

## Female University Undergraduates' Participation in Science, Technology and Mathematics Programmes: Implications for Sustainable Development

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***Abstract:** This paper discusses the importance of Mathematics as an indispensable tool for national development. It further highlights the importance of girl child education and participation in Science, Technology and Mathematics. The cultural impact on female education in Nigerian societies is highlighted. The place of Science, Technology and Mathematics in national growth and development was discussed. The enrolment pattern of Female University Undergraduates in Science, Technology and Mathematics. The implications of female university undergraduates' participation in Science, Technology and Mathematics for sustainable development were identified and discussed. Recommendations were proffered. Among the recommendations include: the need for the federal, state and local governments to strengthen the society awareness on the disparity in enrolment of male and female University undergraduates in science, technology and mathematics programmes at institutions of higher learning through the radio, television, organized seminars, workshops and conferences by professional bodies.*

*Keywords:* Female, University Undergraduates, Participation, Science, Technology and Mathematics, Sustainable Development.

### Introduction

Education at secondary school level is supposed to be the bedrock and the foundation towards higher knowledge in tertiary institutions. It is an investment as well as an instrument that can be used to achieve a more rapid economic, social, political, technological, scientific and cultural development in the country (Kolawole, 2018). The national policy on Education (2019) stipulated that secondary Education is an instrument for national development that fosters the worth and development of the individual for further education and development, general development of the society and equality of educational opportunities to all Nigerian children, irrespective of any real or marginal disabilities.

Mathematics is one of the subjects taught in Nigerian Universities; it comprises several advanced Mathematics courses students are expected to learn. In the development of nations, science technology and mathematics plays a vital role. Ukeje (2017) observes that without mathematics there is no science, without science there is no modern technology and without modern technology there is no modern society. In other words, mathematics is the precursor and the queen of science and technology and the indispensable single element in modern societal development. So, if any nation must develop, the study of science, technology and mathematics should be given adequate attention in the various levels of her education. Nigeria as a developing nation, appears to have been prepared to resolve the issue of developments in science, technology and mathematics through her policy on education. The policy provides for a 60: 40 admission ratio in the tertiary institutions in favour of science, technology and mathematics (Federal Republic of Nigeria, 2018). Efforts in this direction appear to be yielding dividends as indicated by the admission ratio of Art to Science of 26: 71, 34: 66 and 33: 69 for 2016/2017, 2017/2018 and 2018/2019 academic years respectively (Aguje and Uhumuavbi, 2019). This is an improvement over what it used to be in the past where the ratio was in favour of Arts related subjects. However, the problem that seems to linger for quite sometime now, is the question of female participation in science, technology and mathematics (STM) and related subjects. This has become a source of worry, as it is difficult in the present-day society to address the issue of national development without recourse to gender factor. Recently, there has been rising global consciousness both at the grassroots and policy levels regarding the impact of gender issues in education and national development. There is also the growing consciousness that women constitute more than half of the world's population. Thus, we cannot afford to ignore them in matters regarding national development and STM education, which is a vital tool in the development of nation.

## Mathematics as an Indispensable Tool for National Development

Mathematics has been described as a precision tool used by all scientists in their search for a clear understanding of the physical world. The Encyclopedia Britannica (2018) defines mathematics as the science of structure, order and relation that has evolved from elemental practices of counting, measuring and describing the shapes of objects. Mathematics as a school subject is recognized as the foundation of science and technology without which a nation can never become prosperous and economically independent. The Nigerian government has demonstrated this by adopting education as an instrument par excellence for achieving development. Nigeria's hope in the crucial role of science, technology and mathematics education to national development is reflected in the pronouncements in two major policy documents namely: National Policy on Education {revised 2016} and the National Policy on Science and Technology (2019).

The National Policy on Education recommends the teaching of mathematics at all levels of education. In a similar vein, the National Policy on Science and Technology envisages an education system that shall emphasize all levels and reorient the entire society towards scientific thinking in order to develop new technologies and adapt existing ones to improve societal wellbeing and security. The government has demonstrated commitment to this end by among other things, directing that university admission into the science and liberal arts disciplines should be in the ratio of 60: 40 percent respectively, and have even gone further to establish Universities of Science and Technology (Maduabum, 2019). According to Obanya (2020) a group of specialists in 2018 at UNESCO headquarters in Paris deliberated on the goals of mathematics education and drew attention to some of the following points.

Mathematics permeates the whole of society, and its role would appear to be one of ever-increasing importance as its help is sought in handling situations and problems, which arise outside the field of mathematics itself. Mathematics methods are no longer the prerogative of scientists, engineers and technologists, they are increasingly being used to analyze individual behaviour, to study attitudes and trends in opinion within the society. This shows that there is no way a society or individual can develop without the knowledge of mathematics. Mathematics is at the heart of every development in any country of the world. Unfortunately, despite the place of mathematics in the national development the achievement of students continues to be low from year to year as has been reported by Ugwu, (2019), and Ezike, (2018). This paper therefore examines how mathematics can be used as an instrument for national development. Mathematics contribution to national development could be seen under the following areas: Science and Technology Mathematics has been the backbone of several human endeavors notably science and technology, and this is the life wire of national development. It has advanced so much that what is left for man to attain is the creation of man itself. There is no doubt that technology has brought higher standard of living to people both in advanced countries and developing nations. It is the rising living standard that makes the acquisition of technical competence so attractive to those countries. (New Encyclopedia Britannica, 2018). Today, the products of science and technology are glaring and enjoyable. The invention of satellite, the mobile phones, the high security gadgets etc. are the products of science and technology. In Nigeria, science and technology have been applied in many spheres especially in the oil industry. Mathematics is an instrument for fostering scientific and technological advancement. The usefulness of mathematics to the ordinary man is its ability to develop his reasoning faculty to the extent of modifying man's pattern of reasoning. Hence, the knowledge of geometry and trigonometry are most rapid in architecture, surveying, building, modelling, sculpturing and medicine, which consist major parts of national development, the computer usage worldwide was made possible because of the knowledge of mathematics.

## Importance of Female Education and Participation in Science, Technology and Mathematics.

There has been rapid development in education since independence in Nigeria. More particularly, there has been rapid development in tertiary education with respect to science, technology and mathematics (STM) in the last two decades. This is due to the role of STM in the development of a nation. Aminu (cited in Imarhiagbe, 2016) observes that if anything is important to any nation in solving its problems, it is science and technology education. Earlier, Fafunwa (2016) had observed, that we cannot hope to develop as a nation and be self-reliant with other people's science and technology. We must develop our own in order to be self-reliant. According to Coombs, female participation and interest in STM diminishes as they move up in the educational ladder towards the university level due to a variety of factors that are primarily rooted in their religious and cultural beliefs surrounding the role of women in the society. The issue of low female participation in STM seems to be a global issue. Other studies appear to be supportive of this position. For example, Croxford (2017) in a study on

“participation in science, Engineering and Technology” in Scotland following the introduction of a new programme titled “Science Strategy for Scotland” observed the following:

- i. After taking account of attainment and science qualifications, females were less likely than males to study mathematics, informatics and engineering.
- ii. One quarter of students with two or more sciences at higher grade were studying medicines and dentistry or subjects allied to medicine. The proportion for science qualified females was 34%
- iii. In the final years of compulsory education (S3-S4), all pupils studied at least one science and over half studied at least one technology subject. Gender and attainment were the main factors that influenced differences in choice of science and technology subjects.

The case appears to be the same in the United States of America, where Billings (2019) observed that despite efforts over the last 20 years to redress female under representation, the percentage of women studying computing and related subjects continued to fall in between 1985 and 1990. Accordingly, this status quo was also maintained in the United Kingdom with females making up only 18% of computer science and 11% of software and engineering in 2016. Not only are enrolments low and declining, but proportionately more women than men drop out, fail courses or choose to major in another subject other than science (Selby, 1997). Furthermore, woman in United States Universities in 2000-2001 accounted for only 17% undergraduate science majors. (Billings, 2018). The deleterious trend was repeated in New Zealand with women accounting for a mere 20% of undergraduates in information technology and the sciences (Brook et al., 2019). The issue of low female participation and attainment in STM is not peculiar to Nigeria alone, but a global problem. It is coming more and more into limelight particularly with women accounting for more than half of the world’s population.

### **The Cultural Impact on Female Education in Nigerian Societies**

The woman chances of contributing her own knowledge to the development of her father’s land is affected by her lack of formal education compared to that of the man. In the past the chances of a girl child gaining a formal education was near zero. Although the trend is changing, a lot still has to be done. Education for all (E.F.A) report (2017/2018) revealed education in Sub-Saharan Africa and even Asia was initially available only for males. The report remarked that it entails that women from the onset were disadvantaged in the formal employment sector since jobs in these sectors were mainly negotiable through acquisition of education and skills. The woman’s late entrance into education and the tailoring women education to meet domestic needs is not peculiar to Nigeria. The report went further to buttress this point by citing Avabs (2018) which says that even in Latin America where the expansion of educational system started earlier, women were denied formal education during colonialism but often received instructions to enable them to perform domestic tasks and raise their children. The education of girls is a vital core message of family life/population education program in Nigeria (a programme that emphasizes equal opportunities in education). This concept emphasizes the importance of both genders in all aspects of societal development. Bellany (2018) asserts that there can be no significant or sustainable transformation of societies and no significant reduction in poverty until girls receive equal access to quality basic education. After all, societal development does not start with goods and things. It starts with people, their orientation, organization and self-discipline.

(Bellany, 2018 UNICEF, 2017, Obanya, 2018) have shown that educating girls offers benefits for the girls themselves, the current and future families, and their communities. Education for girls means that as women they will be capable of exercising their rights to participate in political, economic and development efforts. Moreover, research such as stated above have demonstrated that educated girls are more effective mothers. In other words, girl’s education has a strong impact on health, family, welfare and fertility rate. It is a potent population intervention strategy. World Bank (2016) showed that one additional year of female education reduces fertility by 5-10 percent.

Educated women have also recorded a higher survival rate among their children because they nourish their children better, observe health practices and thus have healthier children. Ultimately, child mortality is reduced. A woman needs a good education to quip her skills to function effectively and contribute her quota in the society, if she has no good education she ends up as a baby making factory at home or as a cleaner. In the area of employment women are not carried along as compared to men. Collen (2016) reveals that veteran (knowledgeable) women experience higher unemployment rate than veteran men. In January 2010, the unemployment rate for veteran women was 11.2% compared to 9.4% for veteran men. Employers prefer employing a man to a woman in most cases the man is more equipped for the job because he has a formal education while the woman does not. That is due to deprivation she suffered as she was not sent to school. Sadly, in most cases where the woman and the man have the same qualification and both are qualified for the job in question, the man is still preferred. Women have been hindered from securing gainful employment. Omokhua (2016) identified some of the factors that hinder women education and unemployment

as traditional beliefs, family background, early marriages, physical environment and pregnancy. In this work researchers carried out a purposive research on the impact of socio-cultural factors on women education and employment to see if there are other causes of women unemployment and education. Over the year women have been devalued in our society. In every facet of our society, you find that there is gender inequity. This negative trend is very pronounced in the areas of education and employment. Research (UNESCO 2002, UNICEF 2000) have indicated that issues of cost, culture, school environment and policy are variables leading to the exclusion of girls from benefiting education.

Gender disparity remains a problem. Male and female children have not been given equal education opportunities. Similarly, there is inequality in the participation of women in the labor force and employment prospects compared to their male counterparts. Despite the various national and international declarations on women education and employment, some socio-cultural factors still hinder the furtherance of women education and their right to gainful employment in Nigeria.

### **The Place of Science, Technology and Mathematics in National Growth and Development.**

The Federal Government of Nigeria enunciated the Vision 20:2020 Programme of development aimed at catching up with the rest of the most industrialized nations of the world in the year 2020. The big, anticipated problem is whether this vision of government can be realized without mathematics, science and technology education. This program would be a mirage except mathematics, science and technology education take the central role as the focal point of the nation's educational sector [Ogodo, 2019]. The case of the developed nations and fast-growing economies has shown that a deliberate and strategic policy implementation is the magic for achieving target goals and sustainable economic development. In Nigeria, the long neglect of Mathematics, Science and Technology including poor funding of research and development are more responsible for her economic woes. However, according to Okafor [2012], it is now clear that Mathematics, Science and Technology have become part and parcel of the world's culture and every person and nation now want to use them maximally for adequate development and improvement of the society hence, the implication of this sector of education to the transformation agenda of the Federal government of Nigeria cannot be over emphasized. The Nigerian Government, having discovered the important role of mathematics and science in national development, declared 2017, "National mathematical year". The Ministry of Education was mandated by the Federal Government to demystify mathematics through innovated teaching, since it is a key to national transformation [Nkechi, 2019]. It was therefore noted that government's commitment to mathematical sciences will invariably enhance the capacity of citizens to contribute to national development and increase productivity of the GNDP [Uka, Iji and Ekwueme, 2017]. The science education goals for our National Transformation Agenda therefore should include the following;

- i. improving the quality of life of all Nigerians.
- ii. serving as a tool for functional skills acquisition and job creation leading to reduction in poverty.
- iii. helping to mobilize and develop public-private partnerships to support and fund general education.
- iv. promoting Information and Communication Technology (ICT) at all levels; and
- v. seeking to re-orientate the Nigerian society towards scientific thinking with a view to developing new technologies towards transformation of all sectors of the nation's economy.

As Nigeria faces the challenges of National Transformation Agenda, there is the need to develop technology industries which will provide the basis for chip production, information and communication and computer system. Technology Education for National Transformation Agenda should be able to contribute in solving societal problems such as insecurity, provision of food, shelter, health, clothing, transportation, communication, raw materials, energy, agriculture, power, printing, photographing, potable water, beverages, navigation of land, sea and air, as well as defence and other social amenities. The driving force for technological development for our National Transformation Agenda is economic and physical survival. To achieve the above goals of our National Transformation Agenda, physically, Nigerians need food, good health, defence capabilities and safe shelter. For economic survival there is also the need to develop transportation, communication, trade, machine tools and information devices. Formal education in science and technology will help develop high technology products for meeting the needs of the National Transformation Agenda. Nigerian Government must think of ways to partner with international bodies to move mathematics, science and technology education forward. We should take a look at foreign technologies exhibited and compare with ours so as to enable us to train the young scientist to the quality of the foreign scientist [Ogodo, 2019]. Many countries will be attracted to establish their collaborative efforts with us having seen how possible it is with us. Our capacity building through technology transfer can compete to some extent with the imported ones and even better than the ones from Asia which are not as good as was taught. With time, our technology transfer will compete favourably with other parts of the world [Ogodo, 2011].

Mathematics and technical education are necessary for the sustainability of our National Transformation Agenda. This is because they are instruments per excellence for social and economic reformation, reconstruction and then transformation.

### **The Enrolment Pattern of Female University Undergraduates in Science, Technology and Mathematics**

Evidence of gender gap in the trend and pattern of enrolment in Nigerian universities was observed by different researchers (Ezeliora & Ezeokana, 2017; Imhabekhai, 2018; Makhubu, 2016; Nzewi, 2016; Oke, 2020; Owolabi, 2016; Salman, 2018; Yahaya, 2014). The turnout of graduates in Nigerian universities, according to NUC's report on university annual review, showed that from 2001-2005, males who obtained master's degree were 44,337 (72.79%) while females were 16,567 (27.20%). For graduates with doctoral degrees for the same period, males were 2,587 (64.01%) and females were 798 (23.57%). There was also low evidence of female enrolment in sciences and technology related courses. Olawole and Salman (2018) cited in Salman, Yahaya, & Adewara (2014) noted that participation of females in the study of sciences, technology and mathematics in the Nigerian institutions of higher learning has been discouraging. The females mostly subscribe for social sciences, arts and humanity courses and those that enroll into sciences are taken as gifted ones. This scenario is not only obtainable in Nigeria. At the higher education level in both industrialized and developing countries, women tend to cluster in areas of study which lead to traditional female careers of teaching, nursing and others (UNESCO, 2018). Gender parity in universities is a very vital and significant issue because the key to every nation's social, political and economic growth and development lies in the optimal participation of the citizenry in nation building. If basic education of women has produced unequalled socio-economic benefits at the family and community levels (Bunyi, 2017), the university education will enable a nation to leap forth in social, political, and economic growth. Unfortunately, gender imbalance is noticeable in enrolment in different disciplines and programs, especially at the tertiary level (Nwajiuba, 2016).

The report of situation analysis on education in Nigeria done in 2010 showed that compared with the primary and secondary levels, it is striking that there is much greater gender disparity in tertiary education especially in Nigerian universities. The male/female disparity is witnessed in most science courses, Veterinary medicine, English and technology-based courses with technical education favouring males and pure arts courses like English and Linguistics favouring females (Hodges, 2010). Several studies (Aguale & Agwagah, 2019; Makhubu, 2016; Njoku, 2001; Nnaka, 2017 & Ukpai, 2016) show that women in Nigeria are underrepresented in science and technology which is a serious bottleneck in an endeavour to attain technological progress in the country. With abundant mineral resources in the country which needs to be extracted and refined for economic development, adequate skilled manpower is needed (Nnaka, 2010). This is currently lacking. Increased participation of girls in science, technology and mathematics courses is seen by Nnaka as a way of bridging the manpower gap and fast-tracking national development.

### **The Implications of Female University Undergraduates' Participation in Science, Technology and Mathematics for Sustainable Development**

More efforts have been devoted to gender equality in undergraduate education. A full investigation of gender equity in higher education requires that we look at all aspects of the academy, not simply at undergraduate degrees. At the master's and the doctoral level, as well as the institutional leadership level, women are greatly underrepresented. To improve gender balance in SMT postgraduate education at UD, exclusive scholarship schemes for women have been introduced since the early 1994 to date. Women can compete for the general scholarship schemes as well. Despite having enough qualified women, a large proportion of the scholarships ends up going to men because the women do not apply even when solicited to do so. Here is a case of gender blindness. It is assumed that women do not pursue master's and doctoral degrees because they lack scholarships. It is not enough to make funds available; it is important to establish why women do not take up these opportunities before making the interventions. A flexible programme to support women to do PhDs has recently been introduced at the National University of Rwanda (NUR) in order to support women who have been stuck at the master's level for many years. Analyses of academic staff statistics conducted at UD show that women's success rates are as good as men's, yet women tend to apply in smaller numbers for academic and senior positions.

Women take two to ten years longer for promotion than their male counterparts. While making efforts to increase the numbers of female staff we must first address the slower career mobility for women in higher education. Science and technology enterprise has long been dominated by men, and the male perspective in policy development, performance evaluation, and interpersonal interactions generally prevails. Work by women is frequently undervalued. Women's unequal childcare and family responsibilities account for some of this differential. Each of these issues leads to a cumulative disadvantage for female employees in SMT. Domestic issues and responsibilities constitute primary challenges that female science and technology professionals face which affects their performance and progress at work. For example, women are more affected by the low salaries in the science and technology domains. While male counterparts can earn extra money by going on field trips and working late hours, most women are not likely to do so. We are yet to see an environment at the workplace that is conducive for the reproductive years of the female science and technology workforce. In certain science and technology workplaces, policies that protect pregnant women and nursing mothers working in certain conditions that can be health hazards are needed. These policies should be enforced, and women should be made aware of such policies and potential hazards.

## Conclusion

Ever since the declaration of the Nigeria Transformation Agenda by Federal Government and the declaration of Nigeria Vision 20:2020, various governments in Nigeria have been trying to make sure that the goals of the agenda are met. This they do by designing programmes that will drive the long-term goals of energy production, poverty reduction, employment generation, wealth creation, health, agriculture, and value orientation in the country. The transformation Agenda, this study posited could only be achieved by repositioning Mathematics, Science and Technology Education properly. This is because Mathematics, Science and Technology Education are the keys to open all doors to civilization of every nation.

## Recommendations

The following recommendations were made:

- i. There is need for the federal, state and local governments to strengthen the society awareness on the disparity in enrolment of male and female University undergraduates in science, technology and mathematics programmes at institutions of higher learning through the radio, television, organised seminars, workshops and conferences by professional bodies.
- ii. The dynamic nature of Mathematics, Science and Technology Education must be appreciated by the government at all levels. Teachers should therefore be exposed to regular training to keep abreast with current trends.
- iii. There should be a periodic review of the curriculum to suit evolving technologies. Training methods should also change.
- iv. Students should be engaged in field work and made to write reports.
- v. Education should be adequately funded. Institutions created to support Mathematics, Science and Technology Education and necessary equipment should be provided with the wherewithal to perform these functions.
- vi. Government should encourage the commercialization of successful research in Mathematics, Science and technology in our institutions of higher learning.

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