ADOPTION OF MEASUREMENT AND EVALUATION IN TEACHING SCIENCE SUBJECTS IN SCHOOL IN AKWA IBOM STATE: EMPIRICAL STUDY OF THE PROSPECTS AND EFFECTS

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ABSTRACT

The focus of this study was to examine the adoption of measurement and evaluation in science teaching. The study was conducted in Akwa Ibom State. A descriptive survey design was adopted for the study. The target population for this study was all science and mathematics teachers in public secondary schools in Akwa Ibom State. A stratified sampling technique was used to select 80 science teachers and 40 mathematics teachers from public secondary schools in Akwa Ibom State. This gave a total of 120 respondents used in the study. The research instrument used for data collection was a structured questionnaire titled "MEASUREMENT AND EVALUATION IN SCIENCE TEACHING QUESTIONNAIRE (MESTQ)". Face and content validation of the instrument was carried out by an expert in testing, measurement, and evaluation to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.87, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical techniques such as percentage analysis to answer the research questions, while regression analysis was used to test the hypothesis. The test for significance was done at 0.05 alpha levels. It was discovered in the study that evaluation and measurement ascertain the effectiveness of teaching and the quality of students' performance or achievement before, during, and at the end of the teaching and learning process. It was concluded in the study that measurement and evaluation are critical to the teaching-learning process as no teaching is meaningful without evaluation. Moreover, it was concluded that there is a significant effect of measurement and evaluation in the teaching of science subjects. One of the recommendations was that teachers should be abreast of the various techniques involved in testing, measuring, and evaluating students in their learning activities.

KEYWORDS: Measurement, Evaluation, Science, Secondary school, and Akwa Ibom State

Introduction

Measurement and evaluation are key components of science education and the teaching-learning process. Teaching and learning are incomplete without the process of measurement and evaluation, and the extent to which instrument objectives are attained is achieved through the process of measurement and evaluation. Outlander and Crelsson (2006) showed that the role of practice is to help teachers to work together with students so as to build the connection between theory and practice in real-life situations and therefore increase motivation on the part of the students. The absence of the laboratories hinders the students and teachers from working together in a practical session, and therefore, students fail to connect the theory of what they learn in the classroom with the practical, and then they are de-motivated.

When examining the place of measurement and evaluation in teaching science, it is observed that one of the most important areas where measurement and evaluation are used for the future of societies is education and training. For this reason, all societies, especially the developed countries, aim to bring quality education to individuals by using technology (Milli Egitim Bakanligi [MEB], 2006). In today's world where education is influenced by technology, the use of computer technology in the teaching-learning process has become compulsory because it is negatively affected by a teaching approach that is not reflected in the educational environment and away from technology (Erdemir, Bakirci, & Eyduran, 2009).

Oktay & Cakir (2013) found that the measurement and evaluation supported teaching used in the 8th-grade science class showed a significant difference in favor of the experimental group in terms of success and permanent learning. It is expected that the use of technological applications in education will contribute to the development of the student's attitude toward the course. One of the prominent variables affecting the achievement of a course is the attitude towards that course (Cheung, 2009; Erokten, 2017; Guden & Timur, 2016; Gurbuzoglu Yalmanci, 2016). For this reason, one of the most prominent aims of parents and educators should be to improve and increase the attitudes of students towards the class in a positive way (Akcay, Aydogdu, Yildirim, & Sensoy, 2005). Technology-enriched teaching can also contribute to the achievements of the students by improving attitudes towards the course with interesting and interactive technological applications that can provide attendance.

Statement of Problem

Despite the fact that the Akwa Ibom State government put much effort into building community secondary schools just to improve the quality of science learning in Akwa Ibom State, the majority of community secondary schools lack functional laboratories due to a lack of equipment and materials. Some of the schools have no laboratories at all and try to use a classroom which does not provide a suitable setting for practical work. This has led to difficulty in understanding the science concepts, which is revealed by the poor performance of science students in science subjects on the final examination. Therefore, the study explores the effects of measurement and evaluation in teaching science subjects in Akwa Ibom State.

Objectives of the Study

The main purpose of this study was to examine the adoption of measurement and evaluation in teaching science subjects in Akwa Ibom State. Specifically, the study sought to:

1. Examine the extent to which measurement and evaluation is used in teaching science subjects in schools in Akwa Ibom State
2. Find out the prospects of measurement and evaluation in teaching science
3. Determine the effects of measurement and evaluation on science teaching

Research Questions

The following research question were formulated to guide the study

1. What is the extent to which measurement and evaluation is used in teaching science subjects in schools in Akwa Ibom State?
2. what is the prospects of measurement and evaluation in teaching science?
3. What is the effects of measurement and evaluation on science teaching?

Hypothesis

The null hypothesis states that:

1. There is no significant effect of measurement and evaluation on science teaching

Conceptual Review

Concept of Measurement and Evaluation

Measurement is the process of associating numbers with physical quantities and phenomena. Measurement is fundamental to the sciences, to engineering, construction, and other technical fields, and to almost all everyday activities. For that reason, the elements, conditions, limitations, and theoretical foundations of measurement have been much studied. See also measurement systems for a comparison of different systems and the history of their development. Measurements may be made by unaided human senses, in which case they are often called estimates, or, more commonly, by the use of instruments, which may range in complexity from simple rules for measuring lengths to highly sophisticated systems designed to detect and measure quantities entirely beyond the capabilities of the senses, such as radio waves from a distant star or the magnetic moment of a subatomic particle. Measurement begins with a definition of the quantity that is to be measured, and it always involves a comparison with some known quantity of the same kind. If the object or quantity to be measured is not accessible for direct comparison, it is converted or "transduced" into an analogous measurement signal. Since measurement always involves some interaction between the object and the observer or observing instrument, there is always an exchange of energy, which, although in everyday applications is negligible, can become considerable in some types of measurement and thereby limit accuracy.

According to Tufo (2002), evaluation is seen as a systematic process of determining the extent to which educational objectives are achieved by pupils. This definition indicates that evaluation is a systematic process, and it omits casual, informal, or uncontrolled observation of the pupils. The definition also implies that the objectives of education have to be identified in advance. Without predetermined objectives, it is not possible to judge the progress, growth, and development of students. Evaluations should be as systematic and impartial as possible

(UNEG, 2005). An evaluation is methodical, providing information that is credible, reliable, and useful to enable the incorporation of lessons learned into the decision-making processes of users and funders. Evaluation is based on empirical evidence and typically on social research methods, thus on the process of collecting and synthesizing evidence (Rossi Lipsey and Freeman, 2004). Assessment of evaluation considers value, merit, worth, significance, or quality. It may aim to identify what works for whom, in what respects, to what extent, in what contexts, and how (Pawson and Tilley, 2004). It may examine expected and achieved accomplishments, the results chain, processes, contextual factors, and causality in order to understand achievements or the lack thereof. Evaluation may focus on a broad range of topics, including relevance, accessibility, comprehensiveness, integration, fulfillment of objectives, effectiveness, impact, cost, efficiency, and sustainability. The evaluation process normally involves some identification of relevant standards, some investigation of performance on these standards, and some integration or synthesis of the results to achieve an overall evaluation (OECD, 2010).

According to Scriven (2003), being that evaluation is an initiative, it can focus on any kind of initiative, such as programs, projects, sub-programs, sub-projects, and/or their components or elements. It can be conducted for the purposes of decision making, judgements, conclusions, findings, new knowledge, organizational development, and capacity building in response to the needs of identified stakeholders, leading to improvement, decisions about future programming, and/or accountability, ultimately informing social action and contributing to organizational or social value (Yarbrough et al, 2011).

Concept of Science

The word science comes from the old French and is derived from the Latin word scientia, meaning knowledge, which in turn comes from Scio, meaning "I know." From the middle ages to the enlightenment, science, or scientia, meant systematic recorded knowledge. From classical times until the events of the modern period, philosophy was roughly divided into natural philosophy and moral philosophy. In the 1800s, the term "natural philosophy" gradually gave way to the term "natural science" (Feyerabend, 2005). Natural science gradually specialized into its current domain, which typically includes the physical sciences and the biological sciences. The realm of moral philosophy is currently also included under the auspices of science.

According to Burne (2007), science is defined as the systematic study of anything that can be examined, tested, and verified. Science is the branch of knowledge or study dealing with a body of facts or truth systematically arranged and showing the operations of general laws. It is systematic knowledge of the physical or material world gained through observation and experimentation. According to MacComas (2002), science is classified into two different categories: natural and physical science. He goes on to say that there are related disciplines that are grouped into interdisciplinary and applied science, such as engineering and health science. Not all studies are scientific studies. Scientific studies follow a systematic procedure. Still, science is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe (Heilbron 2003). Science is characterized by knowledge gained as it accumulates as time goes by, building on work performed earlier. Some of this knowledge, such as our understanding of numbers, stretches back to the time of ancient civilization when scientific thought first began. However, in all fields

of science, old or new, researchers use the same systematic approach, known as the scientific method, to add to what is already known (Burne, 2007). This scientific method seeks to explain nature in a replicable way and uses these explanations to make useful predictions. It is done through experimentation that tries to stimulate events under controlled conditions. During scientific investigations, scientists put together and compare new discoveries with existing knowledge. In most cases, new discoveries extend what is currently accepted, providing further evidence that existing ideas are correct.

Concept of Science Subjects

Science subjects not only provide students with an in-depth understanding of the physical, chemical, and biological components of the science subject, but they also help them develop analytical and problem-solving skills. According to Cohen (2021), modern science is typically divided into three major branches: natural sciences (e.g., biology, chemistry, and physics), which study the physical world; the social sciences (e.g., economics, psychology, and sociology), which study individuals and societies; Colander et al (2019), and Nisbet et al (2020); and the formal sciences (e.g., logic, mathematics, and theoretical computer science), which study formal systems, governed by axioms and rules. The disciplines aid in the understanding of the natural and manmade processes in the world. While science is an imperative choice for students who wish to make a career in the field, it can also be a great choice for those who are not so sure of their career paths. Science is diverse and does not restrict students to any one area of study. However, it is important to understand what the science stream subjects are and whether they will be a good fit for you. According to Rucker (2019), there is disagreement about whether the formal sciences are science disciplines, because they do not rely on empirical evidence. Nickles (2013) stated that applied sciences are disciplines that use scientific knowledge for practical purposes, such as in engineering and medicine.

Physics studies the science of matter, motion, force, and energy, and it is one of the world's oldest academic areas. Further studies in physics, such as the study of electromagnetics, thermodynamics, mechanics, nuclear physics, and solid-state physics, enable technological improvements and speed up innovation. Physics in grades 11 and 12 will aid in the development of observational, analytical, investigative, and decision-making skills, as well as conceptual comprehension, creative thinking, and problem-solving abilities. Chemistry is the study of atoms and matter, which are the building blocks of life. This science stream course covers the characteristics, composition, and structure of matter in great detail. Biomolecules, synthetic materials, industrial chemistry, and natural resources are some of the new disciplines of chemistry that have emerged as a result of technological advancements. To make topics easier to understand, the theoretical notions are supplemented with practical experiments. The studies address numerous ideas through themes including surface chemistry, atomic structure, chemical kinetics, and chemical bonding, with organic and inorganic chemistry as the primary sub-divisions. Biology is the study of life forms, and in grades 11 and 12, it focuses on establishing a solid conceptual foundation while also tying the subject to real-world technology, agriculture, health, and industry.

Concept of Science Teaching

Science does not simply sit down and pray for things to happen, but seeks to find out why things happen. It experiments and tries again and again and sometimes fails and sometimes succeeds, and so bit by bit it adds to human knowledge. This modern world of ours is very different from the ancient world or the middle ages. This great difference is largely due to science. Science has become an integral part of our lives. Science has also influenced educational enterprise, and hence it is also an integral part of our educational system. The teaching of science has become an unavoidable part of general education. Teaching of science means going beyond the content to help students understand how we know what we know and giving them the tools they need to think scientifically. Most importantly, it involves making explicit references to the process of science (Lederman, 2007) and allowing students time to reflect on how they have participated in the process (Schwartz et al., 2004).

Teaching of science therefore requires going beyond what is offered in most textbooks, but that doesn't mean it has to replace the content you want to teach.

- In a lecture course, for example, "teaching the process" can mean reorganizing a lecture to show how our understanding of a concept has developed historically, emphasizing contributions from many scientists and the complications and dead-ends along the way.
- In a lab-or field-based course, "teaching the process" can mean designing activities that allow students to actually engage in a real process of inquiry.
- In all cases, "teaching the process" means making explicit reference to those aspects you wish to teach; if students are creating posters to describe the results of their inquiry, you need to make an explicit connection to scientists presenting their research at professional meetings.

The Prospects of Measurement and Evaluation in Teaching Science

Science and learning sustainability is an innovation that aims to sustain learning outcomes among students through effective measurement and evaluation. Future science assessments need to integrate relevant science practices; they need to be able to integrate students' assessment of their knowledge of the core ideas together with science and engineering practices (NRC, 2010). According to Andrew (2018), without evaluation and measurement, it is impossible to know a student's needs and preferences. Evaluation is also used by colleges to determine which students can be admitted. While the specific purposes of measurement and evaluation can vary, there is one underlying theme: measurement and evaluation are required to determine whether students are learning.

For teachers to be able to increase students' scientific literacy, they will need proper teacher education and professional development. Teachers will need to be able to improve pre-service teachers' ability to incorporate STEM concepts, prompting students to ask their own questions, develop and refine their questions and experimental design, and disseminate results to peers and the larger scientific community (French & Burrows, 2018). The major purposes of evaluation are to: diagnose a learner's difficulties in curricular programmes, appraise the teacher's instruction; and Checking learners' progress and guiding them accordingly through

feedback and instructional programmes. Evaluation focuses on what to measure, how to measure and how good the measurement is. There are numerous prospects for measurement and evaluation in the teaching of science, which basically include:

- **Student Progress:** Without measurement and evaluation, it is impossible to know whether students are making any progress. Tests and assignments can tell teachers which students know the material, which students are trying to learn and which students are not trying at all. While evaluations are not perfect in determining student achievement (some students underperform in spite of effort because of learning disabilities), the progress in a student's grades over time can say a lot about where that student is and where he needs to be (Andrew 2018).
- **Student Needs:** The most basic purpose of educational evaluation is to determine what a student's needs are. With proper testing and evaluation in the early grades, learning disabilities and handicaps can be identified and dealt with. Without testing, problems can go unrecognized for years. While educational testing cannot in itself be the basis for a diagnosis, it can point students in a direction that may ultimately lead to a psychologist, who can diagnose conditions.
- **Student Aptitudes:** In today's complex, knowledge-based economy, students must have specialized skills before they can have a successful career. The streaming of students into educational programs begins with standardized testing, which identifies student aptitudes and abilities (Andrew 2018). While standardized tests are somewhat controversial due to their potential for misuse, there is no denying that they can be effective in identifying intellectual gifts and helping students know the areas in which their talents can be useful.
- **College Admissions:** Eventually, students get to their last year of high school. At this point, a student needs to get the best grades possible in order to get into a good college. While it is possible to debate the merits of college admissions processes based primarily on grades, there is no question that such a process is in place at many colleges. Therefore, a rigorous system of testing and evaluation, in which teachers provide students with many smaller assignments in order to address issues before the big assignments, will help a school's college placement rate in the long run.

The effects of Measurement and Evaluation on Teaching Science

Future science assessments need to integrate relevant science practices; they need to be able to integrate students' assessment of their knowledge of the core ideas together with science and engineering practices (NRC, 2010). To be able to support learning, teachers will need to be able to transform their teaching practices and develop effective assessments (Crawford, 2014; Bybee, 2014). The lack of use of argumentation is troubling because of the central role it plays in students' ability to use evidence to create arguments for science literacy (NGSS Lead States, 2013). Modeling and using mathematical and computational reasoning are another set of science practices that are important to science literacy (NGSS lead states, 2013). Research on models and modeling highlights the role of analogical restructuring and strategic recruiting of intuitive models in the process of conceptual change (Amin, Smith, & Wiser, 2014). For engineers, system modeling is essential to developing complex technologies and helps students understand the relationships between micro and macro scales and provides opportunities for students to reason scientifically (Cunningham & Carlsen, 2014).

Science can provide concrete examples of abstract mathematical ideas, and mathematics can provide ways to quantify and explain science relationships and thus deepen science knowledge (Czerniak & Johnson, 2014). Learning environments that use measures and evaluation influence students' emotional states (Dogan, 2012), and they provide important opportunities for teachers to create learning environments in which students are motivated, have fewer behavioral issues in class, and learn more effectively (Bate, Day, & Macnish, 2013). Using these opportunities depends on the use of technology by the teacher, and this occurs when teachers use technology effectively in their class (Dilworth et al., 2012; Escuder, 2013). Caglar (2007) points out that the use of educational technology enriches the educational environment and places students in the learning center.

Methodology

A descriptive survey design was adopted for the study. The study was conducted in Akwa Ibom State. The target population for this study was all science and mathematics teachers in public secondary schools in Akwa Ibom State. A stratified sampling technique was used to select 80 science teachers and 40 mathematics teachers from public secondary schools in Akwa Ibom State. This gave a total of 120 respondents used in the study. The research instrument used for data collection was a structured questionnaire titled "MEASUREMENT AND EVALUATION IN SCIENCE TEACHING QUESTIONNAIRE (MESTQ)". Face and content validation of the instrument was carried out by an expert in testing, measurement, and evaluation to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.87, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical techniques such as percentage analysis to answer the research questions, while regression analysis was used to test the hypothesis. The test for significance was done at 0.05 alpha levels.

Results

Research Question 1: The research question sought to find out the extent to which measurement and evaluation is used in teaching science subjects in schools in Akwa Ibom State. To answer the research question percentage analysis was performed on the data, (see table 1).

Table 1: Percentage analysis of the extent to which measurement and evaluation is used in teaching science subjects in schools in Akwa Ibom State

EXTENTS	FREQUENCY	PERCENTAGE
VERY HIGH EXTENT	60	50
HIGH EXTENT	32	26.7**
VERY LOW EXTENT	17	14.2
LOW EXTENT	11	9.2*
TOTAL	**120**	**100%**

** The highest percentage frequency

* The least percentage frequency

SOURCE: Field survey

The above table 1 presents a percentage analysis of the extent to which measurement and evaluation are used in teaching science subjects in schools in Akwa Ibom State. From the result of the data analysis, it was observed that the highest percentage (26.7%) of the respondents affirmed that the extent to which measurement and evaluation are used in teaching science subjects in schools in Akwa Ibom State is very high, while the least percentage (9.2%) of the respondents stated that the extent is very low. The result therefore means that there is a very high extent of the adoption of measurement and evaluation in teaching science subjects in schools in Akwa Ibom State.

Research Question 2: The research question sought to find out the prospects of measurement and evaluation in teaching science (see table 2).

Table 2: Percentage analysis of the prospects of measurement and evaluation in teaching science.

PROSPECTS	FREQUENCY	PERCENTAGE
STUDENT PROGRESS	68	56.7**
STUDENT NEEDS	45	37.5
STUDENT APTITUDES	5	4.2
COLLEGE ADMISSIONS	2	1.7*
TOTAL	120	100%

** The highest percentage frequency
* The least percentage frequency
SOURCE: Field survey

The above table 2 presents the prospects of measurement and evaluation in teaching science in Akwa Ibom State. From the result of the data analysis, it was observed that the highest percentage (56.7%) of the respondents affirmed that the most prominent prospect of measurement and evaluation in teaching science in Akwa Ibom State is for measuring and evaluating students' progress, while the least percentage (1.7%) of the respondents stated that the prospects is for college admissions.

Research Questions 3: The research question sought to find out the effects of measurement and evaluation on science teaching. To answer the research descriptive statistics was performed on the data, (see table 3).

Table 3: Descriptive statistics of the effects of measurement and evaluation on science teaching

Variable	N	Arithmetic mean	Expected mean	R	Remarks
Science Teaching	120	17.60	12.5	0.88*	*Strong to Perfect Relationship
Measurement and evaluation		16.10	12.5		

The above table 3 presents the result of the descriptive statistic of the effects of measurement and evaluation on science teaching. The two variables were observed to have Strong to Perfect Relationship at 88%. The arithmetic mean for science teaching (17.60) was observed to be greater than the expected mean score of 12.5. In addition to that, the arithmetic mean as regards Management (16.10) was observed to be higher than the expected mean score of 12.5. The result therefore means that there is remarkable effect of measurement and evaluation on science teaching.

Hypothesis Testing

The null hypothesis states that there is no significant effect of measurement and evaluation on science teaching. In order to answer the hypothesis, simple regression analysis was performed on the data (see table 4)

TABLE 4: Simple Regression Analysis of the effect of measurement and evaluation on science teaching

Model	R	R-Square	Adjusted R Square	Std. error of the Estimate	R Square Change
1	0.88*	0.78	0.78	0.64	0.78

***Significant at 0.05 level; df= 118; N= 120; critical R-value = 0.197**

The above table 4 shows that the calculated R-value (0.88) was greater than the critical R-value of 0.197 at 0.5 alpha levels with 118 degrees of freedom. The R-Square value of 0.78 predicts 78% of the effect of measurement and evaluation on science teaching. This rate of percentage is highly positive and therefore means that there is significant of measurement and evaluation on science teaching. It was also deemed necessary to find out the effect of the variance of each class of independent variable as responded by each respondent (see table 5).

TABLE 5: Analysis of variance of effect of measurement and evaluation on science teaching.

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	165.70	1	165.70	410.20*	.000b
Residual	47.70	118	0.40		
Total	213.33	119			

a. Dependent Variable: Science Teaching
b. Predictors: Measurement and Evaluation

The calculated F-value is 410.20 and the P-value as .000b. Being that the P-value (.000b) is below the probability level of 0.05, the result therefore means that there is significant effect exerted by the independent variable i.e. Measurement and Evaluation on the dependent variable which is science teaching. The result therefore means that there is significant effect of measurement and evaluation on science teaching. Therefore, the result is in agreement with the research findings of Oktay & Cakir (2013) which stated that the measurement and evaluation supported teaching used in the 8th-grade science class showed a significant difference in favor of the experimental group in sense of success and permanent learning. It is expected that the use of technological applications in the education will contribute to the development of the

student' attitude toward the course. The significance of the result caused the null hypotheses to be rejected while the alternative was upheld.

Conclusion

Measurement and evaluation are critical to the teaching-learning process as no teaching is meaningful without evaluation. Evaluation is the end product of the teaching and learning process. Evaluation ascertains the effectiveness of teaching and the quality of students' performance or achievement before, during, and at the end of the teaching and learning process. Educational measurement, therefore, is the application of various techniques to quantify, describe, and determine a learner's behavior or performance during or at the end of the teaching-learning process. Good knowledge of measurement and evaluation will help the teacher to a very great extent in determining the progress or otherwise of the teaching learning process. There is a very high extent of the adoption of measurement and evaluation in teaching science subjects in schools in Akwa Ibom State. The most prominent prospect of measurement and evaluation in teaching science in Akwa Ibom State is for measuring and evaluating students' progress. There is a significant effect of measurement and evaluation on science teaching.

Recommendations

1. Teachers should be abreast of the various techniques involved in testing, measuring, and evaluating students in their learning activities.
2. The government of Akwa Ibom State should purchase enough science apparatus as well as teaching and learning materials for science subjects to provide a conducive environment to learn science subjects in secondary school, especially in community secondary schools.
3. A closer look at the concept of measurement and evaluation is necessary for clarity and understanding.

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