Journal of Education and Practice www.iiste.org
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.14, No.23, 2023

Assessment of Correspondence of Standard Measures of Facilities and Equipment in Chemistry Laboratories in Secondary Schools in Anambra State, Nigeria

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Abstract
This study assessed Standard Measures of facilities and equipment in Secondary Schools that have Chemistry laboratories in Anambra State. The study was prompted by poor achievement of students in Chemistry in external examinations in Anambra State which was attributed to the non-correspondence of secondary schools' Chemistry laboratory facilities and equipment to WAEC standard measures. The study adopted a descriptive design. Two research questions guided the study and two hypotheses were tested at 0.05 level of significance. The study used checklist instrument from West African Examinations Council (WAEC) to collect data on the level of correspondence of available Chemistry laboratory facilities and equipment to the standard specified by WAEC. The dependence of location to the level of correspondence to WAEC standard was also investigated. The instrument was not face validated because it is standardized being WAEC document. The reliability of the instrument was determined using Kendall Coefficient of Concordance (W) which gave reliability coefficients of 0.82 and 0.78 respectively for items in the two clusters (1 and 2) of the instrument. The population of the study comprised two hundred and eleven (211) public secondary schools that have Chemistry laboratories in Anambra State. The sample for the study was forty eight public secondary schools that have Chemistry laboratories which were selected by stratified random sampling. Observed and expected frequencies and ratios were used to answer the two research questions while the two hypotheses were tested using Chi-square (X^2) at 0.05 alpha level. The results revealed that (1). For Chemistry laboratory facilities: (i) laboratory room, storage room, laboratory tables and laboratory chairs corresponded to the standard stipulated by WAEC (ii) Chemistry laboratory equipment, running water, adequate electricity, storage room for chemicals, preparatory room and fume cupboard did not correspond to the standard stipulated by WAEC, and (iii) dark room was unavailable in all the schools. (2) Out of 79 equipment available in schools, 38 items corresponded to the standard stipulated by WAEC while 41 items did not correspond to the standard stipulated by WAEC. **HO_1 and HO_2** had significant dependence of school location on the correspondence of Chemistry facilities and Chemistry laboratory equipment in the Chemistry laboratories to the standard specified by WAEC. Based on the findings of the study, the researchers recommended that Chemistry teachers should maintain a proper stock/inventory of Chemistry laboratory facilities and laboratory equipment in order to provide periodic reports to schools' management for guidance and budgeting of schools' requests on chemistry; laboratory facilities and equipment. The State Ministry of Education should conduct periodic monitoring of Chemistry laboratories in secondary schools to ensure that schools' Chemistry laboratories are adequately equipped in Chemistry facilities and equipment to correspond to standard measures specified by WAEC.
Keywords: Chemistry, Laboratory, Facilities, Equipment, Standard, Correspondence.
DOI: 10.7176/JEP/14-23-04
Publication date: August 31st 2023

Background to the Study

Chemistry is a field of study that studies the nature and behavior of matter which describes anything that is physically real and occupies space especially non-living matter (Igwe, 2015). According to Brown (2018), Chemistry provides an explanation of the physical and chemical properties of atoms and molecules as well as practical methods for creating new molecular structures and materials that have useful applications. In-fact, Chemistry as a natural science covers elements that make up matter, to compounds composed of atoms, molecules and ions; their compositions, structures, properties, and the changes they undergo during reactions with other substances.

In the world today, Chemistry, its product and applications have become formidable tools in the field of science for rapid industrialization, development and advancement of nations (Okeke, 2014). The subject plays key roles in industrial sector making enormous contributions to the overall progress and advancement of nations. Indeed, Chemistry has become a driving force to many sectors of the economy in Nigeria as a nation and other nations of the world.

The study of Chemistry is essential in meeting the basic needs of man such as food, clothing, shelter, health, energy, clean air, water and soil. Helmenstine (2020) stated that Chemistry explains how food changes from raw, cooked, rots to other products as well as the actions of cleaning agents, vitamins, supplements and drugs. This implies that Chemistry meets the needs of man through its relevance, functionality, content, application (Kay, 2015). It is then possible that the self-reliance of a country largely depends on the extent to which the understanding of Chemistry has permeated the day-to-day economic and military activities of that nation. Nigeria as an example relies greatly on crude oil as a major source of export and foreign trade, meaning that the whole oil industry stands on the pillar of Chemistry.

In the senior secondary schools in Nigeria, Chemistry is a popular science subject among the students due to the subject's relevance in the pursuit of further studies in the sciences such as medicine and surgery, engineering, nursing, pharmacy, nutrition, geology, Chemistry, physics. This implies that Chemistry is a prerequisite for admission into Nigerian Universities for the study of science and science related courses. In Nigeria, the objectives of Chemistry education as contained in the secondary schools curriculum (Federal Ministry of Education in Igwe, 2015:3) include:

a. To facilitate transition in the use of scientific concepts and techniques acquired in basic science with Chemistry.
b. To provide basic theoretical and practical knowledge in Chemistry concepts and principles through contents and sequencing.
c. To show inter-relationships between Chemistry and other science subjects.
d. To show Chemistry and its link with the industry, everyday life, hazards and benefits
e. To provide students not proceeding for higher education with adequate foundation for other future careers.

In order to achieve the asserted objectives involves engaging in laboratory practical activities and conducting investigations through experiments. Sequel to this, the Federal Ministry of Education (2013) made provisions for essential educational services in schools which included the provision of Chemistry laboratories. The laboratory in general and according to Igwe and Olayiwola (2015), is an instructional facility for learning what science is and how scientists work. Morris (2015) stated that the school laboratory is a room or building equipped with facilities and scientific equipment/materials and set aside for scientific inquiry, discovery and motivation of achievement in learning. Okeke (2014) asserted that the laboratory is used by the teacher to help students to learn about science and how the scientists investigate the world around them for mastery of learning contents, cultivation of scientific cultures and high performances in science. Isozaki (2017) opined that laboratory activities avail students the opportunity to think logically, ask reasonable questions, seek appropriate answers and solve problems. To do all these in the Chemistry laboratory, students are brought in direct contact with facilities and equipment/materials, which they manipulate through procedures that reflect scientific thinking. In-fact, the use of Chemistry laboratory encourages hands-on and minds-on activities by the learners for active through participating in knowledge construction.

In realizing that the Chemistry laboratory is a unique facility needed for the effective and result oriented study of Chemistry, the West African Examinations Council (WAEC) introduced a standard measure for Chemistry laboratory facilities and laboratory equipment for Chemistry laboratories in secondary schools in Nigeria. Noting also that the content of Chemistry laboratory is unique as some are fragile and could easily break, the need for standard measure by WAEC as a regulatory organization became very fundamental. The West African Examinations Council (WAEC) was established by law in the English speaking West African countries to conduct examinations and award certificates comparable to those of equivalent examining authorities internationally (WAEC, 2020).

The WAEC therefore promulgated a benchmark to serve as a standard for provision and utilization of facilities and equipment in secondary schools Chemistry laboratories. By the WAEC standard, a typical secondary school Chemistry laboratory for fifty students should in summary contain the following as basic requirements:

1. Facilities - a building designed for laboratory operations, running water, adequate electricity, storage room for chemicals, dark room, preparatory room, storage cupboard, fume cupboard, laboratory tables, chairs and so on.
2. Equipment – weighing balance, beakers, flasks, measuring cylinders, test tubes, and so on.

Thus, by emphasizing knowledge and skill through hands-on and minds-on scientific activities under the guidance of the Chemistry teacher in the laboratory, Chemistry students are provided with the opportunity to interact with materials within the environment through observing, classifying, measuring, questioning, hypothesizing, collecting and interpreting data. Reports have shown that emphasizing the teaching of Chemistry contents using laboratory experiments is more enjoyable more so when the required materials are rightly available (Shana and Abulibdeh, 2020). There is therefore, the need to assess the interaction of students with facilities and equipment in Chemistry laboratories based on the standard stipulated by WAEC.

Assessment is a term commonly used in research work particularly in education research. It could be the act of assessing and making judgment about something. McIntosh (2020) stated that assessment is the act of deciding the amount, value, quality or importance of something. This has over the years been the indices used to check the level or standard or quality of things. In education, it serves as a tool for determining the effectiveness of a teaching process, infrastructure, and instructional guide as well as gives information on the ability and knowledge base of the students. In this study, assessment is basically used as a means of determining the level of correspondence of Chemistry laboratory facilities and equipment to the standard given by WAEC.

The need for standard measure in every aspect of Chemistry laboratory is a universal requirement purposed to attain a particular aim. This is because chemists do not use facilities and equipment for experimental work but rather specific measures guided by standards are used. According to Cambridge English dictionary (n.d), standard is a level of quality that people expect and generally accept as normal; something considered by authority or by general consensus as a basis for comparison while measure is an official action to achieve a particular aim or a unit or an instrument for measuring. Every activity in the Chemistry laboratory is expected to be used according to the measure which is in line with a given standard.

The laboratory tables, chairs, darkroom, and equipment are not joggled but portray standard measures. In fact life in Chemistry world can easily be described as a life of measurement. To determine what a given unknown sample is, there is need to measure certain characteristics of the sample using standard facility or equipment.

The need for accuracy in Chemistry investigation and results is very crucial as that is a major parameter that makes science investigation unique. Universally and by human estimation, accuracy and precision authenticate a matter. This need calls for measures that provide a standard in every aspect of science learning particularly in the study of Chemistry.

Igwe (2015), stated that the history of science is replete with examples of scientists who were harmed or killed or examples of science laboratories completely destroyed by one laboratory hazard or another through wrong handling of facilities and equipment. The non-compliance to standard measures could results to many students crowding around few equipment laboratory which could lead to pushing, tripping and even serious injuries.

According to (Shitaw (2017); urban area is an area which is developed and civilized based on geographical conditions while rural area is an area which is under development and not civilized, based on geographical conditions. Urban areas are characterized by large size, high density population, heterogeneity, mobility amongst others. While rural areas are characterized by low population density, homogeneity, slow rate of change amongst others. The characteristics of an area are usually reflected in the schools within the area since the school is a built up of the location. While standard measures could be assumed to be a needed prevailing condition in all secondary schools' Chemistry laboratory, some studies showed that location may determine correspondence to the standard measure in schools Chemistry laboratories. According to Ovansa (2017), schools in rural areas are laden with poverty, inadequate water supply, poor electricity supply and poor learning environment which effect is made evident in the standard measures in the Chemistry laboratory and the opposite is obtained in urban schools.

Wang (2013), opined that schools in urban locations have more facilities and equipment and a higher tendency to maintain stipulated standard in Chemistry laboratory than schools in rural locations. Shitaw (2017) and Ntibi and Edoho (2017) on the other hand stated that in today's world, location whether rural or urban, has no effect on correspondence to given standard measures in secondary schools' Chemistry laboratories. Hence there seems to be no conclusive evidence of the effect of location (urban or rural) on correspondence to standard measures given by WAEC for secondary schools' Chemistry laboratories.

The study conducted by Emendu (2015) drew very clear emphasis on the need for identification of basic facilities and equipment for Chemistry laboratories in Anambra state, as a result of the poor performance of students in Chemistry in external examinations. Hence the need for assessment of standard measures in secondary schools' Chemistry laboratories in respect of laboratory facilities and equipment in Anambra State became very obvious.

This study was anchored on Abraham Maslow's Hierarchy of needs theory (1908 – 1970). The theory is of the view that people have a number of needs and as these needs are met when they are able to go on to pursue other needs. The hierarchy of needs was displayed as a pyramid and portrayed that people are motivated to fulfill basic needs before moving on to other more advanced needs. Maslow believed that people have inborn desires to be self-actualized. In order to achieve these ultimate goals, however, a number of more basic needs must be met such as the need for food, safety, love and self-esteem.

Maslow's hierarchy of needs is most often displayed as a pyramid from the basic to the more complex as (i) psychological needs such as food, water and air (ii) safety needs ie, keeping oneself away from any harm such as safety against accidents and injuries, health and wellness; and financial security, (iii) social needs (iv) self - esteem needs, and Self - actualization needs.

The Chemistry laboratory has all kinds of instruments, materials and people working in it. The goal of the use of laboratory is to ensure that purposeful learning takes place and so standard measures that provides facilities and equipment in the Chemistry laboratory have to be met to ensure positive learning. Maslow believes that people acknowledge their basic needs before addressing higher needs and ultimately self-actualization. Using proper laboratory facilities and equipment in adherence to standard measures will increase the level of activities in the Chemistry laboratory and this will ensure disposition to positive learning, performance and achievement.

Statement of the Problem

There is poor performance of students in Chemistry among Chemistry students and this to a large extent has been attributed to poor performance in the practical aspect of the WAEC examination. The reason for the poor performance in the practical has also been blamed on the non-correspondence of laboratory facilities and equipment in the secondary schools' Chemistry laboratories in Anambra State to the standard measure given by WAEC. Most of these facilities and equipment which are supposed to be in the secondary schools' laboratories are either not available, have never been purchased at all or damaged and not replaced. In the event of the above assertions, the very purposes of mastery of contents, cultivation of skills, high performance in the subject in examinations and the practical activities are hindered.

It appears that there is non-correspondence of laboratory facilities and equipment in Chemistry laboratories in Anambra State to the standard measures stipulated by WAEC and this is a worry to these researchers. This is so because the situation could hinder scientific and technological emancipation of Nigeria which will be detrimental to national development. Again, the poor standard Chemistry laboratory facilities and equipment due to non-consideration of standard measures in the Chemistry laboratory activities as stipulated by WAEC could continue to result to poor learning and low achievement of the desired goals of Chemistry teaching in secondary schools in Anambra State. The problem of the study therefore is to ascertain if the level of Chemistry laboratory facilities and equipment in secondary schools in Anambra State corresponds to the standard measures stipulated by West African Examinations Council (WAEC).

Purpose of the Study

The main purpose of the study was to assess the correspondence of standard measures of Laboratory Facilities and Equipment in Chemistry laboratories in secondary schools in Anambra State. Specifically, the study sought to assess:

1. If available Chemistry laboratory facilities correspond to the standard measure stipulated by WAEC.
2. If available Chemistry laboratory equipment correspond to the standard measure stipulated by WAEC.

Significance of the Study

The findings would be beneficial to students, Chemistry teachers, school management, professional associations, Ministry of Education and the nation as a whole, thus:

To the students, it would help them to have an understanding of standard measures and the benefits of compliance to standard measures in the Chemistry laboratory in the mastery of content and acquisition of skills in the subject. This may spur the students to solicit for assistance from parents, old boys'/ girls' associations and donor organizations for equipping of the schools' Chemistry laboratories with facilitiues and equipment to correspond to standard expectation.

The Chemistry teachers would by virtue of this study realize how much compliance with standard measures can contribute to the teaching of the subject and how much better they can achieve the Chemistry goals with minimal stress if only there is compliance to the given standards. This is expected to beef up on the responsibilities of periodic inventory/stock taking of Chemistry laboratory facilities and equipment by management and store keepers.

The outcome of this study would enable school management to be able to develop better strategies for administering Chemistry laboratory work particularly when the population of Chemistry students is high with regards to Chemistry laboratory facilities and equipment.

The Ministry of Education would by this finding of the study be better informed on the decisions and policy to make to curtail sub-standard Chemistry laboratory teachings in secondary schools in the State. The result may provide a guide to the Ministry of Education on the distribution of Chemistry laboratory facilities and equipment to schools in urban and rural locations.

The findings would enable professional bodies like Science Teachers Association of Nigeria (STAN) and Teacher Registration Council(TRC) to have evidence during seminars, workshops upon which to update the knowledge of the Chemistry teachers.

The nation as a whole would benefit richly through the findings of this study. When standard measures are upheld, the students would develop a balanced perspective of learning and of commitment to guiding principles.

In the near future, the students would grow into passionate and well-trained scientists who would push further the boundaries of science bringing about economic growth and national development.

Scope of the Study

This study was delimited to assessment of the correspondence of standard measures of Laboratory Facilities and Equipment in Chemistry laboratories in secondary schools in Anambra State. It verified how Chemistry laboratory facilities and equipment in secondary schools corresponded to the pre – examination of facilities and equipment standards stipulated by WAEC for secondary schools' Chemistry laboratories. School location as an intervening variable in correspondence of facilities and equipment in Chemistry laboratories to standard measures stipulated by WAEC was considered. The subjects of the study were secondary schools with Chemistry laboratories in public secondary schools in Anambra State, Nigeria.

Research Questions

The following research questions guided the study:

1. How do Chemistry laboratory facilities available in Anambra State Secondary Schools correspond to the standard measures stipulated by WAEC?
2. How do Chemistry laboratory equipment available in Anambra State Secondary Schools correspond to the standard measures stipulated by WAEC?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

HO_1. The level to which Chemistry laboratory facilities available in Anambra State Secondary Schools correspond to the standard stipulated by WAEC does not depend significantly on location (urban or rural).

HO_2. The level to which Chemistry laboratory equipment available in Anambra State Secondary Schools correspond to the standard stipulated by WAEC does not depend significantly on location (urban or rural).

Review of Related Literature

Chemistry as a Subject of Study

Chemistry emerged as the scientific discipline involved with elements and compounds composed of atoms, molecules and ions: their composition, structure, properties, behavior and the changes they undergo during reaction with other substances (Okeke, 2014). According to Ababio (2015), what started as a satisfaction of man's basic needs later developed as a branch of science called Chemistry. Chemistry is one of the three main branches of pure science, outside Biology and Physics. Chemistry is a branch of science that deals with the composition and changes of non-living matter. Matter is anything that has mass and occupies space. According to Igwe (2013), the world is an aggregates of matter. Chemistry has many branches today, viz: Physical Chemistry, Organic Chemistry, Biochemistry, Inorganic Chemistry, Nuclear Chemistry and Analytical Chemistry. By relevance, Chemistry forms the basis for most of the advanced technology that we have in the world today, which range from biomedical engineering to the oil and gas exploration. Chemistry has found a place in the bedrocks of all disciplines of life endeavour. Chemistry is central in the drive for global economic development. It plays the major roles in food (fertilizers and insecticide), clothing (textile fibres), housing (cement, concrete, steel bricks), medicine (drugs), and transportation (fuel, alloy materials) and contributes greatly to scientific and technological development that affect our lives in many ways.

The Need for Laboratory in Science Teaching and Learning

The need for laboratory in science learning was possibly born out of the curiosity about nature and process of sciencing. This is because practical work including laboratory work has been part of science education for more than a century, and is considered an essential component of science learning (Isozaki, 2017). Omiko (2015) opined that laboratory is a room or building specially equipped for scientific experiments, research, or a room in a school or college in which practical side of science is taught. Piggot (2019), stated that science laboratories are crucial part of secondary school science learning. This is because science laboratory facilities allow students to get a first-hand learning experiences as they perform various experiments on theories and concepts taught. Effective teaching and learning of science involves seeing, handling and manipulating real objects and materials and these processes can only be meaningful when they are carried out in the laboratory (Babayemi & Kareem, 2019). According to Hofstein and Mamlok-Naaman (2007), many research studies have been conducted to investigate the educational effectiveness of laboratory work in science education in facilitating the attainment of the cognitive, affective, and psychomotor (practical) goals.

Rayner-Canchem and Rayner-Canchem (2015), established that constructivist teaching practices were found to occur more often in the science laboratory than in the regular classroom. Yuzuak (2019), stated that the science laboratories have been considered as the most convenient place to teach science. This is because the nature of science calls for tangible proofs, tangible evidence, and tangible reliability before the reports can be authenticated and accepted as theories and laws (Okeke, 2014). It is the process of validating the reports and knowledge that brought about experimentation in diverse ways. Therefore, experimental work is an essential component of any course in science. Experimentation as a process is designed to acquaint learners with the basic tools, basic processes, and techniques used in the science laboratories. It also envisages development of problem solving skills which are capable of helping the learner to acquire ability to identify a problem, to design, and setup the experiment, to collect and analyze data through experiment and to interpret data so as to arrive at plausible solution in the course of time (Isozaki, 2017)..

According to (Kay 2015), the school science laboratory is a specially designed room or hall where basic experimental skills are learnt by systematically performing a set of prescribed and suitably designed experiment. However, Igwe (2013) sees science laboratory as being either in-door (as could be found in the school system) or out-door (as could be found in the mountain side, river side, mining sites and lake side). Science laboratory activities have long and distinctive central roles in the implementation of science curriculum (Lumetta (2017) and Hofstein & Kind, 2012).

Some examples of Nigerian science projects which laid much emphasis on laboratory work in Nigeria included the Nigerian Integrated Science Project (NISP) developed by Science Teachers Association of Nigeria (STAN) and the Nigerian Secondary School Science Project (NSSSP) developed by Comparative Education Study and Adaptation Centre (CESAC-NERDC). Their views are still being widely adopted in secondary schools to develop certain skills and attitudes.

Igwe (2015) opines that all learning involving practical work in science laboratories creates opportunities for students to interact with the material world and perform experiments by one's own hands and minds. This implies that sciencing through doing by one's self creates a thrilling experience which is very relevant to understanding. Omiko (2014), opined that making science learning activity-based creates opportunities for students to experience the fun, creativity, and excitement as part of innovative and entrepreneurial activity. Isozaki (2017) observed that learning by doing is imperative in successful learning because it stimulates the senses the more and students learn better and retain knowledge longer.

The school science laboratory serves as a platform where practical experiment are thoughtfully sequenced into the flow of classroom instruction aimed at making concepts real and practical. Effective laboratory experiences have clear learning goals that guide the design of the experiment. The science learning goals of laboratory experiences according to NRC (2014:57), include the following:

i. Enhancing mastery of subject matter: laboratory experience may enhance students' understanding of specific science facts and concepts and the way in which these facts and concepts are organized in science disciplines.
ii. Developing Scientific Reasoning: laboratory experiences could promote students' ability to identify questions and concepts that guide scientific investigation.
iii. Understanding the complexity and ambiguity of empirical work: interacting with the unconstrained environment of material world in laboratory experiences may help students (learn to address the challenges inherent) concretely understand the inherent complexity and ambiguity of natural phenomena. Laboratory experience may help the students to learn to address the challenges inherent in directly observing and manipulating the material world, including trouble shooting equipment used to make observations, understand measurement errors, and interpret results data.
iv. Develop Practical Skills in laboratory experiences, may help students to learn to use the tools and conventions of science. For example, they may develop skills in using scientific equipment correctly and safely, making observations, taking measurements and carrying out well defined scientific procedure.
v. Understanding the nature of science laboratory experiences may help students to understand the values and assumptions inherent in the development and interpretation of scientific knowledge, such as the idea that science is a human endeavor that seeks to understand the material world, and that scientific theories, models, and explanations change over time on the basis of new evidences.
vi. Cultivating interest in learning science as a result of laboratory experience that makes science "come alive", and students may become interested in learning more about science and see it as relevant to everyday life.
vii. Motivation in learning science through developing teamwork abilities: Laboratory experience may also promote a student's ability to collaborate effectively with others in carrying out complex tasks, to share the work of the task, to assume different roles at different times, and to contribute to and respond to ideas. (NRC, 2014)

Laboratories are exemplary sites of modernity and so do not only function as passive reflectors of an increasingly globalized culture and society, but also as active examples, as forces for change whose influence is by no means limited to science (Schmidgen, 2018). It then becomes very essential that every science laboratory must offer opportunities to learners to safely interact with materials and equipment.

Standard Measures in Chemistry Laboratory

The ability of secondary schools Chemistry laboratories to help improve the students' understanding, appreciation of science and prepare the next generation of scientists and engineers is influenced by the standard measures in the laboratory (Igwe & Olayiwola, 2015). According to Merriam-Webster dictionary, standard is something established by authority, custom or general consent as a model, example or point of reference, while measure is an official action done; unit used in stating the size, quantity or degree of something; or an instrument for measuring. International Renewable Energy Agency (2020) stated that standard is a reference point backed by authority, on which actions, quantity, quality and degree of something or instrument can be determined, compared and accepted. Standards contain technical specifications or other precise criteria designed to be used consistently as a rule, guideline, or definition.

Chemistry as a branch of science follows the process and culture of science in its investigation which is the engagement and utilization of accurate, precise measurement as a fundamental component of scientific work. According to Aritra (2015), measurements and units are important in scientific investigation because without proper measurements, physical laws can never be expressed precisely just from qualitative reasoning. There is need for precision and accuracy in science laboratory measurements. In order to attain precision and accuracy, standard measures require standard unit of measurement for purposes of reference, comparison and reproducibility.

According to Carr (2020), the study of Chemistry world embodies a life of measurements because in the Chemistry laboratory, substances or chemicals are given units of measurement for understanding to take place. For instance, a particular color is measured by matching it to a standard; the boiling point, melting point, density, heat of combustion. Again, to learn how best to prepare a compound, there is need to measure the best temperature, pressure, time and concentration for the components required in the synthesis and to make comparison to existing standard measures. Carr (2020) opined that non-chemists might only use a yard stick for an occasional measurement but a chemist needs to understand far more about measurement than using simple concepts to make estimates. For this reason, the scientist developed the International System of Units known as S.I Units. This was done to standardize measurement across all scientific disciplines.

Without the ability to measure, it would be difficult for scientists to conduct experiments or form theories. Not only is measurement important in science and chemical industry, it is also essential in farming, engineering, construction, manufacturing, commerce and many other occupations and activities. Scientists use many skill measurements as they investigate the world around them. They make observations by gathering information with their senses. Some observations are simple. For example, figuring out the color or texture of an object. However, if scientists want to know more about a substance, they need to take measurements which are usually compared with an acceptable measure considered as the standard measure for reference purposes (Pranav 2019). The International System of Units is a decimal and metric system of units established in 1960 and periodically updated. This study made use of standards in considering the outcome of this study.

In the secondary schools, standard measure enables comparison of results such as why the performance of a particular school varies so much from another school. This case could be traced to a number of students using a particular facility such as the laboratory facility designed for fifty (50) students being used by a hundred (100) students. There is every tendency for low performance as some students will be aloof and some non-chalant. There could be wasting of materials and high possibility of accident as a result of overcrowding. Standard measure in every aspect of secondary school laboratory is very crucial with all the basic facilities such as running water, adequate electricity, storage room for chemicals, dark room and preparatory room in case of Chemistry. There is also the need for standard measure in facilities, equipment, reagents and chemicals availability and safety equipment for goal oriented Chemistry laboratory activities. Hence standard measures in facilities, equipment, chemicals/reagents, and emergent safety equipment are considered in this study.

Facilities and Equipment in Secondary School Chemistry Laboratory

Laboratory facilities are needed in all its ramification for purposes of achieving specific goals of attaining the objective of Chemistry education thereby cultivating the needed knowledge and skill (American Chemical Society, 2016). The facilities of interest in this study are as follows: Well-equipped Chemistry laboratory, running water, adequate electricity supply, storage room for chemicals and preparatory room

The West African Examinations Council stipulated in its Observatory Checklist for Chemistry Laboratory (OCCL) that for a Chemistry laboratory designed for fifty (50) users, the standard measure for each facility is one per school. Chemistry laboratory furniture includes laboratory tables, chairs, preparatory tables and fume cupboard. The equipment is summarized as measuring equipment, glassware equipment, heating equipment and safety equipment. The standard measure of each of the equipment is given by WAEC for all schools to adopt.

School Location and Standard Measures in Secondary Schools' Chemistry Laboratories

School location is used to describe the geographical position of a school (Idika, 2017). Communities are usually defined by the socio- economic status of the residents, the population density, the quantity of social amenities and infrastructure available. Hence school location refers to the particular place, in relation to other areas in the physical environment where the school is sited. Schools located in urban location are termed urban schools while those located in rural locations are described as rural schools. In Nigeria, rural life is uniform, homogenous and less complex than urban life with cultural diversity and heterogeneity.

Schools location in terms of urban or rural has been considered as a variable in determining the standard measures in secondary schools Chemistry laboratories. According to Owoeye and Yara (2011), school location is one of the potent factors that influence the distribution of educational resources, the laboratory and its components. The authors opined that since urban areas are more densely populated, they may be better favored with respect to distribution of social amenities such as pipe borne water, electricity, healthcare facilities while the rural areas are less favored. This could also be true in the distribution of educational facilities and the state of the facilities in terms of compliance to standard measures. These speculated conditions imply that all schools may not have the opportunity of having standard measures in Chemistry laboratories. It then becomes necessary to determine if school location is a factor in standard measures in secondary schools' Chemistry laboratory.

Research Methods

The study adopted a descriptive survey design. Descriptive survey design is one in which a group of people or objects considered as true representation of the population from which they are drawn is used for study. According to McCombes (2022), descriptive research aims at accurately and systematically describing a population, situation or phenomenon. The design was considered appropriate for this study because it will enable the researchers to collect relevant data from the sample through the West African Examinations Council (WAEC) checklist containing standard measures for facilities and equipment for secondary schools' Chemistry laboratories.

Area of Study

The study was carried out in Anambra State, Nigeria. The State is one of the five States geographically located in South East of Nigeria. The State is divided into twenty one (21) local government areas with an estimated population of about 5.08 Million according to the 2015 estimates as contained in a compendium published during the 25 years anniversary of Anambra State (Okonkwo, 2017).The indigenous ethnic group in the State are the Igbos (98%) and a small population of Igalas (2%). The occupation of the people are majorly trading, farming, fishing and civil service.

Anambra state has six education zones, namely: Aguata, Awka, Nnewi, Ogidi, Onitsha and Otuocha education zones. The State was chosen for the study because of reported cases of poor performance of students in Chemistry in external examinations due to the state of the Chemistry laboratories in secondary schools in the State. Public schools used for the study are under the control of the government who are policy makers. Again, Anambra State being an educationally advantaged State, secondary schools are expected to have well equipped Chemistry laboratories such that the incidence of poor performance of students in public examination in Chemistry should not have been reported and has been attributed to paucity of laboratory facilities and equipment in Chemistry laboratories. The researchers therefore sought to assess the correspondence of Chemistry laboratory facilities and equipment to standard measures stipulated by WAEC to substantiate the correspondence or otherwise.

Population of the Study

The population of the study consisted of all the public secondary schools that have Chemistry laboratories in the six Education Zones of Anambra State. A total of two hundred and eleven (211) public secondary schools that have Chemistry laboratories was involved the study (Anambra State Post Primary Management Board, 2021).

Sample and Sampling Techniques

The sample comprised forty eight (48) public secondary schools that have Chemistry laboratories. This was done through stratified random sampling from a total of two hundred and eleven (211) public secondary schools in this order: Aguata zone had 46 schools, Awka zone had 48 schools, Nnewi zone had 39 schools, Ogidi zone had 29 schools, Onitsha zone had 23 schools and Otuocha zone had 26 schools) of Anambra State. The public schools were stratified into zones and four schools from rural locations and four schools from urban locations were then randomly selected from each of the six Education Zones of the State, making a total of 48 schools that have Chemistry laboratories as the sample of the study.

Instrument for Data Collection

The instrument for data collection for this study was a checklist specifications developed by West African Examinations Council (WAEC) for facilities and equipment for secondary schools' Chemistry laboratories. The checklist contained information on standard measures (quantity, number of students and ratio) of facilities and equipment organized into two (2) clusters: A and B. The clusters sought information on quantity available and number of users for each item in the clusters.

For ease of administration, the researchers also sought information on the name of school, location, as well as provided instruction guiding how to response to Clusters A and B of the checklist. Cluster A has ten (10) items and sought information on laboratory facilities. Cluster B has seventy nine (79) item and sought information on laboratory equipment.

Validation of Instrument
The observatory checklist used by the researchers was face validated by one expert from Chemistry option and one expert from Measurement and Evaluation option of the Department of Science Education, Faculty of Education, Ebonyi State University Abakaliki, and one Chemistry expert from the Department of Pure and Industrial Chemistry, Nnamdi Azikiwe University, Awka. They restructured the number of clusters from four to two for this study, still based on the specification provided by WAEC as a guide and for the variables of the study.

Reliability of Instrument
The instrument was subjected to a test of inter-rater reliability using Kendall Coefficient of Concordance. A trial test of the instrument was conducted using Chemistry laboratories in secondary schools in two (2) urban and two (2) rural locations outside the area of study. Three (3) research assistants who were Youth Corpers teaching Chemistry in their schools of posting served as observers to the four secondary schools' Chemistry laboratories. The research assistants were assisted by the Chemistry teachers of the visited schools to observe available facilities and equipment and took record of the quantity available and the number of users. The values were rated in terms of standard measures. The two clusters (A and B) yielded reliability coefficients of 0.82 and 0.78 respectively.

Method of Data Collection
The researchers and three research assistants were used for the research work. The research assistants were trained by the researcher on how to collect data using the designed checklist. The training of the research assistants helped to standardize the data collection procedure as it strengthened the consistency of the procedure. They observed the Chemistry laboratories in collaboration with the Chemistry teacher. For each cluster, the items listed in the checklist was observed in the Chemistry laboratory and the number available recorded. The ratio per school or per student as specified by WAEC was determined. The copies of the instrument was collected immediately they were completed. This helped to reduce or avoid losses of copies of the instrument as well as ensured maximum returns. A period of six weeks was used to conduct of the entire exercise.

Method of Data Analysis
Research questions 1 and 2 were answered using frequencies and ratios while Chi - square (X^2) independence was used to test the hypotheses at 0.5 level of significance. When the observed ratio is equal to or less than the expected ratio, it implied that the item corresponded to the WAEC standard measure and also the reverse was the case when the observed ratio was greater than the expected ratio.

Results
Research Question 1
How do Chemistry laboratory facilities available in Anambra State Secondary Schools correspond to the standard measures stipulated by WAEC?

Table 1: Correspondence of Ratio of Available Laboratory Facilities Specified By WAEC

S/N	ITEMS	Ratio Specified	Quantity Available	No of Users	Ratio	Remarks
1	Chemistry laboratory room	1:1 School	47	48	1: 0.98	Did not Correspond
2	Running water	1: 1 School	24	48	1: 0.5	Did not Correspond
3	Adequate electricity	1: 1 School	22	48	1: 0.46	Did not Correspond
4	Storage room for chemicals	1:1 School	44	48	1: 0.92	Did not Correspond
5	Dark room	1:1 School	00	48	0: 48	Unavailable
6	Preparatory room	1:1 School	15	48	1: 0.31	Did not Correspond
7	Storage Cupboard	1:1 School	48	48	1: 1	Corresponds
8	Fume Cupboard	1: 1 School	3	48	1: 0.6	Did not Correspond
9	Laboratory tables	1:10 students	368	1870	1: 5	Corresponds
10	Laboratory chairs	1:1 student	1895	1870	1: 1	Corresponds

The result of data analysis presented in Table 1 revealed that (i) the following Chemistry laboratory facilities: storage cupboard, laboratory tables and laboratory chairs corresponded to the specifications by WAEC. (ii) Chemistry laboratory room, running water, adequate electricity, storage room for chemicals, preparatory room and fume cupboard did not correspond to the standard stipulated by WAEC. (ii) dark room was unavailable in all the schools

Research Question 2
How do Chemistry laboratory equipment available in Anambra State Secondary Schools correspond to the standard measures stipulated by WAEC?

Table 2: Ratio of Chemistry Laboratory equipment to number of users.

S/N	ITEMS	Ratio Specified	Quantity Available	No of Users	Ratio	Remarks
1	Weighing Balance (2kg capacity)	1:25	65	1870	1: 29	Did not Correspond
2	100cm^3 Beakers (Borosilicate)	1:1	1282	1870	0.7: 1	Did not Correspond
3	250cm^{3}Beakers	2:1	2408	1870	1:1	Did not Correspond
4	2000cm^{3}Beakers	1:10	145	1870	1: 13	Did not Correspond
5	Boss Heads	1:1	1183	1870	0.6: 1	Did not Correspond
6	Beehive shelves 7.5cm diameter	1:25	280	1870	1:7	Corresponds
7	Burettes (Borosilicates) 50cm^3*0.1cm^3	1:1	1616	1870	0.9: 1	Did not Correspond
8	Burettes Brushes	1:5	856	1870	1: 2	Corresponds
9	Bucket (Polythene) 10dm^3	1:50	207	1870	1: 9	Corresponds
10	Bunsen Burners	1:1	873	1870	0.5: 1	Did not Correspond
11	Calorimeters with stirrers (copper) 250cm^3	1:25	214	1870	1: 9	Corresponds
12	Combustion tube 30*2cm	1:1	2135	1870	1: 1	Corresponds
13	Clips	1:1	1823	1870	0.9: 1	Did not Correspond
14	Condenser Liebig 50cm^3	1:50	74	1870	1: 25	Corresponds
15	Copper Plates 20cm*5cm*3mm	1:25	262	1870	1: 7	Corresponds
16	Cork Borers	1 set:50	13	1870	1: 143	Did not Correspond
17	Corks Assorted Dimension	1 pkt:10	655	1870	1: 3	Corresponds
18	Cotton Wool	1 bdle:50	95	1870	1: 20	Corresponds
19	Crucibles Porcelain with lids 58*36mm*4	1:1	753	1870	0.4: 1	Did not Correspond
20	Petri Dishes 10cm*5cm	1:1	1027	1870	0.5: 1	Did not Correspond
21	Deflagrating spoon, with cover	1:50	88	1870	1: 21	Corresponds
22	De – ionizer,	1:50	102	1870	1: 18	Corresponds
23	Dropping Pipettes (glass)	1:1	1305	1870	0.7: 1	Did not Correspond
24	Funnels (polythene) 6.5cm	1:1	1336	1870	0.7: 1	Did not Correspond
25	Funnels glass (6.5cm)	1:10	792	1870	1: 2	Corresponds
26	Filter paper (11cm)	1:2	1248	1870	1: 2	Corresponds
27	Flask, Volumetric (1000cm^3)	1:25	116	1870	1: 16	Corresponds
28	Flask, Volumetric (2000cm^3)	1:50	75	1870	1: 25	Corresponds
29	Flask, distilling with side arms (250cm^3)	1:50	44	1870	1: 43	Corresponds
30	Funnel (Separating) 100cm^3	1:50	504	1870	1: 4	Corresponds
31	Funnel, Thistle (25cm^3)	1:50	523	1870	1: 4	Corresponds
32	Flasks, Flat Bottom (250cm^3)	1:25	427	1870	1: 4	Corresponds
33	Fire Blanket (asbestos cloth)	1:50	03	1870	1: 623	Did not Correspond
34	Flasks, Conical (250cm^3)	3:1	1961	1870	1: 1	Did not Correspond
35	Flat bottom flasks (500cm^3)	1:25	166	1870	1: 11	Corresponds
36	Bell-jar (open top, 25cm*15cm)	1:50	65	1870	1: 29	Corresponds
37	Gas Jar Cover	1:50	238	1870	1: 8	Corresponds
38	Gas jar (20*5cm)	1:50	230	1870	1: 8	Corresponds
39	Glass Rods (6 – 5mm)	3kg:50	295	1870	1: 6	Corresponds
40	Glass Tubing assorted	4kg:50	136	1870	1: 14	Corresponds
41	Graduated Cylinders (100cm^3, glass)	1:5	630	1870	1: 3	Corresponds
42	Graduated Cylinders (25cm^3, glass)	1:5	318	1870	1: 6	Did not Correspond
43	Graduated gas Syringes, plastic (50cm^3)	1:1	241	1870	0.1: 1	Did not Correspond
44	Glass wool	1kg:50	15	1870	1: 125	Did not Correspond
45	Grease (Vaseline)	250kg:50	96	1870	1: 19	Corresponds
46	Indicator Bottles, plastic (50cm^3)	1:1	653	1870	0.3: 1	Did not Correspond
47	Meter Rules	1:10	283	1870	1: 7	Corresponds
48	Mortar And Pestle	1:50	148	1870	1: 13	Corresponds
49	Pipettes (25cm^3)	1:1	1496	1870	0.8: 1	Did not Correspond
50	Pipettes straight graduated 0 – 25cm^3	1:5	658	1870	1: 3	Corresponds
51	Porous Pot 3cm*18cm	1:50	214	1870	1: 9	Corresponds

S/N	ITEMS	Ratio Specified	Quantity Available	No of Users	Ratio	Remarks
52	Periodic Table	1:50	230	1870	1: 8	Corresponds
53	Reagent Bottles (250cm^3)	1:2	1589	1870	1:1	Corresponds
54	Reagent Bottles wide Mouth (250cm^3)	2:1	644	1870	0.3: 1	Did not Correspond
55	Retort Stands, 45cm rod, base 20cm*15cm	1:1	1665	1870	0.9: 1	Did not Correspond
56	Retort clamps	1:1	1646	1870	0.9: 1	Did not Correspond
57	Retort Rings (7cm)	2:1	673	1870	0.4: 1	Did not Correspond
58	Rubber stoppers assorted single double holes	3:1	440	1870	0.2: 1	Did not Correspond
59	Rubber stoppers, assorted, solid	2:1	374	1870	0.2: 1	Did not Correspond
60	Stand, burette, wooden heavy base, 20*15*2.5cm	1:1	885	1870	0.5: 1	Did not Correspond
61	Spatula (Nickel) 15cm	1:1	619	1870	0.3: 1	Did not Correspond
62	Test tube racks to hold 10 tubes	1:1	1167	1870	0.6: 1	Did not Correspond
63	Splints, wood	12bdles:50	123	1870	1: 15	Did not Correspond
64	Test Tube (borosilicate, 16*150mm)	10:1	3040	1870	2: 1	Did not Correspond
65	Boiling tubes (borosilicate, 24*24*25mm)	3:1	1093	1870	0.6: 1	Did not Correspond
66	Test tube holders (wooden)	1:1	1010	1870	0.5: 1	Did not Correspond
67	Tapers Wax	0.5kg:50	142	1870	1: 13	Corresponds
68	Thermometers, 0^0C to 110^0C	1:1	376	1870	0.2: 1	Did not Correspond
69	Thermometers, 0^0C to 360^0C	1:25	20	1870	1: 94	Did not Correspond
70	Tongs, crucibles (15cm, stainless steel)	1:1	167	1870	0.1: 1	Did not Correspond
71	Tubing, rubber (5mm Internal Diameter	1:5	84	1870	1: 22	Did not Correspond
72	Tripod stands to suit standard bunsen burners(20cm high)	1:1	726	1870	0.4: 1	Did not Correspond
73	U - tubes short with arms (absorption)	1:25	97	1870	1: 19	Corresponds
74	Voltmeters, 0 -5volts * 0.1V	1:5	03	1870	1: 623	Did not Correspond
75	Wash bottles, polythene (250cm^3)	1:5	1362	1870	1: 2	Corresponds
76	Wire gauze with asbestos center (15cm^2)	1:1	391	1870	0.2: 1	Did not Correspond
77	Watch glasses (7.5cm)	1:1	965	1870	0.5: 1	Did not Correspond
78	Weighing bottles with cap, glass (25*50mm)	1:25	267	1870	1: 7	Corresponds
79	Water baths	1:25	138	1870	1: 14	Corresponds

The result of data analysis presented in Table 2 revealed that (i) items 6, (Beehive shelves 7.5cm); 8, (Burettes Brushes); 9, (Bucket (Polythene 10dm^3); 11, (Calorimeters with stirrers {copper} 250cm^3); 12, (Combustion tube 30*2cm); 14, (Condenser Liebig, 50cm^3); 15,(Copper Plates 20cm*5cm*3mm); 17, (Corks Assorted Dimension); 18, (Cotton Wool); 21, (Deflagrating spoon, with cover); 22, (De – ionizer); 25-31,(Funnels glass (6.5cm), Filter paper (11cm), Flask, Volumetric (1000cm^3), Flask, Volumetric (2000cm^3), Flask, distilling with side arms (250cm^3), Funnel (Separating) 100cm^{3,} Funnel, Thistle {25cm^3}); 34 - 41, (Flasks, Conical {250cm^3}, Flat bottom flasks (500cm^3), Bell-jar {open top, 25cm*15cm}, Gas Jar Cover, Gas jar (20*5cm), Glass Rods (6 – 5mm), Glass Tubing assorted, Graduated Cylinders (100cm^3, glass); 45, (Grease (Vaseline) 47, (Meter Rules) 48, (Mortar And Pestle) 50-53, (Pipettes {straight graduated 0 – 25cm^3}, Porous Pot {3cm x 18cm}, Periodic Table, Reagent bottles {250cm^3}); 67, (Tapers Wax) 73,(U - tubes short with arms (absorption) 75, (Wash bottles, polythene (250cm^3) 78 (Weighing bottles with cap, glass (25 x 50mm) and 79 (Water baths) corresponded to the Chemistry laboratory equipment as stipulated by WAEC.

(ii) items 1-5, (Weighing Balance (2kg capacity), 100cm^3 Beakers (Borosilicate), 250cm^3 Beakers, 2000cm^3 Beakers, Boss Heads); 7, (Burettes {Borosilicates 50cm^3*0.1cm^3}); 10, (Bunsen Burner); 13,(Clips); 16,(Cork Borers); 19, (Crucibles Porcelain with lids 58*36mm*4); 20, (Petri Dishes 10cm*5cm); 23, (Dropping Pipettes (glass); 24, (Funnels (polythene) 6.5cm); 33, (Fire Blanket, asbestos cloth); 42-44, (Graduated Cylinders {25cm^3, glass}, Graduated gas Syringes, plastic {50cm^3}, Glass wool); 46, (Indicator Bottles, plastic (50cm^3); 49, (Pipettes {25cm^3}); 54-66,(Reagent Bottles wide Mouth {250cm^3}, Retort Stands, 45cm rod, base 20cm*15cm, Retort clamps, Retort Rings {7cm}, Rubber stoppers assorted single double holes, Rubber stoppers, assorted, solid, Stand, burette, wooden heavy base, 20*15*2.5cm, Spatula {Nickel} 15cm, Test tube racks to hold 10 tubes, Splints {wood}, Test Tube {borosilicate, 16*150mm}, Boiling tubes {borosilicate, 24*24*25mm}, Test tube holders {wooden}); 68-72, (Thermometers, 0^0C to 110^0C, Thermometers, 0^0C to 360^0C, Tongs, crucibles {15cm, stainless steel}, Tubing, rubber {5mm internal diameter}, Tripod stands to suit standard bunsen burners{20cm high}); 74, (Voltmeters, 0 -5volts * 0.1V); 76, (Wire gauze with asbestos center {15cm^2}); and 77, (Watch glasses {7.5cm}) did not correspond to the stipulated ratio by WAEC.

HO_1: The level to which Chemistry laboratory facilities available in Anambra State Secondary Schools correspond to standard measures stipulated by WAEC does not depend significantly on school location

Table 3: Level of Influence of School Location to the Correspondence of Chemistry Laboratory Facilities to the standard measures stipulated by WAEC

S/N	ITEMS	Ratio Specified	Location	O & E Freq	No of Users	X^2cal	X^2crit	
1	Chemistry laboratory room	1:1 School	Urban Rural	24 (24) 23 (24)	24 24	0.04	3.841	Uphold Ho
2	Running water	1: 1 School	Urban Rural	22 (24) 2 (24)	24 24	20.17	3.841	Reject Ho
3	Adequate electricity	1: 1 School	Urban Rural	22 (24) 00 (24)	24 24	24.17	3.841	Reject Ho
4	Storage room for chemicals	1:1 School	Urban Rural	23 (24) 21 (24)	24 24	0.042	3.841	Uphold Ho
5	Dark room	1:1 School	Urban Rural	00 (24) 00 (24)	24 24	NA	NA	NA
6	Preparatory room	1:1 School	Urban Rural	12 (24) 3 (24)	24 24	24.38	3.841	Reject Ho
7	Storage Cupboards	1: 1 School	Urban Rural	24 (24) 24 (24)	24 24	0.00	3.841	Uphold Ho
8	Fume Cupboard	1: 1 School	Urban Rural	1 (24) 2 (24)	24 24	42.21	3.841	Reject Ho
9	Laboratory tables	1:10 students	Urban Rural	220 (133) 148 (55)	1322 548	14.16	3.841	Reject Ho
10	Laboratory chairs	1:1 Student	Urban Rural	1358 (1322) 537 (548)	1322 548	2.31	3.841	Uphold Ho
	Overall X^2cal Value					12.75	3.841	Reject HO_1

The result of data analysis presented in Table 3 revealed that the overall X^2cal value of 12.75 is greater than the X^2crit value, hence, HO_1 is rejected, meaning that the level to which Chemistry laboratory facilities available in Anambra State Secondary Schools in correspondence to standard measures stipulated by WAEC does depend significantly on school location.

HO_2: The level to which Chemistry laboratory equipment available in Anambra State Secondary Schools correspond to standard stipulated measures by WAEC does not depend significantly on school location

Table 4: Level of Influence of School Location on Correspondence of Chemistry Laboratory Equipment in Anambra State Secondary School

S/N	ITEMS	Ratio Specified	Location	O & E Freq	No of Users	X^2cal	X^2crit	*Inference*
1	Weighing Balance (2kg capacity)	1:25	Urban Rural	61 (53) 4 (22)	1322 548	15.96	3.841	Reject Ho
2	100cm^3 Beakers (Borosilicate)	1:1	Urban Rural	1175 (1322) 107 (548)	1322 548	371.24	3.841	Reject Ho
3	250cm^{3}Beakers	2:1	Urban Rural	2003 (2644) 405 (1096)	1322 548	591.06	3.841	Reject Ho
4	2000cm^{3}Beakers	2:25	Urban Rural	120 (106) 25 (44)	1322 548	10.05	3.841	Reject Ho
5	Boss Heads	1:1	Urban Rural	963 (1322) 220 (548)	1322 548	196.32	3.841	Reject Ho
6	Beehive shelves 7.5cm diameter	1:25	Urban Rural	257 (53) 23 (22)	1322 548	785.25	3.841	Reject Ho
7	Burettes (Borosilicates) 50cm^3*0.1cm^3	1:1	Urban Rural	1068 (1322) 330 (548)	1322 548	135.52	3.841	Reject Ho
8	Burettes Brushes	1:5	Urban Rural	740 (265) 116 (110)	1322 548	851.74	3.841	Reject Ho
9	Bucket (Polythene) 10dm^3	1:50	Urban Rural	163 (27) 44 (11)	1322 548	784.04	3.841	Reject Ho

S/N	ITEMS	Ratio Specified	Location	O & E Freq	No of Users	X^2cal	X^2crit	*Inference*
10	Bunsen Burners	1:1	Urban Rural	845 (1322) 28 (548)	1322 548	665.54	3.841	Reject Ho
11	Calorimeters with stirrers (copper) 250cm^3	1:25	Urban Rural	193 (53) 21 (22)	1322 548	369.86	3.841	Reject Ho
12	Combustion tube 30*2cm	1:1	Urban Rural	2025 (1322) 110 (548)	1322 548	723.91	3.841	Reject Ho
13	Clips	1:1	Urban Rural	1490 (1322) 333 (548)	1322 548	105.70	3.841	Reject Ho
14	Condenser Liebig 50cm^3	1:50	Urban Rural	54 (27) 20 (11)	1322 548	34.36	3.841	Reject Ho
15	Copper Plates 20cm*5cm*3mm	1:25	Urban Rural	262 (53) 00 (22)	1322 548	846.17	3.841	Reject Ho
16	Cork Borers	1 set:50	Urban Rural	13 (27) 00 (11)	1322 548	18.26	3.841	Reject Ho
17	Corks Assorted Dimension	1 pak:10	Urban Rural	655 (133) 00 (55)	1322 548	2103.75	3.841	Reject Ho
18	Cotton Wool	1 bdl:50	Urban Rural	95 (27) 00 (11)	1322 548	182.26	3.841	Reject Ho
19	Crucibles Porcelain with lids 58*36mm*4	1:1	Urban Rural	611 (1322) 142 (548)	1322 548	683.19	3.841	Reject Ho
20	Petri Dishes 10cm*5cm	1:1	Urban Rural	731 (1322) 296 (548)	1322 548	380.09	3.841	Reject Ho
21	Deflagrating spoon, with cover	1:50	Urban Rural	88 (27) 00 (11)	1322 548	148.81	3.841	Reject Ho
22	De – ionizer,	1:50	Urban Rural	102 (27) 00 (11)	1322 548	219.33	3.841	Reject Ho
23	Dropping Pipettes (glass)	1:1	Urban Rural	1195 (1322) 110 (548)	1322 548	362.28	3.841	Reject Ho
24	Funnels (polythene) 6.5cm	1:1	Urban Rural	1215 (1322) 121 (548)	1322 548	341.38	3.841	Reject Ho
25	Funnels glass (6.5cm)	1:10	Urban Rural	743 (133) 49 (55)	1322 548	2798.40	3.841	Reject Ho
26	Filter paper (11cm)	1:2	Urban Rural	1120 (661) 128 (274)	1322 548	396.53	3.841	Reject Ho
27	Flask, Volumetric (1000cm^3)	1:25	Urban Rural	70 (53) 46 (22)	1322 548	31.63	3.841	Reject Ho
28	Flask, Volumetric (2000cm^3)	1:50	Urban Rural	56 (27) 19 (11)	1322 548	36.97	3.841	Reject Ho
29	Flask, distilling with side arms (250cm^3)	1:50	Urban Rural	36 (27) 08 (11)	1322 548	3.82	3.841	Uphold Ho
30	Funnel (Separating) 100cm^3	1:50	Urban Rural	390 (27) 114 (11)	1322 548	964.45	3.841	Reject Ho
31	Funnel, Thistle (25cm^3)	1:50	Urban Rural	475 (27) 48 (11)	1322 548	7557.94	3.841	Reject Ho
32	Flasks, Flat Bottom (250cm^3)	1:25	Urban Rural	263 (53) 164 (22)	1322 548	1748.62	3.841	Reject Ho
33	Fire Blanket (asbestos cloth)	1:50	Urban Rural	3 (27) 00 (11)	1322 548	32.33	3.841	Reject Ho
34	Flasks, Conical (250cm^3)	3:1	Urban Rural	1857 (3966) 104 (1644)	1322 548	2564.08	3.841	Reject Ho
35	Flat bottom flasks (500cm^3)	1:25	Urban Rural	166 (53) 00 (22)	1322 548	262.92	3.841	Reject Ho
36	Bell-jar (open top, 25cm*15cm)	1:50	Urban Rural	51 (27) 14 (11)	1322 548	22.15	3.841	Reject Ho
37	Gas Jar Cover	1:50	Urban Rural	238 (27) 00 (11)	1322 548	1659.93	3.841	Reject Ho

S/N	ITEMS	Ratio Specified	Location	O & E Freq	No of Users	X^2cal	X^2crit	*Inference*
38	Gas jar (20*5cm)	1:50	Urban Rural	230 (27) 00 (11)	1322 548	1537.26	3.841	Reject Ho
39	Glass Rods (6 – 5mm)	3kg:50	Urban Rural	170 (80) 125 (44)	1322 548	250.36	3.841	Reject Ho
40	Glass Tubing assorted	4kg:50	Urban Rural	136 (106) 00 (44)	1322 548	52.49	3.841	Reject Ho
41	Graduated Cylinders (100cm^3, glass)	1:5	Urban Rural	603 (265) 27 (110)	1322 548	493.74	3.841	Reject Ho
42	Graduated Cylinders (25cm^3, glass)	1:5	Urban Rural	267 (265) 51 (110)	1322 548	31.66	3.841	Reject Ho
43	Graduated gas Syringes, plastic (50cm^3)	1:1	Urban Rural	237 (1322) 04 (548)	1322 548	1430.52	3.841	Reject Ho
44	Glass wool	1kg:50	Urban Rural	12 (27) 03 (11)	1322 548	14.15	3.841	Reject Ho
45	Grease (Vaseline)	250kg:50	Urban Rural	75 (6610) 21 (2740)	1322 548	9159	3.841	Reject Ho
46	Indicator Bottles, plastic (50cm^3)	1:1	Urban Rural	415 (1322) 238 (548)	1322 548	797.64	3.841	Reject Ho
47	Meter Rules	1:10	Urban Rural	255 (133) 28 (55)	1322 548	125.16	3.841	Reject Ho
48	Mortar And Pestle	1:50	Urban Rural	123 (27) 25 (11)	1322 548	359.15	3.841	Reject Ho
49	Pipettes (25cm^3)	1:1	Urban Rural	1266 (1322) 230 (548)	1322 548	186.91	3.841	Reject Ho
50	Pipettes straight graduated 0 – 25cm^3	1:5	Urban Rural	433 (265) 225 (110)	1322 548	226.73	3.841	Reject Ho
51	Porous Pot 3cm*18cm	1:50	Urban Rural	147 (27) 67 (11)	1322 548	818.42	3.841	Reject Ho
52	Periodic Table	1:50	Urban Rural	210 (27) 20 (11)	1322 548	1247.70	3.841	Reject Ho
53	Reagent Bottles (250cm^3)	1:2	Urban Rural	1099 (661) 490 (274)	1322 548	460.51	3.841	Reject Ho
54	Reagent Bottles wide Mouth (250cm^3)	2:1	Urban Rural	361 (2644) 283 (1096)	1322 548	2574.36	3.841	Reject Ho
55	Retort Stands, 45cm rod, base 20cm*15cm	1:1	Urban Rural	1439 (1322) 226 (548)	1322 548	199.56	3.841	Reject Ho
56	Retort clamps	1:1	Urban Rural	1494 (1322) 152 (548)	1322 548	308.54	3.841	Reject Ho
57	Retort Rings (7cm)	2:1	Urban Rural	607 (2644) 66 (1096)	1322 548	2537.33	3.841	Reject Ho
58	Rubber stoppers assorted single double holes	3:1	Urban Rural	320 (3966) 120 (1644)	1322 548	4764.58	3.841	Reject Ho
59	Rubber stoppers, assorted, solid	2:1	Urban Rural	264 (2644) 110 (1096)	1322 548	3029.40	3.841	Reject Ho
60	Stand, burette, wooden heavy base, 20*15*2.5cm	1:1	Urban Rural	822 (1322) 63 (548)	1322 548	618.35	3.841	Reject Ho
61	Spatula (Nickel) 15cm	1:1	Urban Rural	549 (1322) 70 (548)	1322 548	868.93	3.841	Reject Ho

S/N	ITEMS	Ratio Specified	Location	O & E Freq	No of Users	X^2*cal*	X^2*crit*	*Inference*
62	Test tube racks to hold 10 tubes	1:1	Urban Rural	1037 (1322) 130 (548)	1322 548	380.28	3.841	Reject Ho
63	Splints, wood	12bundles:50	Urban Rural	66 (318) 57 (132)	1322 548	242.31	3.841	Reject Ho
64	Test Tube (borosilicate, 16*150mm)	10:1	Urban Rural	2430 (1322) 610 (548)	1322 548	5256.54	3.841	Reject Ho
65	Boiling tubes (borosilicate, 24*24*25mm)	3:1	Urban Rural	802 (3966) 291 (1644)	1322 548	3637.69		Reject Ho
66	Test tube holders (wooden)	1:1	Urban Rural	780 (1322) 230 (548)	1322 548	406.74	3.841	Reject Ho
67	Tapers Wax	0.5kg:50	Urban Rural	102 (14) 40 (6)	1322 548	745.81	3.841	Reject Ho
68	Thermometers, 0^0C to 110^0C	1:1	Urban Rural	263 (1322) 113 (548)	1322 548	1193.62	3.841	Reject Ho
69	Thermometers, 0^0C to 360^0C	1:25	Urban Rural	20 (53) 00 (22)	1322 548	42.55	3.841	Reject Ho
70	Tongs, crucibles (15cm, stainless steel)	1:1	Urban Rural	167 (1322) 00 (548)	1322 548	1557.10	3.841	Reject Ho
71	Tubing, rubber (5mm Internal Diameter	1:5	Urban Rural	84 (1322) 00 (548)	1322 548	233.63	3.841	Reject Ho
72	Tripod stands to suit standard bunsen burners(20cm high)	1:1	Urban Rural	650 (1322) 76 (548)	1322 548	748.13	3.841	Reject Ho
73	U - tubes short with arms (absorption)	1:25	Urban Rural	97 (53) 00 (22)	1322 548	58.53	3.841	Reject Ho
74	Voltmeters, 0 - 5volts * 0.1V	1:5	Urban Rural	3 (265) 00 (110)	1322 548	369.03	3.841	Reject Ho
75	Wash bottles, polythene (250cm^3)	1:5	Urban Rural	1313 (265) 49 (110)	1322 548	33.83	3.841	Reject Ho
76	Wire gauze with asbestor center (15cm^2)	1:1	Urban Rural	302 (1322) 89 (548)	1322 548	1171.14	3.841	Reject Ho
77	Watch glasses (7.5cm)	1:1	Urban Rural	916 (1322) 49 (548)	1322 548	579.07	3.841	Reject Ho
78	Weighing bottles with cap, glass (25*50mm)	1:25	Urban Rural	260 (53) 07 (22)	1322 548	818.70	3.841	Reject Ho
79	Water baths	1:25	Urban Rural	66 (53) 72 (22)	1322 548	116.83	3.841	Reject Ho
	Overall X^2cal Value					997.46	3.81	Reject HO_2

The result of data analysis presented in Table 4 revealed that the overall X^2cal value of 997.46 is greater than the X^2crit value of 3.81, hence, HO_2 is rejected. This means that the level to which Chemistry laboratory equipment available correspond to standard measures stipulated by WAEC does depend significantly on school location.

Discussion on Findings

Level to which Chemistry Laboratory Facilities in Secondary Schools in Anambra State Correspond to the Standard stipulated by WAEC

The analysis of the result in Table 1 in chapter four showed that in terms of Chemistry laboratory facilities, laboratory room, storage room, laboratory tables and laboratory chairs corresponded to the standard stipulated by WAEC standard; Chemistry laboratory equipment, running water, adequate electricity, storage room for chemicals, preparatory room and fume cupboard did not correspond to the standard stipulated by WAEC while dark room was not available in all the schools.

The results is so because the laboratory rooms, storage rooms laboratory table and laboratory chairs have been provided when the Chemistry laboratories were being constructed to ensure that students are actively involved in experimental activities. Again, maintenance and repairs may have been constantly carried out to keep the facilities in good conditions. For running water, adequate electricity, store room for chemicals and preparatory room not corresponding indicates that funds may not have been made available to provide those facilities. It is possible that power gadgets have broken down without any maintenance attention. That dark room is not available could stem from the fact that utility of such facility is scarce and therefore draws no attention to the Chemistry teachers or the school authorities.

The result is in consonance with Nwele (2012) who found that the extent of availability of laboratory facilities is very low in science laboratories in secondary schools in Abakiliki zone of Ebonyi state. The finding also agrees with the finding of Zengela and Alemayehu (2016) in their study on the practice and problems in science laboratory activities in the secondary schools in Wolaita Zone, Ethiopia. Zengela and Alemayehu found that there was inadequate supply of laboratory facilities. This they concluded is a major constraint to laboratory activities in secondary schools.

As regards hypothesis one, there was a significant dependence of school location (urban or rural) on correspondence of Chemistry laboratory facilities in Anambra State secondary schools to the standard specified by WAEC. This results is an indication that the supply of Chemistry laboratory facilities differs significantly between the urban and rural area. This result agrees with Nwele (2012) whose work reported poor safety measures in science laboratory of which Chemistry is apart.

Level to which Chemistry laboratory equipment available in Anambra State Secondary schools corresponds to standard stipulated by WAEC

The analysis of the result presented in Table 2 showed that thirty-eight (38) items of equipment in the Chemistry laboratory correspond to the ratio of equipment to users as stipulated by the WAEC standard. However, forty-one (41) items of laboratory equipment did not correspond to the standard stipulated by WAEC of all the available 79 equipment available in secondary schools in Anambra State. This provision is below the average of required Chemistry laboratory equipment.

This result is so because probably purchases are not being made to stock the laboratory of the needed equipment. It could be that the maintenance culture of the school is low whereby some equipment that are broken down could not be repaired. It is also possible that some of the Chemistry laboratory equipment have been stolen without any replacement being made. This definitely reduces the number of equipment available for use in Chemistry laboratory.

The result is in tandem with the outcome of the study conducted by Chogyel and Wangdi (2021) on the factors influencing the teaching of Chemistry in class nine and ten in the schools under Chhukha District, Bhutan. The study highlighted that the lack of laboratory resources, limited time allocated for Chemistry theory and practical classes, and teachers' heavy workload impacted negatively to the teaching of Chemistry.

In terms of hypothesis two, there was a significant dependence of school location (urban or rural) on the correspondence of Chemistry equipment available in Anambra State secondary schools to the standard specified by WAEC. This result means that the correspondence of Chemistry equipment availability to the standard stipulated by WAEC has a big gap between urban and rural schools due to location. This result is in line with the study of Oko (2017) which indicated that safety devices were not adequately provided for in the secondary school science laboratory in Abakaliki Education Zone.

Conclusion

This study assessed the standard measures in secondary schools' Chemistry laboratories in Anambra State using WAEC specification as a standard in correspondence of laboratory facilities and equipment. The poor performance of students in Chemistry in the State has been attributed to poor achievement in the practical aspect of the WAEC examinations. Again, the poor achievement in practical Chemistry was attributed to possible non-correspondence of laboratory facilities and equipment in the secondary schools' laboratories in Anambra State to the standard measures stipulated by WAEC. It appeared that most of the facilities and equipment which were supposed to be in the secondary schools' Chemistry laboratories were either not available, not purchased at all or damaged and not replaced.

This study adopted a descriptive survey design, in which a group of people or objects considered as true representation of the population are drawn for used for study. The design was considered appropriate because it enabled the researchers to collect relevant data from the sampled schools using the West African Examinations Council (WAEC) observatory checklist for Chemistry laboratory containing standard measures for facilities and equipment for the secondary schools' Chemistry laboratories.

The study was carried out in all the six (6) Education Zones in Anambra State, Nigeria being one of the five

States geographically located in South East, Nigeria. The State was chosen for the study because of reported cases of the state of the Chemistry laboratories in secondary schools in the State as the precursor for poor achievement of students in Chemistry in external examinations. Co-educational public schools were used for the study. The choice of the area for this study was also informed by the consideration that Anambra State being an educationally advantaged State should have secondary schools with well-equipped Chemistry laboratories. However, poor performance of students in public examination in Chemistry has been attributed to paucity of Chemistry laboratories in terms of facilities and equipment. Therefore, the researchers assessed the correspondence of Chemistry laboratory facilities and equipment to standard measures stipulated by WAEC to establish the cause of the poor achievement.

The study population consisted of all the public secondary schools that have Chemistry laboratories in the six Education Zones of Anambra State. The sample comprised forty eight (48) public secondary schools that have Chemistry laboratories. And data were collected using the observatory checklist for Chemistry developed by West African Examinations Council (WAEC) specifications for facilities and equipment for secondary schools' Chemistry laboratories, which contained information on standard measures of (quantity, number of students and ratio) of facilities and equipment. The instrument was appropriately validated and reliability established using inter-rater reliability by Kendall Coefficient of Concordance at coefficients of 0.82 and 0.78 respectively. The final reliability coefficient was 0.80. Research questions were answered using frequencies and ratios while Chi - square (X^2) independence was used to test the hypotheses at 0.5 level of significance.

The results of the study revealed that the level of correspondence of facilities and equipment to the standard stipulated by WAEC for use in secondary schools Chemistry laboratories was low in secondary schools in Anambra State. Recommendations were made, which these researchers hope that when implemented would make available sufficient laboratory facilities and equipment and consequently enhance greatly students' performance in Chemistry.

Recommendations

Based on the findings of the study, the researchers recommended the following:

1. Anambra State Government should pay close attention to the need for compliance to standard measure specified by WAEC for Chemistry laboratory facilities and equipment for secondary schools' Chemistry laboratories in the State.
2. Schools authorities should adequately supervise the supplies of Chemistry laboratory facilities and equipment made by contractors who were awarded contracts to provide and furnish public school laboratories.
3. Teachers should from time to time give feedback to school management on the state of available Chemistry laboratory facilities and equipment to ensure correspondence of the listed items to the standard specified by WAEC.
4. Workshops and seminars should be organized for Chemistry teachers and laboratory attendants on the need for the management of Chemistry laboratory facilities and equipment to maintain stability of laboratory materials to meet the standard specified by WAEC for secondary schools' Chemistry laboratories.

Educational Implications of the Study

The findings of the study have educational implications to Chemistry students and teachers. Students taught practical Chemistry in a Chemistry laboratory where the facilities and equipment correspond to standard specified by WAEC learn the concepts and practices of Chemistry better. There would be a high level of adequacy of all the needed resources for learning in Chemistry laboratory and less probability of over–crowding when there is correspondence of Chemistry facilities and equipment to WAEC specification.

For the teachers, learning environment would be conducive and the practical teaching would be with ease as the required facilities and equipment would be available at the right mix.

Limitations of the Study

1. Some secondary schools were reluctant to grant access to school laboratory initially which brought about delay in executing the project.
2. The WAEC officials were reluctant in supplying the benchmark needed for this study.

Acknowledgements

The researchers are very highly appreciative of the kind gesture of Asso. Professor Harold Chinedu Okeke; the Director/CEO Nedtac Consults, Enugu, Enugu State, Nigeria. The Consult provided Advisory and Financial Support, which ensured the successful completion of Doctoral project that produced this paper. The researchers are also grateful to the Secondary schools' authorities whose Chemistry laboratories were used for the field work of this study. The researchers wish to state unequivocally that there is no conflict of interest between them in

carrying out the entire work.

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