment in which the learners spends most of their time as in whether it was predominantly manual or automated and whether their reasoning pattern was empirical or superstitious will affect their career choices in science. Most rural environment in Nigeria do not have electricity, lack technology therefore scientific exploit may not be

noticed thus the need to pursue science (physics in particular) may not be seen. Buttressing this argument is a study by Udeani (2012) whose findings revealed that 75% of the females who choose science live in the urban environment. Hence with improved rural environment: the number of female students in the science field will increase because more females from the rural environment will choose a career in science. Another significant factor in female participation in science careers is the Socio Economic Status (SES) of the family. In this article SES simply means educational status of the family. Educated parents tends to send their female students to pursue a career in science as compared to the uneducated parents; a study by Udeani (2012) revealed that 71% of the female students that choose science where from parents that were educated.

Societal expectations are a major factor influencing female underrepresentation in physics careers. The socio-cultural forces at work tend to discourage girls from choosing careers in physics related courses. Ekpo (2004) has also alluded in pointing out that sex roles are somewhat rigid in Africa particularly in Nigeria thus gender bias is still very prevalent. It is common place to see gender stereotypes manifested in the day-to-day life of an average Nigerian; certain vocation and professions are considered to be gender oriented; for instance careers like hair dressing, nurse, teaching, catering, secretary among others are said to be for females while careers like military, physical scientist, engineering, mathematics, architecture and the likes are considered to be for males; hence all these societal beliefs may tend to influence students choice of a career; particularly the female group. The societal expectations that a woman should be feminine in looks and behavior also influence the choice of a career, as it is the believe in some quarters that the study of physics and engineering courses exposes girls adversely and make them to become masculine in nature. Pollina (1995) argued that at times parents, teachers, counselors and peer do communicate to girls that physical science is unfeminine and an inappropriate field of study for women. Researchers have found that gender role socialization begins when children are still in the womb (Fausto-Sterling, 1985) and this goes a long way in affecting their choices in life. Directly or by means of role models, girls are taught that their life's work is tending to the home and children (Kelly, 1988) thus to pursue courses in the physical science may be a no go area even though they are interested in the physical science areas. Schools, curriculum and teachers at times may reinforce traditional gender roles as well as sexiest stereotypes from kindergarten through university (Leach, 1995; Rosser, 1995). Childhood experiences are important as a foundation for learning and applying physical principles. Toys marketed for girls are usually passive, simple, and relate to nurturing while toys marketed for boys are active, more complex and often related to sports or things mechanical or electrical (Fausto- Sterling , 1985 : Baird, 1997). Thus these cultural factors and societal expectations tend to negate female participations and enrollment in physics and other related courses.

**Role Model**

In the Nigeria society at large female scientist particularly in physics have had low visibility. The lack of female role models in physics have affected female enrollment in physics. The road to a career in physical science is paved with courses dominated by male students and male instructors. The few females who are in the sciences are more inclined to pursue a career in the biological sciences, medicine, nursing, health education, environmental education and the likes but not towards the physical sciences

like physics or engineering courses. According to Ekpo (2004), out of the few female students found in the physical science courses some of them end up not practicing the profession, all these lead to the low participation of women in physics. This affects the choice of physics as a career among female students. A Study by Udeani (2012) revealed that majority of the female students in the science courses agreed that their interactions with female scientists influence their choice of the career; hence if there are more female scientist in the country there will be an increase in the number of female students in physics. The lack of role models has been suggested as yet a factor that inhibits enrollment of females into physics. Buttressing this; a study by Udeani (2012) reveals that majority of students in non-science group had not been acquainted or interacted with female scientists. Also the commonly held image of the professional physicist may be responsible in putting off girls and young women rising through the educational ranks to aspire towards pursuing a career in physics; for instance if asked to draw a physicist many school children draw an unattractive (usually balding) male in a white lab coat surrounded by laboratory equipment and working alone (Weinreich-Haste, 1981). If individuals do not see a physicist as being a woman, it may be because of the lack of images in textbooks and majority of the foremost and notable physicist are men. Physics is seen by school children as a field in which solitary work and competition are key. This message is usually conveyed by popular media and by the stories of prominent early scientist such as Galileo, Newton, Cavendish, Faraday and Eistein to name only a few. Girls prefer communication, collaboration and working as part of a team (Pollina 1995; Vedelsby, 1987). Of course, this is exactly how all of modern scientists and engineers work. Professional engineers of either gender readily point out that they spend most of their time communicating and collaborating. Girls may be unaware of this and drop out of science career (physics in particular) path before they have chance to find out that the current day scientist works in cooperation and not in competition. Thus the low visibility of females in physics profession does not encourage girls who may want to further their careers in physics.

**Teacher/Classroom Interaction factors**

Research on gender difference has clearly shown that boys and girls differ substantially with regards to making sense of physics as presented in what may be called traditional physics classroom (Fond, n.d; Hyde & Mckinley.1997). The predominant pattern of teacher-student interaction pattern in a traditional Nigeria physics classroom tends to favor the male students. A study carried out by Kelly (1988) revealed that girls receive less attention in physics classrooms as compared to their male counterpart.

Baird (1997) opined that some teachers enter the classroom believing that there is gender difference in learning; in the sense that they hold lower expectations for girls in the physics classroom. According to him, the physical science teachers are more likely to (a) ask girls lower-order questions (b) call on boys to answer specific questions of higher order (c) make male students as group leaders in group work (such as laboratory activities, discussion group and the likes). Some physics teachers treat female students like invisible objects; some treat them as a waste of resources. For instance consider a physics teacher who was asked why he always seems to ignore female students in class: he replied that most female students do not end up becoming physicists (or pursue a related career in physics) so why waste his time. A female student once complained that she does not like going to laboratory classes because she doesn't feel welcomed; she explains that when the physics teacher do check the progress of each group in the

laboratory, if she asks questions the teacher always look at the male partner in answering the question and once the male partner is satisfied with the answer, the teacher moves ahead not minding if she understood the answer. A study by Biraimah (1982) as cited in Kind, James and Barmby (2007) on teacher students interaction patterns over a period of several months in a co-educational science school in Togo revealed that physics teachers had little regards for the ability, character and potential of female students. It was also revealed in the study that physics teachers most often described their female students in negative terms such as disruptive behavior or lack of interest in school while the male counterpart are often acknowledge in positive words such as responsible, hardworking and scholarly. Thus the teacher-students interaction pattern in physics classroom often discourages female students from enrolling or participating effectively in physics.

The way physics is presented in the classrooms do often tends to discourage females from pursuing a career in physics or its related courses; thus it is not that females are not intelligent enough to study physics but the classroom environment tends to be hostile towards them and this tends to discourage them from pursuing a career in physics even though they are willing to do so. It is the belief of this writer that if females are given adequate or equal opportunities as their male counterpart they will be able to do well in physics; since some recent studies over the last decade had shown a decline or bridge between the gender gap achievement of male and female students when some innovative science teaching methods are explored (Bilesanmi-Awederu & Oludipe, 2009) as against the use of the traditional method of instruction which promotes gender bias in the classroom. This thus suggests that the more exposure that females are getting in science through the use of appropriate innovative science teaching methods the better their scores.

## Conclusion

The writer have been able to argue in this article that the underrepresentation of females in physics is not necessarily due to gender based brain difference that have been advanced by some theorists and researchers in some quarters; rather it is due to gender role socialization through some conscious and unconscious socialization activities within the environment. In order to address this issue of gender imbalance in physics: there is the need to resolve these prevailing sociological factors; because if this is not done there will be continuous female attrition in physics and other physics related careers in our society.

## Recommendations

The review of literature makes it clear that the actualization of gender balance in physics requires the efforts of various stakeholders in the society. Parents, teachers, counselors and the society at large have been found one way or the other(directly or indirectly) to be engaged in practices that discourage female pursuance of a career in physics, physical sciences and other related areas to physics. Thus members of these groups should modify their behavior in that regards and encourage females to participate actively in physics. Based on this; the following recommendations are advanced in this paper:

1) Teachers should do the following when teaching physics in the classroom:

- Use non-sexist language; avoid practices that reinforce gender stereotypes and confront gender bias in texts when they find it.
- Provides information on women scientists and technologists in the classroom so as to serve as role model to female students.
- Foster an atmosphere of true collaboration between male and female students during classroom and laboratory activities ( don't allow males to dominates activities all the time; at times female should be given opportunity to take leadership role and the likes)
- Portray physics to students as a way to solve problems not only in the classroom but also in their day to day activities.
- Stress the relevance of science by relating it to social and environmental issues.
- Make the teaching/learning of physics meaningful so as to attract female attention and interest in learning physics.

2) Parents should encourage their daughters in exploration of mechanical and electrical toys at their early stage; they should discourage roles that promotes gender stereotype among their children. They should encourage their female children who are interested in taken a career in physics related courses.
3) Counselors must encourage female students to engage in rather than to avoid physical science courses; so that the female students will be interested in pursuing a career in physics or its related courses.

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