DETERMINANTS OF JUNIOR SECONDARY SCHOOL STUDENTS' LEVEL OF ACQUISITION OF SCIENCE PROCESS SKILLS

Dr. Ngozi M. Eya

Abstract

The research work conducted in Nsukka education zone of Enugu state was intended to find out the determinants of JSS students' level of acquisition of Science Process Skills. Two research questions and two hypotheses guided the study. The design of the study was an ex-post factor. A total sample of sixty JSII students (30 males and 30 females) randomly drawn from both single sex and co-educational schools in one educational zone of Enugu state participated in the Study. A Science Process Skill Rating Scale (SPSRS) designed by the researcher was the instrument used for collecting data. The data collected were analyzed using mean and standard deviation for answering the research questions while Analysis of variance (ANOVA) was used for testing the hypotheses. The major findings of the study are that gender is a significant factor ($P<0.05$) in the level of acquisition of science process skills and that there is significant difference ($P<0.05$) in the acquisition of science process skills between students from singles sex and co-educational schools. A number of educational implications were pointed out and relevant recommendations were made.

Education is seen as a vital tool in the production and sustenance of national development, Federal Republic of Nigeria (FRN), National Policy on Education (2004) stated that education will continue to be highly rated in the national developmental plan because it is considered the most important instrument of change and a means of preparing individuals for future living in the society.

Science is the systematic study of anything that can be tested and verified. Science contributes to the quality of life in so many areas: health, nutrition, agriculture transportation, material and energy production (Akpan, 2008). According to Ware (1992) in Akpan (2008) the International Council of Scientific Union-Council on Teaching of Science (ICSU-CTS) summarizes the importance of science and technology to economic development as follows:

> *"Long term sustained growth can be acquired only if the money invested in science and technology is matched with the provision of funds for complementary educational programmes directed both to the preparation of scientists and technologists and to the improvement of science literacy of the population as a whole"*.

Science has developed into one of the greatest and most influential fields of human endeavour. Today, different branches of science investigate almost all that can be observed and detected. Science has therefore become a crucial factor for sustainable development of any nation.

Science is taught in junior secondary schools as basic science. The major challenge of basic science education in Nigeria over the years is that the basic science that is taught in schools fall below expectations both in content and in methodology (Achimugu 2014). Evidence from literature shows that the teaching methods employed by teachers are mostly conventional lecture method which does

not involve much of student-student or teacher – student interactions. (Achumugu 2005, Adejoh 2011, and Okeke 2013), Eya (2011) also found that, most junior secondary schools in Enugu State do not have basic science laboratories. She also stated that most science equipments and materials were not found in majority of the secondary schools. These poor conditions pose serious problems in the teaching and learning of basic science at J.S.S level. This is because, scientific processes and attitudes are not emphasized and acquired and the productions of basic science cannot use the science they learnt in school to solve their personal and social problems.

In a bid to solve these problems, the federal government produced a new basic science curriculum for use at the junior secondary school level in line with the 9-year basic education in Nigeria. This curriculum is student centered and places emphasis on learning science as process rather than as a body of knowledge or as examination centered subject. According is to the Federal Ministry of Education (2007), the overall objectives of the curriculum is enable learners to

1. Develop interest for science and technology.
2. Acquire basic knowledge and skills in basic science and technology.
3. Apply their scientific and technological knowledge and skills to meet societal needs.
4. Take advantage of the numerous career opportunities offered by science and technology.
5. Become prepared for further studies in science and technology.

To implement these laudable objectives, the teaching methods to be adopted as recommended are guided discovery, inquiry, demonstration, discussion, field trips, excursion, project, process based concept mapping, scaffolding, team teaching, role play and cooperative learning (NTI 2009).

There are three major dimensions of science. They are its content (science knowledge), its method (science process) and its application (resulting in tangible products). Science applies the scientific method to conduct inquiry into nature in order to obtain scientific knowledge. The scientific method, scientific thinking and critical thinking have been terms used at various times to describe these science skills. Today the term "science process skills" is commonly used. Science-A-Process-Approach (SEPA) defined science process skills as the set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists.

The purpose of science education is to enable individuals to use science process skills, in order words, to be able to define the problems around them, to observe, to hypothesize, to experiment, to conclude, to generalize, and to apply the information they have with the necessary skills. Science process skills are skills which every individual can use in each of his/her daily life by being scientifically literate. These skills help to increase the quality and standard of life of individuals as the individual can easily comprehend the nature science. Science process skills affect the personal, social and global lives of individuals. They are necessary tools used to produce scientific information in order to perfect scientific research and to solve life problems. These skills can be gained by students through certain science education activities. Scientists use their creativity in every stage of scientific research. Individuals need to think creatively and to be able to use their scientific process skills to develop their fundamental scientific understanding.

The following are a list of the thirteen science processes advocated by the American Association for the Advancement of Science (AAAS). The processes include:

1. **Observation:** This is the most fundamental of all the processes. Observation may be defined as the gathering of information through the use of any one or the combination of any of the five basic senses- sight, hearing, touch, taste and smell.
2. **Measurement:** Measurement is an observation made more specific by comparing some attributes of a system to a standard of reference.
3. **Classification:** This is the process of grouping objects on the basis of observable traits Objects that share a given characteristics can be said to belong to the same set.
4. **Quantification:** Quantification is the process of using numbers to express observation rather than relying only on qualitative descriptions. The process has two major values. By expressing something in numerical terms the need for translation of verbal meaning is reduced. Secondly the use of numbers allows the mathematical logic to be applied in an attempt to explore, describe and understand nature.
5. **Inferring:** Inferring is an inventive process in which an assumption is of course generated to explain an observed event.
6. **Predicting:** This process deals with projecting events based upon a body information.
7. **Relationship:** The process skill of relationship deals with interaction of variables. Interaction can be thought of as a kind of counter influence occurring among a system's variables.
8. **Communication:** This process actually refers to a group of skills, all of which represent some form of systematic reporting of data. The most common examples include data display tables, charts and graphs.
9. **Interpreting Data:** This process refers in the intrinsic ability to recognize patterns and associations within bodies of data.
10. **Controlling Variables:** This process is also a kind of group process because one may engage in several different behaviors in an attempt to control variables. In general, this skill is any attempt to isolate a single influence of a system so that its role can be inferred.
11. **Operational Definitions:** An operational definition is one that is made in measurable observable terms. An operational definition should neither require interpretation of meaning nor is it relative.
12. **Hypothesizing:** Hypothesizing is again intrinsic and creative mental process rather than a more straight forward and obvious behavior. Consequently, developing this ability is probably less a product of linear training but more of function of intuitive thinking that emerges from experience.
13. **Experimenting:** This process is a systematic approach to solving a problem. Using experimenting is synonymous with the algorithm called scientific method which follows these five basic steps.

Problem ⟶ Hypothesis ⟶
Predictions ⟶ Test of Predictions
Evaluation of Hypothesis

The first eight processes are called basic processes while the last five are called integrated processes. When students are exposed to these process skills especially at junior secondary level, they will actually experience science rather than just learn about science. They will engage in the development of principles and generalization of science rather than merely learn by rote.

There is the need to improve students' acquisition of science process skills especially at the early stage of their education. This is important considering the findings of Eya (2015) which reported that junior secondary school students show low level of acquisition of integrated process skills. There is the need to investigate into some speculated possible

factors that militate against students' acquisition of science process skills especially at junior secondary level. This study is therefore geared towards finding out the effect of gender and school type on JSS students' level of acquisition of science process skills.

Research Questions

The research will try to find possible answers to these questions

1. To what extent does students mean rating on the level of acquisition of science process skills depend on gender?
2. To what extent does students mean rating on the level of acquisition of science process skills depend on school type?

Research Hypotheses

In order to investigate the problem of the study, the following null hypotheses were formulated:

1. There is no significant difference ($p<0.05$) in the mean rating of science process skills acquired between males and females in junior secondary schools.
2. There is no significant between ($P<0.05$) in the mean rating of science process skills acquired by students in single sex and co-educational schools.

Method

The study was an expost-factor design. The study was conducted in one out of the five educational zones in Enugu State. The educational zone is Nsukka. The zone is made up of six local government areas namely, Igbo Eze North, Igbo-Eze south, Udenu, Igbo-Etiti, Nsukka, and Uzo Uwani. The population of the study is made up of 6, 344 JS II basic science students in the 60 government owned secondary schools in Nsukka Education zone. (Post primary school management Board, PPSMB, 2014, Nsukka zonal office) The sampling technique used for this study is simple random sampling technique. The researcher used this technique to select six out of the sixty secondary schools in the total population. The researcher went further to select 10 basic science students from each of the sampled schools through simple balloting without replacement. This gave a total sample size of 60 students.

The instrument used in collecting data for the study was the Science Process Skill Rating Scale (SPSRS), which was developed by the researcher from experiences in integrated science and consultation of the core curriculum for basic science as well as relevant literature in the areas of science process skills of observing, measuring, classifying, communicating, inferring, experimenting and interpreting data. The construction of the instrument involves writing statements in behavioural terms reflecting activities which students should be able to perform in the course of their basic science lessons under each of the seven skills categories. A total of 39 behavioural statements were listed under the seven skills categories. By attaching a 4-point scale to the statements in the behavior category, the scale is formed. The scale is an observational schedule that can be used for rating the level of science process skills acquired by basic science students. The students are expected to perform the different activities in the class while the teacher observes them and rates their level of acquisition of the skills. The scale points include very low 1, how-2, high-3, and very high -4. Attached to the instrument is a set of some questions based on the rating scale to guide the students in performing the various activities expected of them in the rating scale.

Results

The results were presented according to research questions and hypothesis as follows:

Research Question 1

To what extent does students' mean rating on the level of acquisition of science process skills depend on gender?

Table 1: The Mean and Standard Deviation of Students' Level of Acquisition of Science Process Skills according to Gender.

Science Process Skill	Male		Female	
	Mean	**S.D**	**Mean**	**S.D**
Observation	34.90	10.22	31.33	10.79
Measuring	37.33	10.26	28.03	7.81
Classifying	39.91	10.20	32.53	12.50
Communicating	35.53	13.28	26.20	7.20
Inferring	29.10	7.56	20.06	6.31
Experimenting	30.43	13.04	22.61	7.45
Interpreting Data	27.06	9.08	20.63	7.15
Overall Mean	**33.47**	**10.52**	**25.91**	**8.46**

Table 1 shows that the mean rating and standard deviation of male students level of acquisition of science skills of observing, measuring, classifying, communicating, inferring, experimenting and interpreting data are 34.9 and 10.22, 37.33 and 10.26, 39.9 and 10.20, 35.53 and 13.28, 29.10 and 7.56, 30.43 and 13.04 respectively. Their female counterparts has mean rating and standard deviations of 31.33 and 10.79, 28.03 and 7.81, 32.53 and 12.50, 25.20 and 7.20, 20.06 and 6.31, 22.64 and 7.43, 20.63 and 7.15 respectively in the above mentioned skills. The overall mean rating of the male students in those Skills is 33.47 with an overall standard deviation of 10.52 while the female students has an overall mean rating of 25.91 and overall standard deviation of 8.46. From the results, it is seen that the mean rating of the male students in all the seven skill categories is greater than that of the female students. Moreover, the overall mean of the males is also higher than of the female students.

In order to make a decision on the influence of gender on the level of acquisition science process skills, hypothesis 1 was tested.

Hypothesis 1

There is no significant difference ($P<0.05$) in the mean rating of the level of science process skills acquired between males and females in Junior secondary schools. The hypothesis was tested using one way analysis of variance (ANOVA) as shown in table 2 below.

Table 2: Summary of One-Way Analysis of Variance of Students Mean Rating on the Level of Science Process Skill Acquisition According to Gender and School Type.

Skill	Source of Variation	Sum of Squares	d/f	Mean square	f. ratio	f. prob	Decision
Observation	Gender	190.81	1	190.81	1.72	0.19	Signifi-cant
	School type	470.63	2	235.31	2.18	0.12	Signifi-cant
Measuring	Gender	1297.35	1	1297.35	15.58	0.002	Signifi-cant
	School type	1615.63	2	807.81	10.21	0.002	Signifi-cant
Classifying	Gender	660.01	1	660.01	5.06	0.02	Signifi-cant
	School type	799.60	2	399.80	3.07	0.05	Signifi-cant
Communi-cating	Gender	16700.01	1	16700.01	6.43	0.01	Signifi-cant
	School type	1950.0	2	975.31	8.96	0.004	Signifi-cant
Inferring	Gender	380.01	1	380.01	4.91	0.03	Signifi-cant
	School type	917.63	2	458.81	6.62	0.002	Signifi-cant
Experimen-ting	Gender	123.26	1	123.26	0.86	0.35	Signifi-cant
	School type	8271.50	2	70.71	0.61	0.48	Signifi-cant
Interpreting data	Gender	620.81	1	620.81	5.12	0.02	Signifi-cant
	School type	765.10	2	382.55	3.16	0.04	Signifi-cant

Table two show the ANOVA results of male and female students mean rating of the level of acquisition of observing, measuring, classifying, communicating, inferring, experiment and interpreting of data of the seven (7) science process skills. As can be seen from

table 2, calculated value of f-ration of 1.72, 15.58, 5.06, 6.43, 4.91, 0.86 and 5.12 exceeds the table value of 0.19 0.002, 0.02, 0.01, 0.03, 0.25 and 0.02 in the skills of observing, measuring, classifying, communicating, inferring, experimenting and interpreting data respectively with respect to gender. These indicate that there is a statistical significant difference between the mean rating of male and female students in their acquisition of science skills. Thus the above stated hypothesis was rejected.

Research Question 2

To what extent does the student's mean rating in the level of acquisition of science process skills depend on school type? The research question was answered using table 3.

Table 3: The mean rating (x) and S.D of student's acquisition of science process skill according to school type

Science Process Skill	Mean Rating of all Boys	S.D	Meaning Rating of all Girls	S.D	Mean Rating Co-Educational	S.D
Observation	36.65	10.93	29.80	10.52	32.90	9.59
Measuring	38.50	9.75	25.90	7.15	33.65	9.53
Classifying	40.50	11.45	31.15	10.81	36.35	11.9
Communicating	38.65	14.89	25.15	7.63	28.80	6.81
Inferring	29.70	7.56	22.10	7.43	30.95	9.76
Experimenting	31.15	13.14	34.00	10.06	30.45	12.1
Interpreting Data	32.90	15.35	25.30	8.16	25.35	7.74
Overall Mean	**35.68**	**7.88**	**28.47**	**6.60**	**31.69**	**6.83**

A close observation of table 3 reveals that the mean rating of the single sex (all boys and girls) schools are higher than that of the co-educational schools especially in the skill of observing, measuring, classifying, communication, experimenting, and interpreting data. Overall mean rating according to school type are also higher for single sex schools than co-educational schools. From table 3, we also find out that within the single sex schools mean rating of the boys school is higher than that of the all girls schools.

In order to take a decision on the influence of school type on the mean rating in the level of acquisition of science process skills, hypothesis 2 was tested.

Hypothesis 2

There is no significant difference ($p<0.05$) in the mean rating of level of science process skills acquired by students in single sex schools and co-educational schools. This hypothesis was tested using one-way analysis of variance (ANOVA) as in table 2.

From table 2 the calculated F-ratio of 2.18, 10.21, 3.07, 8.96, 6.62, 0.61 and 3.16 for the skill of observing, measuring, classifying, communicating, inferring, experimenting and interpreting data are greater than the table value f – ratios of 0.12, 0.002, 0.05, 0.004, 0.002, 0.48 and 0.04 for those skills respectively for 2 degree of freedom at 0.05 level of significance. This indicates that there is a statistical significant difference between the mean rating of single sex schools and the co-educational schools in their level of acquisition of science process skills. The above stated null hypothesis was therefore rejected. Males are also higher than that of the females in the level of acquisition of science process skills.

Discussion

The discussion of the study is made under the following sub-headings:

1. The gender factor on students' level of acquisition of science process skills
2. Level of acquisition of science process skills and school type factor.

Gender Factor on Student's Level of Acquisition of Science Process Skills

In this study, the effect of gender on students' acquisition of science process skills as measured by their mean ratings in their level of acquisition of the different science process skill categories was investigated. The result from table 1 showed that the male students had higher mean rating than their female counter

parts. This was further confirmed by the ANOVA results in table 2 which revealed that gender was a significant factor on students' level of acquisition of science process skills. This result agrees with the findings of Ajunwa (2000) which indicated that there was a significant difference in the acquisition of science process skills in the favour of males. The result is contrary to the findings of Jack (2014) who found no significant difference of sex on students' acquisition of science process skills. In summary, evidence obtained in this study with regards to how gender affect acquisition of science process skills shows that the mean rating of the male students in all the seven skill categories studied is greater than that of the female. Moreover, the overall mean rating of the males is also higher than that of the females in the level of acquisition of science process skills.

Level of Acquisition of Science Skills and School Type Factor

The results of analysis of the influence of school type on the mean rating of the students' level of acquisition of science process skills in table 3 indicated that the mean rating of the single sex schools are higher than that of the co-educational schools. From the table also, it was seen that among the single sex schools, the mean rating of the students from all boys' school was higher than that of the all girls' schools. This was further confirmed by the result in table 2 which revealed that there is a statistical significant difference between the mean rating of the single sex schools and the co-educational schools in their level of acquisition of science process skills. This result does not appear to be supported by the findings of Jack (2014) who found no significant difference of school type on students' acquisition of science.

In summary, the evidence obtained in this study in regards to how school type affect acquisition of science process skills reveal that

1. Students from single sex schools obtained a significant higher mean rating on the level of acquisition of science process skills than the students from co-educational schools.
2. Amongst the single sex schools, the mean rating of the students from all boys school is higher than that of the students from all girls schools.

Conclusion

The findings of this study served as an empirical basis for making the following conclusions

1. Gender has significant influence on students' mean rating on the level of acquisition of science skills. Male students obtained a higher mean rating than their female counterparts on the level of acquisition of science process skills.
2. There is a significant difference in the mean rating of the single sex schools at the co-educational schools. Also, students from all boys schools had a high mean rating than students from all girls schools.

Implication of the Study

The findings and conclusions of this study have a number of educational implications especially with regards to teaching and learning of science at the junior secondary school level.

The female showed a lower mean rating in the acquisition of science process skills than their counterparts and also the students from co-educational schools showed a lower acquisition than the single sex schools. It suggests that remedial efforts of teachers be targeted on the female students as well as students in the co-educational schools.

Recommendations

With regards to the findings of this study and their implications, the following recommendations are made.

1. Workshops, seminars and conferences should be organized at regular intervals for science teacher at the JSS to enable them update their scientific knowledge. This will help to foster the actualization of the goals of the new basic science curriculum.
2. Necessary infrastructures as well as enough equipment and chemicals for teaching basic science should be provided by the relevant stakeholders. The resources should be equitably shared to both the single sex and co-educational schools to enable these schools teach basic science to their students more effectively and realistically.
3. Basic science teachers who cannot secure sponsorship to training program should make sacrifices to sponsor themselves to conferences, seminars and workshops to ensure their professional growth.
4. Teachers of basic science should as much as possible try to make their basic science classes gender friendly so as to be able to carry all the students (both males and females) along.

References

Achimugu, L. (2014). Teaching Basic Science for Creativity: the Use of Cooperative Group Assignment. *Proceedings of the 55nd Annual Conference of STAN, 195-199.*

Adejoh, M.I. (2011). Improving the Quality of Basic Science Teaching and Learning through Educational Reforms. *Proceedings of the 52nd Annual Conference of STAN, 182-191*.

Ajunwa, C.A (2000). Acquisition of Physics Process Skills by Secondary School Students *Unpublished Ph.D Thesis. University of Nigeria Nsukka.*

Akan, B.B. (2008). *Science Education and Economics Development. In Nigeria and Future of Science Education*. Data Print and Packaging Ltd. Ibadan.

Eya, N.M. & Elechi, C.N. (2015). Research on the Level of Acquisition of Science Process Skills by Junior Secondary Schools Students and Implication on Economic Reform and Development in Nigeria International Journal of Scientific and Allied Research (IJSAR) http://www.indejournals.org.

Federal Ministry of Education (2004). *National Policy on Education.* Abuja Federal Government Press.

Federal Ministry of Education (2007). 9-year Basic Education Curriculum: Basic Science for JSS 1-3 Abuja, Nigeria Educational Research and Development Council. Abuja Federal Government Press.

Jack, G.U. (2014). Influence of Identified Student and School Variables on Students Science Process Skills Acquisition. www.jiste.org/journals/index.php./JEP/article/view/4783.

National Teachers Institute (NTI, 2009). Manual for Re-training of Primary Science Teachers, in Basic Science and Technology, An MDG Project, Kaduna, BTI Press, 26-39.

Okoye, P.O. (2013). Teachers Knowledge of the Contents and Activities of Basic Science Curriculum for MDCS. *Proceedings of 54th Annual Conference of STAN*, 415-424.

Dr. Ngozi M. Eya
School of Science Education,
Enugu State College of Education (Tech.),
Enugu.