ISSN: 0976-3376

Available Online at http://www.journalajst.com

ASIAN JOURNAL OF
SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 10, Issue, 07, pp.9900-9909, July, 2019

RESEARCH ARTICLE

POSSESSION OF MEASUREMENT AND OBSERVATION PROCESS SKILLS AS DETERMINANTS OF STUDENTS' ACHIEVEMENT IN CHEMISTRY PRACTICALS IN SENIOR SECONDARY SCHOOLS

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ARTICLE INFO

Article History:
Received 19th April, 2019
Received in revised form
14th May, 2019
Accepted 17th June, 2019
Published online 31st July, 2019

Key words:
Process Skill, Measurement Skill, Observation skill, Achievement, Practical Chemistry, Coefficient.

ABSTRACT

This study investigated the possession of science process skills of measurement and observation as determinants of students' achievement in Chemistry practical. The study employed a correlation design. Two research questions and two hypotheses guided the study. Both purposive and random sampling techniques were used to select 10 schools out of 26 schools from and two hundred Senior Secondary two (SSII) Chemistry Students as the sample for the study by balloting with replacement. The students were exposed to a practical exercise (titration) for 60 minutes per group of five students. Two instruments: Assessment Format for Chemistry Students (AFCS) and Chemistry Practical Achievement Test (CPAT) were used to collect data. The Assessment Format for Chemistry Students (AFCS) was used to assess the students on the spot during the practical exercise and a four (4) point rating scale which was trial tested on 6 Chemistry students outside the schools for the main study. Six Chemistry teachers assessed the skills of measurement observation of the six students' simultaneously. Through Inter Rater Reliability based on Kendal's Coefficient of Concordance, a reliability coefficient of 0.86 was obtained indicating that the instrument (AFCS) was reliable. The CPAT has reliability coefficient of 0.88 based on test-re-test using Pearson Product Moment Correlation approach. The Chemistry Practical Achievement Test (CPAT) was used to obtain achievement scores of students on practical exercise which took six months to complete. A lesson plan guided the teaching of the skill to be measured. The values from AFCS and the scores from CPAT were analyzed for Correlation Coefficient using Pearson Product Moment Correlation Statistic for the research questions while step-wise linear regression analysis at 0.05 level of significance was used to test the null hypotheses. The results showed that students' possession of measurement and observation skills determined to a high extent their achievement in Chemistry practical. There was a significant relationships between measurement and observation skills and achievement of students in Chemistry practical. Recommendations included that Chemistry practical be constantly conducted in schools and teachers should adopt guided discovery approach in teaching the theory aspect of chemistry.

***Citation: Dr. Iheanyi O. Igwe (Mstan, Fcon & Fcai) and Dr. Beatrice Arisa Bayim.* 2019.** "Possession of Measurement And Observation Process Skills As Determinants Of Students' Achievement In Chemistry Practicals In Senior Secondary Schools", *Asian Journal of Science and Technology*, 10, (07), 9900-9909.

INTRODUCTION

The word 'education' came from the Latin word "educare" which means to educate, to bring up, and to lead out. Through education an individual can develop his or her fullest potentialities (Ndum and Okey 2012). Education also means the process of helping others to make the society better; socially and economically. The end objective of education therefore is to produce an individual who is honest, respectful, skilled, co-operative and who would conform to the social order". Therefore, education involves the entire process of developing an individual to become an independent and integrated personality. This encompasses training and acquiring special skills, knowledge, attitudes and values that are capable of making the individual responsive in the society.

Thus, development cannot be attained in the society without education, implying that sustainable growth and development in any nation can only be ensured on the bedrock of effective and efficient education system. It is for this reason that the curricula content and intended outcomes of education are geared towards solving national problems. Chemistry as a programme of study in this paper part of Science. Science is regarded as one of the most needed subjects to measure the level of development of a nation. Development and sustenance of scientific base can only be achieved if the citizens are exposed to scientific education. National Policy on Education document (FRN, 2013) stipulated that Science Education will lead to functional and applied research in sciences at all levels of education. Federal Ministry of Science and Technology, FMST in Odo (2012) defined science as an objective

knowledge about nature, properties and behavior of the physical world. In this context, science is all about knowledge of physical world seeking to know what something is, what something is made of and how something behaves and interacts with other things. UNESCO in Kazeni (2005) noted that science as interconnected series of concepts and conceptual schemes develops as a result of experimentation based on observations and measurement. These are key activities in the study of science and necessary components of the teaching and learning; suggesting that science is not only about a body of facts, skills and theories but practically based.
The goals for Science Education in Nigeria according to the FRN (2013: 29) are as follows:

to cultivate inquiring, knowing and rational mind, for the conduct of a good life and democracy; to produce scientists for national development; to service studies in technology and many processes which the scientist engages in". These processes involve activities like scientific method, critical thinking, and reflective thinking (Kazeni in Odo, 2012). However, the Curriculum Project: Science-A - Process–Approach (SAPA) popularized the use of science process skills to replace the above terms (Igwe 2003). For scientists to function properly they must require science process skills. Science process skills are broadly transferable abilities appropriate to science disciplines and reflective of the behaviors of scientists (American Association for Advancement of Science, (AAAS) 1975). They are the desired skills and premises which govern the scientific method. Science process skills are cognitive and psychomotor skills, which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation, and communication (Okoli, 2006). Myer (2006) stated that Science Process Skills are desirable skills scientists use in carrying out activities, implying that in a practical class students need to experiment and with the necessary science process skills. In a practical class, students are taught to find out the truth of ideas, facts or assumptions for ultimate confirmation or rejection. Okoli (2006) stated that the rationale for using practical approach in science teaching lies in the fact that if children are fully involved in activities and challenged to come out with results, they are more likely to learn than if they are simply told or presented with outcome of experiments. The use of practical as a method de-emphasizes rote memorization of scientific concepts and principles while emphasizing knowledge and skill acquisition through "hands-on and minds-on" scientific activities under the guidance of a science teacher (Nwosu and Okeke, 1995 and Okoli, 2006). Nwosu in Igwe (2003) stated that process skills enable the scientists to explore the environment and solve problems, even when the information base changes. Thus, meaningful learning of science must include the acquisition of the science process skills. The American Association for Advancement of Science (AAAS) in 1975 did a pioneer work on identification of activities that constitute science process skills. The activities which are based on operational difficulty and intellectual demands are;

Basic Science Process Skills: observation, measurement, inferencing, classification, prediction and communication; and

Integrated Science Process Skills: formulation of hypothesis, identification of variables operationally, designing, investigations, experimentation, analysis of data, indication of cause and effect relationship and formulation of models. Padilla (1990) and Odo, (2012) recognize these categories for successful conduct of chemistry practical. In this study, measurement and observation are the process skills dealt with.
Measurement skill is chosen for this study because it is the skill that students often use during the conduct of practical in the senior secondary school practical Chemistry activities. Harlen and Finely in Enebechi (2008) showed that the skill of measurement is very fundamental in practical Chemistry. Measurement skill involves the use of standard equipment to arrive at exact value of an object. According to Abboth as cited in Nwokorie (2008), the official definition of 1 litre is the volume of 1 kg of pure water at 4^0c. Whelan and Hodgson (1994) further stated that the aim of any measurement is to find out the true value of a given quantity which all practical work is geared to confirm. Practical Chemistry involves building accuracy and dexterity in order to obtained acceptable results. Measurement is a skill that ensures accuracy, carefulness and dexterity. Without measurement skill, results of an experiment will be inaccurate and faulty. This is why this study sets out to investigate the level at which possession of measurement skill determines achievement of students in Chemistry practical.

Observation is another fundamental science process skill chosen in this study. This is because we observe objects, and events using all our five senses and then we learn about the world around us. The ability to make good observations is essential to the development of the other science process skills. Sciencing actually starts with observation of objects and events. These observations lead to asking of questions. Crucial to the methods of science is the ability to ask the right questions and to make selected observations, relevant to that question. Observation can also be made by recording information using scientific tools and instruments. Observation is influenced by past experiences often involving instruments like (microscopes, telescopes, oscilloscopes, ruler and tape) and require careful recording and description (Igwe and Olayiwola, 1999). For effective observation the following questions must be asked, what, how, when, where and why? A researcher must be sure that the question can be answered with an experiment. Human senses are subject to errors in perception. This is why scientific instruments are developed to improve or magnified human powers of observations like microscopes, cameras, oscilloscopes, radio receivers and so on (Explorable.com 2009).

For accurate result to be obtained in a practical class, accurate observation must be made. Scientists do not conduct experiments without observations. Observation is the most direct way to gain knowledge about something in nature. The ability to observe can be extended by using various tools such as micro scopes, telescope, thermometer, burette and pipette, ruler and so on. Practical classes in chemistry are successful when the outcome of the reaction is properly observed. Hofstien (2004) noted that a very important strategy of communicating science in primary and Secondary School is observation learning strategy. With this skill, the pupils or students use all their senses that is seeing, hearing, smelling, tasting and touching to learn science and to bring about positive achievement in science. That is why the possession of this skill by standard is one of the skills paramount to this research work. The level of attainment of the goals of science process skills can only be determined if learners are properly assessed on the extent of acquisition of the skills. This has drawn the attention of researchers who either carried out assessment of the skills acquired or developed assessment tools that can be use to assessed possession of science process skills (Onwu and Mozube, 1992, Mari in Igwe, 2003, Omotayo and Yusuf, 2002, and Kazeni 2005). Science process skills assessment gives the teacher the opportunity to ascertain the students' level of attainment in skills acquisition. The result of such assessment would provide the teacher with information that would guide his methods and approaches towards improving and sustaining meaningful teaching and learning of science (Odo 2012). Chemistry studies the nature, composition and properties of non-living matter (Igwe, 2017). It is one of the essential science subjects for most of the professional courses offered at the university level. Poor achievement in Chemistry limit students' opportunities to offer professional courses like Human medicine, Veterinary medicine, Pharmacy, Nursing, Agriculture, Biochemistry (Anugwo and Asogwa, 2015). In Nigeria, the trend of academic achievement of chemistry students in the Senior Secondary School Examination (SSCE) has been shown to be very low (Ajagun, 2006). Several research reports (Okoli, 1995, Omotayo and Yusuf 2002, Okoli, 2005, and Nwagbo and Chukelu, 2011) are consistent with the fact that students achieve poorly in secondary school Chemistry as a subject whose major part for assessment is the practical work.

This assertion has been confirmed by the Chief Examiner's report in chemistry (WAEC 2014 and 2015). Njoku (2007) in his findings attributed students' descending differential achievement in Chemistry into three categories of quantitative analysis, qualitative and theory of practical questions to wrong way and manner teachers teach practical chemistry. The WAEC Chief examiners' reports show that the poor performance in chemistry is largely due to poor performance in practical work and lack of knowledge to use the laboratory, non adherence to instructions, poor/wrong inferences, writing of wrong units and omitting of units (WAEC 2015). The attitude of students towards practical work for acquisition of chemistry knowledge seems to determine the extent to which the students are able to develop measurement and observation process skills to enhance their achievement. Linking the possession of these process skills to achievement in practical chemistry is the rational for this study.

Statement of the Problem: The use of chemistry practical stimulates students' understanding of concepts and transforms abstract learning to concrete and meaningful reality. The students who simply memorize and recall facts find it difficult to apply their knowledge to unfamiliar context. The use of practical chemistry helps students to develop science process skills. That is why practical chemistry is compulsory in senior secondary schools and forms 40% of the total scores in chemistry in Secondary Schools Certificate Examination. A pass or failure in Practical Chemistry determines the final grade in Senior Secondary Chemistry Examination. Previous studies and West African Examinations Council (WAEC) Chief Examiner Reports showed that poor performance in Chemistry is largely due to poor performance in practical work, lack of knowledge to use the laboratory, non adherence to instruction, poor/ wrong inferences, writing of wrong units and omission of units. All these activities directly or indirectly are hinged on measurement and observation process skills. Nevertheless, little work was found on possession of measurement and observation skills needed during chemistry practical to enhance achievement. For this reason, it is necessary to investigate whether the measurement and observation skills are determinants of achievement of students in Chemistry practical in Cross River State.

Purpose of the Study: The main purpose of this study was to determine students' possession of measurement and observation skills as determinants of senior secondary school students' achievement in practical chemistry. Specifically the study investigated:

- Possession of measurement skill as a determinant of students' achievement in chemistry practical
- Possession of observation skill as a determinant of students' achievement in chemistry practical

Significance of the Study: The findings of the study were significant to curriculum planners, instructors of Chemistry, science educators, researchers, students and employers of labour. The findings of the study serve as sources of information and guides to Curriculum Planners who will in turn provide relevant curriculum needs and implementation strategies that will inculcate science process skills of measurement and observation to improve students' achievement in Chemistry practical. Findings will help them in strengthening areas of weakness in the curriculum in terms of development of process skills. The findings of the study would assist teachers of chemistry to be aware of the skills, as that which could be used to improve achievement in chemistry practical. The results will reveal the level of measurement and observation process skills possessed by secondary schools chemistry students. The findings of this study will serve as a guide to employers of labour to determine whether the skills would demand emphasis during teachers' training workshop and re-training programmes of chemistry teachers. The ultimate result will be improvement in achievement in chemistry.

Scope of the Study: The study was delimited to the possession of measurement and observation skills as determinants of secondary school students' achievement in practical Chemistry. The study made use of senior secondary two [SS II] Chemistry students in Calabar Education Zone of Cross River State, Nigeria. The choice of SS II students was because this class has effectively been having practical teaching in chemistry in well equipped laboratories and had been exposed to continual WAEC Chemistry practical examinations.

Research Questions

The research question that guided the study was:

- What is the extent to which possession of measurement skill determines students' achievement in Chemistry practical?
- What is the extent to which possession of observation skill determines students' achievement in Chemistry practical?

Hypotheses: The following null hypothesis was tested at 0.05 alpha level.

HO_1: There is no significant relationship between students' possession of measurement skill and achievement scores in Chemistry practical.

HO_1: There is no significant relationship between students' possession of measurement skill and achievement scores in Chemistry practical.

Review of Related Literature

Conceptual Framework

Concept of Measurement Skill: When you need exact information about an observation, you measure. Measurement describes an observation exactly by comparing it to standards. It also includes both a number and a unit. The number of things in a group, the size of an object, the speed of a car, your height and weight the quantity of acid and base are all things you can measure. According to Hubbard (2007), measurement is an estimation of the magnitude of an attribute such as length, weight or volume of an object. Therefore, it usually involves the use of measuring instruments like a ruler, a scale, a burette or a pipette, which are calibrated to compare the attributes of the affected object or some standards definition as a meter, a kilogram, a gram or a cubic centimeter. According to Joshua (2013), most measurements are carried out with instruments used by the tailor, carpenters, builders, surveyor, agriculturists, medicals practitioners, scientists, laboratory technicians and other practitioners for their own forms of measurement. He emphasized that in the classroom, and in the entire school system, measurement of a special type referred to psychological measurement constantly taking place in the classroom through the use of test instruments. Generally this nature of measurement requires a systematic process of assigning numerical value to traits. Finding the extent to which any trait is present in an object or individual in quantitative method and assignment of numerical values in an orderly manner following a set of rules or guidelines is measurement. Nwokorie (2008) observed that such measurement is very important in the understanding of science laboratory practical. In all research work, measurement is a process by which numbers rather than descriptive phrases are assigned to objects and individuals' attributes.

According to Whelan and Hudson (2014), to measure a particular physical quantity one looks for some physical phenomenon that depends on the quantity. In measuring any physical quantity, one may choose an instrument whose design is based on convenient phenomena. Such phenomena need to be applicable to a chosen range and required sensitivity. In secondary schools the main practical classes in chemistry involves the use of measuring volumes of acids and bases in volumetric analysis. A Volume of liquid per cubic centimeters (cm^3), it is believed to be the mass of 1 liter of pure water at the temperature of its maximum density (4^0c)

Concept of Observation Skill: Observing is a fundamental science process skill. We observe objects, and events using all our five senses, and this is how we learn about the world around us. The ability to make good observations is also essential to the development of the other science process skills. Science starts with observation of objects and events. These observations lead to asking of questions. Crucial to the methods of science is the ability to ask the right questions and to make selected observations, relevant to that question. Observation can also be made by recording information using scientific tools and instruments. Observation is influenced by past experiences often involving instruments like (microscopes, telescopes, oscilloscopes, ruler, tape and so on) and require careful recording and description. Surprising or unexpected observation occasionally contribute to new and important knowledge (Ostlund 1998). A scientific process or scientific method requires observation, formulation and testing of hypotheses. It consists of the following steps;

- "Observing something and ask questions about a natural phenomenon (scientific observation).
- Make your hypothesis.
- Make prediction about logical consequences of the hypothesis.
- Test your predictions by controlled experiment, a natural experiment, an observation study or a field experiment.
- Create your conclusion on the basis of data or information gathered in your experiment" (Explorable.com 2009).

For effective observation the following questions must be asked, what, how, when, where and why? A researcher must be sure that the question can be answered with an experiment. Human senses are subject to errors in perception example, optical visions which can results in erroneous scientific observation. This is why scientific instruments were developed to improve on magnified human powers of observations like microscopes, cameras, oscilloscopes, radio receivers and so on (Explorable.com 2009). For accurate result to be obtained in a practical class, accurate observation must be made. Scientists do not conduct experiments without observations. Observation is the most direct way to gain knowledge about something in nature. The ability to observe can be extended by using various tools such as micro scopes, telescope, thermometer, burette and pipette, ruler and so on. Practical classes in chemistry are successful when the outcome of the reaction is properly observed.

Chemistry Practical in the Secondary School Curriculum: For Chemistry practical to be successful, it must involve process skills. Chemistry practical is teaching Chemistry in an inquiry manner in the laboratory which is described by Mari in Igwe (2003) as faculty for learning what science is and how scientists work. Practical work is an important aspect of Chemistry teaching in the school curriculum. It forms 40% of the total score in the WAEC result. Practical class in Chemistry can be successful when students acquire process skills especially measurement. Volumetric analysis (titration) is one aspect of practical chemistry using quantitative technique of measurement. For example, the molarity of an acid can be made known by standardizing it with a known molarity of a base (Igwe & Olayiwola, 1999). Chemistry laboratory work emphasizes among others the preparation of solutions. Hussain (1998) emphasized that laboratory activities are meant to teach basic skills like the use of thermometer, measuring some quantity of liquid and observing colour changes. Without laboratory practical, work would be impossible and science process skills cannot be acquired for improve performance in chemistry. In Cross River State, Chemistry teaching in Secondary schools has constantly witnessed students' continuous poor performance. It could be that teachers cannot organize and conduct practical classes. It could also be that laboratories are not well equipped. It could also be that students' volumetric analysis titre values and that of the teacher are at variance and in most cases the supervisor's titres were very outrageously different from those of the students so that they could not be taken as correct but discarded (Ikeobi, 1996). It could also be that students could not observe appropriately the changes that went on during titration or they could not measure the volume of base and acid during titration.

Theoretical Framework: This research was based on the theory of constructivism. Constructivism is a theory of learning which Brooks and Brook (1999) viewed as one that best describes the learner's mental knowledge as actively involved in the learning process. According to Fosnot (1996) constructivism is the concept that learners actively construct their own knowledge and meaning from their experiences. Knowledge is deemed fluid and in a constant state of change. Therefore, students' ability to construct viable knowledge to adapt and be flexible is highly paramount. The main activity in a constructivist classroom is ability to solve problems. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. Constructivist teaching takes into account students' current conceptions and builds from there. Inquiry is a key part of constructivist learning (Ed online n.d). Vygotsky (1978) introduced socialization into constructivism. He defined the "zone of proximal learning" to mean students' ability to solve problems beyond their development level under the guidance of an adult or within their peer group.

Review of Empirical Studies: Some empirical studies that relate to the research were reviewed. Achimugu (1997 & 2012) also carried out a study on "strategies for effective conduct of practical chemistry in senior secondary schools in Nigeria. In this study common measurement errors in practical chemistry were outlined to include: giving of wrong or no unit of a substance, wrong titres or outrageous different titre from that of the teacher, inaccurate burette reading, volume of pipette not stated by students and so on. Other common errors include; spelling errors/poor communication skills, wrong charges on works, variability to observe correctly changes such as particles solubility, inability to observe colour change, precipitates, odour and inference not agreeing with the observation or entirely wrong inference. Other problems that may be observed are; inability to separate observation from inference arising from addition of reagent in drops and then in excess, inability to separate the observations and inference arising from precipitating agent during confirmatory test of anions among others. The review was relevant to the present study because it outlined the proceedings and precautions involved in measurement during chemistry practical in order to develop scientific skills appropriate for academic achievement in chemistry practical. But this study deals with possession of the process skills as determinants of achievement in Chemistry practical.

Summary of Review of Related Literature: Chemistry through hands-on and minds-on process which is activities based that involve the acquisition of process skills. Literature did not reveal adequate use of practical exercises in teaching Chemistry. The review showed that they are 15 process skills categorized into basic and integrated skills base on intellectual difficulties with integrated skills being more difficult. Review also revealed that Chemistry is practically oriented subject and that possession of science process skills lead to effective conduct of practical Chemistry. The constructivism theory formed the theoretical framework. The theory of constructivism is founded on the premise that learners actively construct their knowledge and meaning from experiences which could be gathered from the practical class. This theory is relevant to this study since it hitches on the fact that learning can be structured based on the learners' experiences which can be obtained from interaction with the environment. The literature reviewed did not show any specific work on possession of measurement and observation process skills on students' achievement in Chemistry practical in secondary school students particularly in Cross River State. This was the gap this study eventually filled.

Research Method: The study employed a correlation research design. A correlation study is aimed at estimating the degree of relationship between the variables under review and not necessarily to determine a cause – effect relationship. The purpose of correlation research is to determine to what extent there exists a relationship between two or more variables (Ofo, 2001). This design is relevant to this study because the study sets out to establish whether there is relationship between the possession of measurement and observation skills and achievement in chemistry practical. The area of study was Calabar Education Zone of Cross River State. The Education Zone is made up of eighty (80) Public Secondary Schools spread across seven (7) local government areas of Cross River State of Biase, Akamkpa, Odukpani, Calabar Municipality, Calabar South, Akpabuyo and Bakassi Local Government Areas. The schools in the area are located in both urban and rural areas. Out of seven (7) Local Government Areas in the zone only two (2) are in the urban areas, Calabar Municipality and Calabar South local government areas. Out of the eighty (80) schools located in the area, only twenty six (26) schools have well-equipped laboratories suitable for chemistry practical and were thus used. The people in the rural area of the zone are majorly peasant farmers and small scale businessmen, while the people in the urban area of the zone are mainly civil servants, few private practitioners and businessmen. The schools are mostly day-schools and students walk to school on foot or use other means of transportation.

The population of the study comprised all SS II chemistry students from 80 schools in Calabar Education Zone, totaling 2051 students (Planning Research and Statistics office Calabar, 2017). SS II students were used because it is in this class that students select subjects to register for Senior Secondary School Certificate Examination (SSCE). It is also in this class that intensive practical classes are carried out and volumetric analysis taught. It is expected that it is in this class that possess measurement and observation skills. The sample size was two hundred (200) SS II chemistry students drawn from ten (10) Secondary schools out of twenty six that were well equipped in the zone. Selection was by purposive sampling technique. Twenty (20) students were randomly selected by simple random sampling technique through balloting with replacement from each of the school. The instruments for data collection were a Chemistry Practical Achievement Test (CPAT) and Assessment Format for Chemistry Students (AFCS). CPAT had questions that were adapted from Senior Secondary II Chemistry Curriculum. The instrument consisted of a set of practical instructions to guide the students on how to carry out volumetric analysis in chemistry laboratory. The instrument was divided into two sections. Section A provided the personal data of the students, while section B is the achievement test questions. CPAT was scored over 100%. Assessment Format for Chemistry Students (AFCS) developed by the researchers used was a four-point rating instrument from 1-4 corresponding to Extremely Low [EL], Low [L], High [H] and Extremely High (EH) possession of science process skills respectively.

A lesson note was used to spell out specific skills that the students were expected to acquire during and at the end of the practical exercise. The drafts of the instruments, AFCS and CPAT were submitted to three experts for face validation. Two of the experts came from Science Education (Chemistry Education option) from the Department of Science Education Ebonyi State University Abakaliki while the other expert came from measurement and evaluation option of Cross River University of Technology, Calabar. The experts made amendments in terms of adequacy, clarity of language and choice of terminology. The items that did not show adequate assessment of the relevant skill were dropped, or reframed. Some items were added to make 26 items.

Inter Rater Reliability based on Kendal's Coefficient of Concordant in which 6 Chemistry teachers were used to assess measurement and observation skills of 6 students in a practical class. The 6 Chemistry teachers were trained on how to assess the skills of each student on the spot using AFCS. Their ratings were used to compute the reliability coefficient which yielded a value of 0.86. Based on this value the instrument, AFCS was judged to be suitable for the study. Copies of the instrument, Chemistry Practical Achievement Test (CPAT) were distributed to all respondents. The samples and equipment/materials for the practical activities were provided by the researchers with the help of two research assistants drawn from each sampled school for the students. The practical exercise was carried out in the chemistry laboratory for one hour (1hour) per group. The students were grouped into 5 per group and each student worked as an independent candidate to ensure close and appropriate monitoring by the researchers. Every member of the group carried out the practical at the same time. The researchers with the help of the two research assistants assessed and rated the skill of measurement and observation exhibited by the testee while he/she worked. The raters used the Assessment Format for Chemistry Students (AFCS) to rate each student according to his/her level of performance and possession of measurement and observation skills. The research questions were answered using coefficient of correlation method based on Pearson Product Moment Correlation Statistic. The research questions were interpreted using the following format.

The null hypothesis was analyzed using linear regression statistic at 0.05 level of significance to test the significance of the value of't' for the hypothesis. Result of the hypothesis was interpreted, thus:

- Reject Ho if the significance of " t" is less or equal to 0.05 alpha level
- Accept Ho if significance of " t" is greater than 0.05 alpha level.

RESULTS

Research Question 1: To what extent does possession of measurement skill determine students' achievement in chemistry practical?. Table 2 above shows a correlation coefficient between possession of measurement skill and achievement of students in Chemistry practical of 0.71 which indicates a high relationship according to Nwana (2008). This implies that possession of measurement skill highly determines achievement in Chemistry practical. The coefficient of determination is 0.504 which is 50.4%. This figure shows students' contribution to the achievement in practical Chemistry.

Research Question 2: To what extent does possession of observation skill determine students' achievement in Chemistry practical?. The results Table 3 show a correlation coefficient (r) of 0.67 which is within the region of high correlation. This implies that possession of observation skill highly determines achievement of students in chemistry practical. However, the coefficient of determination (r^2) is 0.45 which when converted to percentage gave of 45%. This value explains the variation in practical Chemistry achievement as explained by the students.

Hypothesis 1 (Ho_1)

(HO_1): There is no significant relationship between possession of measurement skill and students' achievement scores in chemistry practical. From Table 4, computed ' r' gave a value of 0.705. The coefficient of determination (r^2) is 0.5041 which is 50.41%. This value indicates the variation in practical Chemistry achievement as explained by the students. On the test of significance of the hypothesis 1, as indicated in Table 4, the significance of 't' is 0.0000, which is below 0.05 alpha level. From the two values, the null hypothesis (HO_1) which states that there is no significant relationship between measurement skill and students' achievement scores in Chemistry practical is rejected. The researchers therefore conclude that the relationship between measurement skill and students' achievement scores is significant.

Hypothesis 2 (Ho_2): The relationship between possession of observation skill and students' achievement scores in chemistry practical is not significant. From Table 5, r represents the coefficient of correlation which establishes only relationships between the two variables. The coefficient of determination (r^2) for computed r value is 0.4458 which is 44.58%. This value explains students' opinion on how observation skill determines achievement scores in Chemistry practical. On the test of significance of the hypothesis 2, as indicated in Table 5, the significance of 't' is 0.0000, which is less than 0.05 alpha level of testing. From the two values, the null hypothesis (HO_2) which states that, the relationship between observation skill and students' achievement scores in chemistry practical is not significant is rejected. The researchers therefore conclude that the relationship between observation skill and students' achievement scores is significant.

DISCUSSION

Results from items of AFCS instrument on possession of measurement and observation skills and CPAT instrument for achievement were obtained after analysis and used for discussion.

Possession of Measurement Skill as Determinant of Students' Achievement: The items 1-10 were geared towards testing for the possession of measurement skill by students and their achievement in Chemistry practical from CPAT. The result as found on Table 2 shows that possession of measurement skill determines to a high extent the achievement of students in Chemistry practical with a correlation coefficient (r) of 0.71. This result confirms the findings of Whelan and Hodgson (1994) and Nwokorie (2008) who in

Table 1. Interpretation of Correlation Coefficient

Correlation coefficient	Interpretation coefficient
0.80- 1.00	Very high, near perfect relationship
0.60-0.80	High relationship
0.40-0.60	Medium relationship
0.20-0.40	Low, definite positive relationship
0.00-0.20	Very low, virtually no relationship

Source: (Nwana, 2008:311)

Table 2. Correlation Coefficient of Measurement skill with Achievement of Students in Chemistry Practical

	Achievement	Measurement
Achievement	1.000	.705
N	(200)	(200)
	P = .000	P = .000
Measurement	.705	1.000
N	(200)	(200)
	P = .000	P = .000

$r = 0.71$ $r^2=0.504$

Table 3. Correlation coefficient of observation skill with achievement of students in Chemistry practical

	Achievement	Observation
Achievement	1.000	.668
N	(200)	(200)
	P =	P = .000
Observation	.668	1.000
N	200	(200)
	P = .000	P =

$r = 0.67$ $r^2= 0.45$

Table 4. Significance of Relationship between Measurement Skill and Achievement scores in Chemistry Practical

Variable skill	Computed R	R – square	Adjusted R-square	Standard error	Beta	t- cal	Sig. t
Measurement	0.7052	0.50412	0.4815	7.2639	0.5052	8.340	0.0000
Constant					15.484		0.0000

Significant at $p < 0.05$ Degree of freedom (df) = 198

Table 5. Significance of Relationship Between Observation Skill and Students' Achievement in Practical Chemistry

Variable Skill	Computed R	R-Square	Adjusted R-Square	Standard Error	Beta	t.cal	Sig. of "t"
Observation	0.6677	0.4458	0.4431	6.2660	0.6677	12.778	0.0000
Constant					7.500		0.0000

Significant at $p < 0.05$ Df = 198

their separate studies found that measurement skill has the richness to help students to arrive at exact amount or quantity of base and acid required for titration in a practical class. This helped the students to achieve positive results in practical Chemistry in this study also. This finding contradicts WAEC (2014; 2015) Chief examiner reports which noted that students were weak in measurement related skills like averaging non-concordance titres values, omission/wrong use of units, failure to express numerical answers to three significant figures, alteration of titres values to agree with those of the teachers. The students by this result demonstrated that they have overcome the pitfalls of wrong measurement through the acquisition of measurement skill to perform better in the Chemistry practical. This will also help them to perform excellently in subsequent examinations. This could be the reason for the high possession of measurement skill by the students in this study. The result of HO_1 in Table 4 showed that the significance of 't' is 0.0000, which is below the significance level of 0.05 used for the testing. Therefore, there is a significant relationship between measurement skill and students' achievement in Chemistry practical. This finding agrees with the findings of Nwosu and Okeke (1990) and Okoli (1995) who in their separate studies observed that when a person becomes specially equipped with the tools required for scientific inquiry or problem solving as well as an ability to use these skills in the laboratory for a variety of investigation, he/she will record positive achievement. The finding also supports Nwosu in Igwe (2003) that process skills have qualities that are enduring and can contribute to the ability of students' to answer questions and solve problems. Affirming this Myer (2006) stated that science process skills which include observation, measurement and others build deductive skills that aid in building for higher achievement and problem solving in science. The findings of this study also agree with the findings of Odo (2012) who observed measurement skill as one of the skills that relates with achievement of students in Chemistry practical as well as looked at the actual conduct of practical work in the laboratory, should students imbibe it in their studies. This is true because if students did not give or make accurate measurement, their inferences as well as interpretation will be faulty.

Possession of Observation Process Skill as Determinant of Students' Achievement: Items 11 –17 in AFCS were used to assess the skill of observation as exhibited by the students in chemistry practical.

When this was correlated with students' achievement, it gave a correlation coefficient (r) of 0.67 which shows a high relationship. This study agrees with Okoli (2006) who found that the level of scientific literacy has effect on the level of acquisition of science process skills such as observation; thus, agreeing that the possession of process skill of observation determines achievement in science. This findings support that of Feyzioghu (2009) that there is a positive significance between efficient use of laboratory and students' achievement in Chemistry Education. The finding here also supports that of Ogunleye and Babajide (2011) who indicated that students' level of commitment in science significantly affects their practical skills in the subject and this commitment demands a thorough observation. On the test of significance of the hypothesis 2, as shown in Table 5, the significance of 't' is 0.0000, which is less than 0.05 alpha level of testing. Hence, there is a relationship between observation skill and students' achievement scores in chemistry practical. This result is in line with Odo (2012) who noted that a high possession of observation skill by Chemistry students brings about a positive influenced in their performance. This finding could be based on the discovery theory of Bruner and Piaget development theory that the development of observation skill starts from cradle. This assertion accounts for the high correlation coefficient between observation skill and achievement scores in Chemistry practical.

Recommendation

The recommendations made for the results of this study are:

- Chemistry teachers should use guided discovery method of teaching in chemistry practical classes in order to build science process skills in students.
- Chemistry practical should be conducted frequently in the laboratory.
- Students should be taught the skill of measurement necessary in the laboratory activity
- Students should be taught the skill of observation as necessary skill in laboratory activity.

Limitations

The study had the following limitations

- The study covered only two science process skills. There are other skills that affect students during volumetric analysis that were not discussed. Therefore, individual rather than generalized effect applies here.
- Personal perception of the assessors could have played a role in not getting absolute result
- There was inter-twine situation for the on the spot assessment in that as one was observing one skill, another skill quickly displayed. This may have affected result

Conclusion

The purpose of this research was to determine whether possession of measurement and observation skills was determinants of students' achievement in chemistry practical. It was revealed that possession of measurement and observation skills highly determined the students' achievement in Chemistry practical. The study also found significant relationship between measurement and observation skills and students' achievement scores in Chemistry practical. Based on the findings and their educational implications, the researchers made recommendations which they believed that when implemented will help students to possess both measurement and observation skills to a very high extent for maximum achievement in practical chemistry in senior secondary schools in Cross River State.

REFERENCES

Achimugu, L. 1997. Organizing and conducting Senior Secondary Certificate Examination (SSCE) Chemistry practical; *Proceedings of Kogi State Third Annual STAN Workshop*, held at FCE Okene in October, 13-16

Achimugu, L. 2012. Strategies for effective conduct of practical Chemistry works in Senior Secondary Schools in Nigeria. *Journal of Science Teachers Association of Nigeria (JSTAN)* 47(1) 125 – 135.

Ajagun, G.A. 2006. Towards good performance in science education. *Nigeria Journal of Teacher Education and Teaching.* 2(1) , 117-125.

American Association for Advancement of Science 1975. Context for the learning of science process skills. Retrived from (www.springerlink.com/ index/ RS7GSGVK) on 28th February, 2014.

Anugwo, M and Asogwa, S. 2015. Assessment of the extent of utilization of basic and integrated press skills in the teaching of Chemistry in senor secondary in Ebonyi State. *JSTAN* 50, 1, 97-106

Bayim, B. A. 2016. Possession of Observation, measurement and interpretation process skills as determinants of students' achievement in Chemistry practicals in senior secondary schools in Calabar Education Zone of Cross River State. *Unpublished PhD thesis of the Department of Science Education,* Ebonyi State University, Abakaliki.

Chemistry (Meriam) 2014. Webstes Medical Dictionary. *Retrieved August 1st, 2014.*

Ed-online (n.d) Concept to Classroom. Retrieved from (http://www.thirteen.org/ edonline/concept2class /const ructivism/ index.htm/) on 12th August 2014.

Enebechi, R.I. 2008. Senior secondary students mastering Biology contents and Possession of relate science process skill: A correlational study. Unpublished M.Ed Thesis, University of Nsukka (UNN). Nigeria Nsukka

Explorable.com 2009. Scientific observation. Retrieved Feb. 12, 2014 from (Explorable.com http://explorable.com /scientific-observation)

Feyzioglu, B. 2009. An Investigation of the Relationship between Science Process Skills with efficient Laboratory use and Science Achievement in Chemistry Education. *Journal of Turkish Science Education,* 6(3), 114-132.

FRN 2013. *National policy on education* (4th ed). Lagos: NERDC Press.

Hofstein, A. 2004. The Laboratory in Chemistry Education: Thirty years of experience with developments, implementation and research: Chemistry Education; Research and practice, 5(3), 263. *Retrieved from* *(http://www.uoi.gr/cerp/2004_october /pdf/06hofsteininvited.pdf).*

Hubbard, G. 2007. *How to measure anything: Finding the volume of intangibles*. New York: John Willey and Sons.

Hussain, I. 1998 Activities based low cost materials (equipment glassware, chemicals) in teaching chemistry at Secondary School level in Patkistan (Doctoral) University of Peshawar, NWFP, Pakistan. Retrieved from (http://eprints.lec.gov.pk/5571).

Igwe, I.O. 2003. *Principles of science and science teaching in Nigeria (Introduction).* Enugu-Nigeria: Jones communication publishers.

Igwe, I.O. and Olayiwola, M.A. 1999. *Concise practical Chemistry textbook.* Ado-Ekiti: Adedayo. Printing Nig. Ltd.

Ikeobi, O. I. 1996. "Talkback" *STAN Bulletin* 3, (1) 6-7.

Joshua, M.T. 2013. *Foundation of test and measurement in education* .Calabar: University of Calabar Publishers.

Kazeni, M.M. 2005. Development and validation of a test of Integrated Science process skills for the further Education and training learners. *Unpublished M.Sc Ed Dissertation.* Faculty of Natural and Agricultural Science, University of Pretoria, South Africa.

Myers, E. 2006. Personal Study of Science Process Skills in a General Physics Classroom. *A Master of Arts an Education and Natural sciences (unpublished).* Environmental Education. Cape Stone.

Ndum, V.E. and Okey, S. 2012. Nigerian educational standard and the state of education in Nigeria education (ed) by O. Ibenene, O. N. Alumide and H. Usoro. Onitsha West and Solomon Publishing Company Ltd.

Njoku, Z. C. 2007. Comparison of students Achievement in the three categories of questions in SSCE practical Chemistry examination, *JSTAN* 42 (1x2).

Nwagbo, C. and Chukelu, U.C. 2011. Effects of Biology practical activities on students process skill acquisition. *JSTAN* 46 (1) 58-70

Nwana, O. C. 2008. *Introduction to Educational Research.* Ibadan: HEBN Publisher PLC.

Nwokorie, J.E. 2008. Senior secondary school students' understanding of measurement in Chemistry laboratory practical in Calabar Educational Zone of CRS Nigeria. *Unpublished M.Ed Thesis.* University of Calabar.

Nwosu, A.A. 1990. The Effects of Teachers Sensitization on Secondary School students' level of acquisition of Science Process skills. *An Unpublished Ph.D Dissertation* Department of Education UNN.

Nwosu, A.A. and Okeke, E.A. 1995. The effect of teacher's sensitization on the acquisition of science skills. *JSTAN* 3(1&2) 39 – 45.

Odo, E.E. 2012. Levels of possession of science process skills by final year Nigerian Certificate in Education Students of Selected science subjects in Ebonyi State College of Education, Ikwo. *Unpublished M.Sc (Ed) Dissertation.Ebonyi State University A*bakaliki.

Ofo J. E. 2001. *Research methods and statistics in education and social sciences.* Lagos: Joja Educational Research and Publishers Ltd.

Ogunleye, B.O. and Babajide, V.F.T. 2011. Commitment to science and gender as determinants of students' achievement and practical skills in Physics *JSTAN* 46(1) 125 – 135.

Okoli, J.N. 2005. Effects of investigative laboratory approach and expository methods on acquisition of science process skills by Biology students of different levels of Scientific literacy. *JSTAN* 41(1&2) 79 – 8 .

Okoli, J.N. 2006. Effect of cooperative and competitive science laboratory interaction pattern on students' achievement and acquisition of science practical skills in integrated science. *Journal of Pure and Applied Science* 2(1) 8 – 21.

Omotayo, K. A. and Yusuf, M.A. 2002. The acquisition of qualitative skill among girls at the junior Secondary school level. *Teacher Education Today* 2(1&2), 49 – 55.

Onwu, G O. M. and Mozube, B. O 1992. Development and validation of a Test of science process skills. *JSTAN* 27(22) 37-43

Ostlund, K 1998. What research says about science process skills. *Electronic Journal of Science Education 2(4)* Retrieved from (http:// wo//feverbunr.edu.home. page/jcannon/ejse/ostlund.htm/) on 15th March 2014.

Padilla, M.J. 1990. The Science Process Skills. *Beyond the Steretype to new trajectories in science teaching STAN.* Abuja: Cultural complex 42 – 44.

Vygotsky, L. 1978. *Interaction Between Learning and Development: In mind in Society (Trans.M. Cole) Cambridge MA*: Harvard University Press.

WAEC 2014 & 2015. *Chief examiners' reports. Lagos*: WAEC.

Whelam, P. and Hodgson, M.J. 1994. *Essential pre-University Physics*. Lebanon: John Murray publishers.

Appendix 1. Chemistry Practical Achievement Test (CPAT)

Section A: Personal Data

Gender: ____

Name of school: ______________________________________

Section B:

Instructions

a. Attempt all questions
b. Read the instructions carefully and carry out the activities. You may repeat any of the steps to confirm your observations.
c. Record your observations and answer the questions that follows

Time allowed is 1hour

A is a solution of H_2SO_4containing 4.9 gdm^{-3}

B is a solution containing x gdm^{-3} Na_2CO_3

(a) Put A into the burette and titrate it against 20.0 cm^3or 25.0 cm^3portions of B using methyl orange as indicator. Record the volume of your pipette, tabulate your burette readings and calculate the average volume of A used.

The equation for the reaction involved in the titration is:

$$H_2SO_{4\,(aq)} + Na_2CO_3 \longrightarrow Na_2SO_{4\,(aq)} + H_2O + CO_{2\,(g)}$$

(b) From your results and information provided above, calculate the:

i. Concentration of A in $moldm^{-3}$;

ii. Concentration of B in $moldm^{-3}$

Appendix 2. Assessment Format for Chemistry students (AFCS)

Process Skills	Item Numbers	Skills to be observed	Rating			
			1	2	3	4
MEASUREMENT	1	Ability to measure accurately the volume of acid using burette				
	2	Ability to measure accurately the volume of base using pipette				
	3	Ability to add the required drops of methyl orange (indicator)				
	4	Ability to avoid spillage of acid during measurement/titration				
	5	Ability to ensure gentle shaking of the conical flask to give a homogenous mixture				
	6	Ability to remove the funnel after pouring acid in the burrete				
	7	Ability to place the finger appropriately on the pipette during measurement of base.				
	8	Ability to handle the pipette in a proper way during measurement				
	9	Ability to clamp the burette firmly at each titration				
	10	Ability to handle the burette appropriately in order to take the lower meniscus.				
OBSERVATION	11	Ability to observe accurate level of the lower meniscus of acid in the burette				
	12	Ability to observe the level of base in the pipette before transferring it to beaker/conical flask				
	13	Ability to observe colour change when an indicator is added to the base				
	14	Ability to observe colour change when acid is added to the base				
	15	Ability to observe the colour change when the titration is going on				
	16	Ability to observe the progress of colour changes during titration				
	17	Ability to make better observation of meniscus with the help of filter paper				

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