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Lead City University, Ibadan, Nigeria

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Editorial

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Equipping Teachers for Inclusive Science Technology Engineering and Mathematics Methodologies for Sustainable Development

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Abstract

Persistent gender inequalities abound in the teaching and learning of Science, Technology, Engineering and Mathematics (STEM), particularly, but not only in African countries. While these inequalities stem from broader cultural and social factors, and are not predominantly the result of teaching in schools, teachers can play a strong role in supporting all learners, particularly girls. To perform well in STEM, girls need to develop a passion for STEM subjects and to choose to study STEM and develop STEM careers. It is argued that developing inclusive teaching methodologies is necessary but not sufficient in mathematics classrooms. To develop classrooms where all learners feel supported to succeed in mathematics, STEM requires shifts in teachers' beliefs, practices and dispositions about who can and cannot learn mathematics. This paper outlines some of the persisting gender disparities in mathematics and STEM, it discusses challenges in achievement and affect in mathematics and STEM, and develops the argument that teachers need to strongly believe and communicate that all learners can do mathematics, to high levels. This argument is developed through reflecting on the researcher's two recent research projects: the first is on helping teachers to work more productively with learner errors in mathematics and, the second, on learners' mathematical identities.

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Gender Challenges in Mathematics Education

With some slight variations, gender parity in achievement in mathematics has been reached in richer countries, as measured by the Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) studies. This is the case even at the top end of the achievement scale. However, recently there has been some slippage of girls in Australia suggesting that equality has to be continually monitored and achieved. In Africa, boys still achieve somewhat higher than girls, based on the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) and the Analysis Programme of the CONFEMEN Education Systems PASEC studies with some notable exceptions. For example, in SACMEQ girls have attained equality with boys in Lesotho, Namibia and Botswana but are slightly better in Mauritius, Seychelles and South Africa. It is important to be careful when interpreting these results because sometimes "equal" means "equally low". For example, in South Africa, the mean score for mathematics for girls in SACMEQ III was 510 (for boys it was 480), while in Kenya, the girls 'mean score was 545 (for boys, 570). So, girls in South Africa are not performing as well as girls in Kenya, even though they are more "equal".

The results for attitudes and affect towards mathematics are somewhat different, showing that even when girls' achievement is as good as boys', their attitudes are less positive. Boys show higher self-confidence and positive attitudes while girls show more mathematics anxiety. A recent paper outlined a "gender equality paradox", showing that even when girls achieved equally with boys in science and mathematics in wealthier countries and were more capable of college level study—they were less likely to choose to study STEM subjects in further studies. This was because they achieved relatively better in reading than in science and mathematics (based on PISA results), and were more likely to choose careers based on their academic strengths. The study shows that "paradoxically, the sex differences in the magnitude of relative academic strengths and the pursuit of STEM degrees rose with increase in national gender equality" Stoet and Geary, 2018 (p. 581).

A number of explanations for these differences have been given in the above studies. For SACMEQ, the role of female teachers and principals is important because they can act as role models. However, Dickerson et. al. (2015) shows that the number of female teachers does not have a significant effect on

achievement outcomes in African contexts. They show that broader cultural factors, in particular, the empowerment of women, explain gender disparities, rather than any immediate school effects (p.15-16). These broader cultural factors include the status of women in society, violence against women and girls and poverty. Issues such as socio-economic status and race are also important. For example, in South Africa, it is mainly poor black students who achieve low results in STEM. Stoet and Geary suggest that the "gender equality paradox" may be the result of a wider range of opportunities available to women in more 'equal' countries whereas STEM careers are more likely to support equality for women in less equal societies. Given these arguments, it is clear that, while female and male teachers can become better at developing inclusive methodologies for boys and girls, real change will only come when the broader society and culture takes the empowerment of women seriously. As teachers and teacher-educators, we can and must contribute to this broader empowerment.

Moreover, as suggested above, the challenges go beyond gender-equality, because in many countries, both girls and boys perform poorly. For instance, in South Africa, the achievements on the Annual National Assessments decrease substantially as learners progress through the system, with the average result in 2014 going from 68% in grade 1 to 56% in grade 3, to 43% in grade 6 and 11% in grade 9. Learners' difficulties in these tests include algebraic and spatial relationships, problem-solving,and logical reasoning, i.e. they do not develop the higher-order mathematical skills required for success in STEM. Reasons given for learners' poor performance include: teachers' weak subject knowledge (a favourite reason currently in South Africa) and learners' difficulties in the language of instruction, which is English (This is not the main language of most learners). The broader societal reasons such as violence, poverty and inequality in schools and in society are not being discussed frequently enough, especially by those of us who work in the areas of curriculum and pedagogy; but they are crucial. Also important are issues such as increasing assessment in schools, which produces increased mathematics anxiety, teachers' and parents' beliefs about who can or cannot do mathematics. Teacher demoralization also plays out strongly in many schools in South Africa.

Towards Research-based Solutions

Researchers such as Jo Boaler (2016) argue that all learners can do mathematics to any level. Research from neuroscience shows that our brains change throughout life and no one has a “non-maths” brain. Moreover, mistakes in mathematics can grow our brains—struggling with challenging ideas provides opportunities for learning, and beliefs about ourselves as to whether we can or cannot do mathematics transform mathematical workings in our brains. This research suggests a fundamentally different approach to teaching and learning mathematics in schools. Currently, teachers favour the achievement of correct answers, and learners believe that errors are problematic and become afraid to make mistakes and, therefore, to learn.

Boaler, 2016 argues that mathematics is the only subject where students and mathematicians give very different answers to the question: “What is mathematics?” For mathematicians, mathematics is an exciting, creative endeavor, where problem solving, curiosity, excitement, intuition and perseverance play important roles. For school and even undergraduate mathematics students, these aspects of mathematics are often not experienced and remain opaque – with students believing that mathematics is a set of procedures to be followed, which only particularly gifted people can do and understand. So how mathematics is usually taught does not provide opportunities for accessing mathematical knowledge nor for students to identify with mathematics and aspire to STEM careers.

Research from Education suggests that parents' and teachers' beliefs about mathematics have a large influence on children. In a study with Grade 1 and 2 children and parents, Maloney et. al. showed that when parents with mathematics anxiety frequently help their children with homework, their children learn less mathematics and develop more mathematics anxiety. Maloney et. al. (2015) talk about the “intergenerational transmission of low mathematics achievement and high mathematics anxiety” (p.1480). Research in wealthier countries has shown that teachers' beliefs play a significant role in learners' achievement in and dispositions toward mathematics. For example, a study in the US showed that the more a field attributes success to giftedness rather than effort, the fewer the female and black academics are in that field because stereotypes about who belongs in the field are perpetuated . The same study found that mathematics professors hold the most fixed ideas about giftedness.

Many black, female and poor learners are excluded from mathematics, as are many white, male and richer learners. In fact, worldwide, very few learners succeed at and enjoy mathematics. Given this scenario, how do we develop teaching approaches that are inclusive, that show all learners that they can enjoy and be successful in mathematics? This is particularly important in Africa, given our socio-economic developmental needs. However, given some of the research I have quoted above, it is relevant everywhere.

The rest of the paper, presents results from two research projects: the first is about teacher development in relation to working with learners' mathematical errors and the second, about mathematical identity. Neither of the two projects has a specific focus on gender, but both focus on improving all learners' access to mathematics through improving teachers practices and approaches to teaching and to learners.

The main premise of the teacher development project was that teachers working together provide a sustainable method to support shifts in practices, towards learner participation and reasoning in mathematics. The project showed that a number of teachers did, in fact, shift their practices to include learners. The project on identity came about because we saw, through the teacher development project, that for sustainable changes, shifts in teachers' dispositions are as important as shifts in their practices.

Teacher Development for Inclusion: Working with Learner Errors

The Data Informed Practice Improvement Project

The Data Informed Practice Improvement Project (DIPIP) worked with high school mathematics teachers in Professional Learning Communities (PLCs) to support their joint learning about teaching and learning mathematics. PLCs are groups of teachers who come together to engage in regular, systematic and sustained cycles of inquiry-based learning and provide spaces where teachers can reflect and learn deliberately and systematically together, to facilitate collective and sustainable shifts in their practice. PLCs aim to establish school cultures that are conducive to ongoing learning and the development of learners, teachers and schools. These aspects of PLCs suggest that they can be useful mechanisms for sustainable teacher professional development, particularly where teacher development is seen as requiring ongoing

interpretation and re-interpretation by teachers in relation to their local contexts rather than once-off, fragmented inputs by outsiders.

The focus of inquiry in the DIPIP project was learners' mathematical errors, particularly the reasoning underlying these errors. The assumption, based on the substantial errors and misconceptions research in mathematics, is that systematic errors arise from partially valid mathematical reasoning and that making that reasoning explicit for teachers can help them to value learners' current mathematical thinking and develop more sophisticated mathematical ideas. The focus on errors was a mechanism to access three important elements of teaching and learning mathematics: how learners' thinking makes sense to them and can be worked with, even (and especially) when partially correct; how teaching practice can shift to take account of learners' errors and thinking; and teachers' content and pedagogical content knowledge.

Supporting teachers to work with learner errors in PLCs engages a number of principles of inclusive teaching and some of the research from neuroscience. It shows teachers that almost all mathematical errors are valid, have some element of reasonable thinking and can be worked with and built on. Although many mathematics teachers accept this idea at face value, it is a difficult idea to work with in practice, because teachers tend to promote correct answers in their classrooms, and errors are often seen as problems to be corrected. We worked with the notion that errors are opportunities to be embraced and which can be inclusive of more learners.

The PLCs participated in a sequence of developmental activities in which the teachers analysed learners' errors in different teaching contexts. The activities were test analysis, learner interviews, curriculum mapping, choosing “leverage” concepts, readings and discussion, planning lessons together, teaching the planned lessons, and videotaping and reflecting on the lessons together. Although the activities were set up before the project started, we built in areas of choice and flexibility for PLCs, including which mathematics content to work on, based on their analyses of learner errors in their schools.

The tests that were analysed were international (tests), national (tests) and teacher-set tests, depending on the needs and interest of the PLC. The test analysis provided an overview of strengths and weaknesses in learners' mathematical knowledge in a particular school or class. Based on the test analysis, teachers chose learners who had made interesting errors that they

wanted to understand more deeply and interviewed these learners. They then took the results of these two analyses and mapped them against the curriculum, working out where the key concepts were taught and what curricular issues might have contributed to the errors. Based on these three activities, teachers chose a leverage concept, which is a concept that underlies many of the errors that learners made in a topic, for example, the equal sign and the differences between equations, expressions and formulae. Once a concept was chosen, the DIPIP facilitator found literature on that concept, including learner errors in respect of the concept. The PLC read and discussed these papers and drew on these discussions to plan lessons together, which aimed to surface learner errors in the topic and to find ways to engage them, rather than to avoid them. These lessons were taught and videotaped and the community then reflected on episodes in each teacher's lessons in order to understand their strengths and challenges in dealing with learner errors in class. In some years, communities changed the order of activities or emphasized some more than others.

Over the four years of the project, 12 schools and 50 teachers participated consistently. For at least three years, 22 teachers from six schools in four communities (one community was made up of three neighbouring schools). The PLCs met weekly during school terms, after the school day had ended. This required substantial commitment from the teachers some found it difficult to sustain.

Researching the DIPIP Project

The project developed a number of research focuses, including how the teachers' practices and knowledge shifted over time, how the communities interacted and what distinguished teachers and schools who stayed with the project for 3-4 years from those who left after shorter periods. In this paper I will focus on how teachers shifted their practices to take account of learner errors and learner thinking and to include more learners in classroom activities.

A total of 223 lessons from 19 teachers over four years, totaling more than 150 hours of lessons, were analysed using the Mathematics Quality of Instruction (MQI) instrument. The MQI instrument has five dimensions: Mode of Instruction (MI), Richness of mathematics (RM), Working with students and mathematics (WSM), Errors and imprecision (EI) and student participation in

meaning making and reasoning (SMR). Each dimension was recorded at one of three levels: low, medium or high. We allocated numbers 1, 2 and 3 to each level, scored eight-minute episodes in each lesson, averaged across the episodes in each year for each teacher, calculated differences for each teacher across the years and then calculated averages for each PLC. Since there were large differences across PLCs, we reported on each PLC separately. The requirements to reach level 3 were high, and only a few teachers accomplished this a few times, so we took a shift of 0.5 as a large shift in practice.

Community 1 made mid-level changes in two dimensions from 2011 to 2012: Working with students and mathematics (0.31) and student participation in meaning-making and reasoning (0.17). Both shifts declined in 2013. The shifts could be accounted for by two of five teachers, both of whom made major changes to their teaching in 2012, and both of whom participated much less in the community in 2013, one because of illness. The other teachers' practices remained fairly stable over the four-year period. Community 2 made changes from 2012-2013 (they started the project in 2012) for three dimensions as follows: mode of instruction (0.23), richness of mathematics (0.39) and working with students and mathematics (0.45) and in 2013-2014 in four dimensions as follows: mode of instruction (0.41), richness of mathematics (0.39), working with students and mathematics (0.30) and student participation in meaning-making and reasoning (0.49). The changes were accounted for by six out of the nine teachers shifting in some or all of the dimensions over the three years, with three teachers not making major changes. In Community 3, we saw changes as follows from 2012 to 2013: mode of instruction (0.58), richness of mathematics (0.96), working with students and mathematics (1.58) and student participation in meaning-making and reasoning (1.7). So, overall we saw sustained shifts for about half of the teachers. It should be noted that very few projects have looked at teacher change in relation to PLCs and those that have, have shown modest shifts in practice, only some of which are sustained, results which are consistent with our study.

In our analyses of teacher conversations, we saw that different activities supported different kinds of conversations and that between 20% and 33% of the time was spent on content knowledge. The latter finding was important because our project did not take a direct focus on content knowledge but we found that a focus on errors does support teacher talk about their own

mathematics content knowledge . One element that we worked hard to avoid was the issue of blame. Usually teachers blame learners for their errors, saying things like: they did not understand, they did not work hard enough, they aren't careful enough, or even: they are lazy, they don't get any help from home. When we moved the focus from what is wrong in errors to what is correct, we hoped that blame would be removed from learners, and that teachers would come to see making errors as a normal part of learning mathematics. This did not happen as much as we would have liked and a number of the conversations in the PLCs still showed some blaming of learners for their errors. This finding led us to think about how teachers see learners and to develop a project on mathematics identity.

Researching Identity in Mathematics Classrooms

In our research (Gardee and Brodie, in preparation), we look at teacher and learner relationships with each other and with mathematics through the lens of identity. Identity is a useful lens because it brings together the cognitive and affective dimensions of learning and becoming as well as the personal and social aspects of both cognition and affect. It also allows us to explore teachers' practices and their dispositions simultaneously. Our working definition of identity is how people see themselves and how they are seen by others as mathematics learners and how their views of themselves and mathematics influences their practices in mathematics . We access learners' identities by observing their participation in class and by talking to them about their experiences in mathematics in and outside of school and about how mathematics figures into their plans for the future. We access teachers' views of learners by observing their pedagogical practices and their social relationships with learners and by talking to them about these.

We have developed a framework to study identity (Figure 1), which posits a relationship between personal and social identity and agency. It should be noted that social structures and broader cultural values play a role in social identities, which include how people are positioned by gender, race, poverty and inequality. While personal and social identities interact to form a mathematical identity, learners' agency is crucial in navigating between personal and social identity (Gardee and Brodie, in preparation). Figure 1 is further elaborated through the notion of offered and constructed identities

(Table 1), where we see how learners' social and personal identities are affected by what teachers offer them in the classroom, and how learners' agency mediates between what is offered and what is constructed.

Table 1: Identities Offered and Constructed

Classrooms where learners are offered opportunities for affiliation are those where teachers emphasise mathematical ideas and connections between them and encourage learners to both do mathematics and communicate mathematics. Teachers allow for different methods and ideas and see mistakes as opportunities for learning, have high regard for learners and believe that all learners can succeed. In these classrooms, teachers emphasise that effort, rather than ability, is needed to be successful at learning mathematics

In some classrooms, all learners are offered opportunities to construct their social identities in affiliation with the classroom community. In other classrooms, only some learners are offered opportunities for affiliation while other learners are marginalised. Research shows that learners are typically marginalised from classrooms where teachers see success in mathematics as following single procedures taught by the teacher, with no option for different ideas, and attribute success to ability, creating the illusion that not all learners can be successful learners of mathematics. Success in these classrooms is attributed to requiring some form of ability, 'specialness' or 'gift', rather than hard work .

The first quote below comes from a teacher who offer identities of affiliation to all learners in his class and who teaches in ways which encourage learners to persevere, to make errors and to learn from their errors. The second two quotes come from a teacher who believes that learners must repeat and apply mathematical principles; only some are able to do this, and some will never be able to do it. This teacher offers identities of marginalisation to most learners in his class and identities of affiliation to only very few high achievers. As shown by the learners' quotes below, he does not support students who try and make errors.

Teacher 1

"It is very crucial to give learners an opportunity to work out the problems themselves. To find out what is problematic and to try and find solutions. For me what is important is for you to see the challenge and your mind expands if you face an obstacle."

Teacher 2

"If it is maths principles, you just need to know them because maths principles are the ones that govern you. There is nothing new and everything has been discovered."

"Because when God probably created people, we know in science there are right people and there are left people. There are people that are good in numbers. There are people who are not good in numbers. There are people who are good in figures. There are people who are not good in figures. That is the way it is."

Learners in Teacher 2's Class

Jack: "You tried doing your work and then like you get something wrong. That is when he will tell you like what does he say again? Hm… oh he tells you sometimes, he tells you what you wrote here is the same thing as writing rubbish."

Lane: "He just doesn't care … whether you understand it or not… cos I've asked him many times to help me. He said no."

Senzo: "He gives you a sum, you try it then he comes and checks and tells you that that is rubbish. You know that is demotivating. You know he doesn't really care."

Learners do not always construct the identities that are offered to them. Even if learners are offered identities of affiliation, they may not affiliate with the classroom community but may construct identities of compliance or resistance. Learners comply by participating when called on by teachers without much meaningful engagement, but last to satisfy the teacher, parents or job requirements. Learners resist by choosing not to participate in the classroom or choose alternative ways of participating or disrupting the class. Similarly, learners who are offered identities of marginalisation can use their agency to

construct different identities. Learners can construct their mathematical identities in compliance with the identity of marginalisation offered by choosing not to participate much with the teacher. However they may try and access help from other sources, perhaps because of their personal identity as they may still enjoy learning mathematics and wish to pass it. Learners can also construct their mathematical identities in resistance to the identity of marginalisation offered by agentively participating and attempting to develop their social identities as full members of the community. These learners' personal identities may be invested in enjoying mathematics. The learners may feel the need to be members of their classroom community, perhaps because they enjoy mathematics or would like to prove to themselves or others that they are capable of learning mathematics and being members of the classroom community. In order to construct such different identities in the face of marginalisation by the teacher, learners need considerable external resources.

We interviewed and observed learners in Grades 9 and 10 and developed a set of parameters which gave us indicators of their identities. Table 2 shows two high-achieving learners, Jack and Shane, offered identities of affiliation by both their Grade 9 and 10 teachers. Table 3 shows two low-achieving learners, both offered identities of affiliation by their Grade 9 teacher and identities of marginalisation by their Grade 10 teacher. In both classes, Shane constructed an identity of affiliation. Even though he recognised that the Grade 10 teacher was not as good for all learners as the Grade 9 teacher, he continued to draw on external support, view mathematics as useful and do well in mathematics. Jack, who constructed an identity of affiliation in Grade 9, constructed an identity of compliance in Grade 10 and no longer participated in mathematics learning in class, no longer saw mathematics as useful and was not achieving as well. A big issue for both of these high achieving learners was how the Grade 10 teacher treated other learners - they wanted to see their teacher care about all learners, not only the high achievers.

Table 2: Constructed Identities: Jack and Shane

Table 3 shows how Lane and Senzo constructed identities of affiliation in grade 9, because of how the teacher taught them. They participated in class and out of class and their marks were improving and they were thinking of pursuing mathematics in their further studies. In grade 10 they were offered identities of marginalisation, and while Lane constructed an identity of compliance, participating in class in limited ways and thinking about choosing a career that did not involve mathematics, Senzo constructed an identity of marginalisation, completely disengaging from mathematics in class and in his vision for the future. Both learners' results reduced rapidly.

Table 3: Constructed Identities: Lane and Senzo

The results above are representative of the bigger sample of 5 teachers and 19 learners. Two teachers, one in Grade 9 and one in Grade 10 offered identities of affiliation to all learners, and learners in these classrooms constructed identities of affiliation and compliance. Three teachers, one in Grade 9 and two in Grade 10, offered identities of affiliation to some learners and marginalisation to others. Learners in these classes constructed identities of affiliation, compliance and marginalisation, based on their own agency. So, while teachers are central in learners' construction of identities, this construction does depend on learner agency and how they integrate their personal and social identities, as they make sense of their own lives in relation to their experiences in school and out of school.

An important point from our data is that the teachers who offered identities of marginalisation to some learners were often insulting and rude to these learners, meaning that there was no or little ethic of care in their classrooms. All of the learners commented on this. They wanted to feel valued by and cared for by their teachers – both as mathematics learners and as human beings, and they wanted all learners to be treated with care – not only themselves. It is this care – how we treat all learners – that may make a big difference to the experiences of girls in schools and the larger in society. It is interesting that the learners quoted above are boys and the teachers are male, and yet they want to be cared for and valued, as do all human beings.

Conclusion

I have argued that the best way to deal with gender disparities and low achievement among all learners is to work with teachers to shift both their practices and how they see learners as mathematics learners, thus influencing the identities that learners construct. I have shown that teachers can understand learner errors as positive opportunities for learning and can shift their practices to include more learners in reasoning and meaning-making, through working on these aspects of their practice in professional learning communities, as a sustained and sustainable approach to teacher development.

However, shifting these practices may not be enough, because learners need to be accepted as mathematics learners and they need to see all learners

accepted, valued and cared for. Shifts in practice are difficult to make and require considerable support. Shifts in identity, and how teachers see learners are even harder to make than changes in practice, as they both reflect and influence the broader culture and society and will require much bigger changes in schools and in all of our broader societies.

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Equipping Girls with Communication and Information Retention Skills for Sustainable Development

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Abstract

This paper is concerned with equipping girls with communication and information retention skills for sustainable development. It defines communication, the functions of communication and why girls need communication. After communication, the message becomes information. It, therefore, defines information, the uses and why information should be retained and retrievable when needed. The paper is anchored on the perception theory by Berelson and Steiner (1964). The theory states that perception is a complex process through which individuals select, organise and interpret sensory stimulation in such a way as to paint a meaningful and coherent picture of the world. Severin and Tankard posited that selective perception, selective exposure, selective attention and selective retention are factors that affect perception. This paper suggests that, because of poor communication skills which has led to poor retention and retrieval of information, many girls have been left in the lurch and their careers have been jeopardised. An understanding of communication skills and how the brain retains and recalls information (and recalls the information later) will go a long way towards retaining girls in school and fostering their education. Memory aids such as

mnemonics, mind mapping and pegging are discussed as ways of learning, retention and pushing back the frontiers of knowledge. This paper concludes that communication and information retention are important skills to be acquired by girls since these skills will ensure their sustainable development.

Word Count: 227

Keywords: Communication, information, information retention, mnemonics, pegging.

Introduction

What is Communication?

Communication has been defined by many scholars. According to Baran (2010) "Communication is a process of creating shared meaning". Bitner (1989) defines communication as "a system through which people can exchange symbols and thus propagate learning at an accelerated rate". Murphy (1977) states that "Communication is the exchange of meaning by which one mind affects another". Burgoon et al (1994) define communication as a symbolic behaviour that occurs between two or more participating individuals. It is a process, transactional and effective. It is purposive, goal-directed behaviour that can have instrumental or consumatory ends. Little John (1992) posits that "Communication is one of the most pervasive, important and complex clusters of behavior". "Communication involves understanding how people behave in creating, exchanging and interpreting messages". McBride (1980) concludes that "Communication is at the heart of all social intercourse.

Reasons for Communication

Daramola (2012) posits the following as some of the reasons why human beings communicate. It is a basic human activity, therefore, it is ubiquitous and unavoidable. We communicate to make an attitude that is desirable to become more popular by increasing the uniformity of the opinion.We also communicate to enhance our prestige and to make our opinions and feelings (to become) known, to exchange information and greetings, assign roles to people, e.g. in the family or at work, satisfy needs at work or other places, promote and achieve peace and to help us feel good about ourselves.

Characteristics of Communication

It is dynamic and not static. It is a continuous process, which means that it has no beginning nor end. It is a complete process because it occurs at many levels and reflects many influences. It is irreversible. This is because once a statement is made, it cannot be called back. It is non-sequential. That is, the elements in communication are not rigidly patterned in a linear or circular manner (Daramola, 2012).

The Communication Process

According to Daramola (2012) the process of communication can be divided into the following components. The Stimulus: This is what triggers off the communication; the reason or the 'why' of the communication. The Source: This is individual or group or corporate body that initiates the communication. Feed forward: This is a system or means of gauging the response or reaction of the audience who will receive the communication message. The Message: This is content of the communication. What is this message all about? The Medium/Channel: This refers to the form through which the message will be conveyed. The Receiver: This is the individual or group for whom the message is for; in other words, the recipient of the message. Feedback: The response from the recipients or receivers of the message. How do they feel about the message? Noise: Noise can be defined as any obstacle to communication fidelity; any element that will disturb, distort or prevent communication from reaching its intended audience in a wholesome manner. Some obstacles include physical noise, psychological noise such as negative attitudes and linguistic noise such as using the wrong choice of words or words that have more than one meaning.

Classes of Communication

Communication can be divided into the following categories;

a. Intrapersonal Communication (with self)
b. Interpersonal Communication (with other people)
c. Group Communication
d. Communication within an Organisation
e. Public Communication

f. Mass Communication
g. International Communication
h. Global Communication

Types of Communication

Communication can be further subdivided into

1. Verbal: Communication with words
2. Non-verbal: Communication which involves facial expressions, dressing, eye contact, paralanguage, gestures, posture and even silence.

From the above, it is obvious that communication is a complex process. For their success in life girls must be thoroughly equipped with effective communication skills.

What is Information?

Madden (2000) has defined information as “a stimuli originating in one system that affects the interpretation by another system of either the second system's relationship to the first or of relationship the two systems share with a given environment”. Nauta (1972) defines information as “that which is common to all representations that are synonymous in the interpreter”. Derr (1985) states that “information is an abstract meaningful representation of determination which have been made of objects”. Buckland (1991) defined information in three ways: as a process, as knowledge and as a thing. “When someone is informed”, he states, “what they know is changed”. (Information as process) “Information is also used to denote that which is perceived in information as process”. The term 'Information' is also used attributively for objects, such as data and documents that are referred to as 'Information'; they are regarded as being informative... [45, p. 351].

Importance of Information

According to findings by the Glasgow Caledonian University information is important for the following reasons:

- Intellectual development, which leads to academic credibility.
- The development of subject knowledge, leading to an ability to discuss your subject with authority.

- An ability to meet the research requirements of your course.
- Attainment of higher marks in your assignment.

Why Girls Need Information

Young girls, as they are growing up, soon discover that there are problems peculiar to them. They, therefore, need adequate and correct information to help them tackle these challenges. Some of the problems they need to grapple which include puberty, menstruation, appearance, education, dating, bullying, friendship, how to take care of themselves, self-esteem, peer pressure, drug abuse, conflicts, violence, gender inequality, social isolation, time management, child marriage, female genital mutilation and confusion. The list can go on and on and sometimes appears to be endless. However, it is clear that girls need a lot of correct and relevant information that will help them to solve these problems.

Theoretical Framework

This paper is guided by the Perception Theory propounded by Berelson and Steiner (1964). The theory states that "Perception is a complex process by which individuals select, organize and interpret sensory stimulation into a meaningful and coherent picture of the world". Severin and Tankard (2001) describe the process of receiving and interpreting a message as decoding. The process involves the taking in of stimuli through the five senses and the processing of the information. They state that there are three other processes that are similar to selective perception. They are selective exposure, selective attention and selective retention. Selective exposure refers to the normal tendency of human beings to expose themselves to information or messages that are consonant with their existing attitudes and avoiding those messages that are not .Selective attention refers to the tendency of human beings to pay attention to those parts of the message which agrees with their perceived and strongly held attitudes, behaviours and believes. Selective retention refers to the tendency for the recall or retrieval of information to be influenced by wants, needs, attitude and such other psychological factors while avoiding the recall of those that are not in consonance with these. The Perception Theory is relevant to this paper because girls will interpret messages they receive according to their strongly held beliefs, attitudes and other psychological factors.

Literature Review

This paper will examine three main memory techniques and see how they can be incorporated into the teaching and learning procedures to provide better understanding and retention of information.

Mnemonics: The first of these memory aids is referred to as mnemonics. This is a system such as a pattern of letters, ideas or associations which assists in remembering something. (Oxford Dictionary). The word comes from the Greek word, mnemonikos, which means 'memory or relating to memory.'

Mnemonics are useful if one wants to remember lists. For example, if one wants to memorise and remember the North American great lakes, the acronym, HOMES, will come in handy. HOMES stand, for Huron, Ontario, Michigan, Erie and Superior – the Great lakes.

To memorise colour codes as they are used in electronics, one only has to remember the mnemonic: Bill Brown Realized Only Yesterday Good Boys Value Good Work and one will remember that the colour code starts with black (0), brown (1), red (2) orange (3), yellow (4), green (5), blue (6), violet or purple (7), Grey (8), white (9) or RACOLA – Reduction is addition of electrons and occurs at the cathode oxidation is loss of electron and it occurs at the anode.

To memorize the names of the planets (and Pluto) all that is needed is to remember this sentence: my very educated mother just showed us nine planets and you will remember Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. If you want to remember the colours of the rainbow, all you need to remember is ROYGBIV or Richard Of York Gave Battle In Vain and then we can easily remember the colours of the rainbow – Red, Orange, Yellow, Green, Blue, Indigo and Violet.

(1) Mnemonics are also useful for foreign language acquisition. This is done by using these acronyms to tie down new words in our memory.

(2) Patients with memory deficits will also find mnemonics helpful.

(3) Students who are wrestling with difficult or abstract subjects can find mnemonics a saving grace.

Other mnemonics include:

(i) Order of mathematical operations:

Please Excuse My Dear Aunt Sally

(Parentheses, Exponents, multiplication, Division, addition and subtraction).

(ii) The seven articles of the United States constitution.

Large Elephants Jump Slowly and Sink Rapidly (Legislative, Executive, Judicial, Supremacy, Amendment; statehood ratification.

(iii) RICE for instructions for treating sprain.

(Rest the injured area, Ice the sprain, compress with a wrap or bandage, Elevate the injured area)

(4) FANBOYS for the seven coordinating conjunctions in English grammar.

(For, And, Nor, But, Or, Yet, So)

(5) Spelling mnemonics

(a) For the word ARITHMETIC. A rat in the house may eat the ice cream

(b) For the word NECESSARY. Not Every Cat Eats Sardines. Some Are Really Yummy.

(6) Medical Mnemonics

(a) ABC – Airway, Breathing and Circulation

(b) APGAR – Appearance, Pulse, Grimace, Activity, Respiration (used to assess newborn babies).

(c) ASHICE – Age, sex, history, injuries, illness, condition, ETA/ extra information.

(d) FAST – Face, Arms, Speech, Time – Stroke symptoms

(e) SLUDGE – Salivation, Lacrimation, Urination, Defecation, Gastric upset, and Emesis (effects of nerve agent or organophophate poisoning).

(7) (a) Biology: Paul Clarke Our Friendly Grief Spreader

(Taxonomy groupings: Phylum, Class, Order, Family, Genus and Species).

(b) ABC of an environment.

(Abiotic, Biotic and Cultural – parts of an environment)

(c) MRS GREN – For characteristics of living things (Movement,

Reproduction, Sensitivity, Growth, Respiration, Excretion, Nutrition – Also MR NIGER).

(8) Chemistry

(a) The first nine elements of the periodic table

(Harry He likes Beer But Can Not Obtain)

Food: Hydrogen (1) Helium (2) Lithium (3) Beryllium (4) Boron (5) Carbon (6) Nitrogen (7) Oxygen (8) Fluorine

(b) Must Every Prefect Be Perfect

(To remember the five alkanes in organic chemistry – Methane, Ethane, Propane, Butane, Pentane).

(c) Please Stop Calling My African Zebra In Latin Class – To remember the reactivity series- potassium, sodium, calcium, magnesium, aluminum, zinc, iron, lithium and carbon.

Mind Mapping

A mind map can be defined as a diagram for representing tasks, words, concepts or items linked to and arranged as a central concept or subject using a non-linear graphical layout that allows the user to build an intuitive framework around a central concept. The mind map therefore is a diagram, which is visual and can be used to record and organize information in a way that the brain finds captivating and easy to process. This Mind Map explains the process of Digestion in a way the mind can easily retain and recall the information when needed.

Fig. 1: An Example of a Mind Map

In a mind map, information is arranged in a way that resembles how the brain functions – in a radiant rather than a linear manner. The brain likes to work by associating and connecting every idea, memory or piece of information to tens, hundreds or even thousands of other ideas and concepts (Anokhin, 1973).

Uses of Mind Mapping

1) *Encourages Critical Thinking*
   According to Miller *et al.* (2002), their patient care programme at Front Range Community College resulted in enhanced thinking skills which includes critical thinking, while brain and comprehensive thinking.

2) *Improvement of Writing Skills*
   Al-Jarf (2009) investigated the impact of using mind mapping software on freshman students' acquisition of English writing skills. The result of the research showed that the students that used mind mapping included more relevant details, showed better organisation and performed better at all levels of ability.

3) *Mind Mapping Promotes Group Collaboration*
   Zampetakis *et al.* (2007) discovered that mind mapping helped students to develop synergistic interaction, assemble collective knowledge and work with group minded attitude. It also enhanced the flow of communication among the members which contributed to the creative process. Paykoc *et al.* (2004) also used brainstorming and (they) found out that it enhanced critical thinking and cooperation and created an avenue for collaborative problem-solving in a participative and open environment (an experience they enjoyed very much.)

4) *Mind Mapping Enhances Learning*
   The use of different colours, symbols and images helps the students to construct ideas in meaningful ways. In a study by Abl-EL-Mona and Adb-EL Khalick (2008) found out that students achieved higher grades in conceptual understanding and practical reasoning. Mento *et al.* (1999) discovered mind

mapping renewed enthusiasm in classrooms and increased students' confidence and skill in mastering assigned material. Goodnough and Woods (2002) had earlier reported that mind mapping provided a motivating and interesting approach to learning because of the use of colours and symbols which made the learning process more creative.

Budd (2004) corroborated and proved that mind mapping helped students to participate actively during learning. Also in a study by D. Antoni and Pinto Zipp (2005), 10 out of 14 students agreed that they were better able to organise and integrate the materials presented to them in their course through the use of the mind-maping technique. In another study by Polsen (2003/2004), the majority of the students used in the study attested to the flexibility mind mapping offered them and also testified to the creative aspects of mind mapping and how it assisted them in understanding new concepts and ideas, in addition to the confidence and a more positive attitude towards learning it gave them. Goodnough and Long, (2002) concluded that mind mapping caters, through its combination of graphics, symbols and text to both verbal-linguistic and visual-spatial intelligence. Also, it enhances expressive thinking and provides an alternative way to share knowledge and understanding with peers. In another study done at New Church Community Primary School in Warrington, the mind mapping technique used led to a number of improvements in pupils learning such as improved concentration, staying longer on tasks, improved questioning and answering during class discussions and improved independence (Cain, 2001/2002).

5) *Mind Mapping Fosters Creativity*

In a study by Zampetakis *et al.* (2007), mind mapping was chosen as an effective strategy for improving the creativity of engineering students.

Paykoc *et al.* (2004) used mind mapping in Turkey and found out that the students were able to improve on the quality and quantity of their work and were also able to air their opinions in a participative atmosphere. In the same vein, another study by Al-Jarf (2009) concluded that the ability of students to generate, visualize and organise ideas improved when they were exposed to the mind-mapping technique. The students reported that they became faster and more adept at generating and organising ideas for their writing.

6) *Mind Mapping Boosts the Memory*

Medical students who used mind mapping improved their long term memory by 10%, according to a study by Farrand, Hussain and Hennessey (2002). These students reported that mind mapping (was provided) an effective study method, particularly when applied to written materials and could also encourage a deeper level of processing for better memory function Wickramisinghe *et al.* (2007) discovered that a majority of the medical students in their study found mind mapping to be helpful (useful), particularly for memorising information in an organised way, compared to their previous self-study methods. Research by TOI (2009) corroborated the above finding. His study showed that children that were exposed to the mind mapping technique recalled words more effectively, with improvements in memory by 32%. Earlier, Wong Ang Gek Moi and Ong Lee Lian (2007) found that by using the mind mapping to teach comprehension skills, students understanding and memory increased. This agrees with the 1992 study by Entrekin who concluded that mind mapping helped students to remember the relationships and steps necessary for mathematical processes. In the same vein, a survey by Mento *et al.* (1999) concluded that the majority of students in their study noted the simplicity and power of mind mapping and its advantage over linear note taking for the purpose of recall and creative thinking.

In a nutshell, mind mapping has been shown, through various researches, to have the ability to do or help with the following:

1) Boosting of memory
2) Fostering of creativity
3) Enhancement of learning
4) Enhancement of presentation
5) Promotion of group collaboration
6) Improvement of writing skills
7) Encouragement of critical thinking

It is, therefore, clear that the introduction of the mind mapping technique will be a great way to help girls in their careers and life and will really boost their success and sustainable development.

In his book Unlimited Memory, Kevin Horsley (2013) identifies the three Cs, which are creating imagery, connecting concepts together and creating a habit. These he notes, improve concentration and, therefore, aid recall. He advises students to use the P.I.C. method when reading and recalling information. "P" stands for purpose. When you read a book with a purpose, recall will be easier.

'I' stands for interest. We learn more about things we are interested in and this improves recall. "C" stands for curiosity. If we develop curiosity, it will be easier to recall information. He also promotes the SEE principle, which represents the senses, exaggeration and energisation. Information through our five senses can be exaggerated and energised to ease recall. For example it is easier to recall a mango that is the size of a house (Exaggeration) or a mango that is singing the National Anthem or reminding us of the cranial nerves.

Horsley introduces a concept for retention which he calls 'the car method.' In this method, he wants you to imagine that you squeeze an apple into the grid of your car, then stab a carrot into your bonnet. You enter your car and squeeze dried fruits onto the dashboard of your car, sitting on blue berries and strawberries. As if that is not enough, you throw an egg on the face of the passenger, then you pour a basket of seeds and nuts on the back seat of your car. You come out of your car and find a giant orange on the top of the car, you open your boot and you can see a lot of fish and, finally, from your exhaust pipe you can see Brussels sprouts and broccoli coming out with the smoke. With this car method you can remember the super foods – apple, carrot, dried fruits, strawberries and blueberries, egg, nuts and seeds, orange, fish, brussels sprouts and broccoli. So when this system is applied to subjects at school, learning becomes very interesting and recall is amazing.

In a similar vein, Horsley demonstrates that one can use the parts of the body as memory aids. For example, he describes how you can use the body to remember the different types of intelligence available. You can picture yourself standing on a hot lamp or electric bulb. The bulb reminds you of creativity, so you can refer to your feet as the body part for creative intelligence, the knee can help you remember personal intelligence; Your thigh can remind you of social intelligence if you picture your children or brothers seated on your thigh socialising with you. The waist can be used to remind you of spiritual intelligence, if you can picture an angel fastening your belt for you. The stomach can help you recall physical intelligence, because all your physical activities come from energy from food from the stomach. The left or right hand can be used to recall sensual intelligence, the mouth for numeric intelligence, the nose for spatial intelligence and the head for verbal intelligence.

The list goes on, but the point is that one can use the body parts as pegs to help the process of recall.

A variant of this pegging method is one that requires the student to first of all memorise words that will be used as pegs from one to ten. For example, one is bum, two is shoe, three is tree, four is door, five is hive, six is sticks, seven is heaven, eight is gate, nine is vine and ten is hen. Horsley then used this method to remember Anthony Robbins ten emotions of power. It goes thus: there is a bum who needs love and warmth. So just picture a bent object and something warm like fire on the bums head. Then this bum is given a pair of shoes and he is grateful and appreciative. Tree stands for three, picture cats on the tree, cats are normally curious and so you remember that curiously is the third in Robbins ten emotions of power. Four is door, imagine a door jumping excitedly and passion fruit is being poured on the door (4th emotion: excitement and passion) Five is represented by bee hive. It will take determination to break through a bee hive. Six is represented by sticks. Imagine a stick that is flexible and you have the sixth emotion. Seven is represented by heaven.Confident people are in heaven. Eight is a gate. Just imagine a cheerful gate and you have

the eight emotion. Nine is a vine that will produce vitality. Vitality is the ninth emotion. The tenth emotion is represented by a hen that is distributing eggs, thereby contributing to the society. So without much stress, we have been able to peg Anthony Robbins ten emotions of power easily. They are love and warmth, appreciation and gratitude, curiosity, excitement and passion, determination, flexibility, confidence, cheerfulness, vitality, and contribution to the society.

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Social Media as a Correlate of Prostitution Among Senior Secondary School Girls: A Challenge

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Abstract

Social media are characterised as Web 2.0 resources and emphasise active participation, connectivity, collaboration, and sharing of knowledge and ideas among users. Prostitution is the act of engaging in sexual intercourse in exchange for money. It is a common practice found among students all over the world. Some even consider prostitution as the only choice for paying for their education. To ensure reliability and validity of the data collected. Eight senior secondary schools were randomly selected. A sample of 160 Senior Secondary 3 (SS3) students were randomly selected as the sample. The data were obtained by the use of questionnaire and oral interview (from the students in the selected schools). Data were analysed and the result presented with the use of tables and percentages to facilitate simple presentation, interpretation and classification of the data collected. The hypotheses were tested using Pearson's Product Moment Correlation as the statistical tool. The hypotheses

result tested shows that the calculated r values of all the three hypotheses were close to 1 and hence the null hypotheses H0 were rejected while the alternative hypotheses H1 were accepted. The calculated r values were 0.96, 0.92 and 0.99, respectively. Hence, it was concluded that there is a significant relationship between students' gender and use of the social media for prostitution among students in senior secondary schools and there is a significant effect of wrong usage of social media. Apart from the frequency of use, most students use social media for wrong purposes such as flirting, through sending of "hot messages, manipulating images and hot videos" and sharing contacts for dating and prostitution. Some recommendations were made. Students of senior secondary schools should be commended for maintaining a regular online presence on social media. The frequent use of social media should not be addictive. The federal and state governments in Nigeria should strengthen their laws against prostitution and other related vices.

Word Count: 313

Keywords: social media, prostitution, secondary school girls

Introduction

Social media are characterised as Web 2.0 resources that emphasise active participation, connectivity, collaboration and sharing of knowledge and ideas among users (Emmanuel and Chux, 2014). Social media resources can be divided into three distinct categories. While one category emphasises content sharing and organising sites like Delicious, Digg, Flickr, YouTube and RSS readers, the second category encompasses content creation and editing websites such as Blogger, Google Docs, Wikipedia and WordPress. The third category includes social network sites (SNS) like Facebook, Ning, Myspace and Orkut that serve as online communities that enable users to connect with old and new friends, and hare ideas and resources (Mcloughlin and Lee, 2007). Social media are internet social networking sites that connect people for different purposes. Ekeanyanwu and Kalyango (2013) describes them "as the ninth Wonder of the World because such media platforms are becoming

increasingly connected, interactive, participatory, integrative, community-based, ubiquituous and digital".

The explosion of social sites followed the establishment of Facebook in 2004. Social media sites are meant to socially connect friends. Members of this community of friends may be people of like minds and interests who could be continents apart. Social networks have metamorphosed into the social media, which perform roles akin to those of the conventional media.

The Social media play significant roles in societal interconnectivity. They bring the users together for mutual supply and the utilisation of mutual supply and information, thereby providing a platform for social interaction between the audience and the users (Picard, 2009; MacMillan, 2009). However, unlike the conventional media, there is no control, no code of ethics and no gatekeeping. These shortcomings have created room for vices such as falsification, incredibility, lack of professionalism, falsehood, sedition, blackmail, pornography, invasion of privacy, and other unacceptable media practices. They have also been used to promote prostitution.

Dixon (2012) points to a study of about 300 British university students in which 10% reported knowing a student who had worked as a prostitute or escort in 2010. This is up from about 6% in 2006 and 4% in 2000. Dixon explains that the rise coincided with an increase in college tuition fees. McCaskey (2012) corroborates the findings of Dixon by pointing out that the use of the social media could promote prostitution among students. For instance, Abati (2009) reports the case of a female university student who turned into prostitution after armed robbers raped her. She was reported to have used the social media to promote her prostitution.

Oladunjoye (2000) also reports a significant level of prostitution, not only among students of higher institutions in Nigeria but also among secondary school students. Umeh and Umeh (2003) disclose that there is a high incidence of a Nigerian female students "practising prostitution, stealing and other vices to support themselves and maintain their dependant relatives." In a related study, Okunbor and Agwubike (2009) also found a high rate of prostitution among female students in Nigerians secondary schools and higher institutions. Hence, this study will focus on social media as a correlate to prostitution among secondary school students in Osun State using Iwo Local Government Area as the reference point.

Statement of the Problem

Many boarding secondary school girls sneak out of their hostels to meet clients they met through the social media; their freer counterparts in day secondary schools also meet clients during and after school hours. These girls, according to Uzokwe (2008), are easy tools in the hands of ritual killers and kidnappers. Furthermore, when a girl or a woman accepts money for sex, she has conferred on the man the authority and power to decide what kind of thing he may do to her. She would be expected to endure brutality, rape and other things that could be done to her behind closed doors. The prevalence and sophistication in promiscuous behaviour by secondary school students as confirmed by Olugbile and Uzokwe (2008) is enough to trigger a discourse.

Research Hypotheses

- H_o: There is no significant relationship between prostitution among girls in senior secondary schools and their access to the social media
- H_1: There is significant relationship between girls' gender and use of social media for prostitution in the senior secondary school.
- H_o: There is no significant relationship between the use of the social media and prostitution rates among girls of the senior secondary school.
- H_1: There is significant relationship between the use of the social media, moral decadence and prostitution rates among girls of the senior secondary school.
- H_o: There is no significant effect of the wrong usage of social media and prostitution on the academic performance of girls in senior secondary schools.
- H_1: There is a significant effect of the wrong use of the social media and prostitution on the academic performance of girls in the senior secondary school.

Method of Data Analysis

The data collected were analysed and results presented with the use of tabulation and percentages to facilitate simple presentation, interpretation and classification of data collected. The hypotheses were tested using Pearson Product Moment Correlation as the statistical tool. The formula is stated below.

where:
N = scores of respondents
X = the first question of the questionnaire obtained from the respondents and test for hypothesis.
Y = the second question of the questionnaire obtained from the respondents and test for hypothesis;
ΣX = Sum of X scores
ΣY = Sum of Y scores
$\Sigma X2$ =Sum of Squared X scores
$\Sigma Y2$ = Sum of Squared Y scores
ΣXY= Sum of X and Y

Test of Hypotheses

The need for hypotheses is to provide direction for the study and prevent the review of irrelevant literature and the collection of useless or excessive data. A test of hypothesis has been described as a statistical technique that uses sample data to ascertain a hypothesis about the parameter of population. Two hypotheses were tested in this research.

Relationship between girls gender and use of social media for prostitution in the senior secondary schools

Hypothesis One

- H_o: There is no significant relationship between girls' gender and use of social media for prostitution in the senior secondary schools.
- H_1: There is significant relationship between girl's gender and use of social media for prostitution in the senior secondary schools.

Question 6 (vii and viii) of the section B of the questionnaire shall be used to test this hypothesis.

let X1 represent question 6 (vii) and Y1 represent question 6 (viii) from the section B of the questionnaire:

Table 1: Correlation Matrix on Relationship between Girls' Gender and Use of Social Media

In respect of the level of significance the closer the value of r to 1, the stronger the relationship between the variables and vice versa.

However, since the calculated r 0.96 is closer to 1, the Null Hypothesis (H_o) is rejected while the Alternative Hypothesis (H_1) is accepted. It is, therefore, concluded that there is a significant relationship between girls' gender and use of social media for prostitution among senior secondary schools.

The purpose of using social media among senior secondary school girls

Hypothesis Two

H_O: There is no significant relationship between the use of the social media, moral decadence and prostitution rates among girls of the senior secondary school.

H_1: There is significant relationship between the use of the social media, moral decadence and prostitution rates among girls of the senior secondary school.

Question 5 (iii and v) of the section B of the questionnaire shall be used to test this hypothesis.

Let X2 represent question 5 (iii) and Y2 represent question 5 (v) from the section B of the questionnaire:

Table 2: Correlation Matrix on Relationship between Use of Social Media and Prostitution Rates

In respect of the level of significance the closer the value of r to 1, the stronger the relationship between the variables and vice versa

However, since the calculated r 0.96 is closer to 1, the Null Hypothesis (H_o) is rejected while the Alternative Hypothesis (H_1) is accepted. It is, therefore, concluded that there is a significant relationship between the use of the social media and prostitution among senior secondary school girls.

Effects of the wrong use of the social media and prostitution among senior secondary school girls

Hypothesis Three

H_O: There is no significant effect of wrong use of social media prostitution on the academic performance of girls in the senior secondary schools.

H_1: There is a significant effect of wrong usage of social media prostitution on the academic performance of girls in the senior secondary schools.

Question 7 (ix and x) of the section B of the questionnaire shall be used to test this hypothesis. Let X3 represent question 7 (ix) and Y3 represent question 7 (x) from the section B of the questionnaire:

Decision Rule
Calculated r= 0.9910532=0.99
And level of significance = The closer the value of r to 1, the stronger the relationship between the variables (vice-versa).

However, since our calculated r of 0.99 is closer to 1, we will reject the Null Hypothesis H0 and therefore, conclude that there is significant effect of wrong use of social media and prostitution on the academic performance of girls in senior secondary schools.

Discussion of Findings

The result indicates that girls of senior secondary schools use the social media in a high extent for different purposes. It shows that most of them do not often use the social media for contributing to public discussion, academic purposes, reading news, leisure/entertainment and searching online resources. They use them for flirting through sending hot messages, for manipulating images and hot videos and for sharing contacts, for dating and for prostitution among others. The findings are also in line with those of McCaskey (2012), which show that most girls use the social media for flirting/prostitution.

The findings also show that female students use the social media for prostitution more than their male counterparts. This correlates with the findings of Hargittai (2007), Johnson (2008), Madden and Zickuhr (2011), Hampton *et al.* (2011) which show that there is a significant relationship between gender and social media use. They were of the view that there is high correlation between the use of social media by the girls and high involvement in prostitution.

Also, the finding that depicts that the wrong use of social media affects academic performance of the girls and reduces the standard of education agrees with the explanations of Fewster (2010), Belicove (2012), The Telegraph (2009), Jansze (2010), and Holmes (2009) that there is a significant correlation between the use of social media, students' involvement in prostitution and standard of education in higher institution. Lastly, the negative effect of the use of the social media among students, leading to prostitution, is that it leads to

unwanted pregnancies, drug abuse, ST diseases and social stigma, among others.

Summary of Findings

The study on the social media and prostitution rate in senior secondary schools has opened up a number of challenges for the social media as agent of prostitution among students of senior secondary school.

Respondents that fell between the age range of 10-14 years and 15-19 years gave all the information used for this study and virtually all the respondents were students. The study revealed that prostitution is a major social disease among female students and a large percentage of female students do have sex partners.

In testing for the hypotheses, the calculated r values of all the three (3) hypotheses were close to 1 and hence, the null hypotheses (H_o) were rejected while the alternative hypotheses (H_1) were accepted. The calculated r values were 0.96, 0.92 and 0.99 respectively. Hence it is concluded that there was a significant relationship between students' gender and the use of the social media for prostitution in senior secondary schools. There was also a significant relationship between the use of the social media and prostitution in senior secondary schools. There was also a significant effect of the wrong usage of social media and prostitution on the academic performance of students in senior secondary schools.

The study also revealed that the use of social media leads to prostitution and prostitution leads to unwanted pregnancies, disease infection.

Conclusion

The findings of this study suggest that students of senior secondary schools have adopted the use of social media and they use them frequently. Apart from the frequency of use, most students use the social media for bad purposes such as flirting, through sending hot messages, manipulating images and hot videos and sharing contacts for dating and prostitution. It was also instructive to note that gender plays a significant role in the use of social media for prostitution among students of institutions of higher learning as female students tend to use social media more than their male counterparts.

Recommendations

Based on this, the following recommendations are suggested.

- Students of senior secondary schools should be commended for maintaining a regular online presence on social media. There are many advantages of this. Social media are resources channels for educational and learning purposes. They also serve as news and information channels and help users stay connected with distant relations. However, the various schools Principals, teachers, parents, guardians, and other stakeholders in the education sector should mount a concerted orientation programme aimed at discouraging young people from the negative use of the social media, especially carrying out prostitution or other related disgraceful habits and lifestyles.

- Warning that the frequent use of the social media should not turn to addictive use is of paramount importance. Anything addictive could turn negative and eat into the students' studies and other related time schedules. In other words, addictive social media use could negatively affect students performance in their educational pursuits. This is a possibility that must be researched into and appropriate measures taken.

- The federal and state governments in Nigeria should strengthen its laws against prostitution and other related concerns. Both punitive and corrective measures must be aggressively taken to eradicate such cankerworm from our society. However, Government, non-governmental organisations (NGOs), religious institutions and bodies should address the conditions that lead our young people into prostitution in the first place. Sociologists and social psychologists could also engage in relevant research to advise the aforementioned bodies so that this negative phenomenon can be rooted out of the society. This, for us, should be the highpoint of any concerted effort to eradicate the incidence of prostitution among secondary school students.
- Seminars and workshops should be organised periodically on the dangers of promiscuousness in our lives.

- HIV/AIDS orientation should be organised for greater awareness by the Guidance and Counseling departments in secondary schools.

- The counseling departments should embark on the dissemination of valid HIV/AIDS information to students, staff and the community through.
  (a) The use of audio-visuals like films (film strips), slides (overhead projectors), bulletin board among others.
  (b) The use of electronic media like the internet, where it is available, usable and accessible.
  (c) HIV/AIDS information being integrated into school subjects like biology and health education so as to catch them young.

- The government, Ministry of Health and some NGOs should extend the fight against HIV/AIDS-a bi-product of prostitution to higher institutions and secondary schools where there is a larger group of people who are vulnerable.

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Use of Audio-visual Materials in Equipping Girls for Sustainable Development in Nigeria

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Abstract
Education is the cornerstone of national growth and development. The use of audio-visual materials aids the effective, cognitive, affective and psychomotor development of students at all levels in Nigeria through what the ears and eyes hear and see respectively in the teaching and learning process. Audio-visuals are necessary for teaching and learning in this 21st century. They are useful in training and equipping individuals that can contribute meaningfully in the society and thus help achieve sustainable development in Nigeria. There are many factors that can limit the effective use of audio-visuals in equipping girls for sustainable development. These include inadequate infrastructure, inadequate skilled manpower, cost and limited access to the internet. This position paper, therefore, recommends the provision of adequate infrastructure, recruitment of skilled manpower, provision of adequate audio-visual materials and effective utilisation of audio-visual materials from primary to tertiary institutions in order to equip the girl child to contribute significantly to sustainable development in Nigeria.

Word Count: 156

Keywords: Equipping, audio-visual materials, girl education and sustainable development

Introduction
Education is a veritable tool for national development. It empowers people and strengthens nations. According to the National Policy on Education (2013), education is an instrument par excellence for achieving the developmental goals of the nation. As observed by Adedokun (2011), education, more often than not, holds the key to other conditions such as taking proper decisions

about living and acquiring skills that can assist one economically, politically and socially. Anugwom (2009) thus opines that education is the main tool for imparting skills and attitudes relevant to the contribution of the individual to the development of the society. It is a key every individual should possess in order to make significant contributions to national development. In the opinion of Imogie (2012), the prosperity of a country depends, not only on the abundance of its revenue nor the strength of its fortifications, but on the number of its citizens that are enlightened through education.

Education is a social process in which one achieves societal competence and individual growth. It is the art of learning about oneself and one's environment for the purpose of self-development while, the use of audio-visual materials in educational institutions is now seen worldwide as both a necessity and an opportunity for institutions to excel greatly developing individuals (Grace & Kalu, 2016).

Audio-Visual Materials

The term audio-visual materials has been defined by Dike (2013) as "those materials which do not depend solely upon reading to convey meaning. They may present information through the sense of hearing as in audio resources; sight, as in visual resources; or through a combination of senses". Indeed, the variety of such resources is a striking characteristic.

The 6th edition of the Oxford Advanced Learner's Dictionary (2000), defines 'audio-visual' as "using both sound and pictures as audio-visual aids for the classroom". This implies that audio-visual materials need to serve as an aid in the classroom for teaching and learning to take place. Also, the definition shows that audio-visuals are materials whose information contents can only be perceived through the ears and eyes. That is to say, its information contents can be perceived through the sense of hearing with the aid of sounds – referring to the audio resources; or perceived through the sense of sight in the form of pictures or objects – referring to visual resources. The combination of audio and visual (audio-visual) implies that information can be perceived with the ears and eyes at the same time. Therefore, the term "audio-visual" refers to both audio materials, visual materials and audio-visual materials. They include phonographs, films, film-strips, micro-phones, speakers, slides, projectors,

posters, chalkboards, charts, models, diskettes, television, audio-video machines, computers and cell phones (Aina, 2004).

In the words of Anzaku (2011), "the term "audio-visual material" is commonly used to refer to those instructional materials that may be used to convey meaning without complete dependence upon verbal symbols or language". Instructional materials include a textbooks with illustrative pictures or diagrams while, some audio-visual components are in the form of processes and experiences. For example, dramatising an event or a procedure. Some audio-visual materials like motion pictures require the use of electronic equipment to bring out their value. However, some audio-visual materials do not need equipment at all, for example, an exhibit or a study print. The effective use of audio-visual materials is very necessary for sustainable development in any society especially in Nigeria.

Most of these audio-visual materials are found in the classroom but their effective management by teachers in the classroom, as observed by Dike (2013), is an issue which is a common trend among institutions of learning. He further added that, most institutions have a large number of students in the class and the chalkboard, most often, is the available visual material in the class that can aid students understand the lecture. At this time, however, the teacher may not be able to effectively manage the use of the chalkboard to ensure all in the audience benefit. The management of these entails the use of colourful and bright writing materials for all to see. In a similar vein, Aina (2014) opines that management of the chalkboard in a large class entails that the teacher use an audio means – the microphone and good speakers-so that those in the class who may not see the information clearly from the chalkboard can benefit with the use of micro-phones; hence ensuring that information is effectively gathered by the students and learning is assured by all.

Sustainable Development

The concept of sustainable development lies in the idea that a society is able to maintain its level of political, economic, cultural and educational status both in the short and long run. It is the highest level of societal growth. It connotes quantitative and qualitative growth in all sectors of a country. Sustainable development has its goals. The sustainable development goals (SDGs) are a new, universal set of goals, targets and indicators that the United Nations

member states are expected to use to frame their agendas and political policies over the next 15 years. The SDGs follow, and expand on the Millennium Development Goals (MDGs). The countdown began in September 2015.

On discusses the 17 goals that could transform the world by 2030.

Here are the 17 Sustainable Development Goals.

Goal 1: End poverty in all its forms everywhere.

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Goal 3: Ensure healthy lives and promote well-being for all at all ages.

Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Goal 5: Achieve gender equality education and empower all women and girls.

Goal 6: Ensure availability and sustainable management of water and sanitation for all.

Goal 7: Ensure access to adorable, reliable, sustainable and modern energy for all.

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employ and decent work for all.

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Goal 10: Reduce inequality within and among countries.

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Goal 12: Ensure sustainable consumption and production patterns.

Goal 13: Take urgent action to combat climate change and its impacts

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

To achieve these goals as they relate to the education of girls is very fundamental to societal development. It will also break the gender barrier. Hence, the effective use of audio-visuals in, educating girls is essential in adequately preparing them to contribute significantly to societal development.

Use of Audio-Visual Materials in Equipping Girls for Sustainable National Development

The following are the ways by which the effective use of audio-visual materials can contribute to equipping girls for sustainable development.

Basing Learning in Sense Experience: Stressing the importance of audio-visuals Ngozi Samuel and Isaac (2012), agree that audio-visuals are very important and useful in education because the normal learner, in so far as the functions of his preceptor mechanisms are concerned, gains understanding in terms of multiple impressions recorded through the eye, ear, touch and other senses. Swank (2011), stressing the effectiveness of visual materials in leaning, estimated that about 40% of our concepts are based upon visual experience, 25% upon auditory sensation, 17% on tactile experiences, 15% upon miscellaneous organic sensations and 3% upon taste sensations. With the above assertion, it becomes clearer why audio-visuals are important in the teaching and learning processes. This is because they bring the contributions of the different senses together to get 100% clarity. Hence, the effective management of the chalkboard, microphones and good sound speakers in the classroom by teachers will help the girl - child in the class, no matter its size, to benefit maximally from the lectures.

Encouraging Participation: Natoli (2011), observed that "audio-visual materials are rich opportunities for the girl-child to develop communication skills while actively engaged in solving meaningful problems". In other words, girl certainly like it more and learn better if they are engaged in important and appealing activities. For example, involving girls in bulletin-board displays will aid their

understanding through asking questions or when they join the teacher in dramatising an event or a process.

Serves as a Source of Information: Audio-visual materials serve as a good source of information because information can come from the good use of perceptual instructional materials, especially those provided from our locality. When they are effectively managed in the class, their familiarity gives a background for understanding the information. Mcnaught (2007) observed that audio-visual materials are very useful in teaching. He further stressed that where consistency of presentation is desirable, audio-visual materials are also useful. They provide experiences not easily secured in other ways and hence contribute to the depth and variety of learning.

Making Learning Permanent: Learning according to Saleh (2015) "is any improvement in behaviour, information, knowledge, understanding, attitude, values and skills." Hence, audio-visual resources can play a major role in improving an individual in all the above mentioned areas, thereby make learning permanent. On this note, Gopal (2010), noted that "audio-visual methods do seem to facilitate the acquisition, retention and recall of lessons learned, because they seem to evoke the maximum response of the whole organism to the situations in which learning is done. And perceptual materials readily associate themselves with the unique experiential background of each individual". Natoli (2011) also stressed that audio-visual materials are important in the teaching and learning processes because “Having seen something, most people remember; for whatever that thing was, it conjures up an image at a mere mention and can be talked about freely. In a similar vein, Dike (2013) opined that students forget because of lack of interest and opportunities to use the knowledge they have gained later on. Audio-visual resources can, therefore, contribute to the clarity of information presented by allowing students to visualize what is learned. This, according to Dike (2013), informed the dictum:

What I hear, I forget
What I see, I remember
What I do, I know

The author further the effective management of audio-visual materials in the teaching and learning process especially in large classrooms, helps to a large extent in retaining what was learnt, thereby making learning permanent. Students, especially girls are, therefore, able to easily retrieve information during examinations, because both the affective and psychomotor aspect of learning of the girl – child has been greatly heightened with the use of audio-visual materials in the teaching and learning process.

Challenges that Limit Effective Use of Audio-visual in Equipping the Girl-child

The following constitutes challenges that limit the effective use of audio-visuals in equipping girls for sustainable development:

Inadequate Infrastructure: In Nigeria, a formidable obstacle to the use of audio – visuals is infrastructural deficiencies. Computers are made to function with other infrastructural facilities such as electricity under "controlled conditions". For the past fifteen years, Nigeria has been having difficulty providing stable and reliable electricity to every nook and cranny of the country. Currently, there is no part of the country which can boast of electricity supply for 24 hours a day, except perhaps areas where government officials live. Electronic equipment such as radio, television, video recorders and even computers have been damaged due to irregular power supply. When electricity supply is not stable and constant, it is difficult to keep high-tech equipment such as computers functioning, especially under extreme weather conditions as obtains in Nigeria. In rural Nigeria most inhabitants do not have access to electricity, thereby denying rural secondary schools the opportunity to benefit from the use of electronic equipment such as radio, television, video recorders and computers. The few areas with Internet access in Nigeria are found in urban centres. Environmental realities are difficult to manage because fans, sealed rooms and stable electricity are lacking in many urban homes and rural areas.

Inadequate Skilled Manpower: To effectively use audio-visuals in institutions in Nigeria, there should be locally trained workers to install, maintain and support these systems. There is acute shortage of trained personnel in application software, operating systems, network administration and local technicians to service and repair computer facilities. Those who are designated to use

computers in Nigeria do not receive adequate training; at worst, they do not receive any training at all (Okebukola, 2007).

Cost: The price of computer hardware and software continues to drop in most developed countries, but in developing countries, such as Nigeria, the cost of computers is several times more expensive. While a personal computer may cost less than a month's wages in the United States, the average Nigerian worker may require more than two years' income to buy one. Nigeria has over 6,000 public secondary schools. The majority are short of books, paper and pencils. Many of the schools lack adequate infrastructure such as classrooms, and only few are equipped with television or radio. Apart from the basic computers themselves, other costs associated with peripherals such as printers, monitors, paper, modem and extra disk drives are beyond the reach of most secondary schools in Nigeria. The schools cannot also afford the exorbitant Internet connection fees.

Limited Access to the Internet: In Nigeria, there are few Internet providers (that provide Internet gateway services to Nigerians). Such Internet providers are made up of Nigerians who are in partnership with foreign information and communication companies. Many of these companies provide poor services to customers who are often exploited and defrauded. The few reputable companies which render reliable services charge high fees, thus limiting access to the use of the Internet. The greatest technological challenge in Nigeria is how to establish reliable, cost-effective Internet connectivity. In a country where only about 0.6% of the populace has personal computers, the few reliable Internet providers who have invested huge sums of money in the business have a very small clientele. They have to charge high fees in order to recoup their investment in reasonable time. Nigeria has about 500,000 Internet subscribers. All Internet service providers in Nigeria are based in urban areas. For many years, the Nigerian government had a monopolistic control of telecom services, which does not allow for the competitive environment that reduces telephony rates.

Conclusion

Human factors or lack of the manpower to man the available audio-visual (A/V) is the greatest hindrance to the use of A/V resources in equipping girls for sustainable development in Nigeria. The place of audio-visual materials in the effective implementation of any educational programme cannot be undermined. Audio-visual materials perform such functions as the extension of the range of experience available to learners, supplement and complement lecturers' verbal explanations, thereby making the learning experiences richer and have a lasting impression on the minds of the students, especially girls. Audio-Visual materials supplement, clarify, vitalise and emphasise instruction and enhance learning in the process of transmitting knowledge, ideas, skills and attitudes. This calls for the teachers' resourcefulness and improvisation on the management of audio-visual materials during the teaching and learning process.

Way Forward

Based on the challenges that limit the effective use of audio-visuals in equipping girls for sustainable development, the following recommendations are made:

Federal and state governments should diversify their resources so as to encourage and promote the supply and funding of technologies in schools which will in turn increase the application of audio-visual materials in institutions of learning in developing the girl-child.

Management and administrators of institutions should ensure that credible and qualified personnel are recruited to perform audio-visual related activities, either in administrative or academic functions, so as to develop the girl-child for sustainable development.

Federal and state governments should ensure that the cost of audio-visual materials is regulated to ensure that schools can acquire and use them in the development of the girl-child for sustainable development.

Federal and state governments should ensure that infrastructure such as electricity is improved significantly, especially in educational institutions. This will in turn encourage and strengthen academic activities in schools, including the use of technologies which encourage audio-visual functions in developing the girl-child for sustainable development.

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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.

Word Count: 78

Keywords: Equipping girls, Physics, Mathematics, sustainable development

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 worlds 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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Encouraging Women and Girls in Stem in Nigeria for Sustainable Development

(A Keynote Speech)

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Abstract
STEM education has taken a role of prominence in many countries, where the leaders are trying to figure out how to appropriately grow the economy and create a sustainable future. With this in mind, one of the most important things that can be done regard to STEM to address many of the United Nations's Sustainability Goals is to provide more assistance to get young people involved who may not have been involved before such as girls. This is particularly true in countries like Nigeria, where there are many young people, where there is opportunity for growth, and where the government seems to understand its role. With this in mind, this speech provides a framework through which one can understand the challenges of STEM education in reference to girls in Nigeria for sustainable development.

Word Count: *134*

Keywords: *STEM Education, Girls, Sustainable Development, Nigeria STEM Education in Nigeria*

Introduction

Worldwide many nations have looked at methods to solve the issue of involving their entire population in Science, Technology, Engineering and Math fields. The world is moving to digitisation of information, monetary systems and farming. In terms of politics, economics, and social issues, the future belongs to those who know how to use mathematics and the sciences in order to solve problems. With this in mind, nations are undertaking a variety of efforts with the hope of bolstering the abilities of their own citizenry. In so doing, they are hopeful that their citizenry can benefit, and that society at large will be better and able to achieve new things. Importantly, many countries in Africa have invested more money in education generally and in STEM education specifically. Nigeria is one of those countries, as both foreign sources and domestic funding has been used to generate more opportunities for students. This has, of course, been supported by the business world in Nigeria because of the belief that the country's education system needs to be modernised in order to combat the challenges facing it in the so-called knowledge economy. Here, we will assess the strengths of these efforts, comparing the work done in Nigeria to the work done elsewhere in this regard.

Background and Perspective

As responsible researchers in any field we should first acknowledge our own biases and explore our own way of viewing the world. With this in mind, I have taken the opportunity to examine my own potential biases in researching this topic. While I am invested personally in the development of the sciences, this should not influence my ability to conduct the research in a way that is reasonable.

My sincerest thanks go to the RAGA 2018 Conference Local Organising Committee for extending the invitation to me. I am very passionate about encouraging girls and women in STEM. As an astronomer this is something I have run into time and time again. I expanded out my activism to include all areas of STEM. I also expanded my expertise from the school where I work to include my larger community. Today I expand that to include Nigeria. I am a learner, so when asked to speak at this conference and write a paper, I searched many papers and books on Nigeria. With this in mind, a big part of

what I bring to the table here is the broad view of what is happening in Nigeria in the context of the rest of the world, as well as an understanding of which future opportunities may exist for Nigeria moving into the future. I ask in return that you critically evaluate my ideas and keep what is useful to you, build on it and share your perspective on educating Girls and Women in STEM with me.

My father was in the STEM field, and he had four daughters. He encouraged each of us to go into STEM and take care of ourselves. He pushed us not to think about our lives in terms of who we were going to marry, but rather, what things we could do to change the world. To live the lives that we chose and contribute to society. My sister Natalie is an Accountant, Georgia is a Nurse, I am an Astronomer, and Samantha is a surgeon. When I was in graduate school, I fell in love with teaching, and I soon found that not every student had had the same opportunities and encouragement that I had the benefit of hands on learning. With this in mind, there may be some ways in which I am biased toward learning the sciences, but this will not impact my ability to identify opportunities for growth in Nigeria.

Nigeria: Land of Opportunity

I had typical stereotypes of Nigeria in my mind when I received the invitation to speak at this conference, and my fellows subsequently reacted with incredulity when I informed them. Is this invitation an internet scam? Are you sure you will be safe? After doing my research, I found that here in Nigeria was exactly where I need to be. I know you are all here because you know this, but please humor me.

You have a new democracy that is primed to provide the same opportunity to all of your citizens. The government is not only growing in size, but it is growing in terms of its scope and ability. This presents plenty of potential upside that you all will be able to take advantage of in the years to come.

Nigeria is incredibly young right now, especially in comparison to the rest of the world. While many countries might be aging, and they are dealing with the effects of this, many hold that Nigeria is suffering from a “youth bulge.” For instance, of your more than 180 million citizens, more than half of them are under the age of 30. This presents an amazing opportunity for Nigeria. Holding this large percentage of the world's young population, if these people are given

the chance to succeed in science, then they can help make Nigeria a place where innovation comes to grow (Okeke *et al.,* 2017).

Your population is largely untapped. Most people do not have a chosen career field nor do their parents have a skill or trade to pass down to them. Due to changes in major fields, it is important to develop new skills and competencies. The oil industry in Nigeria has long been such an important player for driving growth in the region. However, that industry is slowly and surely drying up. The world is changing, with sustainable technology becoming more important today than ever before. This leads to important questions. As people become less reliant on oil, and as the Nigerian oil industry runs into uncertainty, what is next? Where will the skilled people in this industry go for work? Where will those skilled people who could work adjacent to the oil industry go to work next?

You are traditionally a patriarchy. This is really not different than most of the world. But many of your compatriot countries have systems in place that are very established that silently discriminate against women and those from disadvantaged backgrounds. I know because I was in one such system. While women were allowed to do everything, some things were made more difficult for us. The numbers at increasingly higher levels of education reflect this.

With this in mind, you have the opportunity now to start from the bottom and create a system that captures all youths not just the males. You have the opportunity to be the world leader in science and technology by including women. A population that no country has yet taken full advantage of. Your industries know this. They want to employ the best regardless of gender. For example the Next Einstein Forum was disappointed in the number of female entrants for their Einstein contest, and so put out a call specifically requesting female entrants. This resulted in more women seeking out the opportunity(PR Newswire, March 8, 2016). There are women in Nigeria who want to grow in this knowledge and become better. They want to be the future.

We all know that a society benefits when all members can participate. The education of women here in Nigeria has been shown to lead to better health outcomes for children. With this in mind, an important question has to be asked. How do we establish a system now that is inclusive of girls and women? We know that just building a system that is how it was always done does not work. We know simply providing “equal” access does not work. We know that

you cannot grow into a system that was not built for you. One way to understand the situation in science education is through the so-called "leaky pipeline." There is inadequate representation of women in the sciences at the highest levels. Beyond that, the opportunities for women at the lowest levels are lacking. At every level of the pipeline, there are leaks, and this leads to fewer women being elevated into important positions at the end of the day. It is an issue that can be fixed and should be fixed moving forward.

Policy Solutions

What can we do policy wise to support our girls and women in STEM? It begins with taking that extra step to hire female workers and support them in the workplace (Eraikhuemen & Oteze, 2015). It continues with family friendly policies for all workers, male and female. This can improve the work lives of women and show them that the STEM world is there for them to provide opportunities rather than barriers. When men are able to take family leave and care for a newborn, they are able to bond with the child and play a greater role in the parenting so that home life is more evenly shared between the genders. This sort of equality affirms organizations and improves the lives of the people who happen to work in these.

Getting Girls into STEM

When we put out competition advertisements, we can make sure to specifically target groups that we know tend to be under represented, such as women and girls, and demand to have equity in our applicant pools. The Airbus foundation holds workshops specifically aimed at girls called "The Airbus Little Engineer," where girls are introduced to various airplane parts and encouraged to do teamwork to solve a problem (This Day Live, May 9, 2018). However, as with almost every good idea, there were some problems that kept this from being as good as it might have otherwise been. Namely, they ran into the issue of not having the internet connection to run the workshop and not having a suitable replacement. The responsibility is on all of us to make sure that these good opportunities and programmes do not fall by the wayside because of things that might have been fixable and preventable. The government needs to invest in infrastructure for a sustainable pipeline of talent.

Speaking of that government, there is a lot to know about what the Nigerian government can do to improve the opportunities for young people in the sciences. The government has not been slack in this regard. In fact, the Nigerian government has implemented competitions to encourage young people in STEM. In 2018, the Ministry of Science and Technology offered a N1million reward to the best overall student in the Young Nigerian Scientist Presidential Award. (Nigerian Tribune, February 19, 2018) They also provided laptops to the runners up. There is an understanding on the part of the government that the youth in Nigeria can lead the way, bringing the country into the modern era.

The Nigerian National Petroleum Corporation offers a quiz competition. It has done so for two decades, urging young girls to get out and participate in this sort of thing. In addition, at the ceremonies, the achievements of girls in the competition were highlighted and the need to encourage such behavior was emphasised.

There has also been some partnership with big companies that can potentially provide assistance in getting young people involved;the credit card giant MasterCard is in the game with their initiative G4T or Girl4Tech. While it is worldwide, Emma Okonji, Vice President and Area Business Head, created a hands on inquiry based workshop that shows the many facets of STEM fields.(Africa News Service, May 9, 2018) It showcases the MasterCard payments technology and uses current employees and mentors. This particular effort focuses on coding as understanding a computer language, which in turn allows girls to engage with technology from a ground up perspective.

Perhaps, the next step involves getting more people involved in the lives of those young people who are showing promise when it comes to this kind of education. Nigeria is known as a country where communities and families are a pillar. They are the support systems through which young people grow, as they rely on the assistance of others to help them through. This means that perhaps the best solution for Nigeria is involving the whole family in whatever is going on. Getting parents to encourage their children in something that they have never done can help to move society as a whole forward.

Supporting Girls and Women in STEM

While some of the solutions are big and broad, others require us to shift our focus right here, locally. We can do this by making sure that we are buying and hiring tech locally. Nigeria has a wealth of tech start-ups. If your company needs some programming done, you can hire a Nigerian. If your website needs to be hosted, you can hire a Nigerian. These businesses are out there, and they just need to be noticed in order to move forward.

We can look at ways to make sure that all students are supported all the way in their education. One of the existing issues is that many students just do not have the financial support to see their way through education. They begin, learn some skills, and then have to drop out because they do not have the money to finance it. This can be a major problem on the whole because it drains the economy and society of the talent that would have otherwise existed. We can ensure that these future leaders are not abandoned by putting into place programmes to support them (Khan & Rodrigues, 2017).

What we start, we should finish. For example, just this May, the International Center For Investigative Reporting found that the Akwa Ibom Top Science College was not maintaining the campus facilities due to a lack of funding (I reports, 2018). Students were forced to purchase materials on their own and live in conditions not conducive to learning. The college was built in 1986, but funding had dwindled and so that there was no money for upkeep and the needs exceeded the abilities of the students to do on their own. When we make these pushes for new facilities and systems, we need to make sure we have also included funding for the future, so that our endeavours are in vain. We also show those students who would like to pursue opportunities that we are very serious about what we are doing in STEM. Often, it is taking the first step in the process that is critical for allowing these students to explore their motivations and make good on their talents.

It is important that we think of new ideas rather than just falling back on the same old things that have been done in the past. This means that we cannot do what we have done. Student debt is not the answer. Around the world, and particularly in the US where I am, debt has been a bad thing for many students, limiting their options after college. It is creating the kind of crisis that may eventually fall the economy. Currently we limit opportunities for students in higher education due to cost. Students must finance their own education and often go very far into debt to do so. I do not have answer here, but perhaps

one of you does. It is important that we are constantly thinking in a forward-facing manner.

Pedagogy Solutions

Once we get girls and women in the STEM classroom, we need to make sure we are teaching using the tools that we know will reach them and keep them pursuing a career in STEM to the highest levels.To create a sustainable future we also want to be sure that we give these girls in STEM the tools to address the United Nations Sustainability Goals.

Contextualisation

Luckily, one of the teaching strategies that have been shown to have greater results for retaining women and girls in STEM also proves of greater benefit to the entire community. This is what we should seek—those solutions that affirm society as a whole while also boosting groups that have been marginalised in the past. That is the contextualisation of learning. Handed a problem in the community, girls and women are more likely to see the utility of pursuing careers in the STEM fields. To date some of the STEM problems solved in Nigeria by girls and women include issues with water quality, issues in engineering, and much more. Wherever there is a problem, there is a woman who is applying new learning to solve it.

One of the ways that I have seen this in my own work is with the exploration of the universe through telescopes. In my labs I take real data, freely available from telescopes across the world and ask my students to make a real-life discovery and contribute to what we know about the universe. It is amazing to see how engaged girls become when they understand how their project will benefit humanity. I had three women present at the Society for Astronomical Sciences Symposium 2018 in Ontario, CA as a result of running a course where they got hands on.

We must be willing to connect our students with the world around them so that they see that what they are learning can truly have an impact on those around them. With this in mind, it is critical that you involve your students in public outreach. It is never too early to teach students to give back. My students may not prioritize their own learning, but when charged with teaching others they will go above and beyond. In the meantime, they accidentally learn the

material. For example, my school runs the very successful Festival of Tales. My astronomy students are very creative about how to convey science material to the 3,000 young people and their families that attend this event. Topics that they have taught before include marshmallow constellations.

Active Learning

Active Learning has been shown to increase scores for all genders and ethnicities and further it has been found to effectively level the playing field, reducing the score difference between genders and ethnicities. In graduate school, I had direct contact with one such programme. I was a teaching assistant in a physics lab for biological science majors. The students were required to discover through prompts the laws of the universe on their own. There are multiple ways for the students to come to these conclusions and all students experience the uncomfortable feeling of not knowing the right answer.

When the content is broken down into smaller chunks, and students are requested to test their knowledge, it creates better results. Students who fall behind and don't speak up are rescued. Another way that I do this is with multiple choice questions in my lectures. All students must consider the content and compose a response. I am able to visually see how much the class has retained and how much I need to reconsider what I have done.

Social Learning

Girls and women tend to do better when the class looks at the whole person and discussion and socialisation is encouraged. Tools such as the One Minute Paper allow students to process their thoughts around a subject at an individual level and discuss them as a larger group. This will allow the group to process struggles as a team.

Speaking the Right Language

Teaching STEM content in the native language of the student assists in the student seeing STEM as for them (Babaci-Wilhite, 2017). As a part of their world not as a part of a different culture. This of course requires working within the local community. This adds the benefit of creating STEM jobs locally. A great example of this is the telescope in South Africa that held a naming competition for their new telescope. The telescope was named Lesedi, as pupils

were given a chance to play a role in this. It helped to create engagement and excitement for the process. A second example that I frequently encounter in the Physics and Math classrooms is the use of contextualised word problems. Math and physics problems are frequently generic enough that many situations can be applied to them. So the names of people may be changed to those common in the native language of the student. The math problem can be based around the purchase of common staples of the native culture and physics problems can be contextualised to a common household responsibility of the student. This not only reduces a barrier of understanding for the student, but hopefully places a recall when they go about their daily life that Math and Physics are relevant to their lives and are useful tools.

Authentic Role Models

Role models have been shown to positively affect girls and women in STEM fields. The key variables to make a mentorship programme work is to make sure that the mentors have an understanding of the challenges faced by the people under their charge. Those mentors have to be available and willing to work closely with the mentees. By exposing the mentees to new ideas and environments, it is easier to help them succeed.

Partnerships

Future Opportunities

Exchanges for US citizens in the Sciences to Nigeria, currently many in the arts. We need to expand these exchanges to include Science, Technology, Engineering and Math. A Paper by Okeke *et al.* in CBE - Life Sciences Journal makes recommendations to include the participation of Africans in Science globally. Their paper points out that this under representation in the world leads to the 90/10 gap where only 10% of the funding for global health research goes to 90% of the population. Nigeria needs a voice in global science to eliminate such gaps. We need to bring the science to Nigeria so that Nigerian scientists can benefit from this proximity. One such example would be, inviting me to this conference. I am so grateful to the planning committee because I am so excited to be here in such a place of potential for girls and women in STEM. I hope to learn much from you in my time here and that you find value in the perspective that I bring to you.

Conclusions and Questions

How can we build in Nigeria the best ever STEM education system that brings parity for women and girls? How do my ideas resonate with you? Are some of these things ideas that you think you can apply? In reality, there is so much talent in Nigeria right now that it should be easy to work with these young people. They are there and they are excited to get involved. With so many young people who are so anxious to get involved, can we not do our part to ensure that they have proper opportunities? If we can, then Nigeria can be a model for development in STEM education the world over.

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Strategies for Gender Sensitive STEM Curriculum for Sustainable Development

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Abstract

This paper is based on the premise that girls are not as many in STEM disciplines and careers as needed, as established by various statistics and researches, as well as anecdotal evidences. It discusses, the nature of the STEM curriculum that will effectively engage girls in STEM-related careers. The process of developing such a curriculum and its learning outcomes are also considered. The paper advocates for the "voices of girls"and those of their parents, among others, as a first step to such curriculum development, which also must be continuous. In addition, the paper advances a STEM curriculum that ensures that girls who do not choose STEM subjects eventually and STEM careers later on in life develop scientific attitudes and science process skills which ultimately result in more women contributing to national development.

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Keywords: *STEM, Curriculum, Gender Sensitivity, Sustainable Development Strategies*

Introduction

There is abundant empirical data and evidence with substantiated anecdotal evidence that girls are fewer than boys in STEM (Aremu 2006; Ekine 2014). While I would not try to put such evidence forward in this paper (though this may sound unscientific), it must be understood that this is the premise for the discussion about strategies for a gender sensitive STEM curriculum. My task is to provide strategies that should engage more girls in STEM and which could be integrated into a curriculum for STEM.

This paper works with a wide-ranging definition of female engagement in STEM. Whereas the general consensus is about girls in science and technology related careers, like computer science, space science, sobotics, engineering and at times the medical sciences, the view of this paper is more inclusive. It must be understood, that having said all and done whatever is necessary, not all girls would go into STEM-based careers. A sustainable female engagement in STEM, can be achieved through having all females acquire scientific attitudes (curiosity, skepticism and humility) and science process skills (observation, communication, classification, measurement, inference, prediction) at all levels of education, but predominantly at the foundation level. If this is achieved, whatever career these girls choose in life and whatever problems they may encounter in life, they would possess the capabilities that would enable them to be effective in those careers as well as be able to solve problems.

Therefore, the focus of this paper is on curriculum strategies that would enable the girl child acquire scientific knowledge, develop science process skills and a scientific attitude such that firstly, they may become scientists or go into science-based careers, and secondly, if they do not go into science-related careers would go into their careers with scientific attitudes and science skills

Stem Curriculum for All Girls-Why?

Why should we have strategies for engaging girls, especially in STEM? The reasons we present would go a long way in determining the process and the end- product of our curriculum.

Trying to answer the why question has produced some of the following answers as presented in Box 1.

The summary of all these is captured in this phrase “What a man can do, a woman was either not made to do or was made to do differently” (Aremu, 2001).

The essence of this phrase is the uniqueness of the female gender, which should not be eroded in this highly competitive world of “wanting to be”. There are things only women can do effectively and efficiently; same with the male gender. The thought that girls are unique should be the starting point of any kind of gender sensitive curriculum. Some may disagree with the phrase on the premise that women can do what people feel is in the purview of men alone. However, the phrase is not about “the things men do”, as many may want to imply. The phrase is not meant to give a soft landing and an excuse for women not to engage in “tough” things. The phrase does not insinuate that girls cannot do what men are doing. They can and in many cases they do. The phrase, however, shows that women can do such things differently and achieve a great result and they don't have to do those things to show men that they are capable. There is always a unique female angle to doing things that can be done, whether they are things stereotyped as being for men or not. This makes life complete and fulfilling. As women, we owe that to our creator (for me, that is God).

This line of thought is not actually unique to me alone;others have spoken about it in different ways. For example, according to a reporter, Okonji Emma, in his article in the online version of This Day newspaper of May 2018, the United States Consul General in Nigeria, Mr. John Bray is quoted as saying that “the blunt truth is that without women's inclusive participation, any gains in economic growth and development, as well as advances in science and technology, will be lopsided and unsustainable. Therefore, it is critical that women's voices at all levels, find representation in collaborative solutions that will have the impact on them”.

He went on to say that if barriers to the participation of women in STEM are eliminated, the result would be better families, better countries and a better world. What better positive motivation apart from competition, therefore, do we have to ensure more female engagement in STEM? The uniqueness of womanhood, coupled with societal and cultural stereotypes and societal

expectations, implies that deep and serious thought must be taken in planning curriculum activities for girls, especially when it relates to STEM.

STEM Curriculum - What?

A working definition of a curriculum adopted for this paper is that of Oluoch (1982), who defines curriculum as 'all that is planned to enable the students acquire and develop the desired knowledge, skills and attitudes'. These are the skills and attitudes, desired by the society. Therefore, a STEM curriculum in this context comprises " all that is planned to enable students acquire and develop the desired scientific knowledge, science skills and scientific attitudes". The emphasis here is planning, which implies something that has been thought through and designed. "Students" as contained in this definition would be "girls". The learning outcomes of this curriculum would be scientific knowledge, science skills and scientific attitudes. These learning outcomes are such as are desired by the society. The expectations of the stakeholders society, is to have more girls in STEM. So, the scientific knowledge, science skills and scientific attitudes expected to be developed by girls through a STEM curriculum would be such that would lead to more female engagement in STEM. There is, therefore, a need to understand what the scientific knowledge, science skills and scientific attitudes that would be the outcome of the curriculum are. This is because the learning outcomes would be the tool for more engagement of girls in STEM.

Scientific Knowledge

Scientific Knowledge is what most people refer to when they discuss Science. It is actually the content of Science, the basic concepts. It is acquired through academic as well as hands-on activities. These contents include concepts such as soil, air, plants and animals, the solar system, the human body, work energy and forces. At the basic education and senior secondary school levels, these concepts constitute most of the contents of the following subjects: mathematics, biology, chemistry, physics, agricultural science. Without an understanding of these concepts, it is impossible to appreciate Science, its worth and its beauty and, in addition, to actually do Science.Since Science is about the world around us, it should not be difficult to understand and relate

with. However, it seems that the moment it became a subject to be learnt the seriousness of learning set in with its responsibilities and anxieties.

One of the key considerations for girls in science would be relevance. Females generally want to see the relevance to life, love and living of the things they are learning. Since science is about day-to-day living, it should not be difficult to link science to girls. If such provisions are not made in the curriculum, it becomes the imperative of the teachers to ensure such connections.

Scientific Attitude

A person that has a scientific attitude is one that possesses, for example, the following dispositions: open-mindedness, honesty and skepticism as well as curiosity, and humility. This is quite different from attitude towards Science, which encompasses interest, attitude towards scientists, etc. Scientific attitudes can be developed. It is a learning outcome that is most desirable in the 21st century. The list of scientific attitudes to develop could be very long such as contained in this list: empiricism, determinism, a belief that problems have solutions, parsimony, scientific manipulation, skepticism, precision, respect for paradigms, a respect for the power of theoretical structure, willingness to change opinion, loyalty to reality, aversion to superstition and an automatic preference for scientific explanation, a thirst for knowledge, an intellectual drive, suspended judgment, awareness of assumptions, ability to separate fundamental concepts from the irrelevant or unimportant, respect for quantification and appreciation of mathematics as a language of science, an appreciation of probability and statistics, an understanding that all knowledge has tolerance limits and empathy for the human condition. (Author unknown, 1990).

A more recent author (Pudlao, 2012) lists the following as scientific attitudes: belief, curiosity, objectivity, critical mindedness, open-mindedness, inventiveness, risk taking, intellectual honesty, humility, and responsibility. However, the basic dispositions are that of curiosity, skepticism and humility. This is because curiosity triggers new ideas, skepticism encourages attention to the facts and humility helps us discard predictions that can not be verified by research (Jim Carroll University, 2018).

They very essence of these characteristics seems to be averse to some major characteristics of females. Females are usually emotional rather than logical, superstitious rather than reasonable, spiritually focused (religious?) rather than focused on reality. Thus, scientific attitudes could be a major contradiction to a natural tendency and that is why it is very important to put them into consideration in designing a curriculum that targets girls. Female attributes may be an hindrance to deep engagement with science and the process of science. How then do you help females to develop these scientific attitudes without necessarily 'de-femining'(making them less feminine) them? For example, how do we help females to see that although spiritual things, govern the natural, they are not in opposition to it ? In addition, although that, science could be a tool to confirm the supernatural, there is the need to keep searching and researching, with open mind, for things that cannot be explained yet by science because of its finiteness. It must be realized that females experience a lot of things which are in the "unexplainable domain". One of them is the feeling of love. The fact that it is not scientifically verifiable, does not mean it does not exist. As scientists however, we should be willing to change opinion, if and when evidence turns up against our "feeling" or "beliefs".

In themselves, these characteristics of a scientific attitude could be developed through various science contents to promote an appreciation of Science. However, if students do not end up as science students, they would still have benefitted greatly from science.

Scientific Process Skills

The science process skills namely, observation, communication, classification, measurement, inference and prediction are processes of doing science. They are skills that scientists use in the process of scientific investigations. According to the manual on Science Process Skills by the Clean Virginia Waterways project of the Longwood University (N.D), when students are taught to use these skills in Science, they are indirectly being taught skills that they will use in the future in other areas of their lives. As a specific learning outcome of Science. it is necessary that the Science curriculum should reflect these skills in such a way as to take care of the interest of both genders. These skills can be taught in such a way as to attract girls to Science, if areas of interest of girls are put into consideration, for example, things that have to do with fashion, home

making, cooking, use of money and also becoming someone of value through innovative contributions to the development and growth of the society. These would call for more women being part of the curriculum development process, because there is no one that can think like and for women than women. In teaching processes also, it is pertinent that teachers be skilled in adapting curriculum content to the interest of girls.

Curriculum Development in STEM –The Process

The process of developing a gender sensitive STEM curriculum is the same process for any type of curriculum, whether it is for formal or informal learning processes. The process includes the following: gathering information, design, building the content and evaluation. For a subject like Science, this process of curriculum development should be undertaken on a regular basis. This is because even though its theoretical underpinnings do not change, the areas of applications keep on changing. Others have also emphasised this.

"There is the need to continually change education curriculum and infrastructure to meet contemporary realities, given the switch from old skills to digital technology, robotics and artificial intelligence". (Dr Oluranti Adebule, Lagos State Deputy Governor, in her keynote address titled: "Building an inclusive 21st century workforce: The girl-child challenge" at the 2017 Science and Technology Fair organised by Dr Christopher Kolade Foundation (CKF) through its STEMMA Hands-on Empowerment (SHE) Initiative).

The process of gathering information (which also must be done continually)may be the most important one in the processes of developing a curriculum. If information and data are systematically gathered, then there will not be a mismatch in purpose and content and delivery in the curriculum. When applied to the STEM curriculum, we should be asking the following questions.

- Who is my target? This is not just about the gender, it is also about the characteristics of the gender, the likes, the tendencies, potentials and weaknesses and the preferred career choices, hopes and dreams.
- What attitudes do they have towards the subject? This is very vital. Do they think it is only for men, boring and difficult? Do they think it is irrelevant to their future? What factors have influenced these attitudes? What does research say about these attitudes?

- What does the learner already know? Have they encountered Science in their day to day life? How? Where?

It is after these have been clearly answered that the next stages would be engaged in. At the design stage, you identify your goals, learning outcomes, content, instructional strategies, resources and methods of assessment. In addition, you plan how all these would be sequenced and evaluated. After this, you can build the content, putting all you have identified together and then finally, evaluating.

Curriculum design could be of three types (Schweitzer, 2017), It could be subject-centred, learner-centred or problem-centred. STEM curriculum could benefit from the three designs depending on the levels of education and whether it is for formal or informal learning. A learner-centred designed may be preferred for the lower levels, that is basic education, whereas the subject-centred and the learner-centred designs would be preferable for the senior secondary level, with an introduction to the problem-centred design. However at the higher education of level, the design should be basically problem centred.

This paper presents some information that has been garnered which could influence the attitudes of females in Science and which should determine the strategies that could be used. Apart from research, stakeholders' opinions are vital in curriculum design. Members of the community (international and local, schools, teachers, students, graduates, captains of industry, parents, resource managers, counselors, opinion makers, etc) should be consulted. Two groups whose opinions are not usually deliberately sought for, so as to find out what influenced their choice of STEM, while developing curriculum are girls (who chose STEM as subjects and as careers, as well as those who did not) and their parents. These are girls who may just be out of college having completed science and technology-based careers. There is a need to engage these groups in reflective thinking about their earlier years to consider factors that could have influenced them. The parents, under whose supervision they grew up also need to be engaged. It becomes more interesting when these two categories of students may be found in one family. What predisposes a girl to choose science subjects and her sister not to choose the same subjects even with both of them

exposed to the same learning experiences and home environment? This calls for investigations.

Voices of Girls

When asked the question, what do you think influenced your choice of Science subjects, here are some comments gathered:

"I didn't see myself as a social science student"

"From my early days, I wanted to be a medical doctor, so I didn't think about any other subjects except science" (One ended up as a computer scientist, the other psychologist and Public Health practitioner)

"I never really enjoyed non-science subjects at the junior classes"

"Most of the arms of the senior secondary classes were Science classes, we had four arms of science classes, one arm of arts class and one arm of social science class. It seems Science was the expectation and in vogue".

"I found subjects like history, B.K. and literature too tasking; mathematics was easier".

"I didn't like the girls in my class and more girls went to the Arts class, I preferred talking about sports and novels with boys, instead of fashion".

"Because I enjoyed Maths and Integrated Science from primary and junior secondary school, I wasn't a big fan of Social Studies".

"I think Sciences challenged me to think outside the box more than Arts. Although these days, it seems like it is more regimented and it is Arts that actually challenges us in terms of creativity".

"I wanted to be like my Mum and dad" (Both parents had an engineering background).

"I chose to take science courses because it was like the norm in my school. I also was not sure of what I wanted to be in at that time, also it seemed that smart people did science. I eventually chose a social science career because I was more excited about economics and geography. If I had proper counsel, I would have opted for the social science subjects and class. I still passed all the sciences" (She read Human Resource Management in the University).

The latter also spoke about her friend who despite being the best in every subject including the sciences, opted for the Social Science class and a career in Investment banking and this surprised everyone because the expectation was that she would have chosen the high flying Science careers; she had the intelligence. About her she commented as follows "My friend was the last in her family. She had siblings who were already out of school and working and she benefitted from their wealth of experiences. So, she did not waste time doing what was in vogue in the school then(Sciences). She went straight to where she could fulfill her career requirements "

The following are comments from students who participated in the 2017 Science and Technology Fair, an event organised by Dr Christopher Kolade Foundation (CKF) through its STEMMA Hands-on Empowerment (SHE) Initiative – an immersion programme aimed at offering girls from low-income and middle-income families an opportunity to experience science and technology in a simplified way.

Blessing Samuel, an SS 3 pupil of Omole Senior Grammar School in Ogba area of Lagos, said she would not accept the stereotype that tough science-oriented subjects were meant for only boys. This misconception, she said, had led many girls away from science and technology.

Misturah Isiaq, a 16 year-old pupil of Estate Senior Grammar School in Ilupeju, said low self-esteem is the reason many girls abandon science to embrace other disciplines. But, Eneh Abah, an SS 3 pupil of Babs Fafunwa Millennium Senior Grammar School in Ojodu, who switched from science to an Arts-oriented class, said she did so to pursue her passion. Miss Soaniabari Luckyman of Ijeshatedo Senior Grammar School in Okota said she was studying science because she loved engaging her brain to find solution to difficult situations. Some other examples of experiences growing-up of girls that influenced their choice of Science as a career are presented below:

1. Patty Brubaker, the only female in her high school physics class now runs a water treatment plant

Patty Brubaker grew up working on a cattle ranch outside of Lander, Wyoming, with her two sisters. When some little girls were playing with dolls and experimenting with makeup, Brubaker and her sisters were learning how to haul hay and drive a tractor. She saw her mother and father working hard, side by side at the family's meat packing plant. “I was always kind of a tomboy,” Brubaker said. “I never cared much for girly things, and I've never been afraid of physical labor.” (https://denverwatertap.org/2017/03/02/says-girls-dont-science/)

2. Bethany Downer, Scientist-Astronaut Candidate, Project Possum

Growing up, without realising it, my role models were always women. This included my mom and grandmothers, but also in school when assigned hero or role model essays, I always selected distinguished women.

Role models are of integral value to young women. I'm confident that having a visible example of a profession or career that a young person wants to achieve can be highly motivating and validating for them.

When asked “How did your family help to shape your career path in STEM?” She had this to say

Aside from my family being extremely supportive and my parents coming from engineering and science backgrounds themselves, while in high school I participated in several engineering and science camps. I was actively exposed to many STEM areas that helped me decipher what my specific interests were. I am forever grateful for the support that my family gave me since I discovered my love for space, as they always encouraged my academic and professional pursuits, whatever and wherever they were.

(http://rocket-women.com/2018/09/meet-a-rocket-woman-bethany-downer-scientist-astronaut-candidate-project-possum/)

3. Dr Chiara Mingarelli, Astrophysicist, Flatiron Institute When asked to comment on her journey to astrophysics and to where she is now? She says

I grew up in a small town called Rockland, Ontario, close to Ottawa – the capital of Canada. I loved looking up at the night sky, full of stars, and dreaming of making a discovery. When I found out about black holes, and that one could study black holes for a living, I was hooked!

Who were your role models when you were growing up? How important are role models to young women?

My parents read me Eve Curie's biography of her mother, Marie Curie, to me as a bedtime story. I learned that Marie Curie won 2 Nobel Prizes, so I set out to win 3! This was before I found out that only two women have ever won the prize, despite there being a huge pool of talent to draw from, so I am not particularly hopeful of this anymore. Instead, I hope to be a role model myself, and encourage women to pursue what they are passionate about, especially in STEM fields where we are underrepresented.

(http://rocket-women.com/2018/05/meet-a-rocket-woman-dr-chiara-mingarelli/)

4. Kristen Facciol, Robotics Flight Controller, Canadian Space Agency (CSA)

When asked to comment on her journey to the space industry and to where she is now?

My journey began when I was about 10 years old and was able to attend Space Camp in Montreal, Canada. I learned about the Canadarm, the Space Shuttle program, and the Hubble Space Telescope, and immediately became intrigued. Space exploration was a passion that fuelled my interest in science and math.

(http://rocket-women.com/2018/03/celebrating-international-womens-day-2018-meet-a-rocket-woman-kristen-facciol-robotics-flight-controller-canadian-space-agency-csa/)

The video by Microsoft for its DigiGirlz programme titled "Girls Do Science", is also another eye opener. The videobegins by showing young girls discussing their initial positive feelings about and experiences with technology. "It can really help you uncover like little, small little secrets," says one. Another describes a garage door opener and website she built, and yet another shows off a computer she constructed. Their initial interest is hardly the exception to the rule, the video says, noting that seven out of ten girls are interested in science.

But, these girls reveal, there came a time when their seemingly limitless interest in the field became restrained.

" Then, I started thinking it was more of a boys' thing" "In commercials I saw a lot more men doing it," one says. Another adds, "There used to be a girl in the robotics class but she quit, so I'm the only girl left."

"I just think that inventing is for boys because they have Albert Einstein — he invented, he was a guy — and Benjamin Franklin also," says another.

(Report by Julie Zeilinger - March 17, 2015https://mic.com/articles/112956/powerful-ad-shows-why-more-young-girls-don-t-enter-science-and-technology#.Z5JVlJYcG)

The implications of all these are many, but I choose to focus on the following as likely influencers of choice of career in STEM, which should impact curriculum.

- Natural inclinations and interest- for many girls in STEM, they just liked Science
- Parental Background- parents careers, parents support
- Vision of a future career
- Early exposure to mentors and science programmes – camps and science fun programmes

3.0 Implications for Curriculum Design and Strategies

Table 3.1 presents some of the suggested strategies for STEM education for girls, based on the implications derived from the likely influencers identified in this paper. It should be understood that the four influences identified, are not presented in the order of importance or are they the most important out of all the likely ones. These ones are identified because some of their implications may have hitherto been hidden and emphasis needs to be placed on them.

4.0 Whole-School Learning Programme/Experience

Each suggestion and /or recommendation could be developed into individual programmes which could be implemented in schools by non- governmental agencies and STEM advocates. They could also be combined to be delivered through programmes such as camps. These would still achieve some positive

effects. However, it would be more effective if a whole school programme is developed. This would be school based, but in association with parents, community members, STEM advocates and professional associations. All these programmes would be integrated into the school calendar, science classes as well as extracurricular activities. All these stakeholders can examine science lesson plans/textbooks for each class level to see points of integration of the suggested activities and also to provide resources (human, information, technology and material), that teachers/schools could use to make the programmes effective.

It should be noted that STEM activities that would attract the interest of girls right from the foundation level should be guided by what Aremu (2018) has put together as a model called the FACE©model for effective learning. FACE© is an acronym for F - Fit for purpose for enterprise and for all. A - Authentic, C - Collaborative, E- Engaging. The 4-component model brings various proven learning theories and researches in learning together to explain how a learning activity could be designed to be effective. Fit for purpose means it is set to achieve a general goal as well as specific objectives, which must be reflected in all aspects of the learning activity. F - also stands for Fit for Enterprise. The students must see how the learning activity can promote enterprise and innovation. Knowledge is no more knowledge for knowledge sake or for passing examinations, but for creative work and innovation as well as enterprise development. Fit for all means it puts into consideration all the learning styles and preferences of students. A - stands for authentic. Students must see how the learning fits into their future, how relevant it is for their present and what problems of the past it could be used to solve. In essence, learning must be fitted into the day-to-day, past, present and future lives of students. C-stands for "collaborative". Various theories show that tasks and problems solved together, bringing the capabilities of each team member most likely would be implemented effectively and would be a better solution. It implies that students must be engaged in collaborative problem solving and team work. Finally E means "engaging". This implies, the engagement of the mind and the hands, engagement in terms of critical and creative thinking as well as experimentation and doing. The model explains that it is possible that learning activities be planned based on these guidelines. There is a guarantee of retention and effectiveness in such learning.

5.0 STEM Interventions for Girls - Some Considerations

The recommendations and suggestions that have been made in this paper were made as if no such strategies existed before in one form or the other. This is not to ignore what has been done but to point attention to some gaps that currently exists in the interventions. Some of the interventions are cited in Table 3 (with websites for further information).

In addition, these interventions are presented for stakeholders to be aware of what has been done in STEM for girls, so as to understand what works and what does not and so that stakeholders may know who they could collaborate with in delivering their interventions. This is especially for school-based, whole-experience intervention programmes, which would need a lot of external support.

One of the shortcomings identified with these and other interventions like them is that they have not been based on a thorough investigation and data gathering from all stakeholders. Even if such has been done, there is lack of documentation on them. Another is that these interventions are not implemented right from the foundation level of education-the primary school. If students are well engaged right from this level, there is every likelihood that they will not loose interest as they go on in school. When interventions are implemented at the senior school level, the minds of girls have been set and, most likely, the girls that we harvest from these programmes are those who were interested in STEM or those who are in-between opinions. Furthermore, some of the initiatives are paid programmes which, of course, is limited to the few that can afford them. In addition, the selection of girls for many of these programmes are already biased to those who have excellent results in their academics (especially Science subjects). However, the major issues with the initiatives are the fact that evaluation and monitoring as well as sustainability strategies are not built into the intervention design. In some cases, the grants, which funded the projects, dwindled or were no more forthcoming and that was the end of the project; therefore, the intervention could not be sustained. This issue of monitoring, evaluation and sustainability is most likely the reason why with the various interventions that have been carried out, effective results have not been experienced in the nation.

The shortcomings and weaknesses of STEM based interventions call for such interventions for girls to be carried out in schools through a well-designed and well-implemented curriculum package. This intervention would however be meaningful if it begins at the foundational level of education.

Summary

This paper has presented the need for more girls in STEM, beyond the usual well-articulated reasons of under-representation and equality. The reasons proffered have been based on the uniqueness of womanhood and the need to

make full use of as well as benefit maximally from the uniqueness. Having established this, the paper explained what the learning outcomes of a STEM curriculum for girls should promote. This is not just scientific knowledge but scientific attitudes and science process skills in such a way that engages girls, is considerate of their attributes, creates awareness on STEM and leads them into careers on STEM. Such a curriculum according to this paper, should be reviewed continuously and should start with a process of information gathering from all stakeholders, but most especially, girls already in STEM and those not in STEM as well as their parents.

The paper further presented some of the "Voices of Girls" in relation to their choice of science/non-science subjects at basic and high school levels as well as STEM careers in the college. The curriculum implication of some identified influencers of STEM engagement for girls was offered. In addition, recommended strategies were proffered. The FACE©Model for Effective Learning was suggested as a guide for STEM activities to be developed based on the strategies advocated. To end the discourse, some examples of STEM intervention for Girls, where cited and what could be their shortcomings which should be planned for in any curriculum that should be developed.

FACE©Model for Effective Learning (Aremu, 2018)

Conclusion

To conclude, what this paper recommends is a curriculum for a whole school experience to engage girls in STEM, which must be implemented right from the foundation of learning.

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Improvisation in Science Practicals as Means of Equipping Students with Skills in Science for Sustainable Development

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Abstract

All over the world, it has become fashionable that acquisition of education without the appropriate skills relevant to such area of specialisation is of no use to the development of a nation. Equipping students with skills relevant to their practice in their areas of specialisation has become a paramount part of learning. Nowadays, teaching without instructional materials has become a norm due to the non-availability of resources for teaching in the schools. Improvisation comes in handy as an alternative to real materials for practical activities. This study investigates students' achievement in science practicals as a result of their involvement in the production and utilisation of improvised materials. It also determines the influence of gender on students' achievement in science practicals. A total of 240 SS II students of intact classes assigned to experimental and control groups in each LGA were the participants. The treatment lasted 12 weeks. Three hypotheses were tested at 0.05 level of significance. Pre-test, post-test control group, quasi-experimental design was used. Students' science practical achievement test (r = 0.83) was used for data collection. Data were analysed using ANCOVA and Estimated Marginal Means. Treatment had a significant effect on students' post-test achievement score (F(1,232) = 390.959, P 0.05.

Word Count: *244*

Keywords: *Improvisation, Biology practical, Achievement, Gender.*

Introduction

Science plays a very important role in the development of appropriate technology. It is a driver of economic and social change worldwide. Owolabi (2004) defined science as an integral part of human society. Science is the foundation upon which the bulk of present-day technological breakthroughs are built. Its impact is felt in every sphere of human life, so much that it is intricately linked with a nation's development. Science as a field of study has done a lot for mankind. For instance, life has been made a lot easier for man as a result of the advancements in science. The pursuit of science by scientists have a key role to play in sustainable development. Science for sustainable development is the focus of Chapter 35 of Agenda 21. It calls for strengthening the scientific basis for sustainable management, enhancing scientific understanding, improving long-term scientific assessment and building up scientific capacity and capability. Nowadays, nations all over the world, including Nigeria, are striving hard to develop technologically and scientifically, since the world is turning scientific and all proper functioning of lives depend greatly on science.

Biology, the study of life, is a very important science subject and is necessary in acquiring a profitable career in the biological sciences and various aspects of life. Liras (2004) declared that everyone accepts Biology as the science of the twenty-first century. According to Johnson (2006), the importance of biology will continue to have a profound impact on our lives for decades. Developments and advances in biology help to sustain development in all areas that have to do with sustenance of life. Among the West Africa Examination Council (WAEC) objectives for Biology are the following:

- understanding of the structure and function of living organisms as well as appreciation of nature;
- acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology;
- relevant knowledge in Biology needed for future advanced studies in biological science; and
- ability to apply biological principles in everyday life in matters that affect personal, social, environmental, community health and economic problems.

There cannot be positive outcomes in performance in Biology if the right method of teaching especially in the practical aspect where skills can be acquired, is missing. For progressive development in the area of health and to sustain this, the process of learning needs to meet up with the standards and trends worldwide. This can be achieved by making the students participate actively in the teaching and learning process. Biology teaching involves exposing students to several opportunities to enable them understand different types of concepts and principles. The implication is that biology teaching must be effective and meaningful to achieve its goals. It requires being taught with various methods especially those that are practical oriented and encourage child-centred learning mode. The teaching and learning of biology, therefore, entail making the student acquire skills that would help in self as well as national development and sustainability.

In the world today, the knowledge of biology has become paramount, relevant and indispensable. Therefore, teaching this subject without achieving the objectives will negate its usefulness in the society. The poor performance in Biology has been attributed to multifaceted factors among which are inadequate practical equipment (Onyegbebu, 2006), non-utilisation of instructional resource materials by teachers (Wilton, 2007), inability of teachers to provide opportunities for students to apply theoretical knowledge of science concepts in practical situations (Ayogu, 2007) and the use of inadequate teaching strategies for understanding difficult concepts (Nwagbo, 2008).

Mboto, Ndem and Utibe-Abasi (2011) defined improvisation as the act of providing teaching materials from our locality when there is shortage of the standard ones. According to Abolade and Olumorin (2004), most of the standard instructional materials produced in the factory are scarce and expensive to buy. Most times, materials for teaching are not readily available and so, teachers need to find means of passing across knowledge in such a way that the students will not only acquire the knowledge but will be able to apply it to their everyday life. Abolade (2009) emphasised the fact that it is when the original instructional materials are not readily available for use in teaching and learning that the teacher can come up with other forms of instructional materials. Improvisation is all about teachers acquiring and developing the skills of producing teaching materials in time of need from local materials

available in the environment to make teaching meaningful, effective and efficient.

Studies carried out on improvisation in relation to teaching and learning include those by Zarewa (2005) , which has to do with the successful Universal Basic Education (UBE) implementation through the use of locally sourced materials in the teaching of basic concepts in integrated sciences, George and Amadi (2016) on improvisation skills by mathematics teacher; Aina (2013) on instructional materials and improvisation in the physics class: implications for teaching and learning, and Ogbe and Omenka (2017) on the improvisation and utilisation of resources in the teaching and learning of science and mathematics in secondary schools in Cross River State.

Improvised instructional materials make teaching biological concepts more interesting to both students and teachers in the classroom, improvised materials are usually simple and may not have perfect finishing, because they are made from local raw materials that are acceptable to students. Improvised instructional materials help Biology and other science students to realise that science has to do with ordinary things and will possibly motivate them to carry out experiments and learning activities themselves using such improvised materials, (Johnson, 2000).

Improvisation tends to remove abstraction(s) in learning theories because the products of improvisation are tangible, handy and concrete. Improvised instructional materials must be very safe to use during demonstrations and experiments. It must be hazard free or danger-free. The product must not be capable of inflicting injuries on the user or person operating it. Improvised instructional materials should be used effectively in teaching Biology (Ahmed, n.d). This study seek to find out if the improvisation of science materials would actually produce the desired influence in the teaching and learning of science to necessitate its adoption by biology teachers.

The issue of gender is an important one in science education, especially with the increasing emphasis on ways of boosting manpower for technological development as well as increasing the population of females in science and technology fields (Ogunkola and Bilesanmi-Awoderu, 2000). Many reasons have been advanced for the low participation of girls in the sciences. Emerging evidence shows that ability is not a determining factor in whether or not females would participate in science. Strategies have been evoked to attain and

sustain gender equality. The Sustainable Development Goal (SDG) 2030, number 5, which is Gender Equality aims at achieving gender equality and empower all women and girls. Girls and boys have been found to perform equally well if instructional context is fair and conducive (Erinosho, 2008; Lawal, 2009). Researchers such as Arigbabu and Mji (2004), Bilesanmi-Awoderu, (2002, 2006) and Olasehinde and Olatoye (2014) found that there are no longer distinguishing differences in the achievements of students in respect of gender. Researchers like Christine (2004), Amoo (2011) and Kauru (2010) found that girls achieve higher in science. Oludipe (2012) compared male and female students' achievement in basic science and found no significant differences. The study of gender differences among senior secondary school students is inconclusive.

Theoretical Framework

This study hinges on the Constructivist Theory. 'Constructivism is a theory of knowledge (epistemology) which argues that humans generate knowledge and meaning from their experiences' (Azadeh, 2010). In this study, the students are exposed to the process of improvisation of instructional materials and its use in practical activities so as to bring about meaningful and significant learning. Based on this exposure, critical reasoning and practice, students are expected to build up knowledge and skills in practical activity.

Statement of the Problem

It is believed that in science subjects, males are at the forefront when compared to females. Despite the extensive efforts being made worldwide for gender equality, there still exists some gap in the learning of males and females in science. The use of improvisation in the learning of science in order to fit into global trends in the educational system can help to take care of this problem. Therefore, this study seeks to determine the effects of improvisation of science materials on students' achievement in terms of knowledge and practical skills in science (Biology) in Ibadan, Nigeria. The study also focused on how gender influences students' achievement in terms of knowledge and practical skills in science.

Purpose of the Study

The main objective of this study is to determine if the exposure of students to improvised materials and their use will bring about an improvement to their knowledge and practical skills in biology. It also seeks to determine the influence of gender on students' achievement in terms of knowledge and practical skills in science.

Hypotheses

Ho_1: Improvised materials and equipment for science teaching will not significantly improve achievement of students in science practicals.

Ho_2: Gender will have no significant effect on students' achievement in science practicals.

Ho_3: There is no significant interaction effect of the use of improvised materials and gender on students' achievement in science practicals.

Method

The study adopted a pretest, post-test control group, quasi experimental design to determine the effect of improvised materials and their use on students' achievement in terms of knowledge and practical skills in science. However, the control group which was not involved in the experimental processes, was exposed to explanations in practical science through the use of pictures and charts. The experimental groups were also exposed to explanations through the use of charts and pictures after the completion of the study.

Variables of the Study

The following variables were used in the study,

Independent Variable

(a) Instruction with improvised materials

(b) Conventional instruction (without improvised materials)

Moderator variable

Gender (Male and Female)

Dependent Variable

Students' achievement in science practical.

Population and Sample

Three Local government areas were randomly selected from the Ibadan metropolis for this study. From these, six schools were purposively selected and intact classes were used. The researcher used 240 Senior Secondary School Two (SS II) students of intact classes for this study. Schools were assigned as experimental and control groups using the random sampling technique. The research assistants for the study were the biology teachers of the schools.

Instruments

The following instruments were used for the study:

(a) Students' Achievement in SciencePractical Test (SASPT)
(b) Teachers' Guide on Instruction using Improvised Materials (TGIIM)
(c) Instructional Guide for Teaching with Conventional Instruction (IGTCI) – without teaching materials
(d) Evaluation Sheet for Assessing Teachers (ESAT)

Students' Achievement in Science Practical Test (SASPT)

The instrument was developed by the researcher to measure the cognitive achievement of students in SciencePractical Test before and after the implementation of the intervention. The instrument consists of three sections. Section A consists of personal data of the students showing name, sex, age bracket, name of school. Section B consists of ten (10) multiple choice questions options a - d. Section C consists of ten (10) true or false items. Each correct answer in sections B and C was awarded one (1) mark, making a total of twenty (20) marks. To ensure uniformity in the scoring of all items, a marking guide was prepared for the marking and scoring the SATB. The reliability coefficient of the 20 items was determined using Kuder Richardson 20 (KR-20) formula. A reliability estimate of 0.82 and an average difficulty index range of 0.4 to 0.6 was obtained.

Teachers' Guide on Instruction Using Improvised Materials (TGIIM)

The instrument was developed by the researcher to guide the production and use of improvised materials in the teaching of Science Practical Test. The teachers were trained to be able to guide the students during the production and use of improvised materials to learn ecology. The instrument was validated using the Pi's inter-rater, Reliability index with the value of 0.77

Teachers' Instructional Guide on Conventional Strategy (TIGCS) – without teaching materials

The instrument was prepared according to the behavioral objective of the teaching of ecology with the lecture method. The teachers were instructed not to use any instructional materials both for teaching and practical activity. The instrument was used in schools representing the control group. The instrument was validated using the Pi's inter-rater Reliability index was 0.78

Evaluation Sheet for Assessing Teachers' Performance During Training

The instrument was developed by the researcher to determine the teachers' knowledge and skills of improvisation of materials and use for teaching.

Procedure for Data Analysis

Data obtained were analysed using descriptive statistics such as mean, standard deviation and frequency count and inferential statistics such as Analysis of Covariance (ANCOVA). The result was used to test the research hypotheses. The Estimated Marginal Means (EMM) was used to show the magnitude of the posttest mean score.

Table 1 displays the scores of students' achievement in descriptive statistics. Included here are the number of students involved in the study, the mean score and standard deviation obtained from the research. The table reveals that the mean score of the conventional instruction group in knowledge acquisition was less than that of the group taught with the learner centered form of instructional delivery. The availability of more learning resources (i.e., improvised materials) may have contributed to this.

Table 2 displays the descriptive statistics of the students' achievement scores with respect to gender. The male students performed better than their female counterparts in the instruction with improvised material group and the control group in science practicals. Despite this difference, the result was subjected to further test to ascertain if the difference is significant or not.

Testing of Hypothesis

Ho_1: There is no significant main effect of treatment on students' Achievement in Science Practical

The result of the 2 x 2 Analysis of Covariance on Table 3 reveals that there was a significant effect of treatment on students' achievement in Science practicals. CF (1,232) = 390.95, P < 0.05, χ^2 =.771).This means that there is a significant difference in the achievement of students exposed to improvisation and use of instructional materials and the students taught without instructional materials (control group). This shows that students in the experimental groups were more predisposed to learning than those in the control group after their exposure to the treatment. Therefore, Hypothesis 1 was rejected. The mean scores of students across the experimental groups and control group is presented below.

Table 4: Estimated Marginal means of the Treatment group on Students' Achievement in Biology practical

A further clarification on achievement of students exposed to improvisation in practical biology using the Estimated Marginal Means (EMM) as shown in Table 4 revealed that the experimental groups had higher mean scores ($\bar{x}$ = 22.736) than the conventional instruction group ($\bar{x}$ = 14.424). The treatment is observed to have contributed to students' achievement in science practical. The source of the significant difference obtained was traced using Scheffe post-hoc test, as shown in Table 5.

Ho 2: There is no significant main effect of gender on students' achievement in Science Practical.

Table 3 reveals that the effect of gender on participants" achievement in science practicals was not significant (F (1,232) = 0.685, P > 0.05, χ^2=.006).Therefore, hypothesis Ho 2 was not rejected.

The male students had higher mean score ($\bar{x}$=19.228) while the female students had a lower mean score ($\bar{x}$=18.067) but the difference was not significant. The males are, therefore, not significantly better in their achievement in science practical than their male counterparts.

$H0_3$: There is no significant interaction effect of treatment and gender on students' achievement in science practical.

Table 3 reveals that there was no significant interaction effect of treatment and gender on students' achievement in science practical (F (1,232) = 0.141, P > 0.05, η^2 =.001). The effect size of 0.01% was negligible. Hence, hypothesis 3 was not rejected. This shows that treatment does not interact with gender to have an effect on students' achievement in science practicals. On the basis of this finding, the hypothesis was (therefore) not rejected.

Discussions

studies Previously carried out on the production and utilisation of instructional materials in teaching and learning have been found to be very effective in imparting knowledge. This present study was carried out to investigate the effect of improvisation of science materials on students' achievement in terms of knowledge and practical skills in Biology in Ibadan, Nigeria. The study also focused on how gender influences students' achievement in terms of knowledge and practical skills in Science.

Students were exposed to the process and procedure of improvisation and they were allowed to use the materials in carrying out measurements in the area of ecology. This was embarked upon with the aim of allowing the students gain some form of experience, construct knowledge and build up practical psychomotor skills that will help and enable them to be effective in their future endeavors. They will also be able to contribute their quota to sustainable development, especially if they end up in the biological sciences such as medicine and pharmacy. The treatment used produced a tremendous positive effect on the students' achievement in practical biology. This may be due to the nature of the presentation which involved demonstration and activity that has a greater advantage than the conventional lecture method that involves only an impartation of information by the teacher without making use of instructional materials, which eventually forfeits the achievement of expected learning outcomes.

The findings agree with the submissions of Aina (2013) that teachers making use of local materials to improvise physics teaching instructional materials can improve learning in physics.George and Amadi (2016) in their findings revealed that professional and experienced mathematics teachers possess more improvisation skills which helped to promote learning in their class than the non-professional and less experienced mathematics teachers. The findings are also supported by Abolade (2009) who emphasised that it is when the original instructional materials are not readily available for use in teaching and learning that the teacher can come up with other forms of instructional materials to make learning effective. This is in line with the suggestion of Oludipe (2012) that to encourage more women into pure sciences and science-oriented courses, interventions need to be designed that focus not only on the academic achievement of girls but also on how to make science-related occupations more interesting for young, high-achieving girls.

Gender had no significant main effect on the achievement of the students in practical biology. Although the male students had a higher mean score, it was not significant. This shows that gender does not significantly influence the achievement of students in science practicals. This also reveals that female students are now having positive interest in science and technology. There was no significant two-way interaction effect of treatment and gender on students' achievement of in science practicals. The result suggests that the interaction

effect of treatment and gender does not necessarily make a significant contribution to the achievement of the students in science practicals.

Implications of Findings

Results obtained from this study give the impression that exposing students to the process of improvisation and utilisation of materials produced in the process of learning can bring about great, positive strides in (terms of) achievement and interest in science. It was clearly demonstrated in the study that improvisation was very effective in enhancing students' learning outcomes. In order to advocate the adoption of the strategy for use in secondary schools, teachers need to be trained very well on improvisation, especially in all the sciences. This may be done through workshops, short courses, seminars and or conferences.

The implication for the school authorities or heads is that they need to allocate more time on the school time-table to accommodate the buildup of psychomotor skills in students.

Conclusion

Learning requires effort by learners to actively construct their own meaning that is consistent with prior ideas. Such ability requires that learners should learn how to integrate theoretical knowledge with practical activities that relate to real-life situations. This can be described as meaningful learning. This findings has shown that learners who construct their own meaning can more be effective than the traditional or conventional teaching method. This was because the instructional mode enhanced critical thinking, active involvement in learning activities and effective interaction among students. It is noteworthy that students showed a higher level of commitment to solving the problems in their practical class. Hence, this method of instruction can be used to foster the learning of selected concepts in science subjects.

Recommendations

1. There is the need for curriculum planners to include more activities in the curriculum so as to bring about effective impartation of knowledge.

2. Having brought about a significant improvement in students' achievement, this method of instruction should be recommended for the teaching and learning of various concepts in science.
3. More time should be allocated to science subjects on the school time-table to make it possible to use the method of instruction to foster the learning of selected concepts.
4. Teachers should be properly updated and trained, through special short courses, seminars and workshops, on how to improvise and use resources in the environment to bring about effective learning by sudents.

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Impact of Teachers Teaching Methodologies in Equipping Girls in Secondary Schools for Sustainable Development in Nigeria

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Abstract

Education has proved to be an indispensable tool for national growth and development in all sectors of a nations' economy. Teachers teaching methodologies have to do with the various methods or approaches applied by teachers in the teaching and learning process to enhance students' learning and thus make learning permanent. There are many factors that can limit effective teacher teaching methodologies such as administrative factors, teacher factor,

poor instructional materials and inconsistency in curriculum implementation. This paper provides recommendations for the orientation of principals, training of teachers, providing quality instructional materials and consistent curriculum implementation for the attainment of sustainable developmental goals in Nigeria to equip the girl child to contribute significantly to sustainable development in Nigeria.

Word Count: *117*

Keywords: *Impact, Teaching Methodologies, Girl Education and Sustainable Development*

Introduction

There is no doubt that education is a powerful instrument of national transformation. Schools are therefore vested with the responsibility of inculcating the basic skills, attitudes and values that are required to move a nation forward. For this reason, schools are equipped with human and material resources that will enable them perform their roles effectively. Today, there is an increasing faith in the casual relationship between education and economic development especially in the developing countries like Nigeria. Education has been seen as a vehicle for economic, social-cultural and political development of nations and individual (Grace & Kalu, 2016).

Secondary education is the second level of education in Nigeria. According to Federal Republic of Nigeria (2013), secondary education is the education children receive after primary education and before the tertiary stage. The goals of secondary education are to prepare the individual for:

- Useful living within the society, and
- Higher education.

Secondary education does not only occupy an important place in the Nigeria education system, it also serves as a link between the primary and tertiary levels. The Federal Republic of Nigeria (2013) defined secondary education the learner receivers after primary education and before the tertiary stage. Secondary educations in Nigerian schools are for a period of 6 years and are divided into two sections. The first three years is the junior secondary which is part of the Basic 9 education programme and another 3 years for senior

secondary education. The secondary school system is however a very crucial level of education system. It is a gateway to the tertiary education and a ripe age for developing students' potentials. Its benefit should be commensurate with the cost, for this reason, the performance at this level is of significant important to educational planners and mangers. The school as a formal organization is the center for all teaching-learning processes. The principle and teachers as human resources are sine qua non in goal achievement of the school instructional leadership, students' relationship, academic achievement of the students, and high level of students' participation in the teaching learning process carried out in classroom.

It must be stressed that education cannot be an instrument par excellent for achieving national development where the secondary education is not effectively managed to accomplished its aims and objectives. In the administration of secondary schools, the principle is central. Principles are seen to be responsible for three 'Ps' in the school – the people, the programme and the plant (Adeyemi, 2010). This they do by giving direction and leading to achieve objectives; ensure the implementation of schools programmers, including efficient and effective maintenance of school plants with its facilities. They function as managers and instructional leaders. Principals have the primary responsibility of accomplishing the nation's aims and objectives of secondary school education as stipulated in the National Policy on Education (2013). In doing this, they play a number of important roles which include providing effectively leadership in secondary schools that is aimed at "enhancing better job performance of staff and in essence, promoting students' academic achievements. However, one of the most vital aspects of principals" managerial competence is in the area of managing teaching staff in achieving school aims and objectives. This is true when one considers the job performance of teachers in public secondary schools.

Teachers Job Performance

Job performance has been defined or described in various ways by scholars. It is seen as an act of accomplishing or executing a given task (Okumbe, 2009) and the ability to combine skillfully the desired or expected behaviors towards the achievement of organisational goals and objectives (Olagboye, 2014). Job performance therefore, is the way and manner in which a staff in an

organisation performs the duties assigned to him or expected of him in order to realise the organisation's goals and objectives.

In the school system, a teacher's job performance is that performed by a teacher at any given time in the school geared towards achieving both the daily school and classroom objectives and the entire set goals and objectives of education. It could be determined by the employee's behaviour under different situation and/or by his level of participation in the day-to-day running of the school for goal accomplishment. Therefore job performance of a worker could be described as low, moderate, high, etc., depending on the extent of his commitment to work in order to achieve set objectives and goals (Adeyemi, 2010). This means that the variable of job performance such as effective teaching, effective use of scheme of work, lesson note preparation, effective supervision, monitoring of students' work and disciplinary ability are virtues which teachers uphold effectively in the school system.

In this regard, the teachers' performance could be measured through annual reports of their activities in terms of performance in teaching, lesson preparation, lesson presentation, mastery of subject matter, competence, commitment to job and extra-curricular activities. Other areas of assessment include effective classroom leadership, effective supervision, effective monitoring of students' work, motivating students' interest, class control and disciplinary ability of the teachers (Adeyemi, 2010). These activities intended to help teachers to imbibe the totality of the culture in their teaching methods, broaden their subject matter, content knowledge, or stay informed of changing policies of the environment in which the school operates. All these are geared towards improving teaching performance.

It is important to note that teachers' job performance also includes methodologies of teaching which can enhance student learning and academic achievement in the secondary school. These methodologies of teachings can only be possible through innovative means.

Innovativeness in Teachers Teaching Methodology

A teaching method can be define as the active learning guidelines that discuss the benefits of learning, as well as providing guidelines and simple activities that facilitate learning (Yin, 2013). To this end, teaching methods can be in form of storytelling, demonstrations, direct instructions, fields' observations,

discussion, class presentations, etc. In all of these methods of teaching, learning can be teacher-centered approach or student-centered approach. In fact, Fakunle (2008) identifies two main approaches to teaching: the teacher-centered and student-centered. The teacher-centered and student-centered have dominated interaction in classrooms and captures the various methods that students can learn. These can of course be measured either through formal and informal methods of assessment. The teacher-centered approach is when the teacher appears in the classroom and gives his lessons in such a way that students concentrates and admire his presence in his class but in reality, learning did not take place because the teacher did not deliver his lesson in such a way that students can learn and assimilate. However, the student-centered approach is when the teacher gives lessons in the classroom with all manners of considerations to the classroom with respect to size of the class, classroom environment, individual differences in learning, etc (Opolot-Okuru, 2008).

According to Federal Republic of Nigeria (2013), the goals of secondary education are to prepare the individual for: useful living within the society, and higher education. This therefore calls for innovations in today teachers' teaching methodologies in the school system. Innovations in education do not only mean new technology rather, it also implies teaching and learning process that reflects equity and pragmatism. Equity means that a teacher should teach with the goal of ensuring that all in the class – fast learner, slow learner and under-achiever get maximum attention and benefits from the class. Pragmatism on the other hand involves the ability of teachers to make their lessons practical with illustrations and examples in order to help students solve problems in a simple or clear way. Innovativeness is very important, necessary and consequential in developing the girl – child in secondary education for sustainable development in any society especially in Nigeria.

Sustainable Development

The concept of sustainable development lies in the idea that a society is able to maintain its level of political, economic, cultural, and educational status both in a short and long run. It is the highest level of societal growth. It connotes quantitative and qualitative growth in all sectors of a country. Sustainable development has its goals. The sustainable development goals (SDGs) are a

new, universal set of goals, targets and indicators that United Nation member states will be expected to use to frame their agendas and political policies over the next 15 years. The SDGs follow, and expand on, the millennium development goals (MDGs). The countdown which began on September 2015 summit discusses the 17 goals that could transform the world by 2030.

Following are the 17 Sustainable Development Goals

Goal 1: End poverty in all its forms everywhere.

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Goal 3: Ensure healthy lives and promote well-being for all at all ages.

Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Goal 5: Achieve gender equality education and empower all women and girls.

Goal 6: Ensure availability and sustainable management of water and sanitation for all.

Goal 7: Ensure access to adorable, reliable, sustainable and modern energy for all.

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Goal 10: Reduce inequality within and among countries.

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Goal 12: Ensure sustainable consumption and production patterns.

Goal 13: Take urgent action to combat climate change and its impacts

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

In achievement of these goals in education, the education of the girl-child is very fundamental to break the issue of gender barrier. Hence the impact of teachers' innovative teaching methodologies can help significantly in equipping the girl-child for sustainable development.

Impact of Teacher Innovative Teaching Methods in Equipping the Girl-Child for Sustainable Development.

In the achievement of sustainable developmental goals in secondary education, Saleh & Kalu (2017) stated below some positive impacts of teacher innovative teaching methods in equipping the girl-child for sustainable development:

Improvement of Cognitive Skills: This refers to the intellectual ability of an individual to recall facts or reproduce knowledge. This skill is intellectual because it has to do with the head where the brain is located. The brain if well developed, can produce knowledge that was learned or recall facts that it has accumulated. Hence, the girl-child is said to possess cognitive intelligence if the student can be able to produce knowledge that was learned by recalling facts.

Improvement of Affective Skills: This refers to the ability of an individual to draw inference or conclusions of what was learnt and see how they best applied to situations at hand. This kind of skill has to do with the heart. The heart is the center of motivation and the seat of decision making. Hence, the girl-child is said to possess affective skills if the student can be able to apply what was learned in situations and circumstances surrounding the students especially after lessons are taught the student is asked to explain concepts, ideas or facts. ***Improvement of Psychomotor Skills:*** This is the ability of an individual to create, design, or manipulates what was learned in the present condition the individual found him or herself. This skill also significantly involves the use of the hands. The girl-child possesses psychomotor skills if he can reproduce what was learnt in the classroom into creative manner or even in diagrammatical way.

Challenges that limit effective teacher teaching methodologies

The following constitute challenges that limit effective teacher teaching methodologies in equipping the girl-child for sustainable development:

1. *Administrative Factor:* Principals' are regarded as instructional leaders. Hence, they are expected to know the various strategies to be employed in enhancing teaching and learning performance. The after-math of lack of principals' knowledge in teaching methodologies will constitute a problem to teachers on how they can be guided in teaching methodologies to be applied for students' performance.

2. *Teacher Factor:* This is when teachers who are recruited dont have pre-requisite training. They may lack the various teaching skills and methodologies in the teaching and learning process.

3. *Poor Instructional Materials:* This is a problem when instructional materials in the classroom and laboratory are inadequate. This can constitute a problem for teachers to apply various methods of teaching. For instance, a class or laboratory that lacks audio-visual materials like projectors, computers, microphones, etc, it will be difficult to apply demonstrations as a method of teaching.

4. *Inconsistency in Curriculum Implementation:* This is when there is rural and urban dichotomy in the implementation of curriculum in teaching and learning which is due to poor instructional materials in the rural than in the urban area.

Conclusion

Education is a veritable tool for national development. It empowers people and strengthens nations. It must be stressed that education cannot be an instrument par excellence managed to accomplish its aims and objectives. However, one of the most vital aspects of principals' managerial competence is the area of managing teaching staff in achieving school aims and objectives. This is especially important in the area of innovativeness in teachers teaching methodologies in the teaching and learning process. Innovativeness is very

important, necessary consequential in achieving the goals of secondary education and ensures SDGs in Nigeria.

Recommendations

Based on the challenges that limit effective teachers' teaching methodologies in equipping the girl-child for sustainable development, the following recommendations are made as the way forward:

1. *Orientation of Principals:* Principals should be orientated on the necessity of ensuring that teaching methodologies are improved in pursing SDGs which is reflected in Goal Number 4 which involves, promoting lifelong learning opportunities for all.

2. *Training of Teachers:* Teacher should be trained on various applications of teaching methodologies to enhance the teaching and learning process. This is especially for teachers who are not from educational background. This is in line with Goal Number 8 which says, "Promote sustained, inclusive and sustained economic growth, full and productive employment and decent work for all"

3. *Providing Guality Instructional Materials:* This involves quality materials in the classroom and laboratory that enhances innovative teaching methodologies that can enhance all round development of a child cognitive, affective and psychomotor. This is line with goal no 9 of SDGs which says “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

4. *Consistent Curriculum Implementation:* This is when all areas of the country whether rural or urban have equal opportunity for teaching and learning process in the area of sufficient plant and facilities for effective teaching and learning. This is line with goal no 16 of SDGs which says "Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institution at all levels''

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Equipping Girls with Communication and Lateral Thinking Skills for Sustainable Development

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Abstract
We live in the world of communication, and communication influences all our actions. Young people, especially young girls learn how to think, feel and judge through the aid of verbal or non-verbal means of communication. The importance of equipping young girls with communication skills that would add value to their lives and help them navigate through the vicissitudes of life cannot be overemphasised. Girls also require the right exposure to the lateral thinking skills that will help them make correct decisions in life. This paper discusses the "hats" of lateral thinking and how they will help (young) girls take important and critical decisions in their lives.

Word Count: *106*

Keywords: *Communication, communication skills, lateral thinking, decision-making,*

Introduction
Every day, young people receive thousands of messages through conversation, in the social media, advertisements, news programmes and many other means of communication. Young people, especially girls, have access to more information (in history) than any other group.

What is Communication?
Communication comes from the Latin word "communis", which means "to make common". According to Baran (2003) communication is a process of creating shared meaning. Bitner (1994) defines communication as "a system through which people can exchange symbols and, thus propagate learning at an accelerated rate". Burgoon, J.K., Buller, D.B., Guerrero, L.K, & Feldman, C.M. (1994) describe communication as a symbolic behaviour that occurs between

two or more participating individuals. It has the characteristics of being a process, it is transactional (in nature), and it is effective. It is a purposive, goal directed behaviour that can have instrumental or consumatory ends. According to Wood (2004), "communication is a systemic process in which individuals react with and through symbols to create and interpret meanings". Daramola (2012) describes communication as "a basic human activity", which dominates our lives from morning till night.

From these definitions, it is clear that communication is complex and not just the use of words alone. Rather, communication includes (the following) what is said, the tone of voice, how it is said, when it was said, why it was said, the context of the message, what was not said but should have been said, the body language used, that is, facial expressions, postures, gestures and more. It, would, therefore be right to state that communication involves the sending of symbols from one person to another through verbal and non-verbal means for the purpose of recalling memories, sharing meanings and creating images in the minds of the participants. Communication influences the actions of the young girl. She learns how to think, feel and judge through the aid of communication. When a young girl inevitably finds herself in a group, she must recognise the fact that groups operate better when there is trust and open communication among members. Group members need to work together as a team. According to Ihebuzor (2014), it has been discovered that in group work, the output of each member depends not only on individual efforts but also on the efforts of the other members. What a group participant contributes and when she contributes determines the success or otherwise of the group.

For a young girl to benefit from this type of interaction, she must try, to the best of her ability, to be objective and open; to speak (communicate) responsibly and to listen effectively. Listening is often confused with hearing. Listening means paying attention to what you are hearing or about to hear. The young girl must, therefore, listen to learn and learn to listen.

Reasons for Communication

According to McBride (1980), communication is the heart of all social intercourse.

- It maintains and animates life.

- It leads people from instinct to inspiration through variegated process and systems of inquiry, command and control.
- It creates a common pool of ideas.
- It strengthens the feeling of togetherness through exchange of messages and translates thought into action, reflecting every emotion and needs from the humble task of human survival to supreme manifestation of creativity or destruction.

Characteristics of Communication

From the above, it can be deduced that communication has the following characteristics:

- It involves two or more people (although one could have intrapersonal communication).
- It involves an exchange of ideas.
- It is a continuous process.
- It is irreversible. Once a statement is made, it has been made.
- It involves the use of words and symbols.
- It needs mutual understanding.
- Communication can be both direct or indirect.
- It is ubiquitous, that is, it is everywhere.
- We cannot do without communication.

Functions of Communication

Communication serves different functions. A few of them are discussed.

Education: "True education is the harmonious development of the physical, mental, moral (spiritual), and social faculties, the four dimensions of life, for a life of dedicated service. If this is true education, then what does it mean to educate another human being? Is not education the process of awakening in another human being a thirst for knowledge and a desire to develop all of one's capacities? And if this is so, then why do we do it? One possible response is in order to create in another human being the desire to be a whole, meaningful person" (Caleb, 2000).

Information: "Is any entity or form that provides the answer to a question of some kind or resolves uncertainty. It is thus related to data and knowledge, as data represents values attributed to parameters, and knowledge signifies understanding of real things or abstract concepts" (Merriam-Webster, 2017).

"Information is conveyed either as the content of a message or through direct or indirect observation. That which is perceived can be construed as a message in its own right, and in that sense, information is always conveyed as the content of a message.

Information can be encoded into various forms for transmission and interpretation (for example, information may be encoded into a sequence of signs, or transmitted via a signal). It can also be encrypted for safe storage and communication. Information reduces uncertainty. The uncertainty of an event is measured by its probability of occurrence and is inversely proportional to that. The more uncertain an event, the more information is required to resolve uncertainty of that event.

The concept that information is the message has different meanings in different contexts" (Luciano, 2010). Thus the concept of information becomes closely related to notions of constraints, communication, control, Data, form, education, knowledge, meaning, understanding, mental stumuli, pattern, perception, representation, and entropy.

Entertainment: "Is a form of activity that holds the attention and interest of an audience, or gives pleasure and delight. It can be an idea or a task, but is more likely to be one of the activities or events that have developed over thousands of years specifically for the purpose of keeping an audience's attention" (Oxford English Dictionary, 1971).

Persuasion: "Is an umbrella term of influence. Persuasion can attempt to influence a person's beliefs, attitudes, intentions, motivations, or behaviours" (Gass, Seiter, John, 2010). "In business, persuasion is a process aimed at changing a person's (or a group's) attitude or behavior toward some event, idea, object, or other person(s), by using written, spoken words or visual tools to convey information, feelings, or reasoning, or a combination thereof" (Business Dictionary, 2018). "Persuasion is also an often used tool in the pursuit of personal gain, such as election campaigning, giving a sales pitch, (Fautsch,

2007) or in trial advocacy. Persuasion can also be interpreted as using one's personal or positional resources to change people's behaviors or attitudes". "Systematic persuasion is the process through which attitudes or beliefs are leveraged by appeals to logic and reason. Heuristic persuasion on the other hand is the process through which attitudes or beliefs are leveraged by appeals to habit or emotion" (Schacter, Daniel and Wegner, 2011).

Motivation: "Motivation can be defined as that which compels a person to act with determination, or that which gives rise to an inclination that manifests itself through a specific behavior. In certain circumstances or under certain stimuli, the individual assumes particular attitudes and acts on them" (Rodrigues-Goulart, 2005).

Edward J. Murray (1986) cited in Rodrigues-Goulart (2005) "asserts that moti-vation has two essential components: impulse and motive. Impulse refers to the internal process that incites a person to act. Motive is that which gener-ates the behavior and helps the person achieve his objective. The objective is the reward that satisfies the individual's internal urges".

What are Communication Skills?

Types of Business Communication Skills

Speaking

Speaking or verbal communication is perhaps the most frequently used way to get a message across at the workplace, and it includes presentations, workshops, in-person interviews and telephonic and video conferencing. It is direct, it costs nothing, and is instant. It is also effective because it allows the receiver to pick up critical non-verbal cues such as facial expressions, tone, pitch and body language.

This communication skill is best used in situations where establishing a personal connection is important, such as conflict-resolution scenarios, team-building exercises and while selling a product. But as more and more businesses go global and (they) work with partners, clients and customers all over the world, verbal communication is losing out to digital platforms.

Doyle (2018) has identified the following communication skills as being important for everyone. They are:

Listening skills: Everyone should take time to practise active listening. Questions should be asked to ensure clarity. Listeners should pay attention to non-verbal communication such as eye contact, gestures and tone of voice, because all these colour communication.

Clarity and Cohesion: Communication must not be ambigious. Listeners must not find it difficult to understand the information encoder is trying to pass out.

Friendliness: This is a communication skill that goes a long way. A friendly tone or a simple smile can enhance your communication considerably.

Confidence: This is a communication skill that must be acquired to achieve believability. You must believe in what you are saying before others will believe you.

Empathy: This helps you to connect with other people on a deeper level. It shows that you care and that you understand and respect other people's points of view.

Open Mindedness: This means you should enter into communication with a flexible mind that is free from bias and open to new ideas, even unorthodox ideas.

Respect: This requires giving recognition to others and their ideas.
Feedback: Communication is (a) two-way (street) involving giving and receiving. Therefore, the ability to give and receive feedback is a valuable communication skill.

Picking the Right Medium of Communication: There are instances where face to face communication is the best. However, there are instances where face to face communication will be inadequate. It is important for the communicator to be able to pick the right medium for his/her communication delivery.

Why Girls Need Communication Skills

It is important for girls to have effective communication skills because of the reasons listed below.

- To enable them communicate with confidence. A timid girl, who cannot communicate effectively, will get into some kind of trouble sooner than expected.
- Friends: There are true and false friends.The young girl needs to communicate effectively to set her boundaries and those areas that she will not cross.
- Family frustrations and building better hands: The girl child has a lot of problems, particularly in a culture where the girl is seem as disadvantaged just because of her gender. She needs sound communication skills to extricate herself from the frustrations within the family and also to build better social bonds in and outside the family.
- Digital drama and texting problems: The world is in the embrace of the digital fora. The girl must be adept at using data and social media so that she does not fall into the hands of social media fraudster. Texting of messages has become a way of life. How will she balance this very exciting phenomenon and still remain her normal self? This is a challenge.
- The social butterfly: This refers to the girl and her peers. She needs communication skills to clearly inform her peers about her values and limits.
- Romantic relationships: This is a very import part of a girl's life which may make or break her. Many girls' lives have been ruined because they failed to communicate effectively in this area. For example a girl's dressing can communicate wrongly to the opposite sex and this can lead to sexual assaults or even rape.
- Powerful adults and relationships: Communication skills are needed by the girl to communicate her wishes, (wants) and dislikes in the presence of powerful adults and relatives who may want to coerce her into doing things she dislikes. For example, a father who is a doctor, could insist that his daughter must also become a doctor. This may not be an easy situation for the girl.

Equipping Girls with Communication Skills

It is obvious that all the communication skills discussed are required by girls for sustainable development. It is also clear that the handlers of the girls at

home, in schools, churches, mosques and other settings have to be aware that these girls need these communication skills to reach their full potentials in life. Because of space, this paper cannot go into how all the ten communication skills can be inculcated in girls. However, girls need to be equipped with the art of public speaking, regarded as the mother of all communication skills . The fear of public speaking for girls can be as terrible as the fear of death. When a girl, particularly a shy one, is asked to speak in public, she may begin to fidget, to sweat and she may experience the feeling of a thousand butterflies in her abdomen. How can she be taught not to have stage fright?

Miller (2011) gives the following piece of advice. He emphasizes the fact that the girl must prepare very well before the event. In addition, he advises the girl to do the following:

- Make an audio recording of herself speaking
- Listen to herself again and again critically. She will discover mumbling, voice volume trailing off and other shortcomings
- Fix these problems and record again.
- Work on the problem spots or areas, that is keep rehearsing.
- Celebrate.

Miller (2011) added that overcoming the fear of public speaking will require the following:

- Knowing why you are afraid of public speaking and why you need to conquer this fear.
- Eliminating negative thoughts about yourself and your ability in public speaking.
- Comparing yourself with others. By all means you should learn from people but make sure you personality comes through in your speech.
- Keeping eye contact with your audience. Make eye contact with different parts or sections of your audience by turning your head towards their direction.
- Not speaking with a monotone. Vary your tone for more effective delivery.
- Using hand gestures as well as your voice.
- Reducing words like uhm, ah, oh (crutch words) during the delivery of your speech.

- Using the stage more effectively. Audiences react better and connect better with speakers who move gracefully around the stage than those who just stand on the same spot throughout the entire delivery.

  Rehearsing many times with these techniques and not forgetting to imagine that you have a live audience before you.

Lateral Thinking

Lateral thinking is a term created by Edward de Bono in 1967. It refers to a system of solving problems using an indirect and creative approach that is not immediately obvious. De Bono uses the example of King Solomon in the Bible who used the lateral thinking approach to identify the real mother of the child whose maternity was being disputed by two women. Solomon ordered that the child should be cut into two and shared between the two women. The response of the two women to this order led to the revelation of the real mother of the child.

De Bono posited that the brain thinks in a number of distinct ways which can be deliberately challenged and used in a structured way in order to develop tactics for thinking about problems. He identified six distinct directions in which the brain can be challenged to identify and bring up solutions to problems. These distinct ways he named "The six Thinking Hats." These are; the blue, white, red, black, yellow and green "hats"

- The blue hat: This hat requires that we ask and answer the following questions."What is the subject? What are we thinking about? What is the goal? Can we look at the big picture?
- The white hat: The hat encourages us to ask the question, "What are the facts available?"
- The red hat: This hat recognises that we are emotional beings and encourages us to ask the question, "What do you feel about this?"
- The black hat deals with logic: It identifies reasons to be cautious and conservative, to be practical and realistic.
- The yellow hat: This is an optimistic hat. It looks at problems from the angle of benefits, seeks harmony, looks at the brighter, sunny side of life and situations.

- The Green hat: This represents creativity and thinking outside the box. It asks the questions, “can we do it better? What can this lead to? Where shall we be in ten or twenty years?”

Why Girls Need Lateral Thinking Skills

Lateral thinking as defined by De Bono, is used mainly for solving challenging problems in ways that may be unusual. Why do girls need lateral thinking? It will be pertinent to examine some of the challenges that may be peculiar to girls.

Some of the problems that girls may have include the following:

- *Appearance:* Girls can notice changes in their bodies due to the onset of puberty, which can lead to both psychological and physiological problems. In addition, when they see models on television or in a firm film, they want to be like them.
- *Education:* Girls want to excel in their academic pursuits. and if they do not score high grades in school, can become a problem for them.
- *Dating:* As they mature, attraction to the opposite sex and sexual intercourse becomes very big problems.
- *Bullying:* This can be at home from their parents or at school. Girls can become withdrawn as a result of bullying.
- *Friendship and mood swings:* As a result of change in their bodies, they can become moody, emotional and even irrational. They can fall in love one moment and then engage in ugly fights with the person the next moment.
- *Self-esteem:* Girls usually compare themselves with other girls, their looks, dressing, carriage, etc. Comparison can make them self conscious and can affect their self esteem negatively.
- *Peer pressure:* Peer pressure encourages, forces or cajoles teenage girls to conform to certain behaviours as a way of showing that they belong to the group. This can impact negatively on the development of teenage girls or girls generally.
- *Substance use and abuse:* Peer pressure may also directly or indirectly be responsible for girls trying out alcohol, marijuana or other drugs.
- *Menstruation:* This can lead girls to develop a lot of misconception and misgiving about this because of lack of knowledge and misunderstanding.

- *Depression:* Girls can become depressed for any of the above reasons, or for no clear reason. They may just be reacting to being pressured from many angles.

Developing Lateral Thinking Skill

Lateral thinking requires a great deal of imagination and can be learned. For example, take an object, may be an empty bottle or a cup and then imagine 20 things you can do with the object. Do this exercise everyday, with different objects and you will begin to hone your lateral thinking skills You can also familiarize yourself with lateral thinking techniques which include the following;

- *Alternatives:* This can be used to breed new ideas. Thinking of alternative ways to (do or) implement concepts can generate a whole lot of new ideas that will help solve a problem.
- *Focus:* Focusing on particular areas, e.g., areas that nobody is thinking about, can help to produce breakthrough ideas and this can be very helpful to the individual or an organisation.
- *Challenge:* This is based on looking for ways outside the traditional ways of thinking and solving problems. It is hinged on the belief that there may be better or easier ways to do a task, even if there is no apparent problem with the way its being done now.

  Random entry: This requires using unconnected or unrelated impart to open up new lines of thinking. The technique is to encourage the mind to think of connections between things that seem unrelated. This is a great technique for generating new ideas.

  Provocation and movement: This technique encourages out-of-the-box thinking. It enables the thinker to come up with innovative ideas to consider. Provocation, exaggeration, wishful thinking, reversal, escape and distortion are some of the techniques used to encourage a plethora of ideas.
- *Harvesting:* This is the selection of ideas that appear to be practical from a list of other ideas that have been generated through the use of other techniques already discussed. It is about turning starter ideas into ideas that work. Harvesting helps to identify ideas that can be used right now or the one that needs further investigation.

- *Ideas Treatment:* Ideas need reshaping or restructuring to become strong. It is useful for the harvesting of starter ideas to make them more useful and practical for a specific situation.

Solving Girls Problem Using Lateral Thinking

The final part of this paper will attempt to solve these problems earlier highlighted. It should be noted that the solution provided are not exhaustive. This cannot be because by the very nature of lateral thinking, ideas are never exhaustive, they keep unfolding.

- *Appearance:* The lateral thinker will solve the problem in the following ways (a) look for alternatives: What can be? Can she change her appearance? What are the alternatives available? (b) Focus: What areas about her appearance does she not like? Can make up solve the problem? Is it her attitude that needs treating? (c) Challenges: The girl can be challenged. What can she do about it? She can be asked to think up different solution. (d) provocation and entry-Exaggeration, wishful thinking, refusal or escape can be used to keep her in line and help her solve the problem. (e) all the ideas can be harvested, the most practical of the ideas can be adopted.
- *Education:* The same process enumerated above can be used to help the girl know that she can study hard and excel in her studies and that she needs a couple of co-curricular activities, so that she can have a balanced academic life.
- *Dating:* Using the some lateral thinking skills, she can be made to appreciate the need to say no to sex when she is not ready. She can be given sex education and other items of information to make her safe.
- *Bullying:* After examining all the options available, she can be taught how to stand up to bullies and how to take decisions that will help her to solve the bullying problem.
- *Friendship and mood swings:* Using lateral thinking techniques, she should be taught that sometimes it may be all right to fight with friends, if opinions differ, but it is always good to discuss such problems and then forget them. She should be encouraged to stay in the right company. She should be taught that it is all right to apologise when she is wrong.
- *Self-esteem:* Let her know that some of the models she sees on television are fake. They have too much make-up on. Explain to her patiently that

one person is different from another and she should like herself the way she is.

- *Peer pressure:* The girl should be taught that she is special, unique, created for a purpose and does not need to conform to others. She should be herself always without apologies to anyone.
- *Substance Use:* The girl should be shown, through audio visuals and other methods that substance abuse will ruin her body. She should be encouraged to adopt other techniques arrived at through lateral thinking to solve that problem.
- *Menstruation:* All her doubts in this area should be cleared. She should be taught that this is a natural process that is getting her ready for child bearing.
- *Depression:* This can be a serious problem and she should be encouraged to find a creative solution to the problem. The parent or guardian should also look out for other signs of abnormal behaviour like excessive sleep or total sleep deprivation. This will determine whether this depression is one she can easily get out of or if it will require the services of a psychiatrist.

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Gender Influence on Misconceptions of Concepts in Geometry Among Senior Secondary School Students in Ogun State, Nigeria

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Abstract

A bid to address what causes poor achievements in mathematics examinations among secondary school students led to the present study whose main objective was to examine the influence of gender on conceptions of geometry in selected geometrical concepts and sub-concepts among senior secondary schools students in Ogun State, Nigeria. A total of 757 students from 56 co-educational schools in the State participated in the study. A researcher-designed 26-item questionnaire on Geometry Conception Test (GCT) validated

by six experts was used for data collection. A reliability index of 0.83 was obtained for the instrument using the Pearson Product Moment Correlation Coefficient. The identified misconceptions and alternative conceptions were validated by two university lecturers and two secondary school mathematics teachers. Frequency counts, percentages and Chi-square statistics were employed to analyse the data collected for the study. The finding showed that correct conceptions, misconceptions and alternative conceptions exist among students in learning geometry. Also, the number of students with misconceptions and alternative conceptions were more than those with correct conceptions of geometry in 23 (items) out of the 26 selected concepts of geometry. A significant difference existed in the number of male and female students with correct conceptions, misconceptions and alternative conceptions of geometry, $\chi^2 = 8.95$, $p < 0.05$. *It was recommended that teachers should give correct conceptions of geometrical concepts using real-life examples from the students' environments and engage both sexes in practical activities that would enable them to discover the correct properties of geometrical shapes.*

Word Count: *245*

Keywords: *Conceptions; Geometry; senior secondary school; students' gender*

Introduction

Mathematics is a tool for solving human problems, it is also useful in the development of science and technology in any nation. Aspect of mathematics which everyone is aware of such as shapes of objects, sizes, lengths, distances and designs of different types are all embedded in geometry. Geometry is defined as the mathematics of measurements and the relationships of lines, angles, shapes and their properties (Adu, 2004; Tuttuh-Adegun, Sivasubramaniam & Adegoke, 2010). These shapes come as either plane shapes such as triangles, rectangles, squares, rhombus, circles, trapeziums, kites and so on or as solid shapes such as cubes, cuboids, cylinders, cones, pyramid, prisms, spheres and other solids found all around us.

The trends in students' achievement in West African Senior School Certificate Examinations (WASSCE) for May/June between 2006 and 2014, showed that the overall performance of students who passed mathematics at credit level was

less than 60% of the total entry of the candidates going by results of the years considered in this study. Also, as important as mathematics is, the West African Examinations Council's Chief Examiners' Reports in May/June 2007, 2008, 2009, 2010, 2011, 2012, 2013 and 2016 revealed that many candidates avoided questions on geometry while those who attempted them did them poorly. This indicated that questions on geometry were unsatisfactorily attempted by the candidates.

A major factor among others identified in respect of such performance had to do with mix ups in their understanding clarifications of geometrical concepts and sub-concepts (during classes) (Johnston-Wilder & Mason, 2005). This is probably due to the previous incorrect ideas which students were exposed to before their classroom experiences, which could likely lead to misconception in geometry classes (Abimbola, 2013; Aysen, 2012; Hewson, 2007; Novak, 2003).

These previous ideas brought into the classroom by students can be correct conceptions, misconceptions or alternative conceptions. Correct conceptions are ideas that agree with scientifically accepted ideas or knowledge. Also, misconceptions could be termed as ideas which are in contrast to or in disagreement with accepted scientific ideas or knowledge (Abimbola, 2013). Alternative conception is a term used to describe a learner's autonomous conceptions of natural phenomena, which is neither wrong nor right nor in conflict with accepted scientific knowledge but expresses learners' views about the conception of natural phenomena which is neither wrong nor right nor in conflict with accepted scientific knowledge but expresses learner's views about the concept idiosyncratically (Abimbola, 2013; Hewson, 2007). The correct ideas referred to in this case might have gone through the process of transformation or correction from either misconceptions or alternative conceptions to acceptable ideas.

Studies by George and Charles-Ogan (2015) and Siefa (2013) submitted that students' views on different concepts in mathematics must not be overlooked but should be investigated to find out the reasons why they hold incorrect conceptions. Also, finding solutions to such incorrect ideas as well as finding ways of correcting them stirs up need for a research of this kind. An American scholar named Wellington in a publication in 2009 narrated a scenario in a mathematics class at a New York City public high schoolwhere a student was

asked to say whether a shape it was a square or a rectangle. The response of the student was amazing due to the fact that, the student was confused about the identity of the shape. A square can be said to be a special rectangle because a square has four sides which are all of equal length as well as four angles which are also equal. This implies that the student had a wrong conception of the properties of a square. A square can as well be defined as a special rectangle whose opposite sides are equal. It can also be termed a parallelogram with a right angle. Hence, a square is a parallelogram with a right angle, and thus is a rectangle.

Gagne (1965) and Ausubel (1968) state some of the learning theories that supported the idea of conceptions of learners in classroom situations. According to Gagne (1965), Balogun (2010) and Charles-Ogan (2014) learning from the stables of meaningful instructions occurs in phases or in hierarchies and it takes place when learners acquire knowledge from the known to unknown, from the simple to the complex or from the concrete to the abstract. Gagne's submission was that learning takes place if relevant previous skills are already in existence in the learner's memory. Ausubel (1968), however, purported that a learner's stage of development and what the learner knew before the classroom experience are factors when it comes to learning, and these contribute to achievements in school. Pre-classroom experiences are factors that cannot be avoided when we consider what can influence students' conceptions in the classroom. Among these are past mathematics experiences before classroom situations and the learner's previous ideas which could be correct or erroneous. The erroneous or incorrect ideas can be grouped as misconceptions.

Looking at the roles of gender on human activities, we can say that gender indirectly dictates what we do and how we do them. Gender is the term that categorises humans as either male or female and the realities of the differences are distinctly displayed. Gender is sometimes determined by the way we act, respond to situations, reason and do things. It can also be determined by our appearances or mode of dressing, gesture, occupation, social network and the roles played by both sexes in the society. Gender differentiation has also helped to moderate excesses in the society, whereby females are easily identified as emotional, non aggressive, slow in decision-making, dependent and gentle. Literature on students' activities and achievements in mathematics in relation to

gender remains a focus of interest by many researchers due to the fact that gender issues cannot be conclusive. Males mostly exhibit characters that are dominated by risk taking. They do things that are opposite to the females' in all respects (Timayi, Ibrahim & Sirajo, 2016).The influence of gender in classroom situation is not totally different from what is common to the distinct characteristics of the two genders. Studies have shown that males are different from females in many respects. However, some studies reveal that female strengths has equal in achievements while some studies revealed that the males got upper hands in school achievements. This brings to us to the fact that gender reports are somehow inconclusive in terms of studies carried out.

Statement of the Problem

Mathematics educators are mostly concerned with how students' performance in mathematics examinations can be improved from time to time. This prompted the need to look into possible reasons why students' performance is poor and what can be done to salvage the situation. One of the topics in mathematics where students do not perform satisfactorily is geometry. Lack of understanding of some mathematical concepts, among which is the concept of geometry, was found to be responsible for the to misconceptions and the alternative conceptions from past classroom experiences. Identifying these incorrect conceptions could form the background for finding ways of correcting them. An attempt was made in this study to identify what was incorrect and where the problem arose from, whether from the definitions and meanings assigned to the concepts or as a result of a misunderstandings of the concepts. Hence, this study was conducted to assess the influence of gender on conceptions of geometry among senior secondary schools students in Ogun State, Nigeria.

Purpose of the Study

The purpose of this study was to investigate the following:

1. Differences in the number of senior secondary school students with correct conceptions of geometry concepts in Ogun State, Nigeria based on gender.
2. Differences in the number of senior secondary school students with misconceptions of geometry concepts in Ogun State, Nigeria based on gender.

3. Differences in the number of senior secondary school students with alternative conceptions of geometry concepts in Ogun State, Nigeria based on gender.

Research Questions

The following research questions guided the study:

1. What is the difference in the number of male and female senior secondary school students with correct conceptions of geometry in Ogun State, Nigeria?
2. What is the difference in the number of male and female senior secondary school students with misconceptions of geometry in Ogun State, Nigeria?
3. What is the difference in the number of male and female senior secondary school students with alternative conceptions of geometry in Ogun State, Nigeria?

Research Hypothesis

The following hypothesis was formulated and tested at 0.05 level of significance:

HO_1: There is no significant difference in the number of male and female senior secondary school students holding conceptions, misconceptions and alternative conceptions of concepts in geometry in Ogun State, Nigeria.

Methodology

A descriptive survey design was used for this study. The population for the study comprised senior secondary school II students in Ogun State, Nigeria. The sampling techniques used in this study were proportionate and stratified sampling techniques through which a sample of 757 senior secondary school students were selected from the 20 local government areas of Ogun State, Nigeria. A Geometry Conception Test (GCT) was developed and used as the research instrument in collecting the data for the study. The instrument was in two parts, A & B: Part A sought demographic data from the respondents while Part B consisted of 26, items on conceptions of concepts in geometry and a coding scale to guide the responses groupings into correct conception, misconceptions and alternative conception of the concepts in geometry was also developed by the researcher.

The instrument was validated for content and construct by experts in the fields of science education and mathematics and by experienced secondary school mathematics teachers in Ogun State, Nigeria. The reliability coefficient was computed, using the Pearson Product Moment Correlation statistics and 0.83 was obtained as the reliability coefficient of the instrument.

The responses were analysed qualitatively and quantitatively to identify the nature of conceptions and classified as correct conceptions, which are ideas that agree with scientific ideas; misconceptions, which are ideas that disagree with scientific ideas; or alternative conceptions, which are ideas that neither agree nor disagree with scientific ideas but express the learner's views about the phenomenon. The data collected were analysed statistically using frequency counts and percentages to answer the research questions and chi- square statistics to test the hypothesis formulated for the study at 0.05 level of significance.

Research Question 1: What is the difference in the number of male and female senior secondary school students holding correct conceptions of geometry concepts in Ogun State, Nigeria?

The percentage of female students who displayed correct conceptions of geometry concepts were higher than percentage of the male students in 23 out of the 26 items contained in the Geometry Conception Test (GCT). Male respondents had higher percentage on 3 items of the GCT which are the perimeter of a circle, an angle, and the edge of a shape. Hence, there were differences in the number of male and female students who held correct conceptions of geometry concepts in Ogun State, Nigeria in favour of the female students. The analysis is in Table 1.

Research Question 2: What is the difference in the number of male and female senior secondary school students holding misconceptions of geometry concepts in Ogun State, Nigeria?

The percentages of female students who displayed misconceptions of geometry concepts were higher than the frequency counts and percentage of the male students in 14 out of the 26 items contained in the Geometry Conception Test (GCT). However, percentages of male students who displayed misconceptions were more than the percentages of the female students in only

12 out of the 26 items of the Geometry Conception Test. Differences existed in the number of male and female students who held misconceptions of geometry concepts in Ogun State, Nigeria in favour of the female students. The analysis is in Table 1.

Research Question 3: What is the difference in the number of male and female senior secondary school students holding alternative conceptions of geometry in Ogun State, Nigeria?

There were differences in the number of male and female students who held alternative conceptions of geometry in Ogun State, Nigeria. The percentages of female students holding alternative conceptions were higher than the male students in 23 items out of the 26 items contained in the Geometry Conception Test. Meanwhile, the male students with alternative conceptions of geometry were higher in percentages than their female counterparts in only 3 items of the Geometry Conception Test. These are: circle; quadrilateral; and solid shape. The analysis is in Table 1.

Research Hypothesis (H_0): There is no significant difference in the number of male and female senior secondary school students holding conceptions, misconceptions and alternative conceptions of geometry in Ogun State, Nigeria.

The output of the Chi-square analysis in Table 2 shows that, there was a significant difference in the number of male and female students holding correct conceptions, misconceptions and alternative conceptions of geometry. The calculated Chi-square value, $\chi^2(2)=8.95$, $p < 0.05$ was obtained from the study. The null hypothesis was rejected. It was therefore, concluded that there is a significant difference in the number of male and female students holding correct conceptions, misconceptions and alternative conceptions of geometry in Ogun State, Nigeria.

Table 2: Chi-square Analysis on Frequency Counts of Number of Students Holding Various Conceptions of Geometry Based on Students' Gender

$P < 0.05$ Significant

Discussion

Findings revealed that there was a significant difference in the number of male and female students holding correct conception, misconception and alternative conception of geometry in Ogun State, Nigeria. This means that the proportion of male and female students holding correct conceptions, misconceptions and alternative conceptions of geometry was different from one another when the data was subjected to statistical analysis. The interpretation of the outcome of this hypothesis means that differences existed in the number of students holding conceptions of geometry based on gender. This finding was in line with the findings of Charles-Ogan (2014), Umoinyang (2005), Arleback (2009) Atebe (2008) who found that females had fewer misconceptions and higher mathematical attitudes and achievement than their male counterparts. Previous studies with other views on gender include the study carried out by Ameen (2012) on gender in relation to students' academic performance in comparative effects of two problem solving models in mathematics word problems. The outcome of the study by Ameen (2015) was in favour of the female students. Also, Suleiman (2010) on the effects of three problem-solving models on students' performance in statistics concepts of mathematics curriculum. However in Abdulraheem (2012), Timayi, Ibrahim and Sirajo (2016), gender equality could be achieved when both male and female students are taught under the same condition and with the same strategies. These related studies submitted that gender did not have significant influence on the achievements of students as well as how students conceive various ideas in mathematics and

geometry in particular. However the influence of gender on students' learning remains a topic with a continuous focus with an unending opinion.

Conclusion

It can be deduced from the results of this study that misconceptions and alternative conceptions held by students could affect their performance in geometry as well as in mathematics in general. The study also found that, gender differences existed in the number of students with various conceptions of geometry. Ability to identify these misconceptions and alternative conceptions would help both students and teachers to find ways of correcting them. The implications of the findings of this study is that, mathematics teachers need to first find out conceptions of geometry held by students when teaching geometry. It also implies that both students and their teachers in senior secondary schools have roles to play in reducing misconceptions and alternative conceptions in geometry. This can be achieved by mathematics teachers' first of all identifying these misconceptions and the alternative conceptions and finding ways of correcting them.

Recommendations

Based on the findings of this study, the following are recommended:

1. Mathematics teachers should first of all identify these misconceptions and the alternative conceptions and finding ways of correcting them before proceeding to teach new topics;
2. Mathematics teachers should attend regular workshops and in-service training to get current knowledge of the methods to be used in teaching correct concepts of geometry so as to remedy misconceptions and alternative conceptions of geometry and generally of mathematics.
3. Both male and female students of mathematics should endeavour to master geometrical concepts as much as possible to avoid wrong conceptions of them.
4. Authors of mathematics textbooks should guide against misconceptions and alternative conceptions in the textbooks they publish.

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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.

Word Count: 230

Keywords: Gender gap, STEM, home, boy-child, girl-child

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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