

Choice of Science and Technology Subjects among Secondary School Students

Christiana I. Oriahi¹, P.O. Uhumuavbi² and L.I. Aguele²

1. Institute of Education, Ambrose Alli University, Ekpoma, Edo State, Nigeria

*2. Department of Curriculum and Instruction, Ambrose Alli University, Ekpoma,
Edo State, Nigeria*

KEYWORDS Students. Selection. Discipline. Skill. High School

ABSTRACT This study examines the choice of science and technology subjects among secondary school students. The study employed the ex-post facto design. Two hundred and fifty (250) secondary school students randomly drawn from ten (10) secondary schools were used as sample for the study. Researchers' self developed valuation questionnaire (SVQ) on subject preference by students and choice of course of study in the higher institution of learning duly vetted by specialists in educational measurement and evaluation, guidance and counselling and science education were used to obtain information from the respondents. Descriptive statistics were used in presenting the data while the hypotheses were tested using the Chi-square. Statistical decisions were made at the 0.05 level of significance. Results of data analysis showed that - 1. More girls than boys prefer to study science education courses, 2. More boys than girls prefer to study technology courses in higher institution of learning. Based on the findings, some relevant educational implications were highlighted and some recommendations were made.

INTRODUCTION

The awareness of the vital role of science and technology in national development has prompted both the developed and developing countries of the world to include science and technology subjects in their school curricula to carry out various educational reforms in such areas. In Africa, for example, the African Primary Science Program (APSP) was developed. The experience of the APSP led to the evolution of Science Education Program for Africa (SEPA). In Nigeria, the Ford Foundation funded one of such efforts by Fafunwa in his 1964 experiment with elementary school project in Awo-Omama in Nigeria (Yoloye 1982). In the same vein, under the sponsorship of UNESCO/UNICEF, the western regional government in Nigeria launched a similar project. This included the Midwest Primary Science Project (MPSP), which produced among others, a primary school series called "Science Is Discovering".

With more national consciousness and the continued pressure of modern scientific demands, the Federal Ministry of Education in Nigeria, for example, started adopting a more science oriented policies and programmes in education. Through the help of such organs as the Nigeria Educational Research Council (NERC) and the Comparative Education Study and Adaptation Centre (CESAC), better-oriented curricula efforts began to emerge.

A number of the new curriculum projects initiated were; the Core Curriculum in Primary Science, the Nigeria Secondary School Science Project, the Primary Education Improvement Project, the Nigeria Integrated Science Project, and the Federal Ministry of Education Core Curriculum Project for both Primary and Secondary School Science. These curriculum projects were guided by the general and specific objectives of the National policy on Education. Similarly, in the United States of America, work in curriculum development led to the production of several science curricula, for example the Biological Science Program (BSP), Conceptually Oriented Program in Elementary Science (COPES), Science – A Process Approach (SAPA), Individualised Science Instructional System (ISIS), and Science Curriculum Improvement Study (SCIS). In the United Kingdom, the Nuffield Curriculum development led to the production of the Nuffield Foundation Mathematics Project (NFMP), Nuffield Foundation Junior Science Project (NFJSP) and Nuffield Foundation Combined Science (NFCS).

In Nigeria, the National Policy on Education stipulates that secondary school education should equip students to live effectively in modern age of science and technology (Federal Ministry of Education - FME 2004). The proper teaching and handling of science and technology subjects in schools will result in the training of

the minds of students in the understanding of the world around them in the acquisition of appropriate skills, capacities, competencies necessary for them to live and contribute to the development of their society. In pursuance of this, governments of many nations have planned that science and technical subjects should be taught in such a way as to ensure that every secondary school student has access to science and technology irrespective of sex and creed. In Nigeria for example, as a follow up of the Adebo commission, the 6-3-3-4 system of education was put in place. The three year junior secondary school education took care of pre-vocational subjects while the three year senior secondary catered for sciences and vocational subjects (Oriaifo 2002).

The increasing awareness of the importance of science and technology in national development by governments has resulted in the establishment of special science schools, polytechniques, colleges and universities of science and technology. It is not clear, however, the extent to which students have benefited from or embraced this noble objective of studying science and technology in these institutions.

Science and Technology Education

Science has been defined variously by different authors. Shapin (1996) defines science as the study of the physical and natural world and phenomena, especially by using systematic observation and experiment. In the view of Aigbomian and Imhanlahimi (1997), an operational definition of science is that advanced by the National Science Teachers Association 1963, which states that "Science is an accumulated and systemised learning in general usage restricted to the natural phenomenon. What science does is to expose one to the knowledge of the natural phenomenon and to the use of practical efforts to transform it to reality.

Technology, on the other hand, may simply be described as the act of manufacturing or creating things. Norman (cited in Aguele and Uhumuaybi 2003) defines technology as the 'sum of knowledge, skill and methods related to the production, distribution and consumption of goods and services including the organisation thereof. Merritt (2008) defines technology as the study, development, and application of devices, machines, and techniques for manufacturing and productive processes. From the above definitions,

it is obvious that technological skills are based on scientific knowledge. This implies that technology is the application of the knowledge of science in solving human needs and problems.

As reported by Okoli (1995), most students tend to prefer non-science subjects such as Economics, Secretarial Studies, Literature, Banking and finance to science subjects such as Physics, Mathematics, Chemistry and Biology. Even in Biology that would appear to be popular, judging from the enrolment rate every year, the performance is depressingly poor.

Normally everyone chooses what he or she likes and what one considers being useful to him or her. According to Ocho (1997), people do not value the same things. This is borne out of the fact that one's value determines one's behaviour which may be the behaviour or attachment to school subjects. In this context, it can be assumed that a student's value for science and technology determines his behaviour or attachment to such subjects.

Research findings have shown that the pattern of students' interaction inside and outside the classroom has significant effects on their interest and achievement in science (Fraser et al. 1999). In terms of the classroom, the individual child is motivated not only by his basic needs and drives, but also by the stimulation provided by his peer group. Outside the classroom, one factor that seems to affect students' interaction is the effect of social class stratification. Wherever societies have existed in the past, there has also existed some form of stratification among their members. The simple fact is that 'equality of opportunity' cannot be provided merely by Education Acts. Each child in a society has certain social positions by ascriptions; he/she is born into a particular family, in a particular place and environment and in a relative position with regard to being male or female.

Equally important is the fact that in so far as the school community is an institution set up for the purpose of specialisation and cultural transmission, it must have relations with political and quasi-political organisations which, either by state or local governments, control the forms and means of education provided. In recognition of the vital role of science and technology education in national development, however, there is the need to encourage both sexes, males and females, in the choice of science and technology subjects in schools.

Factors Affecting Students' Choice of Science and Technology Subjects

Students' attitudes towards science subjects affect their choice of the subjects. Generally, a negative attitude towards a given subject leads to lack of interest and when subjects are to be selected, as in senior secondary schools, it leads to avoiding the subject or course. Furthermore, a positive attitude towards science according to Simpson and Oliver (1990) leads to a positive commitment to science that influences lifelong interest and learning of science. This is the reason why major science education reform efforts in Africa have emphasised the improvement of students' attitudes towards science subjects.

Another major factor influencing students' choice of science subject is gender. According to Whitelaw et al. (2000), sex is probably the most important variable related to pupils' attitudes to science. Many studies for instance, Francis and Greer (1999), Jones et al. (2000), reported that males have more positive attitudes toward science than females. Also, Osborne et al. (2003) stressed that there is still a bias against physical sciences held by girls, suggesting that at an individual level the overwhelming majority of girls still choose not to do physical science as soon as they can. In the same vein, Aigbomian (2002) observed that boys perform better than girls in science, technical and mathematical subjects. It is generally believed that socio-cultural and religious practices are at the root of this imbalance. Girls are very often actively shielded from participating in rigorous vocational activities. In Nigeria, for example, boys are usually exposed to receive training from their fathers, on farming, blacksmithing, carpentry etc., to prepare them for a socially acceptable adult life. In most countries of Africa, same is the experience when boys are informally inducted into the trades and professions of their fathers. According to Durkheim (Cited in Aguele and Uhumuavbi 2003) it is the classical division of labour based on sex and age, and backed by various institutional arrangements, that are normally relevant within the home environment. Thus, girls are socialised to play expressive roles that are secondary; to play a service docile role or submissive and to be non-aggressive.

Gender issues in science and technology have been the concern of many educators, and series of researches have been going on in this area. In

an introductory overview on gender indicators for engineering, science and technology, the GST Gateway Tool Kit (2004) report on *Gender Disaggregated Data* informs that:

"Generally, women are underrepresented in almost every area of recognised scientific activity. Even in areas where women are statistically well represented at lower and medium levels – University Faculties, for instance, - they are underrepresented at the highest levels of decision-making and influence".

The report also indicates that:

"A number of other studies have shown that women's employment is heavily concentrated in a few occupations. They work typically as home and farm helpers, nurses, lower-school teachers, secretaries and so on. Compared to men with similar qualifications, tasks and responsibilities, women are over-represented in part-time employment or unemployment and in low paid and unsecured jobs".

The sex-role identification is learned very early in life. Uhumuavbi et al. (2003) believed that the root cause of women marginalisation lies in religion among others. They illustrated that in Nigeria, for example, the two dominant religious sects – Christianity and Islam – emphasised the inferior position of women in the society. These two main religious groups encouraged women to be taught more in areas that make them good housewives and mothers.

Also, career advice by parents and teachers can influence students' choice of science subjects especially in Africa. In a related investigation Okeke (2000) revealed that parents have significant effect on students' choice of career and subjects. If we want to encourage more young students into science, then students need rich opportunities to find out about the many ways sciences can be used in interesting careers, most of the students have not been helped by their parents when making their study choices.

Furthermore, the school has a great role to play in influencing students' choice of science subjects particularly in Africa. The school should support subjects and careers decision making. This will go a long way to encourage students' choice of science subjects. In addition, students need information about the structure and content of the science subjects they want to study. This will help to influence their choice of the subject. Research studies, Igun (2007), Obayan (2007), showed that students need information about the

structure and content of the programmes they are considering providing an understanding of what in particular a discipline involves. Peel (1998) argues that students often receive conflicting advice from parents, teachers, friends and career advisers, and upon entering senior secondary school there can be mis-match between expectations and actual experiences. The difficulty students may have in obtaining informed advice can influence their choice of science subjects. Other factors affecting choice of science and technology subjects as observed by Uhumuavbi et al. (2003) include age long "role dichotomy" between men and women, restriction of subjects in accordance to sex, sociological cum religious factors and derogatory policies and practices.

Until recently, no systemic science instruction was provided in many schools in most African countries including Nigeria. This is bound to influence students' choice of science subjects. However, several world events related to science and technology has affected the teaching of science and students' choice of the subject not just in Africa but throughout the world. Undoubtedly, the first atomic bomb explosion in the desert at Alamogordo on July 16th, 1945 was of great scientific achievement. By the time Sputnik I was launched on October 4th, 1957, science teachers in both developed and developing countries have begun to realise that a new science has began. The interest for the choice of science among students was further encouraged as a result of the competition for supremacy between the United States and the Soviet Union. This competition was keenly watched around the world and by the time the gains of science and technology were fully accomplished in African countries, another event, self-rule, elevated the zeal for science into reality among teachers and students. The era of science education was now in full gear.

There is a paucity of research on gender valuation of science and technology education among secondary school students particularly in Nigeria. The problem of this study therefore, is to investigate the way the different sexes value science and technology education in secondary schools. The focus is on the senior secondary school (SSS) students. The junior secondary students (JSS) are not considered for the study since at this level they are exposed to general education with little or no opportunity for subject choices.

Research Questions

The study sought answers to following questions:

1. What is the subject choice of senior secondary school students?
2. What percentage of senior secondary school students study science?
3. What are gender differences in the valuation of science education in the secondary schools?
4. What are gender differences in the valuation of technology education among the senior secondary school students?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance:

1. There is no significant difference in the gender preference for science education among senior secondary school students.
2. There is no significant difference in the gender preference for technology education among senior secondary school students.

METHOD AND PROCEDURE

The study employed the ex-post factor design. The use of this design was necessitated by the fact that the variables of interest have taken place and cannot be manipulated by the researchers.

The population of the study comprised two thousand five hundred and twenty (2,520) senior secondary school students in all the public senior secondary schools in Delta State of Nigeria for the 2006/2007 session. Using the stratified sampling technique, ten (10) schools made up of four (4) girls schools, four (4) boys schools and two (2) co-educational schools were selected. Twenty five students were randomly selected from each of the schools giving a sample of size 250 students.

The researchers' self-developed valuation questionnaire (SVQ) was used for the study. The instrument was face and content validated by experts in science education, measurement and evaluation and guidance and counselling. Using a test-re-test method, a reliability coefficient of 0.71 was obtained for the questionnaire. This coefficient was considered adequate for the instrument.

The questionnaires were administered to the 250 respondents and data collected were analysed using descriptive statistics and chi-square.

RESULTS

The results of the study are presented in the tables according to the research questions and hypotheses formulated.

Research Question 1:

What is the subject choice of senior secondary school students?

The result in table 1 showed that 46.4% of senior secondary school students chose Science and Technology subjects while 53.6% chose Arts and Commercial subjects. This implies that more students chose Arts and Commercial subjects.

Research Question 2

What percentage of senior secondary school students study science?

The result in table 1 indicated that only 46.4 percent of senior secondary school students study science and technical subjects.

Table 1: Subject choice of senior secondary school students

Subjects	No of students	Percentage %
Science and Technology	116	46.4
Arts and Commercial	134	53.6

Table 2: Distribution showing preferences by gender for science courses of study in higher institution of learning.

Science courses grouped according to departments	Gender	
	Boys (Frequency)	Girls (Frequency)
Biological Sciences	5	18
Physical Sciences	17	20
Health Sciences	34	42
Total frequency	56	80

Table 3: Significance ($P < 0.05$) of chi-square (χ^2) gender difference for science education among senior secondary students (df = 1)

Gender	fo	fe	$\chi^2 = \sum (fo - fe)^2 / fe$	χ^2 calculated	χ^2 critical	Inference
Boys	56	68	2.12	4.24	3.84	Significant
Girls	80	68	2.12			
Total	136	136	4.24			

($P < 0.05$; df = 1)

Research Question 3

What are the gender differences in the valuation of science education in senior secondary schools?

The result in table 2 showed that more girls prefer to study courses in the Physical, Health and Biological sciences.

To further determine the extent of significance of gender difference in preference of science education among secondary school students the hypothesis below was tested.

Hypothesis 1

There is no significant difference in the gender preference for science education among senior secondary school students.

From the chi-square distributions table the critical value of chi-square (χ^2) = 3.84. With a calculated chi-square (χ^2) = 4.24 from Table 3, the difference is significant and the null hypothesis is rejected.

Since the frequency observed (fo) for girls are greater than the expected frequency (fe), as compared to that of the boys it would seem that more girls than boys prefer science courses.

Research Question 4

What are the gender differences in preference for technology education among the senior secondary school students?

The result in table 4 showed that more boys than girls prefer to study technology courses in higher institutions of learning.

To further determine the extent of significance of gender difference in preference for technology education among senior secondary students the result was further tested.

Hypothesis 2

There is no significant difference in the gender preference for technology education among senior secondary school students.

Table 4: Distribution showing gender difference in preference for technology courses of study in higher institution of learning.

Technology courses grouped according to departments	Gender	
	Boys (Frequency)	Girls (Frequency)
Agricultural Engineering	5	8
Architecture	7	5
Civil Engineering	8	0
Chemical Engineering	9	4
Computer Engineering	7	4
Electrical/Electronics Engineering	8	2
Marine Engineering	6	0
Mechanical Engineering	8	3
Meteorology	8	6
Petrochemical Engineering	7	2
Total frequency	73	34

From the Chi-square distributions table with $df = 1$ at $p < 0.05$, the critical value of chi-square (χ^2) = 3.84. With a calculated chi-square (χ^2) = 14.20 from Table 5 the difference is significant and the null hypothesis is rejected.

Since the observed frequency (f_o) for the boys is greater than the expected frequency (f_e) as compared to girls, it would seem that more boys than girls prefer technology courses.

DISCUSSION

The study shows that Science, Arts and Commercial subjects are the three major areas of study in secondary schools. It shows that more students (53.6), chose art and commercial subjects compared to 46.4% who chose science and technology subjects (see table 1). This is in agreement with Okoli (1995) who posited that more students prefer non-science subjects to science. This subject imbalance is in a direct reflection with the view of Peel (1998) who attributed such development to conflicting ideas students receive from parents, teachers, friends and career advisers upon entering secondary school.

The result as shown in table 2 also revealed

that more girls than boys preferred science subjects. This is in contrast to the view of Jones, Howe, Rua (2000) who observed that males have more positive attitudes towards science than females. In the same vein, the study shows that more boys than girls prefer to study courses related to technology. This is in line with Osborne et al. (2003) who asserted that at an individual level the majority of girls still choose not to do physical science as soon as they can, indicating a bias against physical sciences held by girls. This result also agrees with Aigbomian (2002) who observed that boys perform better than girls in science, technical and mathematical subjects. The Gateway Tool Kit Report (2004) on gender disaggregated data which informs that women are generally underrepresented in almost every area of recognised scientific activity further buttressed the findings of this study.

The present study examines the choice of science and technology subjects among secondary school students. Four research questions and two null hypotheses were formulated to guide the study. All hypotheses were tested at 0.05 level of significance.

The design of the study was the ex-post facto design. The population comprised two thousand, five hundred and twenty (2,520) senior secondary school students in all the public secondary schools in Delta State of Nigeria for the 2006/2007 session. The sample which was drawn using the stratified sampling technique, comprised two hundred and fifty (250) senior secondary school students drawn from ten (10) schools made up of four (4) girls schools, four (4) boys schools and two (2) coeducational schools. The instrument for the study was the researchers' self-developed valuation questionnaire (SVQ) which was face and content validated by experts in science education, measurement and evaluation and guidance and counselling. A reliability coefficient of 0.71 was obtained for the instrument through test re-test method. Data collected were analysed using descriptive statistics and chi-square (χ^2).

Table 5: Significance ($P < 0.05$) of Chi-square (χ^2) of gender difference in preference for technology education among senior secondary students

Gender	f_o	f_e	$\chi^2 = \sum (f_o - f_e)^2 / f_e$	χ^2 calculated	χ^2 critical	Inference
Boys	73	53.5	7.1	4.24	3.84	Significant
Girls	34	53.5	7.1			
Total	107	107.0	14.2			

($P < 0.05$; $df = 1$)

Results obtained revealed that:

1. More students chose art and commercial subjects
2. More girls than boys prefer to study science education courses
3. More boys than girls prefer to study technology courses in higher institution of learning.

Based on the findings, recommendations were made. Some of these are that some schools should:

- (i) be adequately equipped and staffed to teach technical subjects up to a significant level;
- (ii) work with guidance counsellors and technology education teachers to discourage sex stereotyping and selection of subjects by gender and
- (iii) participate in professional development and curriculum activities to support the implementation of the course of science and technology.

CONCLUSION

More boys than girls favour technology education, while the girls prefer science education. This does not mean, however, that girls value science education more than boys, because every boy who chooses to do technology courses must ordinarily pass the science courses as well, but that women have clearly defined roles and responsibilities according to a socially defined gender division of labour that generally precludes them from choosing technology courses. There are, nevertheless, ongoing issues of gender equity to be taken into account and the question of impact on research priorities and technology development if there were greater gender balance in science decision making.

RECOMMENDATIONS

From the findings of this study, one can infer that there is gender valuation of science and technology education which are socially determined, and which may vary according to local circumstances within a region as well as between religions. As noted earlier, women's work occurs primarily in the informal sector, and generally takes the form of subsistence production, informal paid work, domestic production and related tasks. Nevertheless, it has been found that women's participation in this

sector tends to be underestimated and hence not adequately remunerated.

In 1997, the Organisation for Economic Co-operation and Development (OECD) hosted a conference on women entrepreneurs in small and medium enterprises. They discovered that women entrepreneurs grow at a faster rate than the economy as a whole in several OECD countries. The removal of a number of obstacles will surely allow for their potentials to be fully tapped.

In view of these varied roles and contributions to social and economic development, it becomes apparent that gender-disaggregated policies are crucial for economic, political and social development. For these reasons, it is recommended that at least some secondary schools should be adequately equipped and staffed to teach technical subjects up to a significant level and work with guidance counsellor and technology education teachers to discourage sex stereotyping and selection of subjects by gender.

In addition, promotional materials should be sent to parents while schools should be encouraged to participate in professional development and curriculum activities to support the implementation of the course and also identify potentially good students and encourage them with special gifts and incentives.

REFERENCES

- Aguele LI, Uhumuavbi PO 2003. Gender differentials in Science, Technology and Mathematics (STM) Education and self reliance. *Knowledge Review*, 2(2): 1-7.
- Aigbomian DO 2002. *Science for All: Implication for the Teacher and National Development: 14th Inaugural Lectures of the Ambrose Alli University, Ekpoma, Edo State, Nigeria*, Benin City: Ambik Press.
- Aigbomian DO, Imhanlahimi EO 1997. *Philosophy of Science and Technology Education*. Agbor: Royal Place Publications.
- Federal Government of Nigeria 2004. *National Policy on Education*. Lagos: Federal Ministry of Education.
- Francis L, Greer J 1999. Measuring attitudes towards science among secondary school students: The affective domain. *Journal of Research in Science Teaching*, 35(1): 877-896.
- Fraser BJ, Docker JC, Fraser D 1999. Assessing and improving school climate. *Evaluation and Research in Education*, 2(3): 109-122.
- Fraser BJ 1989. Twenty years of classroom environment work: Progress and prospects. *Journal of Curriculum Studies*, 2(1): 307-327.
- GST Gateway Tool Kit 2004. Toolkit on collecting gender desegregated data: Gender indicators for engineering,

- science and technology. <http://www.gstgateway.wigsat.org/ta/data/ch/html> (Retrieved May 25, 2006)
- Igun SN 2007. *Fundamentals of Vocational Guidance and Choice*. Benin-City, Nigeria: Otohagwa Ent.
- Merritt RH 2008. "Technology". *Microsoft® Student 2008* [DVD]
- Jones G, Howe A, Rua M 2000. Gender differences in students' experiences, interests, and attitudes towards science and scientists. *Science Education*, 84(1): 180-192.
- Obanya P 2007. *Fundamentals of Guidance and Counseling*. Ibadan, Nigeria: Heinemann Educational Books (Nig.) Plc.
- Ocho RA 1997. Gender valuation of science and technology education among secondary school students in Enugu. In: GA Badmus and LO Ocho (Eds): *Science, Mathematics and Technology Education in Nigeria*. Enugu: The Nigerian Academy, pp. 207 - 219
- Okeke AN 2000. The impact of school subjects on the choice of careers and profession. *West African Journal of Education*, XVII(1): 5 - 11.
- Okoli JN 1995. *Effects of Two Interactive Learning Styles on Students' Achievement and Interest in Biology*. Ph.D Thesis, Unpublished. Nsukka: University of Nigeria.
- Oriafo SO 2002. Refocusing science technology and mathematics in Nigeria. In: SO Oriafo POE Nwaokolo, GC Igborgbor (Eds.) *Refocusing Education in Nigeria*. Benin-city, Nigeria: Da-Sylva influence, pp 50 - 60.
- Osborne J, Simon S, Collins S 2003. Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, 25(1): 1049-1079.
- Peel M 1998. *The Transition from Year Twelve to University*. Report on the Monash Transition Program.
- Shapin S 1996. *The Scientific Revolution*. USA: University of Chicago Press.
- Simpson R, Oliver J 1990. A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education*, 74(1): 1-18.
- Uhumuavbi PO, Oriahi CI, Olusi FI 2003. Science, technology and mathematics (STM) education: catalyst for women development and empowerment. *The Nigerian Academic Forum. A Multidisciplinary Journal*, 5(1): 20 - 26.
- Whitelaw S, Milosevic L, Daniels S 2000. Gender behaviour and achievement: A preliminary study of pupil perceptions and attitudes. *Gender and Education*, 12(1): 87 - 113.
- Yoloye EA 1982. *Developing and Understanding in Education*. Ibadan: University Press.