Journal of Education and Practice www.iiste.org
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.6, No.17, 2015

Psycho-Social Determinants of Gender Prejudice in Science, Technology, Engineering and Mathematics

Dr. N.O. NNACHI
Department of Science Education, Ebonyi State University, Abakaliki

MR. M.N. OKPUBE
Department of Science Education, P.M.B. 053, Ebonyi State University, Abakaliki

Abstract
This work focused on the "Psycho-social Determinants of Gender Prejudice in Science, Technology, Engineering and Mathematics (STEM)". The females were found to be underrepresented in STEM fields. The under-representation results from gender stereotype, differences in spatial skills, hierarchical and territorial segregations and discrimination on job allocation. Social-psychological interventions, role models and self affirmation were examined as strategies for increasing women representation in STEM fields (unbalancing the imbalance in gender representation in STEM).
Key words: Gender Imbalance, Gender Prejudice, Bias or Disparity and Gender Stereotypes.

Introduction

Experience has shown that the number of women in science, technology, engineering and mathematics (STEM) is growing; yet, men still continue to outnumber women, especially at the high echelon of these professions. In the elementary (primary) and secondary levels of education in Nigeria for instance, boys and girls take mathematics and other science subjects at a relatively equal proportion yet in tertiary institutions, female students are much less likely to say that they wish to pursue STEM courses. By graduation, men outnumber women in nearly every STEM fields and some courses such as physics, engineering, survey, architecture and computer science, the variation is alarming with women recording less bachelor's degrees.

This gender prejudice (imbalance) calls for one to ask; what factors contribute or determine under-representation of women in STEM? According to Ceci, Williams and Barnett (2009), gender stereotype – a common belief that by birth, the male folks are naturally inclined to record greater achievements in the fields of STEM accounts for women under-representation in STEM fields. The question is, "Does the stereotype (believe) that boys are better than girls in STEM, still affect girls today? Researchers like Correll (2001), Dweck (2006), Good, Aronson and Harder (2008) and Nosek, Smyth, Sriram, Lindner, Devos, Ayala and Bar-Anan (2009) believe that stereotypes can minimize girls aspiration for STEM careers overtime. The researchers argued that if teachers in STEM tell students that girls and boys are equally capable in mathematics and other science subjects, however, the difference in performance remarkably disappears. Thus, indicating that changes in learning environment can influence girls' achievement in STEM.

Equally worthy of note is the issue of 'self assessment' (how one views ones ability). This has also been found to be a factor in determining gender prejudice in STEM. Primarily, cultural factors have been found to limit girls' interest in STEM. Research evidence such as Correll (2001), Fouad and Walker (2005) and Heilman and Okinoto (2007) show that girls assess their scientific and technological abilities lower than the boys with similar scientific and technological abilities lower than the boys with similar scientific and technological achievements especially in the area of mathematics.

In our society today, most people attribute science and technology fields with 'males and humanities and arts fields with 'females' (Good, Rattan and Dweck, 2009). For instance, implicit bias is common even among individuals who actively reject these gender stereotypes (Griffith, 2010; Schmader and Johns, 2003). They stressed that the consequences of these bias not only affects individuals' attitude towards others but could also influence the female folks likelihood of cultivating their own interest in STEM. Furthermore, people not only liken science and technology with males than with females but often hold negative opinions of females in 'masculine' positions like scientists and technologists of all kinds (Garcia-Retamero and Lopez-Zafra, 2006; Gancher, Friesen and Kay, 2011). The female folks are assessed and judged incompetent than the male folks in jobs unless they are clearly successful in their work. For instance, when a woman is clearly competent in 'men's' job, she is considered to be less likeable. Because both likeability and competence are essentially needed for success in the workplace, women in STEM fields may find themselves in a double bind.

However, if men and women in STEM are very much aware that this imbalance (bias) exists, they can work together to unbalance the unconscious thought process that led to it. This would likely help the females in particular to know that if they encounter social disapproval (prejudice) in their roles as scientists and technologists, it is likely not personal and that measures to address them abound.

In another vein the alarming disparity between the ratio of men and women in STEM fields has often been considered as evidence of 'biologically-driven' gender differences in abilities and interests (Good, Rattan

and Dweck, 2009; Blackwell, Trzesniewski and Dweck, 2007). They argued that the believe substantiating this idea is that men naturally excel in scientific and technological disciplines and professions especially those requiring deep mathematical knowledge whereas women naturally strive in disciplines that make extensive use of language skills. In line of the above scenarios, it requires that for the STEM fields to be diversified gender wise, we must take a deep look at the stereotypes and prejudice (bias) that still pervade our culture. This is because gains in science and technology disciplines are significantly influenced by culture and learning environment. To encourage and keep encouraging more females in STEM fields, demands that careful attention be channeled to the environment in our classrooms and workplaces even throughout our culture.

Science and technology are widely regarded and considered critical to the development of the economy of any nation. The quest for Nigeria to be consistently competitive in the global economy has led the federal government to declare the education sector as one of the emergency sectors of the economy requiring urgent, critical and consistent attention. Expanding and developing STEM workforce is a very critical issue for the government, industry, leaders and educators. Inspite of the remarkable dividends that the women have made in education and the workforce over the years, progress recorded has been uneven, and certain scientific and technological disciplines like engineering architecture, survey, e.t.c. remains overwhelmingly male.

This paper focuses on why there are still insignificant women in Africa, particularly in Nigeria in certain scientific and technological fields and as well provides recommendations that would increase the ratio of African women in science and technological fields. However, it is worthy to note that gender prejudice also known as gender bias or gender disparity or gender imbalance in STEM is not peculiar to any nation (i.e. it is a global phenomenon).

This paper, therefore, is centrally aimed at drawing the attention of the education community world over and the public at large on the nature and rate of gender disparity in the areas of STEM fields especially in Nigeria. The paper intends to add to existing empirical literature on the need to reduce the alarming imbalance in female enrolment in STEM courses. Through this paper, the education community will be encouraged to intensify campaigns for improved female enrolment or STEM fields.

Reasons/Explanations for Low Representation of Women in Science Technology Engineering and Mathematics

Remarkably speaking, a lot of people have attempted to make meaning of the relatively low proportion of women in STEM fields, culminating to the rise of a number of biological, structural and socio-psychological explanations.

Lack of Female Interest

Experience backed with meta-analysis has shown that men prefer working with people. For instance, when interests were classified by realistic, investigative, artistic, social, enterprising, conventional (RIASEC) type, men demonstrated stronger realistic and investigative interests and women exhibited stronger, artistic, social and conventional (Preston's 2004). Gender differences (bias) which favours the males were also found more specific measures of interest in engineering, science and mathematics (Gracia-Retamero and Lopez-Zafra, 2006). To buffers the global nature of this imbalance, Seymour and Hewitt (1997) in a 3-year interview found that perception that non-STEM academic majors offered better education options and better matched their interests was the most common (46%) reasons provided by female students for switching majors from STEM areas to non- STEM areas.

The second most frequently cited reason given for switching to non-STEM areas was a reported low of interest in the women's chosen STEM majors. Additionally, 38% of female students who remained in STEM majors expressed concerns that there were other academic areas that might be a better fit for their interest (Seymour and Hemitt, 1997).

Furthermore, between 2004 to 2012, Ebonyi State University (EBSU) Nigeria recorded the proportion of graduates in Mathematics, Physics, Chemistry, Technology and Vocational Education, Computer Science and Geology in the ratio of 73% and 27% for male and female graduands respectively (Examination and Records Department, EBSU, Nigeria 2014). Also, Preston's (2004) survey of 1,688 individuals who had left sciences also showed that 30% of the women endorsed other fields more interesting as their reason for leaving. The above references picture a clear under-interest by the female folks in STEM fields.

Biology Reasons/Explanations

Biological reasons or explanations on gender differences in STEM fields tend to focus on gender differences in spatial skills. Spatial skills are considered a significant ingredient to success in engineering and other branches of science, and men are sometimes found to outscore women in tests of spatial ability (Xu, 2008). However, studies like that of Stout, Dasgupta, Hunsinger and McManus (2011) and Miyake, Kost-Smith, Finkelstein, Pollock, Cohen and Ito (2010), have shown that spatial skills can be quickly developed through a small amount of training. The researchers believe that if women are brought up in environments were they are encouraged to use and develop their spatial skills gender gap in science and technology which requires spatial sense will likely decrease.

Structural Reasons/Explanations

Structural reasons/explanations on gender differences (low number of women in STEM fields) can be attributed to 'hierarchical segregation' and territorial segregation. Hierarchical segregation is characterized by decrease in the proportion of women in the ladder of power and prestige in the scheme of things in the society. For instance, there tend to be a lack of gender diversity in the upper echelons of many occupations where the highest positions are typically held by men. This is evident in the number of women who are found to be engineers, architects, mathematicians and physicians. Territorial segregation on the other hand is the idea that women cluster in certain fields of study. For instance, women are more likely to teach and conduct research in the humanities and social sciences than in the natural sciences and engineering (Gracia-Retamero and Lopez-Zafra, 2006). They further posits that majority of women in colleges tend to choose disciplines such as psychology, education, English, performing arts and nursing. The researchers argued that the one outstanding reason why women tend to form these 'clusters' is as a result of lack of support in STEM fields where they are outnumbered by men.

Territorial segregation also known as occupational segregation refers to how the STEM fields have traditionally been dominated by men, making it difficult for women to enter these professions (occupations). Even within the STEM fields women's concentration tends to focus on the 'soft' sciences. Evidently, over the past 15 years, no woman has been reported to have made a remarkable break through in STEM fields. It is all men affair.

Social-Psychological Reasons/Explanations

Psychologists have long studied issues related to discrimination, motivation and performance. In recent years, social psychologists have examined how certain social-psychological phenomena may apply directly to the STEM fields, and may explain the relative lack of gender diversity within these fields. Gaucher, Friesen and Kay (2011) found that job advertisements for male-dominated careers tended to use more agentic words (or words denoting agency, such as "leader' and 'goal-oriented") associated with male stereotypes. They suggested that if individuals are given information about a perspective student's gender, that may infer that he or she possesses traits consistent with stereotypes for that gender Social role theory states that men are expected to display agentic qualities and women to display communal qualities. These expectations can influence hiring decisions. For instance, Madera, Hebl, Martin (2009) found that women tended to be described in more communal terms and men in more agentic terms in letters of recommendations. The researchers also found that communal characteristics were negatively related to hiring decisions in academic.

Strategies for Increasing Women Representation in STEM Fields

There are a lot of factors that may explain the under-representation of women in STEM careers. This paper pictured them under the following three major areas of intervention; social-psychological interventions, role models and self-affirmation.

Social-Psychological Interventions

Researchers such as Tyson, Borman and Hanson (2007), Pieronek (2005), Nosek, Smyth, Sriram, Linder, Devos, Ayala and Bar-Anan (2009) and Good, Woodzicka and Wingfield (2010) have tested interventions to alleviate stereotype threat for women in situations where their mathematics and science skills are being evaluated. The researchers expressed hope that by combating stereotype threat, these interventions will enhance women's performance, and as well as encourage a greater number of them to pursue STEM careers. They posited that one simple intervention is simply educating individuals about the existence of stereotype threat.

Role Models

Introducing role models is one of the approaches that can help in alleviating gender stereotype threat. Drury, Siy and Cheryan (2011) in their study found that women who took a mathematics test that was administered by a female experimenter did not suffer a drop in performance when compared to women whose test was administered by a male experimenter. The researchers equally found that it was not the physical presence of the female experimenter but rather learning about her apparent competence in mathematics that positively influenced participants against stereotype threat. In a related study, Gresky Eyck and McIntyre (2005) and McIntyre, Paulson and Lord (2003) in their findings suggested that role models do not necessarily have to be individuals with authority or high status, but can also be drawn from peer groups. This study found that girls in same-gender groups performed better on a task that measured mathematics skills than girls in mixed-gender groups. This was due to the fact that girls in the same-gender groups had greater access to positive role models in the form of their female classmate who excelled in mathematics, than girls in mixed-gender groups. The researchers further found that making groups achievement salient helped buffer women against stereotype threat. Female participants who read about successful women, even though these success were not directly related to performance in mathematics, performed better on a subsequent mathematics test than participants who read about successful corporations rather than successful women.

Self-Affirmation

Researchers such as Martens, Johns, Stout, Dasgupta, Hunsinger and McManus (2011) have investigated the usefulness of self-affirmation in alleviating stereotype threat. Martens et al (2006) found that women who affirmed a personal value prior to experiencing stereotype threat performed as well as on a mathematics test as men and as women who did not experience stereotype threat. Stout et al (2011) found that women who were encouraged to draw self-concept maps with many modes did not experience a performance decrease in a mathematics test. Also, they found that women who did not draw self-concept maps or only drew maps with a few modes did perform significantly worse than men on the mathematics test. The effects of these maps with many modes was to remind women of their "multiple roles and identifies", that were unrelated to, and would thus not be harmed by their performance on the mathematics test. Scholars believe that the effectiveness of such values affirmation exercises is their ability to help individuals view themselves as complex individuals, rather than through the lens of a harmful stereotype.

Summary

The paper presented an overview of male and female representation and attainment in STEM fields. The females were found to be significantly under-represented in STEM fields. This under-representation of women in these fields is determined by gender stereotype, biological reasons like gender differences in spatial skills, structural reasons like hierarchical and territorial segregations social-psychological explanations. Social psychological interventions, role models and self-affirmation were also examined as strategies for increasing women representation in STEM fields.

Conclusion

Based on the results encapsulated in this paper, the researchers found that in most developing countries like Nigeria, cultural beliefs and practices still prevent so many female students from accessing formal education. This ugly scenario has immensely hindered the ratio of female students that would have embraced studies in STEM fields. The researchers therefore, call for the government of the nations in which cultural beliefs and practices like in Nigeria prevent female enrolment in education to institute legislations that will abolish or bring to an end such practices. Also, campaigns against the notion that STEM fields are meant for men as it is believed in most developing countries like Nigeria should be seriously and consistently championed against by all and sundry.

The researchers believe that if the aforementioned determinants of gender imbalance in STEM are well checked, the ratio of women in STEM will significantly increase. In view of this, the schools should properly reorient and educate the students especially the female ones on the effects of gender stereotype (that is, nurturing the feeling that STEM fields are naturally meant for the males). This will encourage the female students to choose career studies in STEM fields and the issue of gender imbalance will become a thing of the past.

References

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's under-representation in science: socio-cultural and biological considerations. *Psychological Bulletin, 135*(2), 21-61.

Correll, S. J. (2001). Gender and the career choice process: The role of biased self-assessments. *American Journal of Sociology, 106*(6), 1691-1730.

Drury, B. J., Siy, J. O., & Cheryan, S. (2011). "When do female role models benefit women" The importance of differentiating recruitment from retention in STEM". *Psychology Inquiry, 22*(4), 265-269.

Dweck, C. (2006). Is mathematics a gift? Beliefs that put females at risk. In S.J. Ceci and W.M. Williams (Eds), why aren't more women in science? Top researchers debate the evidence (pp. 47-55). Washington, DC American Psychological Association.

Fouad, N.A. & Walker, C.M. (2005). Cultural influences on responses to items on the strong interest inventory. *Journal of Vocational Behaviour, 66*(1), 10-23.

Garcia-Retamero, R. & Lopez-Zafra, E. (2006). "Prejudice against women in male-congenial environments: perceptions of gender role congruity in leadership". *Sex roles, 55*(1&2), 51-61.

Gaucher, D., Friesen, J., & Kay, A. C. (2011). "Evidence that gendered working in job advertisements exists and sustains gender inequality". *Journal of Personality and Social Psychology, 101*(1), 109-128.

Good, C., Aronson, J., & Harder, J. A. (2008). Problems in the pipeline: Stereotype threat and women's achievement in high-level mathematics courses. *Journal of Applied Developmental Psychology, 29*(1), 17-28.

Good, C., Rattan, A., & Dweck, C. S. (2009). Why do women opt out? Sense of belonging and women's representation in mathematics. Unpublished paper, Baruch college, Stauford University.

Gresky, D. M., Eyck, L. L. T., Lord, C. G., & McIntyre, R. B. (2005). "Effects of salient multiple identifies on women's performance under mathematics stereotype threat". *Sex roles, 53*(9&10), 703-716.

Griffith, A.L. (2010). "Persistence of women and minorities in STEM field majors: is it the school that matters?" *Economics of Education Review, 29*(6), 911-922.

Heilman, M.E. & Okimoto, T.G. (2007). Why are women penalized for cusses at male tasks? The implied communality deficit. *Journal of Applied Psychology, 92*(1), 81-82.

Madera, J. M., Hebl, M.R., & Martin, R. C. (2009). 'Gender and letters of recommendation for academic: Agentic and communal differences". *Journal Applied Psychology, 94*(6), 1591-1599.

Martens, A., Johns, M., Greenberg, J. & Schimel, J. (2006). Combating stereotype threat: The effect of self-affirmation on women's intellectual performance". *Journal of Experimental Social Psychology, 42*(2), 236-243.

McIntyre, R. B., Paulson, R. M., & Lord, C. G. (2003). Alleviating women's mathematics stereotype threat through salience of group achievements. *Journal of Experimental Social Psychology, 39*(1), 83-90.

Miyake, A., Kost-Smith, L. E., Finkelstein, N. D., Pollock, S. J., Colen, G. L., & Ito, T. A. (2010). "Reducing the gender achievement gap in college science: A classroom study of values affirmation". *Science, 330*(6008), 1234-1237.

Nosek, B.A., Smyth, F.L., Siriam, N., Linder, N.M., Devos, T., Ayala, A., & Bar-Anan, Y. (2009). National differences in gender-science stereotypes predict national sex differences in science and mathematics achievement. *Proceeding of the National Academy of Science, 106*(26), 96-97.

Pieronek, C. (2005). Title IX and gender equity in science, technology, engineering and mathematics education. No longer an overlook application of the law. *Journal of College University Law, 31*(2), 291-350.

Schmader, T. & Johns, M. (2003). Converging evidence that stereotype threat reduces working memory Capacity". *Journal of Personality and Social Psychology 85*(3), 440-450.

Seymour, E. & Hemitt, N. M. (1997). Talking about learning: why undergraduates leave the sciences. Boulder, Co: Wertriew Press.

Stout, J.G., Dasgupta, N., Hunsinger, M., & McManus, M.A. (2011). "STEM the tide: Using in group experts to inoculate women's self-concept in science, technology, engineering and mathematics (STEM)". *Journal of Personality and Social Psychology, 100*(2), 255-270.

Tyson, W., Lee, R., Borman, K. M., & Hauson, M. A. (2007). Science technology, engineering and mathematics (STEM) pathway: High school science and mathematics course work and post secondary degree attainment. *Journal of Education for Students Placed at Risk, 12*(3), 243-270.

Xu, Y.J. (2008). Gender disparity in STEM disciplines. A study of faculty attrition and turnover intentions. *Research in Higher Education, 49*(7) 604-624.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar