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AN ON-THE-SPOT ASSESSMENT OF SCIENCE PROCESS SKILLS IN INTEGRATED SCIENCE

BY

FIDELIS A. ONWIODUOKIT *Associate Professor*
DEPARTMENT OF SCIENCE EDUCATION
UNIVERSITY OF UYO, UYO.

ABSTRACT

The paper aims at identifying process skills involved in Integrated Science as well as show how these skills could be assessed on-the-spot. The skill identified include cognitive, observational, manipulative, computational and communicative. These were assigned relative weights of 30, 25, 20, 15 and 10 marks, respectively. For each process skill, sub-skills were used in constructing performance codes for assessing students' acquisition of the skills. The paper also include a format, using unit 1 (you as a living thing) of the integrated science curriculum, showing how the assessment of the process skills could be done practically on the spot. Considering some inherent problems associated with on-the-spot assessment, it is recommended that more observers be trained and that large classes be broken into groups.

INTRODUCTION

One of the national demands on teachers of junior secondary schools is to teach in a way that will enable pupils to acquire further knowledge and develop skills (NPE, 1981). Skill acquisition is very crucial especially in science teaching/learning at the junior secondary level.

Although the question "how integrated is the science?" is often asked, the importance of presenting science in its wholistic nature at the junior classes cannot be overemphasized. Specifically, the objectives of Integrated Science are to enable learners acquire the following skills:

i)   observing carefully and thoroughly;
  ii)   reporting completely and accurately what is observed;
  iii)   organizing information acquired;
  iv)   generalizing on the basis on the acquired information;
  v)   predicting as a result of the generalization;
  vi)   designing experiments (including control where necessary) to check prediction;
  vii)

Using models to explain phenomena where appropriate; and
  viii)   Continuing the process of enquiry when new data do not conform with prediction.

Man, by nature, is an intelligent being. On the average, man is curious to know what is happening around him especially when the happenings affect his welfare.

Each time one comes across unfamiliar thinks/events, four basic questions come to mind. These questions are: What is it? How does it happen? Why does it happen? And what are the conditions for its possible re-occurence or examination?

Science attempts to answer these questions as it pertains to events and occurrences in the universe. In doing so, certain processes are used. The end product of such enquiries constitute what is known as "scientific knowledge". It should be noted that scientific knowledge is not dogmatic or doctrinal. It is, rather, testable, verifiable and amendable. In other words, the knowledge derived from scientific enquiries is subject to chance as more discoveries are made through more careful observations and experiments. It is for this reason that the processes of science are not rigid but flexible, although cyclic in nature.

This paper intends to discuss the process skills involved in the teaching and learning of integrated science as well as show how the skills could be assessed using on-the-spot assessment technique.

SCIENTIFIC PROCESSES

In teaching Integrated Science, learners should be taught in the same way scientists are engaged in their scientific ventures. The principal work of the scientists includes: observing, describing, explaining ad predicting. To be able to observe, they are required to have trained eyes. With these, they are able to see what others have looked but have not seen.

After observation, the next task is to describe what has been observed before trying to find out possible reason(s) for the occurrence. There could be several things causing the phenomenal effects. The cause can be multiple, linear, immediate or remote. To be able to determine appropriate cause(s) of an happening, the scientist will need to make some wise guesses (hypothesis) and carry out experiments to test them. Predictions are made from the outcome of the experiments. The more reliable the experiments, the more probable the predictions will be.

Hence, in order to solve scientific problems, the following scientific processes are required:

1. observing and identifying problem (OBIP)
2. describing the observed problem (DOBP)
3. hypothesising (HYPO);
4. experimenting (EXPT);
5. interpreting experimental results (INTER);
6. making conclusion and drawing inferences (MACD)
7. predicting (PRED); and
8. further experiments (FUEP).

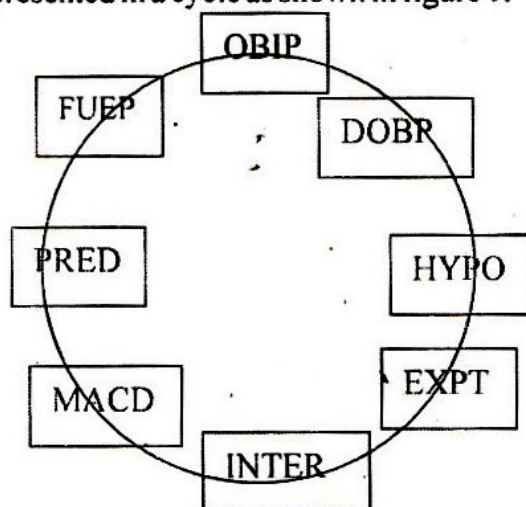This can be represented in a cycle as shown in figure 1:

Fig. I: Processes for solving scientific problems.

While it could be said that the process starts with observation, it should be borne in mind that one can enter the cycle at any point provided that the prerequisite processes are on course.

SCIENTIFIC PROCESS SKILLS

A skill is cleverness at doing something, resulting from either practice or from natural ability. Scientific skills or science process skills, therefore, are skills needed to undertake meaningful scientific enquiry. They are mostly developed rather than being natural. The skills are expected to be inculcated in the pupils as they are guided through scientific processes.

There are many such skills but they can be summarized into five (5) as follows:

1) Cognitive,
2) Observational,
3) Manipulative,
4) Computational, and
5) Communicative.

1. Cognitive Skill: The skill contains variables such as:
   i) Logical reasoning;
   ii) reflective (scientific) thinking;
   iii) synthesising;
   iv) applying knowledge; and
   v) creative thinking.

2. Observational Skill: This has to do with the following abilities:
   i) using sense organs appropriately;
   ii) observing changes in phenomenal effects as independent
   iii) recording of data (or other phenomena observed)
   iv) detecting inconsistencies or contradictions; and
   v) detecting common features or characteristics among objects or events.

3. Manipulative Skill: The sub-skills of manipulative skill include:
   i) handling of objects;
   ii) setting up apparatus;
   iii) modelling;
   iv) eye-hand coordination;
   v) experimenting (manipulating variables); and
   vi) finger dexterity.

4. Computational Skill: This has to do with abilities required in:
   i) quantifying empirical concepts;
   ii) calculation based on data obtained;
   iii) graph plotting;
   iv) making quantitative deductions; and
   v) being accurate in measurements.

5. Communicative Skill: The sub-skills involved here include:
   i) reporting;
   ii) questioning;
   iii) answering question;

iv)   using appropriate language; and
v)   drawing conclusion

It should be noted that the skills though distinct are related. Cognitive skill, for instance, is required in the proper exhibition of all other skills.

ON-THE-SPOT ASSESSMENT OF SKILLS

The common practice in assessing process skills in science has been through pencil and paper tests (Okebukola, 1985; Jegede and Inyang, 1991; and Onwu and Mozube, 1992). Pupils are required to answer questions in their workbooks which are later corrected by the teacher. This is not a useful practice because the assessment is detached from the process within which inculcation of skills took place. Secondly, the practice does not allow the teacher to detect the pupils' problems and to guide them appropriately in the process of sciencing. More often than not, teachers would just mark pupils' anwers right or wrong without discussing with the pupils concerned especially those who got the answers wrong.

An on-the-spot assessment affords an opportunity to correct learners on the spot.

This write-up is intended to encourage teachers to assess pupils' inculcation of science process skills within the processes of scientific enquiry. Assessment should be done on the spot.

ASSESSMENT GRID: The following grid was suggested by Onwioduokit (1993) for assessing skills in practical physics:

1)	Cognitive skill	-	30 marks
2)	Observational skill	-	25 marks
3)	Manipulative skill	-	20 marks
4)	Communicative skill	-	10 marks
5)	Computational skill	-	15 marks.

Considering the greater need for communicative than computational skills at the level of integrated science, the scores assigned to the two skills are, in the present study swapped so that the former carries 15 marks while the letter has 10.

The above shows the relative weight of each process skill in the overall assessment of the pupils. For ease of use, it could be advisable to grade each skill over 100% before finding the equivalent grade in relation to the relative weight. Simply, a pupil who scores 55% under cognitive will finall score 16.50 (that is 55 x 0.30). A similar score under communicative skill will finally become 8.25 (that is, 55 x 0.15). It should be noted that the cognitive skill is given the highest weight because of its crucial role in other skills. For instance, meaningful observation and manipulation are based on proper cognition.

PROCESS SKILLS PERFORMANCE CODES

To be able to assess the skills on the spot, it is necessary to master the performance codes associated with each, with corresponding scores.

1.   <u>Cognitive skill:</u> The following are the performance codes:
i)   ability to make sense out of what is observed;
ii)   knowledge of the science principles involved;
iii)   ability to relate one object or event with others;
iv)   ability to reason logically;
v)   ability to make good guesses;
vi)   ability to design experiments;
vii)   ability to apply the principles of science in solving problem(s) posed;
viii)   ability to deduce from the data or evidence at hand; and
ix)   ability to predict accurately.

For any given concept or activity, these codes can be used to assess how well a pupil possesses the cognitive skill. Each correct item could earn 10 marks, initially, after which the relative weight is brought into consideration.

2.   <u>Observational Skill's Performance Codes:</u>
i)   Correctness of observation that is ability to observe correctly;
ii)   ability to discover characteristics features of objects or events;
iii)   ability to notice changes in characteristics in terms of say, colour, tastes, smell, shape, etc.;
iv)   ability to notice the effect of one substance or object on the other (for examples, a vegetable oil makes a white paper translucent when robbed on it, and water turns a dry white copper (II) tetra-oxo sulphate (VI) blue;
v)   taking correct readings with measuring instruments;
vi)   ability to detect inconsistencies or contradictions; and
vii)   ability to notice errors involved during experimentation.

3.   <u>Manipulation Skill's Performance Codes:</u>
i)   ability to handle objects/ apparatus correctly;
ii)

ability to set up apparatus correctly and with correct bearings;
iii)   ability to manipulate objects/ apparatus correctly;
iv)   having good experimental posture;
v)   ability to have good eye-hand coordination;
vi)   ability to construct models; and
vii)   ability to draw accurately.

4.   <u>Communicative Skill's Performance Codes:</u>
i)   ability to ask useful questions;
ii)   ability to answer questions;
iii)   ability to describe what is observed;
iv)   ability to use appropriate tenses in communicating;
v)   ability to report on the experiment;
vi)   ability to summarize the findings of scientific enquiry;
vii)   ability to discuss the findings; and
viii)   ability to communicate the conclusion.

5.   <u>Computational Skill's Performance Codes:</u>

i) ability to relate the variables involved, quantitatively;
ii) ability to get necessary data;
iii) ability to summarize the data in a graphical form, if required;
iv) ability to undertake all calculations required, accurately; and
v) ability to assign correct units of measurements.

ON-THE-SPOT ASSESSMENT FORM

In order to further show how the assessment of the skills could be done on the spot, lets consider unit one of the first year programme in Integrated Science.

<u>UNIT 1:</u>   You as a Living Thing

Topic	Performance Objectives	Performance level; 5–Excellently; 4–Very well; 3–Well; 2–Partially well; 1– Not well; 0–Not at all	Skill Assessed
1. Characteristics of living things	The child should be able to; 1. Identify those characteristics that separate living from non-living things; 2. Use such criteria to sort objects into living and non-living. 3. Identify self as a living thing. 4. Use these criteria to identify others as living things. 1. Differences between plants and animals 2. Use simple Microscpe	The child is able to; 1. Identify things in the school compound ▱ 2. Identify characteristics of living things 3. Identify characteristics features of objects/ events ▱ 4. Distinguish objects using sense organs ▱ 5. Identify main parts of the body ▱ 6. See how the hand is adapted to tools ▱ 7. Classify objects into living and non-living things using certain criteria ▱ 8. Classify food into types/ groups ▱	 Observational Observational Observational Observational Observational Observational Cononitive

1. Characteristics of living things	The child should be able to; 1. Identify those characteristics that separate living from non-living things; 2. Use such criteria to sort objects into living and non-living. 3. Identify self as a living thing. 4. Use these criteria to identify others as living things. 1. Differences between plants and animals 2. Use simple microscope	The child is able to; 1. Identify things in the school compound ▱ 2. Identify characteristics of living things 3. Identify characteristics features of objects/ events ▱ 4. Distinguish objects using sense organs 5. **Identify main parts of the body** ▱ 6. See how the hand is adapted to tools ▱ 7. Classify objects into living and non-living things using certain criteria ▱ 8. Classify food into types/ groups ▱	Observational Observational Observational Observational Observational Observational
2. Characteristics of animals 3. Human beings as intelligent animals		9. Compare plant with animal cells ▱ 10. Relate definition to mode of feeding ▱ 11. Identify the similarities and differences between man and animals ▱ 12. Contrast the movement behaviours of animals and plants ▱ 13. Use simple microscope ▱ 14. Draw cells as observed ▱	Observational Cognitive Cognitive Cognitive Cognitive Cognitive

It would be noticed that in Unit one, all skills are assessed except computational. The computational skills come in mostly during concepts of measurement, energy and tools.

PROBLEMS ASSOCIATED WITH ON-THE-SPOT ASSESSMENT:

An on-the-spot assessment of process skills in pupils is confronted by lots of problems. Among these are:

a) Large class size: Nigerian classrooms are oversized and have many streams, especially the junior classes. Cases abound where junior secondary one has six(6) streams of over fifty (50) students each. In most cases, one teacher is assigned to teach all the streams. Under such conditions, it will be impracticable for the teacher to undertake an on-the-spot assessment of all the students in each stream.

Associated with the problem of large class size is the shortage of teaching facilities. For instance, most secondary schools do not even have a separate laboratory for Integrated Science. To ameliorate the situation, other teachers could be trained up to serve as observers. This would, however, require establishing an inter-observer index of parity. Secondly, or alternatively, the class could be divided into groups, each group undertaking the activity at different times.

b) Time constraint: Most schools allot three (3) hours to the teaching of Integrated Science in a week. In the context of meaningful assessment, this is inadequate. It would therefore require the teacher to make use of some afternoons for the subject. This is one of the sacrifices teachers should make. Moreover, the teacher should skillfully choose activities to be carried out by students. A careful study of the curriculum shows that some activities that are capable of subsuming other should be chosen for students to practise.

c) Subjectivity in measurement: This is an inherent problem. However, a high inter-observer parity as well as familiarity with the performance objectives will reduce the level of subjectivity in the said measurement.

CONCLUSION

This paper had focused on ways of assessing Integrated Science process skills on the spot. The skills identified include cognitive, observational, manipulative, computational and communicative. Although problems of large class size, insufficient numbers of teachers and equipment, among others exist, it should be noted that the advantages of assessing the pupils on the spot overwhelm all problems. Efforts should therefore be made to cope with the existing problems because assessing pupils on the spot besides providing an immediate feedback for immediate remediation, is also Capable of forestalling examination malpractices always associated with paper and pencil tests.

RECOMMENDATION

To have effective on-the-spot assessment of process skills in Integrated Science, the following recommendations are made:

1)   Teachers of Integrated Science should be very familiar with the performance objectives suggested in the curriculum.

2)   Teachers should be willing to put in extra hours to help the students.

3)   Government should endeavour to equip Integrated Science laboratories in schools and should sufficiently motivate teacher to teach science more meaningfully; and

4)   Observers should be as objective as possible.