

Equipping Girls for Involvement in Physics and Mathematics for Sustainable Development

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Abstract

In Nigeria, the road for women who want to pursue an academic degree in science, technology, engineering and mathematics (STEM) subjects is lined with obstacles. This is further compounded by the anxiety of girls towards mathematics and physics; two key STEM subjects. In this paper, the reasons for the anxiety and low participation of girls in physics and mathematics are discussed. What can be done to equip girls to be involved in physics and mathematics are also explored.

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Brief Overview of Girls' Education in Nigeria

Introduction

In the world, women and girls make up 49.6% of the world's population of about 7.6 billion people, according to the United Nations statistics on population. Over 1 billion of the world's population are in Africa, with 518,636,010 males and 519,050,499 females. Reference with this large number of females in the population, there is no gain saying the importance of female population to the development of any nation.

National Development

Development is very important and it is a critical component of sustainability and growth in any nation. A country is considered to be developed if it is able to provide quality livelihoods for its population. Going by the world's population statistics, providing quality livelihoods and sundry development cannot be achieved without the participation of half the female population. The components that ensure national development include health care, education, housing and essential services that impact on well-being.

Girl-Child Education

Education is the driver of economic growth. It is an enabler of social awareness. Education helps in improving cultural interactions and encouraging peace building. It creates economic stability and ensures awareness of health and the knowledge of methods of prevention of diseases and all that negate the well being of individuals. The girl-child in Nigeria is aged between 3 and 18 years. The education of this age group is critical to national development. Nigeria especially northern Nigeria has a large number of out-of-school girls. Since education is strongly linked with national development, greater attention must be paid to the education of this group.

Girl-Child Education will Impact National Development in Several Ways:

- More female educators, more female role models
- Educated girls become educated wives and mothers
- Leads to more educated girls and boys

- More educated males population
- Healthier society
- Fewer male who abuse women and less domestic violence Less vulnerable girl and women (education empowers, better negotiation skills)
- Less ignorant decisions that are detrimental to health

The education of the girl-child and by extension the education of the female population is the most fundamental strategy for national development. It impacts on all the other components of development: social inclusion, peace building, politics, economic development and the overall development of the country.

Defining Educational Sustainability

'Sustainability' is a process of change and development in such a way that the resources exploited to achieve the change and development are available for future generations'. If we take this definition into consideration, we can then define sustainable education or educational sustainability as: 'development in education that can allow current generations to have access to resources for advancement in education but at the same time allow future generations to have access to the same resources in order to maintain the advancement in education'.

Sustainable education is the fourth of the 17 Sustainable Development Goals (SDGs). These are the set of 17 goals set by the United Nations Development Program. The target is for quality education for all by the year 2030 (www.un.org). Recognising the importance of sustainable education, we must also acknowledge that will encompass science and technology and girls must be a part of this development. Science and technology is changing the way people live, connect, communicate and conduct business. STEM is, therefore, a key driver of economic development. It has been shown (Akinsowon and Osisanwo, 2014), that in Nigeria, very few girls choose to pursue university degrees in the STEM subjects.

Equipping Girls for Involvement in Physics and Mathematics

In our quest to equip girls for involvement in Physics and Mathematics; two of the key STEM subjects we must take note that there are obstacles in the pursuit of academic degrees by females in general (Bolarin, 1987), particularly in the STEM fields, especially on Physics and Mathematics (Sa'id, 2015). It should be noted that barriers and obstacles to female education is worldwide (www.britishcouncil.pk). However, they manifest differently according to the cultural settings of the communities. I will enumerate some of the general obstacles that females are likely to face in pursuing a degree in one of the STEM subjects and then narrow down to some of the obstacles specific to physics and mathematics.

Male Domination of Stem Subjects

Male domination in STEM subjects is obvious and in Nigeria women make up only 17% of all science researchers. For young women, choosing to do a degree on a STEM subject can mean breaking away from the social norm of marrying after high school or during undergraduate studies and having children. In Nigeria, among other countries, STEM students are predominantly male (Udeani, 2012). In many societies, a girl's decision to study science can be understood as a decision that weakens her identity as a female and makes her appear less feminine. Personally, I have seen girls studying in this field who have felt obliged to portray their seriousness in a male-dominated field by not using make-up, deliberately avoiding wearing fashionable clothes and trying to hide their femininity. This image, combined with the pressure of marriage and motherhood, has dissuaded many girls from studying STEM subjects in favour of courses that are considered more appropriate for their gender.

There are Few Female Role Models in Stem

When trying to encourage young women to do STEM subjects, it is not enough to tell them that they can do it. Introducing girls to inspiring women who are experts in these fields can be powerful. For example, when I tell young women how I overcame the odds, I can see that they feel more able to do the same. I returned to the university ten years after completing secondary school, already married with three young children, and completed my degree programme. Having someone standing in front of them saying, 'If I can do it, then you can too', gives a strong message of hope and can make problems seem less challenging.

STEM Subjects are Expensive

STEM courses last longer than courses in the arts and the social sciences, so the financial commitment is greater. This means that women wanting to pursue degrees in these courses require significantly more money to complete them. As a student I struggled to support myself financially, and this had a real impact on my grades. So when asked what would have made my own personal struggle easier, I always say that I wished I had known about the funding opportunities and scholarships available.

STEM Degrees are Long

On the average, STEM degrees last four or five years. In Nigeria, most young women pursuing higher education start at the age of 16. However traditionally in the northern states girls are expected to marry at the age of 18. This can be problematic. Some girls feel more comfortable choosing shorter-duration course in the arts or social sciences, so they can avoid the pressure of getting married while still studying.

Involvement of Girls in Physics and Mathematics

Involving girls in Physics and Mathematics will require addressing their fears and anxiety in respect of these subjects and this will include exploring the roles parents, teachers and the society should play.

3.2.1 Maths and Physics Anxiety

Mathematics and physics are certainly intimidating subjects, but it seems to intimidate and make girls more anxious than boys. Is there anything that can be done to reduce the level of anxiety for these subjects among girls? In order to curb mathematical anxiety and, by extension, physics anxiety, particularly among girls, it is important to understand what the term mathematical anxiety refers to. According to Ashcroft (2002), mathematical anxiety is the feeling of fear, tension and apprehension that affects a student's performance in mathematics. It is basically the anxiety that one develops regarding their ability to do mathematics. This type of anxiety is significantly considered in evaluating the problems students face in mathematics.

It is often believed that girls are more interested in social activities during their teenage years. Hence, they develop anxiety towards the sciences and mathematics. It is also thought that in comparison to boys, girls have a higher likelihood of developing mathematical anxiety. This is because of societal pressures and women's perceptions of mathematics. The behaviour of Mathematics teachers also impact students' attitudes towards mathematics. As such, a female teacher who is anxious may also cause the female students to develop mathematical anxiety by viewing it as a gender stereotype. Boys are perceived to be better performers in mathematics, creating anxiety among girls. This belief, therefore, affects girls' mathematical expectations and performance.

Role of Teachers/Role Modelling

Girls have a higher likelihood of identifying their teachers' negative behaviours and fears regarding mathematics than boys. This negatively impacts their future inclination to mathematics (Bielock et al., 2010). Mathematics teachers' behaviours also impact students' attitudes towards mathematics. As such, a female teacher who is anxious may also cause the female students to develop mathematical anxiety by viewing it as a gender stereotype.

Research has shown that females represent the largest number of teachers in early elementary school in most countries. In the United States, for instance, female teachers constitute approximately 90% of the teachers (Bielock, Gunderson, Ramirez, & Susan, 2010). According to Kelleher et al. (2011), at the primary level of education, Latin America and the Caribbean indicate a large number of female teachers which stood at 78% in 2007. Similarly, these large percentages of female teachers were demonstrated in Central and Eastern Europe at 80%, Central Asia at 86%, East Asia and the Pacific at 60%, and North America and Western Europe at 81%. However, females are poorly represented in the teaching profession in Sub-Saharan Africa and South and West Asia with their proportion being 43% and 35% respectively (Kelleher et al., 2011). These statistics are typical of female under-representation in all sectors, particularly in Sub-Saharan Africa in general and Nigeria in particular. In equipping girls in Nigeria to be involved in physics and mathematics, it is imperative to reinforce strong female teacher role models in these subjects.

The problem of anxiety by girls for physics and mathematics can best be addressed by institutions and the society by developing teaching programmes that enhance students' positive attitudes towards mathematics and physics and assist physics and mathematics teachers to have a better grasp of the subjects (Bielock et al., 2010).

Role of Society/Institutions

Researchers have asserted that mathematical anxiety among females is not as a result of genetics but rather due to social factors. Females often exhibit lower academic performance than their male counterparts due to their understanding of the stereotype surrounding their numerical abilities. The researchers posit that the gender stereotype threat in mathematics arises from the gender references that are made during examinations. This affects the performance of the students. These effects were particularly demonstrated in a research by Walsh, Hickey, and Duffy (1994) who performed two experiments to examine the impact of gender references on performance in mathematics. The first experiment included male-labeled, female-labeled and neutral questions, each of which constituted 33% of the items in the examination. Findings indicated that these slight gender references in the questions have a significant impact on test performance. The performance seemed to have a positive impact on boys and a significantly negative impact on girls (Walsh et al., 1994).

Additionally, research has shown that the impact of gender stereotypes on test performance is demonstrated in cases where students are expected to indicate their gender either at the beginning or at the end of a test. The threat of the gender stereotype is significantly reduced in instances that require women to indicate their gender at the completion of an exam. Generally, it is clear that gender stereotype has no positive impact on men's performance and a negative impact on women's performance, particularly in Mathematics.

Role of Parents

From the review on the impact of gender stereotyping and mathematical anxiety among girls, several issues have emerged. First, most of the fears that female students and teachers develop regarding mathematics are basically as a result of societal effects and culture, rather than biological reasons. Secondly, the stereotype threat has a significant impact on both boys and girls. For boys, gender stereotyping has a positive impact on their performance while for girls the impact is negative.

Parents have a pivotal role to play in the performance of their children. According to Mahuro and Hungi (2016), parents' participation in their children's education plays a vital role in motivating them academically. This implies that the education system can be optimised and improvement in students' performance realised through active parental participation. This means that student-teacher relationships are not enough. Parents can participate through checking the progress records of their children, making random visits to schools and creating a better environment at home for their children to study. This will help to improve their learning outcomes (Mahuro & Hungi, 2016). This means that parents can help to motivate their daughters to perform better in mathematics by creating a good environment that supports their efforts.

Moon and Hofferth (2016) asserted that the educational skills developed by children significantly depend on the availability of educational materials that are provided by parents. Parents, therefore, need to not only provide the materials to their children but also teach them how to use them. Parents' involvement in learning activities also affect performance in the subject. As such, the quality of parent-children relationships is vital in improving the children's test scores in mathematics (Moon & Hofferth 2016). The performance of girls and the dispelling of discrimination can, therefore, be realised if parents help their girls develop mathematical skills at a tender age. This can be realised by providing the relevant materials which would make mathematics more interesting for the children.

Reward and Prizes/Visibility

Recognising how important it is for secondary school girls in northern Nigeria to learn more about the great value of STEM and take advantage of STEM related opportunities available to them, the Peace Corps Nigeria Alumni Foundation (PCNAF) and the Inclusive Community Education & Development Association (ICEADA) entered into an agreement involving the joint sponsorship of a new scholarship and mentoring programme for female Nigerian secondary school girls in Kano State and female Nigerian undergraduate STEM students at Bayero University Kano. Today, there are more opportunities available to girls. Organisations such as the World Academy of Science, the Organization for Women in Science in the Developing World, L'Oreal for Women in Science, the Elsevier Foundation and the British Council Ghana have awards, recognition and fellowships specifically for girls and women. The Visiola Foundation also provides scholarships for girls to study STEM and an annual week-long STEM Summer Camp to pique the interest of women in the STEM fields from an early age.

Conclusion

In this paper, the importance of female education and the impact of their education on national development have been discussed. In discussing how to equip girls for involvement in physics and mathematics, the obstacles that females encounter in pursuing these subjects were discussed and the roles of teachers, institutions and society in helping to overcome the obstacles were explored.

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