

Evaluation in the Science Laboratory and Mathematics Classroom in Nigeria

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Abstract

The paper discussed the importance of evaluation in the Science laboratory and Mathematics classroom. The correlation between Science and Mathematics is strong, emphasizing the need for Science and Mathematics teachers to work together to achieve greater success in the development of the students. Evaluation plays a crucial role in Science and Mathematics delivery. It enables a proper assessment of the teaching and learning process. It assesses the teacher's instructional methods, as well as students' learning outcomes. Effective evaluation is a function of the knowledge and understanding of the various types of evaluation, their advantages and disadvantages, how to use them and when to use them. Evaluation is to be done from the beginning to the end of lesson, thus the different types. This paper thus recommends that Science and Mathematics teachers prioritize evaluation in their lessons to improve teaching and learning outcomes.

Keywords: Evaluation, Science, Science Laboratory, Mathematics, Mathematics Classroom,

Introduction

Science can be defined as the effort to understand the causes of phenomena occurring in our natural environment, to predict the aspects that might happen in the future, and to take related precautions in advance (Chalmers, 2013). In Nigeria, science teaching starts at the primary school level, in the form of natural science to help children build up a positive approach towards science. In the Junior Secondary Schools, science is taught as Basic science with a wider scope. The science curriculum is designed such that it is taught in the laboratory, however, most of our schools lack laboratories, or the laboratories are grossly unequipped. Also, most of the teachers still find it more comfortable to use the lecture method of teaching (MoNE, 2018). In Secondary schools, science has been subdivided into three major areas, they are Physics, Chemistry, and Biology, and till today students are still not as successful in the sciences as expected (Aslan & Erden, 2018).

The Science Laboratory

A place, either indoors or outdoors, where scientific investigation is carried out and monitored under controlled conditions is referred to, as the Science laboratory. The science laboratory consists

of every environment where nature may be investigated and observed in a well-equipped classroom or the field, with no boundaries. It is where investigation is carried out, such that the unknown is discovered and the known is verified. The various laboratories that exist include Physics, Chemistry, Biology, Computer, Mathematics, Agriculture, Integrated, Clinical, Virtual, Multi-purpose, and Diagnostic laboratories. The laboratory, which is a better approach to the teaching and learning process has over time, been emphasized for the effective teaching and learning process. The laboratory environment is where theoretical knowledge is tested and various experiments performed, facilitating the reinforcement of what is learned (Wakeling et al., 2017). A productive laboratory environment is a student-centered classroom, which is interactive, comfortable, and where collaborative learning is encouraged. Evidence abounds in research that science teaching in the laboratory is more efficient and effective than the conventional method. Mathematics and science laboratories are different laboratories but have similar goals, which if properly utilized lead to the actualization of national educational goals.

Laboratory work is an integral part of most science courses and provides an environment for effective teaching and learning. Science and Mathematics teaching will not be effective if laboratories are not in place, functional, or well-equipped (Chalmers, 2013). A good laboratory environment promotes students' curiosity, rewards their creativity, and encourages a spirit of healthy questioning. Laboratory practices aim to improve students' psychomotor skills and abilities by providing a conducive environment for conducting experiments.

The goals of laboratory work are:

- a. Mastery of subject matter
- b. Scientific reasoning development
- c. Ambiguity of empirical work is demystified
- d. Practical skills are developed
- e. Nature of science is understood
- f. Interest is developed in science, and makes learning interesting
- g. Teamwork ability is developed.

Science classroom/laboratory should therefore be designed with the following goals in mind:

- a. To empower the learners to use science process skill
- b. To become authority of the said discipline
- c. Allowing more students' involvement through inductive approaches than traditional approaches
- d. More appreciated by the learners
- e. Scientific and phenomena occurrences should be developed
- f. Should be designed in such a way that various groups of students (slow and gifted learners) should appreciate it.
- g. Teamwork should be fostered among the learners
- h. Cultivating interest in science and interest in learning science

The Interconnectivity of Science and Mathematics

Berlin and White (2010) defined the integration of Science and Mathematics as a technique in which scientific methods are used in mathematics, and at the same time, the method by which mathematics is employed in science, meaning that the two courses cannot be distinguished. The integration of science

and mathematics is a situation in which science and mathematics are fully integrated at all levels to an extent where neither can be separated as a separate course.

Science and Mathematics are intertwined bodies of knowledge that are related to the physical world. Science provides concrete samples while Mathematics provides abstract samples. Mathematics is taught and learned more meaningfully when the scientific method is employed while scientific concepts are expressed and analyzed using Mathematics. Mathematics is seen as a course that needs the experimental or quasi-experimental approach, while science course is an approach that uses discovery, finding, and experimenting. They require the same instructional methods, techniques, and strategies. Science and mathematics are embedded in each other. Consequently, the interrelationship between Science and Mathematics has increased the number of studies and widened the horizon of knowledge. Mathematics is the bedrock of physical science, and as such, if developing nations such as Nigeria must catch up with the developed countries, evaluation in the science laboratory and mathematics classroom becomes a necessity, and the processes for such evaluation, handled with utmost importance.

The Science laboratory and Mathematics classroom are very important for educational and national development. This is because the application of the knowledge of Science and Mathematics acquired in the Science laboratory and Mathematics classroom are needed and applied in so many fields and professions, such as Engineering, Technology, Medicine, etc. However, the emphasis placed on this importance in the curricula for these subjects by the policymakers does not appear to translate to great scientific and technological development in Nigeria yet. This is evidenced in the poor performance persistently being posted by Nigerian students in the Science subjects and Mathematics to date in the West African Secondary School Certificate Examination (WASSCE), as reported by WAEC Chief Examiner (WAEC, 2021-2023). Evaluation is a crucial component of the teaching and learning process of science and mathematics. It is therefore important to discuss evaluation

processes, helping teachers know the types of evaluation. This will enable them to decide on the appropriate evaluation process to use at a particular point in the lesson, to improve students' understanding of science and mathematics, hence enhancing their performance in the subjects.

Evaluation in the Science Laboratory and Mathematics Classroom

Ebael (1972) cited in Dikko (2011) defined evaluation as a judgment of merit, sometimes based solely on measurements such as those provided by test scores, but more frequently, involving the synthesis of various measurements, critical incidents, subjective impressions, and other kinds of evidence. It is the procedure of making decisive judgement from data obtained through measurement. Evaluation spans the entire process of planning, development, and implementation of a programme. It reveals the value of a programme, judges the related administrative practices, and assesses the learning outcome in the learners. The decision made on a programme is a function of the evaluation process. This is done to get feedback on the efficiency and usefulness of the programme, seeking to know if the objectives of the programme have been achieved. The decision may be to continue, modify, improve, change, or terminate the programme. Evaluation deals with both qualitative and quantitative values, the evaluation programme involves testing, measuring and the appraisal of growth, adjustment, and achievement through the means of non-test techniques. It also emphasizes broad personality changes and major objectives of the educational programme.

Evaluation is imperative in the teaching and learning process. Gronlund (1981) cited in Dikko (2011) defined evaluation from an instructional point of view as a systematic process of determining the extent to which the learners achieve instructional objectives. It is done to expand knowledge, correct existing mistakes, and assess learning outcomes (Okoro, 2015). In the science laboratory and mathematics classroom then, evaluation will:

1. Provide a database of information regarding pedagogical processes,
2. Discover students' areas of strengths and weaknesses.

3. Reveals if learning has taken place and the extent it has taken place,
4. Find the strengths and weaknesses of the curriculum.

Classification of Evaluation

Evaluation often seen as test in most schools can be classified depending on its use. It can be categorized as follows:

1. Classification according to the Forms of Evaluation

a. **Functional Evaluation** consists of:

- i. Test of intelligence
- ii. Test of achievement
- iii. Test of aptitude

b. **Philosophically evaluation** consists of:

- i. Standardized test
- ii. Non-standardized tests

c. **Structurally evaluation** consists of:

- i. Objective test
- ii. Essay test
- iii. Oral
- iv. Performance test

2. Classification according to the nature of the measurement

Cronbach (1970) cited in Dikko (2011) grouped evaluation procedures into two in terms of the nature of measurement done:

- a. **Maximum performance:** this refers to how well an individual performs in a task assigned to him/her when motivated to put forth his/her best effort.
- b. **Typical performance:** In elevation, typical performance is ascertaining how an individual behaves in a normal situation. The results of such evaluation indicate what an individual will do (personality) rather than what he/she can do (ability).

3. Classification according to the method of interpreting results

a. **Criterion-reference evaluation:**

This is the type of evaluation whereby a teacher describes what a learner can do irrespective of his/her class or course mate.

b. **Norm-referenced evaluation:** This is the interpretation of test result in

terms of how a learner performs relative to his/her class or course mates. In such a case one may report a student's result by saying, "Vivian performed better than 90% of her classmates in the Physics test."

4. Classification according to use in classroom instruction

A. Evaluation by Placement Method:

Placement Method is the evaluation of students' entry behavior in a pattern of instructions. Placement evaluation is designed by teachers in the form of pre-tests that measure learners' baseline knowledge, seeking to establish whether they possess the necessary knowledge and skills to succeed in the planned instructional being intentionally structured for them.

B. Evaluation by Formative Method:

The formative evaluation is the evaluation which is frequently done by the teacher on the students during instruction. Its purpose is to quantify and qualify the instructional progress in order to ascertain whether teaching and learning are taking place as planned.

Advantages of evaluation formative method

- i. It enables improvement in the teaching process.
- ii. It enhances the teaching and learning quality.
- iii. The feedback provided helps the teacher to identify his shortcoming.
- iv. It makes the students active participants in the lesson.
- v. It encourages individualized instruction.

Disadvantages of formative evaluation

- i. It consumes a lot of time.
- ii. It cannot be used to award certificates.

- iii. It does not provide a single measure.

C. Evaluation by Diagnostic Method:

The diagnostic method of evaluation is done by the teacher to specifically identify the difficulties encountered by the learners. It tries to find out the recurring difficulties being experienced by the learner that are yet to be solved with the help of the formative method of evaluation.

D. Evaluation by Summative Method:

The summative method of evaluation is a form of evaluation administered at the end of a course to determine what an individual has learned from the course.

Advantages of Summative Evaluation

- i. It is not time-consuming.
- ii. It provides a single measure.
- iii. It provides information that can be used for promotion.
- iv. It provides service as the basis award.

Process of Evaluation

1. General Observation
 - a. Definition of objective
 - b. Constructing the instrument (test)
 - c. Administering and scoring
 - d. Decision making
 - e. Reporting
2. Based on Tyler's models
 - a. Selecting objectives
 - b. Identification of situation
 - c. Selection of evaluation method

Evaluation Instruments in the Science laboratory and Mathematics classroom

Evaluation instruments that are suitable for use in the Science laboratory and Mathematics classroom include:

1. **Test:** This instrument contains a set of questions used to assess and quantify learners' understanding, knowledge, or skills obtained due to an instruction. Tests can be classified into:

- a. **Teacher-made test:** This is used to assess the attainment of the objectives of the lesson. It is constructed by the subject teacher.
 - b. **Standardized test:** This is usually constructed by a larger number of teachers. It provides a more standard and reliable measurement of the knowledge and skills acquired by the learner.
 - c. **Objective test:** This test is structured in such a way that there is high objectivity in its scoring. In this kind of test, the learner is expected to match items, supply the correct answer, or choose the correct option from options provided in the form of two options or multiple-choice answers.
 - d. **Essay test items:** This form of test requires creativity in writing on the part of the learner in his attempt to answer the questions. The questions are constructed such that the learner needs to express his idea in whatever way he feels appropriate. The scoring of this form of test can be influenced by factors such as the learner's grammar, logical expression of ideas, handwriting, and the emotional state of the assessor.
2. **Observation:** This is a way of assessing certain behaviours, and operational skills in the learners. This is used during practical science and mathematics lessons.

The evaluation instruments must be valid, consistent with the lesson objectives, reliable, comprehensive, and possess the ability to properly diagnose the strengths and weaknesses of the learners.

Evaluation of the teaching and learning process

Evaluating the teaching and learning process of Science and Mathematics as a whole, the following challenges have been encountered over time:

- a. Lack of laboratory/unequipped laboratory.
- b. Creating engaging lesson plans that fit the curriculum.
- c. Understanding the different learning styles.
- d. Teachers' readiness to switch to innovative ways of teaching.
- e. Staying up to date with learning technology.
- f. Large population in class.
- g. Lack of effective communication in the classroom.
- h. Behavior and classroom management.
- i. Lack of training and retraining of teachers.
- j. Lack of funding.
- k. Communicating with parents.
- l. Pressure from school administrators.
- m. Time-consuming administrative work.

Conclusion

This paper has emphasized the crucial role of proper evaluation in Science and Mathematics delivery. Evaluating in the science laboratory and mathematics classroom in terms of the various types of evaluation, functions, and applications thus becomes imperative to ensure effective delivery of Science and Mathematics lessons. Based on the submission of this article, it is recommended that Science and Mathematics teachers prioritize evaluation in their lessons to improve teaching and learning outcomes.

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