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ABSTRACT

This paper focuses on how best to evaluate student achievement in science. Many issues such as issues of test construction, validity, and reliability, and how to measure hands-on achievement must be considered. Qualitative evaluations are harder to explain, but can yield valuable information. The use of portfolios is an example of a technique that reveals much about student achievement. However, there are problems with portfolio use, including those of reliability, content, and scoring. Performance assessments in science can relate performance objectives to student achievement. Science teachers need to study acceptable new trends in teaching and learning. They must work to engage students in active learning and choose assessments that measure chosen objectives. (SLD)

Qualitative Assessment Versus Measurement of Student Achievement

Marlow Ediger

QUALITATIVE ASSESSMENT VERSUS MEASUREMENT OF STUDENT SCIENCE ACHIEVEMENT

Much emphasis in educational circles and in society is discussed on how best to reveal learner achievement. This paper will focus on evaluating science achievement of students in the public schools. How can it be shown accurately and fairly how well learners are doing in the science curriculum? Toward one end of the continuum, there are advocates who want measurable results from students. Thus percentiles, standard deviations, quartile deviations, and grade equivalents, among others, convey in a single numeral, the achievement of students in science. Numerical results are easier to understand by the lay public as compared to qualitative evaluations. Thus from taking a standardized or criterion referenced test (CRT), a student is on the 60th percentile, a single numeral provides information desired by the lay public. Many people in society take the test results as being accurate and carved in stone (Ediger, 2000, 503-505).

Issues in Quantitative Measurement in Science

There are numerous issues involved in viewing a numeral to show how well students are doing in science. The following are selected issues:

1. how well do test items in a science reveal a representative sampling of what can be measured? If test items favor one school or school district's students more than other learners, then the sample of test items favors a certain population of students who have had more opportunities to learn what is tested on than do the others.
2. how well was the test constructed n terms of validity? Thus students must have had opportunities to study related concepts and generalizations on the test. Compare that with students who have not studied any lessons or units that pertain to selected items being tested.
3. how well was the test pilot studied to determine reliability? A good test then measures consistently, be it in test/retest, alternate forms, and/or equivalent forms reliability. Consistency in reliability should make for the same test score, if in a pilot study, a student receives the same test results when equivalent forms are being used, or if the test is taken over again as in test/retest reliability.
4. how well are test items related to each other? In a well constructed test, according to test specialists, there should be no relationship of one test item to another so that clues are not given in taking a multiple choice test. In actual teaching and learning situations, however, science curriculum experts recommend that learners in science perceive facts, concepts, and generalizations as being related, when feasible. Isolated subject matter in science is more difficult to

remember. For example, from a science experiment, students should be able to relate knowledge to achieve a good summary or a generalization.

5. how well can tests measure hands on approaches in the science curriculum? Hands on approaches stress students being actively involved in making observations of science phenomenon, conducting experiments and demonstrations, problem solving activities, among others. Tests usually are paper/pencil responses by learners to multiple choice test items. In the former learning situation, students are actively engaged in learning whereas in test taking, students respond to multiple choice items and tend to be passive individuals (Ediger,1999,37-46).

Qualitative Evaluation in Science Achievement

Qualitative evaluation in science achievement has made considerable input into evaluating leaner progress in science. The use of portfolios is one example. Portfolios emphasize products and processes of students to be an inherent part of the portfolio. The student here has considerable chances for input in terms of what should go into a portfolio. Thus, the student with teacher guidance develops his/her own portfolio. Contents in the portfolio might well be the following:

1. written reports of science experiments performed by the student from an ongoing lesson or unit of study in thematic science.
2. cassette recordings of oral book reports.
3. drawings, written discourse, and diagrams of science content studied.
4. a video-tape of cooperative learning activities involving the student.
5. art products pertaining to science content studied, such as illustrations drawn of dinosaurs and murals of the different eras in geological history.
6. self evaluation completed in terms of desirable criteria developed.
7. construction experiences, such as developing a project for the oncoming science fair.
8. making papier mache' models such as prehistoric animals.
9. an outline of subject matter read from the basal science textbook.
10. snapshots of dioramas made of prehistoric fauna and flora (Ediger, 2000, 10-12).

In assessing the worth of a portfolio, much more of qualitative information as compared to quantitative results as in a single percentile will be in evidence to indicate learner results. For qualitative assessment a rubric needs to be developed. The results from rubric evaluation will generally indicate five levels from "excellent" to "needs improvement" to appraise separate parts, such as for written work or for the total portfolio. The reason for emphasizing separate parts are the following:

1. written work has quite different standards which need to be used for assessment as compared to a completed mural in science.

2. written work stresses the use of verbal/linguistic intelligence whereas a completed mural emphasizes artistic intelligence.

There are, however, qualitative criteria that may be used to assess the entire portfolio which cut across project lines, such as

1. neatness
2. accuracy
3. creativity
4. thoroughness
5. promptness and dependability.

Perhaps, both sets of criteria may be used such as those which are project specific as well as those that relate to all completed projects in a portfolio.

Portfolio assessment has its own problems, as does the measurement movement. Problems on portfolio assessment include the following:

1. portfolios may be very voluminous and become too time consuming to appraise.

2. Interscorer reliability may be a problem when two or more assess a portfolio, let alone assessing many portfolios in a class or school.

3. interested, responsible people who desire to study student achievement in science through portfolio approaches may find it difficult to notice progress and achievement by viewing an adequate number. A single statistic such as a percentile provides quick, but limited, data on how well students are achieving. A further problem is to know what to look for within the many pages of a portfolio and what specifically relates directly to the achievement of the school's objectives.

4. it presents a problem in terms of assessment, since portfolios cannot be machine scored as can statewide or locally administered tests. To have teachers assist each other to assess portfolios takes away valuable time for planning for science instruction and adds to the work load of teachers.

5. validity of portfolio results are more difficult to determine as compared to the testing and measurement movement, since many entries need to be read to ascertain validity in the science curriculum (Ediger, 2000, 22-31).

Portfolios used to ascertain since achievement of learners do provide

1. contextual information of how well students are doing on a daily basis within ongoing lessons.

2. feedback to the teacher as to what needs additional emphasis in science instruction. The products and processes inherent in a portfolio might well assist teachers to have a well planned sequential program of science instruction.

3. diagnosis and remediation teaching information for each student is inherent and is possible with recorded information on how well a student is doing specifically in science from portfolio information. A test score does not provide this useful information.

4. opportunities for the teacher to provide sequential learnings in science for students and thus provide chances for learners to experience good sequence or order of experiences in the science curriculum.

5. content might well be presented in a relationship of ideas form rather than being isolated items such as in a testing situation. According to testing and measurement experts, a test item should not provide any information pertaining to any other items. This fragments and isolates information rather than showing a relationship of ideas in science subject matter (Ediger, 2000, 75-79).

Performance Objectives in Science

Performance objectives are commonly used in providing guidance to science teachers in terms of what students are to learn. Related to these objectives are performance assessments. Performance objectives and assessments emphasize student learn by doing. The concept of "learning by doing" harmonizes well with a hands on approach in teaching and learning situations. Performance assessments then provide opportunities for science teachers to observe and hear explanations from students pertaining to what has been learned in ongoing lessons and units of study. Students are heavily involved when they are learning by doing as compared to being tested using paper/pencil tests. Observing student performance in a science experiment/demonstration takes more time than students responding to paper/pencil tests on the state or local levels of education. In performance objectives, the science teacher needs to observe student qualitative achievement in the following areas:

1. how well the learner is able to identify relevant problems areas.

2. how well the students is able to clarify the problem in terms of meaningful learning.

3. how well the student is able to plan for solving the problem.

4. how well the student uses a variety of valid activities and experiences to develop an hypothesis or tentative answer to the identified problem.

5. how well the student is able to test the hypothesis in a doing

approach.

6. how well the student is doing in modifying the hypothesis if need be.

7. how well the student deals with modifying an original hypothesis.

8. how well the student does in assessing an original or modified hypothesis.

9. how well the learner is able to clearly write up a science experiment/demonstration.

10. how well the student performs in orally communicating results of the experiment/demonstration as well as.how well the student is able to listen carefully to the thinking of others (Ediger, 2000, 33-34).

Performance objectives may be achieved by students individually or in a cooperative learning situation (See Gardner, 1993 for a discussion on these two intelligence --intrapersonal and interpersonal).

The changing emphases in teaching science can be noticed with the following National Science Education Standards (National Research Council, 1996):

LESS EMPHASIS ON	MORE EMPHASIS ON
Assessing what is easily measured	Assessing what is most highly prized.
Assessing discrete knowledge	Assessing rich, well structured knowledge.
Assessing scientific knowledge	Assessing scientific understanding and reasoning.
Assessing to learn what students do not know	Assessing to learn what students do understand
Assessing only achievement	Assessing achievement and opportunity to learn
End of term assessments by teachers	Students engaged in ongoing assessment of their work and that of others.
Development of external assessments by measurement experts alone	Teachers involved in the development of external measurements.

Science teachers need to study acceptable new trends in teaching and learning. Those deemed to be of high quality in nature as well as those based on sound research should be assessed and implemented.

Psychology of Teaching Science

There are selected principles of learning from educational psychology which need to be implemented in the science curriculum. Each of the following principles of learning may be qualitatively assessed as to science teacher achievement of these ends. Thus, teachers need to engage students in active learning. Learners need to be actively involved in ongoing lessons and units of study. Being a passive recipient of knowledge has no role to play for students in science. Students need to participate fully in planning and implementing experiments and demonstrations. Hands on approaches in learning means that students are actively engaged in learning.

Students need to be ready for new objectives to be achieved. Background knowledge and skills need to be in the repertoire of students so that they may benefit optimally from new concepts, facts, and generalizations to be achieved. Readiness for student learning is a vital principle of learning to stress in the science curriculum.

Third, students need to experience objectives which are challenging and yet achievable. If the new objectives are too easy boredom may set in . Toward the other end of the continuum, if objectives are excessively complex, then frustration might well be an end result. High expectations for learner achievement are important if each expectation is realistic and encourages student sequential progress in science.

Fourth, the interests of students need thorough consideration when developing the science curriculum. If state mandated objectives are stressed, the science teacher and his/her students may plan learning opportunities to achieve these ends. At other times, the teacher may use explicit activities and experiences which stimulate learner interests in the science curriculum.

Fifth, the science teacher needs to assist learners to perceive purpose in ongoing lessons and units of study in science. Thus, reasons for learning are important. A few minutes spent in guiding learners to perceive purpose in new learnings to be achieved is time well spent. A deductive approach may be used whereby the science teacher explains the importance to students in achieving the new objective(s). Also, an inductive procedure may be implemented, such as the science teacher discussing with learners the importance of achieving the new objectives. The latter procedure stresses considerable student input in arriving at purpose for studying the new facts, concepts, and generalizations to be encountered.

The psychology of learning needs to be followed by science teachers so that students individually may learn as much s possible in science. Qualitative assessment is necessary to ascertain if the psychology of learning is being emphasized in the ongoing science curriculum. By using a checklist or rating scale, the quality of instruction may be evaluated. Each of the above named criteria pertaining to the psychology of teaching science may then be appraised. Self appraisal by the science teacher may be used and/or a colleague may assist in using the checklist or rating scale to appraise teacher performance (Ediger, 2000, 101-103).

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