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Levels of Possession of Science Process Skills by Final Year Nigeria Certificate in Education Students of Selected Science Subjects in Ebonyi State College of Education

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Abstract

The study investigated the Levels of Possession of Science Process Skills by Final Year Nigeria Certificate in Education Students of Selected Science Subjects in Ebonyi State College of Education, Ikwo, Nigeria. The skills that were assessed were observation and measurement. The research was guided by two research questions and two null hypotheses. The research adopted the descriptive survey design. A sample of 200 out of 386 final year NCE students of the College who studied Biology, Chemistry and Integrated Science in the 2013/2014 session was used. The instruments for data collection consisted of a set of practical instructions: the Science Process Skills Tests (SPST) and a 12-item Assessment Format for Science Process Skills, (AFSPS), both developed by the researchers. AFSPS which had a reliability coefficient of 0.75 using Cronbach Alpha, was based on four-point scale of very low, low, high and very high rating of respondent's level of possession of the skills. The researcher rated the students' level of possession of the skills using AFSPS while the students were carrying out the activities using SPST. Mean and standard deviation were used to answer the research questions while t-test was used to test the hypotheses. The results showed among others, high level of possession of each of the two skills by the respondents and no gender-related significant difference in the level of possession of the skills. Based on the findings, it was recommended that teacher-trainers should emphasize more on skills acquisition while Provosts of Colleges of Education should provide adequately equipped science laboratories to facilitate the production of NCE science teachers with very high level capability in science process skills.

Keywords: *Science, Process Skills, Observation, Measurement*

Background to the Study

Sustainable growth and development can only be ensured on the bedrock of effective and efficient education system. It is for this reason that the curricula contents and intended outcome of education are geared towards solving national problems. The choice of the subject to be taught and the contents of such subject in the curricula are usually driven by the needs of the nation concerned. No nation can make appreciable progress in terms of sustainable development without solid scientific base. This can only be achieved if the citizens are exposed to qualitative and quantitative scientific and technological education.

Science has been defined in many ways based on perception. Federal Ministry of Science and Technology, FMST in Igwe (2002) defined science as objective knowledge about nature, properties and behaviour of the physical world. In this context, science is all about knowledge of the physical world – what it is, what it is made of and how it behaves on interaction with other things. According to UNESCO in Kazeni (2005) science is interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observations. Deriving from the definitions, science encompasses the knowledge of physical world and methods employed in the acquisition of the knowledge. But knowledge obtained through any process is attractive and worthwhile to the extent that it serves as a solution or contributes to providing solution to man's problem. In line with this therefore, science is a process through which man obtains testable knowledge of the physical world and utilizes the knowledge to solve human problems.

Nigeria has since risen to the challenges of development through science education on the bases of policies, curricula contents and setting of educational objectives. The National Policy on Education set as a goal for science education in Nigeria that "government shall popularize the study of the sciences and the production of adequate number of scientists to inspire and support national development" (FRN, 2004:28). Similarly, in Igwe (2012a and 2012b) the aim of science and technology education is spelt out to help to inculcate science and technology in the thinking and working processes of the society in order to create a science and technology culture. Here, science and technology are extended to the life of the community to explore ethnoscience.

Okpara (1997) advanced as reasons for the study of science education: its potential to improve the living conditions of man and his value orientations as well as its ability to help the citizenry make informed choices in the many areas of public and private life. Similarly, drawing from Association for Science Education (ASE) of America's stated aims of science education as contained in Enebechi (2005:51) science education

a Instills moral and social values in the learner.

b Leads to the development of retainable and transferable skills for the individual to contribute to personal and societal development.

c Instills high cognitive development that would ensure adaptation to broad

sources of knowledge and interaction of ideas that would ensure a complete, all-round man.

The above benefits and objectives cannot be achieved when science is taught using the traditional approaches of teaching represented by the lecture/talk and chalk method which is characterized by delivering lectures without practical approaches (DeBoer 1991). The implication is that more innovative and enquiry based methods such as discovery, concept mapping, inquiry, investigative, laboratory, co-operative and constructivism approaches (Okoli, 1995) would serve better to meet up the desires of teaching science. This paper dwells on inquiry approaches in science teaching and learning and covers observation and measurement skills.

The concept of inquiry in science involves many processes called the science process skills which the scientist engages on. Science process skills are broadly transferable abilities appropriate to many science disciplines and reflective of the bahaviour of scientists (American Association for Advancement of Science (AAAS) in Igwe (2003). Science process skills are majorly cognitive and psychomotor skills, which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication (Okoli, 2006; Igwe and Nwali,2015b).

The acquisition of science process skills is crucial to the development of scientific culture in the learner and for the society (Okoli, 1995, Omotayo and Yusuf, 2002; Nwosu, 2003; FRN, 2004; Igwe and Nwali, 2015a). Science process skills enable the learner to develop and retain cognitive, affective and psychomotor aspects of scientific study which will in turn enable him to study and practice science as part of human culture so that he will be properly disposed to contribute to the development of the society through the practical application of the knowledge obtained.

Contrary to expectations, observations show general poor performance of students in the Primary Science (Basic Science and Technology) and Integrated Science (Basic Science) at the Universal Basic Education (UBE) level (Omotayo & Yusuf, 2002). This trend has been carried on to the secondary school level. Several research reports (Okoli, 1995, Nwagbo, 2001, Okoli, 2006) are consistent that students achieve poorly in secondary school science subjects.

Similarly, statistics from the West African Examinations Council (WAEC) on students' performances in the sciences (Chemistry, Physics and Biology in particular) show that students record poor results in the Senior Secondary Certificate Examinations SSCE, (WAEC, 2005, 2008). WAEC Chief Examiner's reports attribute the poor performances in these science subjects to poor performances in practical aspects of science (WAEC, 2005). Obviously, the level of performance in practical work in science is synonymous with level of possession of science process skills. WEAC specifically showed that Senior School Certificate Examination (SSCE) candidates show weaknesses in questions involving the application of acquired science process skills. This trend poses a lot of

concern which ought to be addressed in order to ensure appreciable and sustainable growth in science and technology. Many factors may be adduced for the poor performance among which is teacher incompetence due to paucity of process skills.

The minimum qualification for teaching in Nigeria is the Nigeria Certificate in Education (NCE) (FRN 2004). By implication, holders of the NCE in the science disciplines are expected to teach Basic Science and Technology as well as Basic Science at the Universal Basic Education, (UBE) level. It is therefore important to assess the level of possession of science process skills by final year trainee NCE teachers, to determine their preparedness to teach Basic Science and Technology and Basic Science with particular reference to acquisition of science process skills by the learners.

Biology, Chemistry and Integrated Science teachers form the bulk of the science teachers in primary and secondary schools as well as the relative number of Biology, Chemistry and Integrated Science students to other science subjects in the Colleges of Education. All the students in the upper basic level offer basic science. The predominance of Biology, Chemistry and Integrated Science teachers in the teaching of Basic Science implies that their level of possession of science process skills will to a large extent affect the extent the skills will be taught well. This study was therefore designed to assess the levels of possession of science process skills by final year NCE students of Biology, Chemistry and Integrated Science.

A factor of interest in the study of level of possession of skills is gender. This study will therefore examine how the level of the possession of science process skills by final year NCE Biology, Chemistry and Integrated Science students is dependent on gender.

Statement of the Problem

The National Commission for Colleges of Education (NCCE) Minimum Standards for NCE in the sciences (Biology, Chemistry and Integrated Science inclusive) lay emphasis on the acquisition of science process skills by NCE students. This emphasis is in realisation of the importance of the skills to science students and for the preparation of the NCE students for teaching the skills at the basic level of education in Nigeria. The teachers' preparation is important since the teacher can only teach well what he is proficient in.

Many of the studies on science process skills known to the researchers were on the secondary school level. But the semester results of science students in the Colleges of Education show poor performance in practical courses possibly due to low level of skills acquisition which would in turn reflect on students' skills acquisition in the basic level of education. This is a bother or worry to these researchers. The problem of this study was therefore: what is the level of science process skills possessed by final year NCE students of Biology, Chemistry and Integrated?

Purpose of the Study

The main purpose of this study was to determine the level of possession of observation and measurement skills by the final year NCE Chemistry, Biology and Integrated Science students. Specifically, the study sought to determine the level of possession of :

(i) Observation skill by final year NCE Biology, Chemistry and Integrated Science students.

(ii) Measurement skill by final year NCE Biology, Chemistry and Integrated Science students.

(iii) Whether level of possession of the science process skills is gender dependent

Research Questions

The following research questions guided the study:

(1) What is the level of possession of observation skills by final year NCE students of Biology, Chemistry and Integrated Science?

(2) What is the level of measurement skill possessed by final year NCE students of Biology, Chemistry and Integrated Science?

Hypotheses

Two hypotheses were tested at 0.05 level of significance in the research.

Ho_1: There is no significant difference in the mean ratings of final year NCE students of Biology, Chemistry and Integrated science on the levels of possession of observation and measurement skills.

HO_2: There is no significant difference in the mean ratings of male and female students on the level of possession of observation and measurement skills by final year NCE Biology, Chemistry and Integrated Science students.

Methodology

The design for the study was the descriptive survey design. In this research, the respondents were required to react to the instructions on the instrument and their responses rated. The researchers sought to find out the extent the respondents could perform the tasks (exhibit science process skills). The level of performance was to be rated according to how well the skill was exhibited. The study was conducted in Ebonyi State College of Education, Ikwo, Ebonyi State, Nigeria. Ebonyi State is one of the South Eastern States of Nigeria. The State depends largely on Ebonyi State College of Education, Ikwo for meeting the manpower needs of her basic education institutions.

The population of study was the 386 final year NCE students who studied Biology, Chemistry and Integrated Science in the 2013/2014 academic session in Ebonyi State College of Education, Ikwo. The population was made up of 185 Biology students, 120 Chemistry students and 81 Integrated Science students (Source: College Departmental Students' Statistics Files, 2014). The sample size for the study was 200 students. This sample size was appropriate in ensuring close observation and proper rating of the students (respondents). Proportionate stratified random sampling technique was used

to determine the number of respondents per discipline. The stratification was based on the percentage of stratum (subject) on the population. The percentages were 47.9, 31.1 and 21.0 for Biology, Chemistry and Integrated Science respectively. The values were approximated to 48% for Biology and 31% for Chemistry and 21% for Integrated science. The sample (200) was now composed of 96 Biology, 62 Chemistry and 42 Integrated Science as shown in Table 1 for the population and sample distribution.

Table1: Distribution of population and sample of the study according to subject areas

Subject Area	Number in Population	Percentage	Sample
Biology	185	47.9(48)	96
Chemistry	120	31.1(31)	62
Integrated Science	81	21	42
Total	386	100	200

To select the subjects (respondents) from each stratum (subject area), simple random sampling technique based on balloting with replacement was used.

Two instruments were used for data collection. The first was an activity instrument, Science Process Skills Test (SPST) adapted by the researchers from the Test of Science Process Skills (TOSPS) developed by Oloruntegbe and Omoifo (2008). The instrument was made up of a set of practical instructions to guide the respondents to carry out laboratory activities. It contained 9 sets of instructions in two sections, A and B. Section A was made up of 6 items drawn from chemistry concepts while Section B was made up of 3 items drawn from Biology concepts. In both cases, the concepts were drawn from the Minimum Standard for Colleges of Education, 3rd Edition, 2012 and were within the contents that cut across the disciplines of the respondents. The instrument provided spaces after each step where the respondent was expected to record observations and conclusions.

The second instrument was a rating instrument: Assessment Format for Science Process Skills (AFSPS) also developed by the researcher. The initial draft of the instrument contained 15 items of assessment drawn from the two (2) science process skills being assessed by the researchers. The right column of AFSPS provided for rating scale numbered 1 – 4, corresponding to Very Low (VL), Low (L), High (H) or Very High (VH) level of possession of the skills respectively. Each of the instruments (SPST and AFSPS) made provisions for the teaching subject and sex of the student which enabled the researchers to classify responses on the basis of gender.

The drafts of the instruments were submitted to three experts for face validation. Two of the experts were from science education (biology and chemistry education options) while the other expert was from measurement and evaluation, all of Ebonyi State University, Abakaliki, Nigeria. Their amendments were effected accordingly, which reduced the items in AFSPS from fifteen (15) to twelve (12). The 12-item instrument

was administered on a group of thirty (30) students in the same level in a College of Education in Enugu State (a different State in Nigeria) for field testing to determine the reliability coefficient of the instrument. Data collected from the respondents on the twelve (12) items were used to compute the reliability coefficient of the instrument (AFSPS) using Cronbach Alpha Approach. By this analysis, a reliability co-efficient of 0.75 was obtained which showed that the instrument had high internal consistency and therefore usable.

The respondents worked in a group of five (5) students in a batch, to ensure close observation by the researchers. The researchers administered a copy of Science Process Skills Test (SPST) to each respondent. The samples/specimen and equipment for the activities were supplied by the researchers with the assistance of the laboratory technologists in the College. The practical exercise was carried out in the laboratory. Every member of each group carried out the exercise at the same time. The researchers observed the students while they worked. they used the Assessment Format for Science Process Skills Test (AFSPS) to rate each respondent according to his/her level of performance of the task.

Mean and standard deviation were used to answer research questions while t-test was used to test the hypotheses (HO_1 and HO_2). To answer the research questions the following ranged scale was used (Igwe, 2012).

0.1-1.0	Very Low
1.1-2.0	Low
2.1-3.0	High
3.1-4.0	Very High

In taking decision on the result of the hypothesis, the following were adopted:
Reject result if the calculated t-test value was greater than the critical (table) value
Accept result if the calculated t-test value was less than the critical (table) value.

Results
Research Question 1: What is the level of possession of observation skill by final year NCE students of Biology, Chemistry, and Integrated Science?

Table 2: Mean and Standard Deviation Results based on Possession of observation skill

S/N	Item	VL	L	H	VH	$\bar{X}$	S.D	Int. *
1	Using senses to identify characteristics or properties.	20	80	70	30	2.6	0.86	High
2	Identification of similarities and differences between objects based on features/properties.	21	82	70	27	2.5	0.85	High
3	Identification of qualitative changes in conditions.	27	81	74	18	2.4	0.83	High
4	Use of observable properties to classify objects or parts of organism.	24	72	81	23	2.5	0.85	High
5	Observation and identification of quantitative changes in formation of products.	27	59	95	19	2.5	0.84	High
6	Identification of differences between substances before and after.	31	67	75	27	2.5	0.91	High
	Grand Mean					2.50	0.85	High

Int.* - Interpretation

Based on the results in Table 2, all the items under observation skill had mean values that occurred in the region of high level (2.1 – 3.0). Also the grand mean recorded a value of 2.50 (with standard deviation value of 0.85) which is within the region of high level. Therefore, the students' observation skill was at a high level.

Research Question 2: What is the level of measurement skill possessed by final year NCE students of Biology, Chemistry an Integrated Science?

Table 3: Mean and Standard Deviation results based on Possession of Measurement Skill

S/N	Item	VL	L	H	VH	$\bar{X}$	S.D	Int. *
7	Determination of appropriate values using the average values of measures.	9	50	121	20	2.8	0.68	High
8	Identification of appropriate devices for measuring quantities.	22	42	113	23	2.7	0.81	High
9	Use of measuring instruments correctly.	19	81	88	12	2.5	0.74	High
10	Repeating measurements to obtain more appropriate values.	37	79	75	9	2.3	0.74	High
11	Specifying the units of measurements using the metric system.	32	70	62	36	2.5	0.96	High
12	Estimation of quantities using the spatula.	26	74	87	13	2.4	0.79	High
	Grand Mean					2.53	0.78	High

In Table 3 the mean value for every item under measurement was found to be within the high level (2.1 – 3.0). The grand mean value was 2.53 with the standard deviation 0.78 which fell within the region of high level. Hence, the students showed high level of measurement skill.

Ho_1: There is no significant difference in the mean ratings of final year NCE students of Biology, Chemistry and Integrated science on the levels of possession of observation and measurement skills.

Table 4: t-test Results Based on the Ratings for Observation and Measurement Skills

S/N	Variable	Item	No	$\bar{X}$	S.D	Df	t-cal	t-crit	Decision
1	Observation	1	200	2.54	0.86				
	Measurement	7	200	2.76	0.68	199	3.23	1.96	Reject HO
2	Observation	2	200	2.51	0.85				
	Measurement	8	200	2.68	0.81	199	2.77	1.96	Reject HO
3	Observation	3	200	2.41	0.83				
	Measurement	9	200	2.46	0.74	199	0.75	1.96	Accept HO
4	Observation	4	200	2.51	0.85				
	Measurement	10	200	2.28	0.81	199	3.00	1.96	Reject HO
5	Observation	5	200	2.53	0.84				
	Measurement	11	200	2.51	0.96	199	0.25	1.96	Accept HO
6	Observation	6	200	2.49	0.91				
	Measurement	12	200	2.43	0.79	199	0.68	1.96	Accept HO
	t-test Value						1.78	1.96	Accept HO_2

From Table 4, the t-calculated for pairs of items 1 and 7, 2 and 8 and 4 and 10 were above the t-critical value (1.96). The HO was rejected for each. For pairs 3 and 9, 5 and 11 as well as 6 and 12 t-calculated were less than t-critical (1.96). The HO was accepted for the pairs. The t-test value (1.78) was less than t-critical (1.96), and therefore, HO_2 was accepted. This means that there was no significant difference in the mean ratings of the level of possession of observation and measurement skills by final year NCE students of Biology Chemistry and Integrated Science.

HO_2: There is no significant difference in the mean ratings of male and female students on the level of possession of science process skills by final year NCE students.

Table 5: t-test results on the Possession of the Science Process Skills based on Gender

S/N	Variable	No	$\overline{X}$	S.D	Df	t-cal	t-crit	Decision
1	Male	85	2.58	0.93				
	Female	115	2.5	0.81	198	0.68	1.96	Accept H O
2	Male	85	2.57	0.96				
	Female	115	2.46	0.76	198	0.87	1.96	Accept H O
3	Male	85	2.43	0.98				
	Female	115	2.4	0.71	198	0.30	1.96	Accept H O
4	Male	85	2.45	0.93				
	Female	115	2.55	0.78	198	0.80	1.96	Accept H O
5	Male	85	2.47	0.9				
	Female	115	2.57	0.79	198	0.86	1.96	Accept H O
6	Male	85	2.61	0.94				
	Female	115	2.4	0.88	198	1.63	1.96	Accept H O
7	Male	85	2.17	0.72				
	Female	115	2.76	0.66	198	0.12	1.96	Accept H O
8	Male	85	2.63	0.93				
	Female	115	2.72	0.72	198	0.74	1.96	Accept H O
9	Male	85	2.43	0.79				
	Female	115	2.48	0.71	198	0.48	1.96	Accept H O
10	Male	85	2.22	0.87				
	Female	115	2.32	0.76	198	0.84	1.96	Accept H O
11	Male	85	2.58	1.05				
	Female	115	2.45	0.9	198	0.98	1.96	Accept H O
12	Male	85	2.44	0.79				
	Female	115	2.42	0.8	198	0.18	1.96	Accept H O
		t-test	Value			0.70	1.96	Accept HO_2

From Table 5, t-cal value for each pair was less than the t-critical value. Therefore, HO was accepted for each item. The t-calculated value for the entire items was 0.70, which was less than the t-critical value (1.96). The HO_2 as stated was accepted. Therefore, there was no significant difference in the mean rating of male and female final year NCE Biology, Chemistry and Integrated Science students in the level of possession of science process skills both for each item and for the entire items. There was no significant gender difference in the level of possession of observation and measurement skills of the respondents.

Discussion of Results

The research question 1 sought to determine the level of possession of observation skill by final year NCE students of Biology, chemistry and integrated science of College of Education, Ikwo. The result in Table 1 showed that the students possess this skill to a high level. This result is in line with Omotayo and Yusuf (2002) and Kazeni (2005) who showed that students performed well in observation skill. It is also probable that since the students have early exposition to observation skill, they show high level performance in the skill.

On the test of significance of hypothesis, there was no significant difference in the possession of observation and measurement skills by the students. This result agrees with Omotayo and Yusuf (2002) who found no significant differences in students' acquisition of observational skills among others. This lack of difference may account for this observed overall high performance of students in the skill.

The research question two sought to find out the level of possession of measurement skill by final year NCE science students of College of education, Ikwo, Nigeria. The finding in Table 2 revealed that the students have a high level possession of this skill. This result is contrary to WAEC (2010) which showed that secondary students' poor performances in certain sciences including biology and chemistry may have been due to poor possession of science process skills. The high level of possession of measurement skill in this study is contrary to the regular experience of the researchers with students at this level of education. Experience has shown that students perform poorly in skills relating to measurement and manipulation of the figures. The reason for the high level of performance by the respondents here might be that most of the items used in the collection of data did not involve manipulation of measuring instruments. This is evident from items 15 and 16 which have lower mean values among the items.

On the test of significance, there was no significant difference in the mean responses of male and female students on observation skill. This result is in line with Agomuoh and Nzewi (2003) and Kazeni (2005) who found that there was no significant gender-based difference in students' achievements based on possession of science process skills. Also, Omotayo and Yusuf (2002) also found no significant gender-related difference in students' acquisition of observation skill.

Educational Implications

The findings of the research have the following educational implications:

1. The final year NCE students' levels of possession of observation and measurement skills are high. The students are therefore well equipped to guide their own students to acquire the skills at equally high level. This will lead to greater efficiency in science education delivery at the basic level and subsequently better students' performance in sciences at the senior secondary level of education.
2. The high level of possession of observation and measurement skills implies that there are high potentials in the final year NCE students to practice science. It is therefore likely that these student-teachers have high capability to apply observation and measurement skills in their scientific work anywhere they find themselves.
3. The high level of possession of the skills will create confidence in the teachers. A person will normally enjoy doing those things he/she feels confident in doing well. With these levels of possession of the skills the respondents as teachers in future will put in their best in teaching the skills. That will in turn enhance the students' optimal performance in the skills and the attainment of the objectives of the science education programmes.

4. The non significance cases of the hypotheses imply that both male and female NCE teachers can teach skills equally well. NCE teacher-trainers shall be confident in giving skill-based assignments or projects to both male and female students in the College of Education. This will ensure unbiased skills development which will be transmitted by both genders in their practice as teachers.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. The results showed high level of possession of the skills. Based on the level of the students used and their job expectancy, there is need for greater input in the training of the students to attain very high level of possession of the science process skills studied.
2. Teachers that teach NCE students should emphasize the inculcation of science process skills. This should be done through regular and properly guided laboratory work as well as regular assessment of science process skills.
3. There should be adequate provisions for laboratory equipment and materials in science laboratories in Colleges of Education.
4. There should be regular workshops and retraining programmes for science teacher-trainers geared towards equipping them properly to inculcate high level of possession of various aspects of science process skills.
5. Provosts of Colleges of Education should ensure that well trained science laboratory technologists and technicians are employed to work in science laboratories as a way of ensuring effective training of student-teachers in science process skills.

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