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Home Factors And Gender Gap In Science, Technology, Engineering And Mathematics (STEM)

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Abstract

Gender gap in Science, Technology, Engineering and Mathematics (STEM) is a global phenomenon which points at future shortage of human resource (females) in these fields. STEM workforce is crucial to any nation's innovative capacity and global competitiveness but women are vastly underrepresented in STEM degree holders. Studies have affirmed the role parents and teachers play in preferring boys to girls, allowing the former more opportunities to explore and probe, especially in the science subjects. There are many possible factors contributing to the discrepancy of girls and boys in STEM, some of which are lack of female role models, gender stereotyping and less family-friendly flexibility in the STEM fields. However, little has been done in examining the contributory factors in the home during the early years such as parental gender stereotyping in choice of toys, choice of colours and household chores children

are exposed to. This study is a mellange of literature review of past studies and present studies, observations and a communiqué from a STEM-related conference. The findings have implications for gendered socialization of boys and girls in the home and across cultures. Stereotypes are also strong in parental interactions of early gendered task assignments in the home, gender labelling of colours gendered toys, which have associated effects on STEM gap in adult years. This study therefore recommends gender neutral parenting without bias between the girl-child and the boy-child.

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Introduction

Gender can be referred to as either of the two sexes (male and female), especially when considered with reference to social and cultural differences rather than biological ones. Gender relations are accordingly defined as the specific mechanisms whereby different cultures determine the functions and responsibilities of each sex. The implications for everyday life are many, and include the division of labour, the responsibilities of family members inside and outside the home, education and opportunities for professional advancement and a voice in policy-making (Economic and Social Development Department, 2001). Gender issues are ever so crucial more so as the world paradigm change even as we begin to re-evaluate human circumstances within the framework of "21st Century", "climate change", "terrorism" issues that are already redefining education, pedagogy, curriculum, the learner and assessment practices (Kashu, 2014).

Gender gap is the disproportionate difference or disparity between male and female sexes. This disparity is even observed among siblings especially in developing countries of Africa. In the workplace, gender gaps refer to job opportunities and salary differences that favour the masculine gender compared to the females. The gender gap in Science, Technology, Engineering and Mathematics (STEM) has been described in the literature countless times as a persistent and progressive problem (Blickenstaff, 2005).The decline in women's representation throughout their STEM education and professional

careers has been coined the “leaking pipeline. The current body of literature no longer attributes continued low female participation rates in STEM fields to lack of academic ability (Brainard & Carlin, 1998; Mann & Di Prete, 2013; Morgan, Gelbgiser, & Weeden, 2013; Wang, Eccles, & Kenny, 2013).

Gender bias is not only manifested by adults in the workplace; early on, children are exposed to gender bias in math through their parents (Eccles & Jacobs 1986; Eccles *et al.*, 1990; Jacobs & Eccles 1992; Midgley *et al.,* 1989; Yee & Eccles 1988). Parents often believe that boys have higher math ability, and parents have higher expectations of math performance for boys than for girls, even though boys and girls perform similarly on tests. Further, parents' stereotyped beliefs affect their children's views of their own math ability (Jacobs, 1991; Parsons, Adler & Kaczala, 1982). Parsons *et al.* (1982) found that among fifth through eleventh graders, children's self-perceptions were affected more by their parents' beliefs in their abilities than by the children's own past performance. In addition, Jacobs (1991) found that among children in grades six through eleven, parents' gender stereotypes about math abilities affected their views of their child's abilities, which in turn affected children's self-perception and performance.

Purpose of the Study

Despite great efforts made over the past decades to narrow down the gender gap in STEM, major inequalities still persist. However, Burke and Mattis, 2007 opined that 'Scientists are made not born'. Efforts are continually geared towards encouraging more women to be involved in STEM. The purpose of this study is to examine, through literature, the extent to which the home factors (choice of toys, house-chores and colour) through which girls develop interest and confidence in science and mathematics or create a gender gap in STEM. This study is therefore premised on analysing past, comtemporary works and analysing current discourse in finding out reasons behind observed gender gap in STEM as far as the home setting is concerned.

STEM and the Gender Gap

Advancement in STEM is essential for national security, economic growth, health and stability of the Nation and the country's citizens (Burke and Martis, 2007). Margolis and Fisher (2002) emphasised that the way to ensure

competitiveness and maximize creativity and innovation in STEM workforce is to attract and retain women. Literature reveals numerous obstacles girls encounter that influence the process while impacting their interest in science and math education. Sadker, Sadker and Zittleman (2009) suggested that the barriers girls encounter in their pursuit of STEM education and careers often begin early on in their academic experiences. Girls receive less encouragement at home and in the classroom than boys who indicate an interest in STEM. There is a lack of female STEM role models, fewer STEM extracurricular activities, societal gender role stereotypes, and a culture that supports male competence (AAUW, 2010; Andre, Whigham, Hendrickson and Chambers, (1999); Herbert and Stipek, 2005; Jacobs, Lanza, Osgood, Eccles, and Wigfield, (2002); Simpkins and Davis-Kean, 2005). As a result, girls are beginning to opt out of science and mathematics courses in 6th-8th grades (Burke and Mattis, 2007).

To meet workforce supply demands, improve innovation, and ensure social equity, STEM professions need the imaginations and talents of girls (Sammet & Kekelis, 2016). Introducing girls to hands-on science, technology, engineering, and mathematics activities early on in their educational experience is critical for cultivating interest in STEM (Baine, 2008).

'STEM workforce issues will only be solved by diverse partners collaborating to create disruptive solutions that promote equity for all girls and underrepresented racial minorities'. One of such partners are the parents that should start up this from the home. We must introduce girls to STEM when they are very young, nurture their STEM interests, and support them to sustain STEM related efforts through college. (Sammet & Kekelis, 2016).

Parenting and Gender Gap in STEM

The family being the first and major agency of socialisation has a great influence and bearing on the development of the child (Threlfall, Seay & Kohl, 2013). One of the mechanisms proposed to explain gender differences in children's behaviour is that parents treat boys and girls differently (Zahn-Waxler, Shirtcliff & Marceau, 2008). The three leading explanations of why parents might treat girls and boys differently are differences in production functions, preferences, or the costs of investing, very compelling evidence emanates from an evaluation by Baker (2013). Most mothers underestimated what their daughters could do even though there are no differences in the

motor skills of boys and girls at the infancy stage. This prejudice may cause parents to unconsciously limit their daughter's physical activity. 'How we perceive children—sociable or remote, physically bold or reticent—shapes how we treat them and therefore what experiences we give them. Since life leaves footprints on the very structure and function of the brain, these various experiences produce sex differences in adult behaviour and brains—the result not of innate and inborn nature but of nurture (Begley, 2009).

In many developing societies and families, girls are often brought up to believe that STEM subjects are “masculine” in nature and the female ability in STEM is innately inferior to that of the male. Those differences also arise from gender conformity. Children settle into sex-based play preferences only around age 1, which is when they grasp which sex they are, identify strongly with it, and conform to how they see other, usually older, boys or girls behaving. This study analysis role of home factors: house-chores, choice of colours and toys on gender gap in STEM.

Several lines of research indicate that spatial language is related to spatial thinking (Casasola, Bhagwat & Burke, 2009). According to Pruden, Spatial language includes descriptions of shapes (round, square), dimensions (big, tall, tiny, small) and spatial features (bent, curvy, edge, line, corner).Using spatial language with children can help give them the mental vocabulary they need to better understand their world (Kris, 2017). Early use of spatial language – the words and ways people describe things, people and places – can be a predictor of success in science, technology, engineering and math fields later in life (Shannon M. Pruden, 2017) Parent's involvement is crucial to help a child master STEM subjects within and beyond the classroom. Parents and teachers alike have many ways of introducing STEM concepts. 'Children can develop complex understandings about the world around them with the right guidance from adults. Early STEM experiences can set children up for later STEM learning. Children need the assurance that they can “do” STEM, as well as understand and speak the language of STEM. (Simoncini, 2018). As Newcombe said, “There is growing evidence that strong spatial reasoning skills in preschool help support math learning in elementary school.” (Kris, 2017) submits thet early childhood is the natural starting point for STEM learning, as young children are curious and want to explore their environments. Children are very capable STEM learners, and their knowledge and skills are often greatly underestimated by

educators and parents. (Simoncini, 2018) is of the view that when children are helped to develop their spatial skills, they are given a mental framework for understanding how the world — this beautiful, mathematical, scientific world — works, and that, in turn, will help them figure out their place within it. Early STEM experiences can set children up for later STEM learning. In line with the Early Years Learning Framework, children should be confident and involved learners. We need children to feel that they can "do" STEM, as well as understand and speak the language of STEM (Simoncini, 2018).

It is possible parents use more spatial language with boys because boys play more with blocks and building sets, which are spatial activities. Parents could also be providing boys with more opportunities for spatial play because of unintended stereotypes that suggest boys are better at those activities than girls. Whatever the reason, there is a point at which boys are exposed to more spatial language.

Gender Bias in the Purchase of STEM-related Toys

One way that children can begin to develop an interest in and understanding of science, technology, mathematics and engineering is through the toys that they interact with (Inman & Cardella, 2015). According to Weale (2016), reporting on the research of the Institution for Engineering and Technology, "Toys can really influence what a child does in later years, therefore STEM toys are a natural move for the industry." 'The use of engineering toys when a child is young could provide a crucial resource for a girl looking to be hired or published in an engineering-related field later in life (Ceci & Williams, 2011). Informal learning experiences provide opportunities for learners to develop interests and understandings that are grounded in the learners' interests, motivations and self-direction, but also allow the learner to explore an interest in a low-stakes atmosphere (without the pressures that come with testing) (Inman & Cardella, 2015).

Bleeker and Jacobs (2004), while finding a definitive link between the influence of parents and a child's mathematics or science achievements, found that this relationship was somewhat complex. 'Encouraging adults to purchase toys that allow children to develop math, science and engineering skills may be a critical step towards the increased participation of women in STEM fields (Inman & Cardella, 2015). In a personal observation, the researcher and a

female Physicist entered an African gift shop. She wanted a souvenir for her daughter and son. She carefully picked a wood- crafted car for the boy and an oversized bangle for the girl. Then the researcher asked why? Her answer, “stereotype” (Aderogba-Oti, 2018). Since that was not the only toy car in the shop, she was compelled to pick a toy car for the girl too.

Weale (2016), reporting on the research of the Institution for Engineering and Technology, found that toys with a science, technology, engineering and maths (STEM) focus were three times more likely to be targeted at boys than girls. And despite high-profile recent campaigns that have had some success, toys for girls are still overwhelmingly pink. The institute for Engineering and Technology’s analysis of leading search engines and toy retailers' websites, found that, of the STEM toys on offer, 31% were listed for boys compared with just 11% for girls. A search using the terms “boys' toys” and “girls' toys” found nine out of ten (89%) toys listed for girls were pink, compared with 1% for boys.

'One way to promote the participation of girls in engineering is to educate parents and grandparents about the importance of purchasing STEM-related toys for girls. As we endeavour to promote diverse participation in engineering, and in particular promote the participation of women in engineering, the many different ways that children can begin to develop interests in and understanding of engineering and STEM concepts must be considered (Inman & Cardella, 2015). The marketing of toys for girls is a great place to start to change perceptions of the opportunities within engineering. The toy options for girls should go beyond dolls and dress-up so we can cultivate their enthusiasm and inspire them to grow up to become engineers.

Parenting and Gender-typed Colours

Gender-typed colour preferences are sparsely documented and there has been increasing concern that they affect children's play preferences. However, it is unclear whether such colour preferences are universal across cultures; it is not also clear whether they affect performance. In a study, Chinese preschoolers (n=126) aged 59 to 94 months were tested. Gender-typed colour preferences were assessed using forced-choice colour cards and pictures of neutral toys in gender-typed colours. The effect of gender labels and how they could affect colour preferences were tested by labelling two gender-neutral colours as gender-typed. Students liking for them were assessed, using a rating task and

a forced choice task with pictures of neutral toys in the labelled colours. Sui Ping Yeung & Wang Ivy Wong (2017), found that applying gender increased the gender difference in colour preferences, thereby providing strong evidence for the social-cognitive pathway and explaining colour preferences. Gender labels was found to improve boys' performance. Even though colour choices are not directly related to achievement or a liking for STEM, it is still significant owing to the end of improving boys' performance when they are labelled. Performance improvement will lead to higher scores, which invariably creates a gap between boys and girls. Jonauskaite, Dael, Chevre and Mohr (2018), reiterated that colours carry social connotations, like pink for girls and blue for boys. In a cross-sectional survey it was found that early gender-coding reflects in absolute colour preferences in children and adults of both genders.

Discussion

This study hinges on the submissions from the Raising Girls'Ambition conference of 2018, where the questions on girl participation in STEM were raised. Apart from the choice of toys, colour and language in the early years, Aremu (2018) posits that everyday kitchen gadgets, that are considered feminine are veritable tools for learning science. For example, the blending machine, the hair dryer, the gas cooker, the washing machine and the vacuum cleaner can indeed be used to teach girls science in a playway method. Aremu goes further to expatiate on activities in the kitchen environment that could be used to teach girls science. Example are mixing cake ingriedients, blending pepper (food grade colour mixtures) and boiling of water and other substatnces that emit gas. Erinosho (2005) found that learn and achieve better in Physics with an unconventional method that makes them understand better. She took her subjects to a popular traditional cloth weaving market (Oje) in Ibadan, Nigeria where they were taught topics in physics using the traditional weaving tools and movement. This result of study is in agreement with that of Kris, (2017) who found that the natural starting point for STEM learning in young children is in their curiousity and the desire to explore their environments; this is natural with male and female children. Educators and parents need to help children, espcially girls (Simoncini, 2018) to develop their spatial skills with a mental framework for understanding how the world works. Although the study of Sui Ping Yeung & Wang Ivy Wong, (2017), is significant in asserting the

improvement of boys when colours are gender-labelled as conducted with Chinese students, it is not certain if the study is replicable. Colours are universal; preferences are not.

Conclusion and Recommendation

Since what we learn and know is a function of both nature and nurture, boys and girls should be exposed to equal learning and not stereotypes. Other resolutions from the conference on involving women and girls in STEM include the following: Girls have to be encouraged to get involved in STEM, curriculum strategies have to be applied to make girls acquire scientific knowledge (Aremu, 2018). Avenues have to be created for girls and women to have confidence in themselves. Community strategies such as placemaking are necessary to develop beneficial use of space to promote people's health, happiness and well being, especially to encourage girls early in STEM (Oyelude, 2018). More STEM role models should be identified and made to serve as mentors to the girls at very early ages. The girl-child should be taught about stereotype threats and how to overcome them. Society has to be taught to remove conscious and unconscious biases against women and girls, thereby discouraging them from STEM subjects. Gender policies should be designed for the school curriculum, and the implementation of the policies enforced to favour gender-sensitive teaching and learning of STEM subjects.

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