



Factors Responsible for Gender Difference in the Performance of Computer Science Students

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1 Introduction

Computer Science is a field which has broken new grounds in scientific discoveries and application to provide solutions to problems confronting humanity. It is considered as the versatile vehicle carrying different societies to better and promising destinations. Hence, the pursuit of Computer Science is imperative for any nation in order to maintain its independence, ensure increased prosperity and keep its place amongst the civilised nations of the world. Computer Science entails quite a lot of technicalities, conceptualisation such as mathematical concepts, as well as in-depth logical reasoning. Its major branches include software engineering and development which encompasses programming languages, Computer architecture, Artificial Intelligence and robotics, Computer networking, algorithmic application, Information Technology amongst others. These branches of Computer Science are usually taken as courses in higher institutions of learning such as Universities, Polytechnics and Colleges of Education.

The mathematical and technical nature of these courses discourages students from pursuing Computer Science as a career. Also, the percentage of women participating in Computer Science courses is low due to the mathematical background of the domain. For instance, Camp (1997) carried out a survey which showed a steady decrease in the percentage of women receiving Bachelor of Science degree in Computer Science in the United States of America. The dearth of females in the participation of Computer Science courses had been traced to lack of interest, inadequate female role models as well as the mental tasking nature of some of the courses which include programming, simulation and mathematical modelling. The study of Computer Science among women is also discouraged because it is believed that with the study of Information and Communication Technology (ICT), young women are overexposed to western lifestyle and consequently their chances for marriage are endangered (Huyer *et al.*, 2003). Computer Science has therefore earned its place as an anomaly over the past generation in which women's professional achievement has regressed (Sanders, 2005).

Based on the role of Computer Science and ICT in the world as a tool for solving problems, women's low and decreasing interest and attitude towards Computer



Science is a major concern. Hence, this study seeks to examine the factors responsible for gender differences in the performance Computer Science students. This is with a view to achieving gender equality as well as empowering girls and women in Computer Science. This is because educational opportunities for both sexes are expected to be equally distributed (Eze *et al.*, 2016). According to the requirements of the Sustainable Development Goals (SDGs), countries are to ensure that by 2030, gender disparity in education is completely eliminated by empowering women and ending all forms of violence and discrimination such as early marriage, child trafficking, sexual exploitation, forced marriage and female genital mutilation against the girl child in every part of the world. Hence, gender equality in education ensures that women are given equal opportunity to effectively participate in all levels of leadership and decision making in political, economic and public life. Gender equality is therefore a necessary tool for fostering a peaceful and a sustainable world that will benefit all the nations of the world as well as humanity. Hence, both male and female students should be given equal opportunities to actively participate in the teaching and learning process. This process will help students to enhance their performance irrespective of gender (Eze *et al.*, 2016). Furthermore, another basic requirement of the SDGs in achieving gender equality is to use ICT to facilitate women empowerment (United Nations, 2016). This will in turn set the stage for a huge acceptance of Computer literacy for the whole society. Hence, this will make the public savvy consumers of information, and they will be less likely to be exploited, deceived, or simply confused by pseudo-scientific claims.

This paper is organised as follows: section 2 focuses on the research methodology, section 3 discusses the overview of gender while section 4 deals with gender issues in Education. Section 5 discusses gender and performance; section 6 focuses on gender and Computer Science while section 7 concludes the study.

2 Research Methodology

An extensive review of relevant literature was carried out to determine the effect of gender on the performance of students taking Computer Science courses. The literature used was between 1974 and 2018. A wide range of studies relating to gender and performance of students in Computer Science were searched in three scientific electronic databases namely CiteseerX, Science Direct and Google scholar. Furthermore, the Google search engine was searched for documents and WebPages that contained relevant references for the study.

3 Overview of Gender

Gender ordinarily without connotation refers to the state of being male or female (Akorede, 2011). It is a multi-dimensional concept of social knowledge that helps to regulate socially defined, sexually differentiated roles and relationships, particularly



power relations among women and men. It also refers to the identification of the sexes usually influenced by cultural factors like religion, politics, social factors and education. Gender can also be defined as the socially constructed and culturally determined characteristics associated with women and men. It can also be referred to as the assumption made about the skills and abilities of men and women or the condition in which men and women work. Gender also refers to the relationship that exists between man and woman and how they are represented (Itzin *et al.*, 1995). Gender can also be defined as a socially learned pattern of behaviour that reflects the emotional expression of attitudes that distinguishes males from females (Keightley, 2011). The World Health Organization refers to gender as the socially constructed roles, behaviours, activities, and attributes that a given society considered appropriate for men and women. Like race and ethnicity, gender is a social construct. It defines and differentiates the roles, right, responsibility, and obligations of women and men. Social norms that define appropriate behaviours for women and men, as well as women's and men's differential social, economic, and political power, are determined by biological differences between females and males. Therefore, gender is a range of characteristics distinguishing male and female, particularly in the cases of men and women and the masculine and feminine attributes assigned to them.

Gender is not synonymous with sex. Sex refers to the biological and physiological process. Gender, however, does not refer to biological attributes, but to the social and cultural structure in a given society and its cultural setting. Hence, some authors have differentiated sex and gender. According to Iman and Mama (1997), sex refers to the physiological denotation like biology, hormones and chromosomes, while gender is referred to as the social and historical construction of feminine and masculine roles, attributes and ideologies.

According to the Gay and Lesbian Alliance Against Defamation, "sex is the classification of people as male or female at birth, based on bodily characteristics such as chromosomes, hormones, internal reproductive organs, and genitalia while gender is one's internal, personal sense of being a man or woman or a boy or a girl".

Different authors have identified the differences in the roles of males and females. The roles of the females are usually considered inferior to that of men (Agu, 2007). For instance, Fafunwa (1974) identified the traditional roles of women in Africa as mainly that of childbearing, housekeeping and the substances of agricultural activities. The role of the woman was to take care of the family while the role of the man was to provide for the needs of his family. A woman that chose to have a career was considered barren or lacking in maternal instinct, and her partner was often regarded as inadequate, as it was assumed he was not a good provider. Also, in the Nigerian income tax law, female civil servants were not permitted to own property nor allowed to obtain a passport without the consent of her husband and could not bail an offender (Agu, 2009).



This inferior status of women in relation to men has led to the gross underdevelopment of women. For instance, regarding education, women account for two-thirds of the world's illiterate population (ATRCW UPDATE, 1989). This is because of the socio-cultural beliefs and practices like early marriage and early pregnancy, imitations into adulthood of teenagers and male preference and poverty which forces girls already in school out of school and into teenage marriage. Thus, the level of women's education affects economic productivity, child health, child welfare, family size and agricultural productivity. This, in turn, affects the developmental level of the society.

4 Gender Issues in Education

The term gender issues in the context of education refer to the differences, both real and perceived, between boys and girls and their relative achievements and opportunities (Oxford Brookes University, 2006). This disparity in achievement has been the subject of research in recent times (Ezenwafor, 2018; Bakare, 2011). The causes for this disparity include innate differences between the sexes, self-perception and social influences as well as the influence of the school and teachers' attitudes.

4.1 Inborn Differences

Inborn difference as a significant factor is considered to affect the performance of males and females. Biddulph (1998) draws attention to boy's motor skills and asserts that boys were stronger than girls. Thus, they are less able to sit still and concentrate on tasks for sustained periods in the early years of their lives. It has also been identified that there may be differences in the development of the junctions of the brain hemispheres, and that language development follows a biological maturation where girls have a faster rate of progress than boys. Consequently, girls have greater verbal ability than boys while adolescent boys are said to excel in visual and spatial ability (Bassey, 1994).

4.2 Self Perception and Social Influences

Self-perception and social influence are complex factors that affect the performance of boys and girls. It ranges from deep-seated stereotype and how children acquire them, to the effects of new economic trends (Oxford Brook University, 2006). Examples of this include marked differences in reaction to praise and criticism, physical affection, and rebuke by boys and girls. It is believed that children are more likely to behave by sex-role stereotypes from an early age.

4.3 School Influence and Teachers' Attitudes

The influence of the school, as well as the different attitudes of the teacher towards boys



and girls, affects the performance of the students (Akiri and Ugborugbo, 2009; Okolocha and Onyeneke, 2013; Chiungjung, 2012). For instance, research by Walden and Walkerdine (1995) indicated that when girls achieved highly in mathematics, they were seen by teachers as doing so by using inferior skills and showing persistence rather than brilliance. This attitude of the teacher towards the child kills the interest and morale. Consequently, the performance of the child in mathematics will dwindle.

5 Gender and Performance

Gender has been erroneously identified to influence the performance of students (Adesoji and Olatunbosun, 2008, Iji *et al.*, 2015; Olaoye and Adu, 2015). Researchers have shown that a particular sex seems to have interest in some areas of study than the other (Dania, 2014; Kyei *et al.*, 2011; Musa and Hartley, 2015). For instance, Aikman *et al.* (2007) reported that females showed lower interest in Mathematics, less confidence as Mathematics learners, less motivation to use Mathematics in the future, and much greater anxiety when learning Mathematics. Thus, the male child performed better than the female child in Mathematics (Keys *et al.*, 2011; Musa *et al.*, 2016). Amelink (2009) reveals the role of gender in science courses in a study that was carried out in 2005. The study revealed that males outperformed females in science achievement. However, Amelink (2009) also revealed that in a study carried out in 2007, males and female showed no measurable difference in their average science performance. MeNees (2003) explained that males showed more interest in Computer Science, Physical Science, and Engineering than their female counterparts while female showed more interest in biological sciences such as Nursing and Psychology. Females showed more interest than male in arts and humanities courses. Hence the female child outperformed the male child in these courses. For example, a study carried out by Moss *et al.* (2009) showed that the mean attainment of girls in English is higher than the mean attainment of boys.

6 Gender and Computer Science

The term Computer Science is defined in several ways. This is because the field of Computer Science is evolving daily at a rapid rate (Muchiri, 2018). However, Computer Science can be defined as the study of the theoretical foundations of information and computation as well as their implementation and application in Computer systems. Computer Science is the study of the theory, design, use and analysis of computer devices (Adigun *et al.*, 2015). The term Computer Science incorporates the body of knowledge which contains theories for understanding computing systems and methods; design methodology, algorithms, and tools; a method for the testing of concepts; methods of analysis and verification; and knowledge representation and implementation. The evolution of ICT especially the Internet in recent years has ushered in a new age referred to as the information era. The introduction of Information and



Communication Technology (ICT) has touched all facets of life such as health, banking, agriculture, education, communications and security. The importance of ICT to life has made the pursuit of Computer Science as a course of study fundamental.

Computer Science has been regarded as a traditionally male preserve field (Davies *et al.*, 2004). This phenomenon is deeply ingrained in most societies because of the low number of female students (Vashti, 1992). For instance, female participation in the Computer Science exams on programming languages such as Pascal, C++, and Java has decreased to a large extent (Sanders, 2005). This gender imbalance could be attributed to the following factors.

6.1 Ability

A number of studies have shown that women may not be as successful as their male counterparts in Computer Science (Fetler, 1985; Campbell and McCabe 1984). Ogozalek (1989) stated that women who have the potentials of computing are less confident of their ability than men. Another study by the Minnesota Computer Literacy Assessment showed that the male students performed better at program reading tasks, a core task in the computing environment (Anderson, 1987).

6.2 Interest

Interest is a factor that contributes to the gender imbalance in the performance of students in Computer Science. It has been revealed that boys have more positive feelings about the Computer, tend to like Computers more and more interested in Computers than girls. Typically, studies have found out that Computer liking and interest decrease with age for both girls and boys but more strongly for girls. (Shashaani, 1994; Whitley, 1997).

6.3 Role Model

Role model is also a factor that is responsible for gender differences in Computer Science (Obasoro and Ayodele 2012; Ayodele and Adebisi, 2013; Solanki and Xu, 2018; Osonwa *et al.*, 2016). Another reason for women's lack of interest and low performance in Computer Science is attributed to lack of female role models. In a survey of teachers in 20 countries, Reinen *et al.* (1993) found that most Computer teachers were male and that most female Computer teachers had less confidence in their skills and knowledge. Thus, Pearl *et al.* (1990) noted that females are likely to succeed in Computer Science if they see more women succeeding at computing or as Computer scientists. Research has also shown that there is a link between the sex of the role model chosen by female students and perceptions of competence (Gilbert *et al.*, 1983). For instance, Becker (1985)



found out that the gender of the teacher affected the attendance of students. In the case of a male teacher, the percentage of girls was lower when compared with a female teacher.

6.3 Self Efficacy

Self-efficacy is defined as the belief that one can successfully execute a certain course of behaviour (Miura, 1987; Adeyemo, 2005). Bernstein (1990) conducted a study that showed that feelings of self-efficacy constitute a significant predictor of success in Computer Science courses. The result of the study also showed that men had higher self-efficacy scores than women with respect to Computer Science courses, and since the self-efficacy score of women is lower, their interest in Computer Science courses tend to dwindle.

6.4 Attitudes

The social learning approach which emphasises previous computing experience, encouragement from significant others such as peers, parents and teachers, role models and generalisation of existing attitudes to mathematics and science, suggests that girls and boys acquire different attitudes towards computing (Clarke and Chambers, 1989). Studies have shown that boys are generally more positive towards Computer Science (Fetler, 1985). The positive attitude boosts their performance compared to their female counterparts.

6.5 Socialisation Issues

Computer Science as a field is viewed as a male domain (Inkpen *et al.*, 1994; Davies, 2004). Also, the use of Computers as well as expertise involved in its operation is considered masculine. Teachers and parents also support the view that the Computer is predominantly for the male child. This is because the male child is more likely to use the Computer at home than the female child. Thus, gender socialisation has a negative influence on female students. Consequently, this subtle discrimination causes women to reject Computer Science.

6.6 Gender Bias in Educational Software

Educational software is often game-oriented, and these games usually feature male characters. This can cause girls to lose interest in Computers since games are more likely to appeal to boys than girls (Lockheed, 1985). Educational software designers usually take the default value of student to be a boy, while the software developed for girls has been based on typical gender stereotypes such as shopping, make-up, fashion, as well as dating and they are usually described as saccharine, boring and stereotyped



(Manes, 1997). Software titles for girls perpetuate sexism and serve only to enrich the companies that produce them (Linn, 1999).

6.7 Access to Computers

Another obstacle of women in the field of Computer Science is the access to Computers. American and British studies have shown that boys have more access to Computers both at school and at home (Glissov, 1991). Boys also tend to dominate Computer resources leaving girls with less access to Computers in school setting. This practice results in the alienation of girls from Computers and Computer Science.

6.8 Anxiety

Most studies have found out that Computer anxiety is higher in females than in males, at all ages and in many countries. Nelson *et al.* (1991) found that females who dropped out of Computer courses had higher Computer anxiety than those who stayed, but the males who dropped out had lower anxiety than those who remained. King *et al.* (2002) also found out that girls had a higher level of Computer anxiety than their male counterpart.

6.9 Persistence

Persistence has also been identified as a factor that contributes to the gender imbalance in Computer Science. It has been found out that women leave Computer Science when their marks do not meet their expectations and when they have a limited understanding of what Computer Science is (Jagacinski *et al.*, 1988).

7 Recommendations

The following recommendations were made based on the finding from this research.

1. The teaching of Computer Science courses especially programming courses should be made simple to remove the fear associated with it.
2. Teachers should ensure programming courses are pragmatic for easy understanding of the students.
3. Since Computer Science is a practical course, governments and parents should provide Computers for Computer Science students to enhance the practice of Computer courses at the students' leisure time.
4. The gender gap that exists between the sexes should be filled by government, parents and teachers by giving both sexes equal opportunity to Computer Science education. Male should not be given more preference than the females.



8 Conclusion

Gender has been erroneously seen to play a significant role in the performance and attitude of students taking Computer Science courses. General observations have also shown that the computer science field is predominantly male and that females may not have the ability to do computer science courses and as a result, they are not successful in the computing environment. Hence, this study investigated the factors responsible for gender differences in the performance of Computer Science students. This is to achieve sustainable development in gender equality as well as empowerments of girls and women in Computer Science. The study showed that ability, persistence, anxiety and interest are some of the factors responsible for gender differences amongst Computer Science students.

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