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ABSTRACT

This paper discusses assessment in science in the context of current discussions of standards and high stakes testing. Setting standards is always challenging, and care is needed to make the standards for science achievement neither too high nor too low. States must be careful to establish standards that are clearly written and that have high validity in covering what has been taught. Attention must be paid to test construction and scoring so that teachers are able to use assessment results to improve instruction. Portfolio assessment has the potential to improve assessment in science. When portfolios are used, decisions about assessment are made inside the classroom, and the student's daily work becomes important for assessment decisions. Hands-on approaches are useful in science assessment. Criteria can be established to see how effective students are in using scientific methods to complete tasks and achieve objectives. (SLD)

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Assessment in the Science Curriculum

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ASSESSMENT IN THE SCIENCE CURRICULUM

There are a plethora of procedures to use in assessing student achievement in science. The procedure used stresses a selected philosophy of assessment. The philosophy selected may be used on the federal, state, or local level of science teaching. There are inherent beliefs in choosing any one way of assessment. In most cases, these approaches will be used on the state and local levels. At the present time, each state is wholehearted involved in the testing and measurement movement. There are, however, other procedures to consider which also offer data and information on how well students are doing in science.

The Standards Movement and High Stakes Testing

The standards movement is very strong in the United States presently. These standards are set by a select group of educators on the state level. How high to set these standards for selected grade levels in a state is indeed a problem. Setting standards for students to achieve in science are subjective. The problem to watch in setting these standards is to establish attainable, challenging objectives for students to achieve. The standards can be set too high so few students can jump the hurdle. They may also be set too low so that everyone passess readily with little effort put forth by the learner. In 1998, when Massachusetts test results were reported for the first time, 81% of the graders were either failing or in need of improvement on the English/language arts exam; 71% of 8th graders faired just as poorly on the science/technology tests; and 74% of 10th graders got failing or needs improvement ratings on the math test. In Virginia, 98% of schools were given failing marks on the first Virginia Standards of Learning Test in 1998. But on some of the tests, such as 8th grade science, as many as 71% of individuals were earning passing grades that year. Last year, the percentage of individual students passing the tests ranged from 39% in 10th grade US history to 85% in writing (Viadero, January 11, 2001).

The above data indicate that standards can be set excessively high if 81% failed or need improvement in English/language arts, 71% faired as poorly in science/technology, and 74% of 10th graders received failing or needs improvement ratings. The state of Virginia really topped it off with complex state standards for students to achieve with 98% receiving failing grades!

A further problem involves writing related test items to measure student achievement. There are states which have been weak in aligning test items with the state standards. Some states, too, do not test on all the state standards. To truly be valid, the state mandated test must cover what is contained in the state standards, or objectives, for students to attain.

State standards or objectives need to be available to all teachers to use in teaching. Teachers have a better idea then of what should be taught. State tests need to cover what is contained in the standards so that validity in testing is in evidence. Science teachers need to have some security in that what is taught will be covered on the test so that validity may be stressed.This is especially important with high stakes testing. If a high school senior does not pass a state mandated exit test, the consequences may be grave. What is a student to do without a diploma at the work place,let alone not being able to go on to higher education, if abilities and interests should permit. There are states which permit a student to take the test over again,as many as three times. If a student cannot possess the state exit test, he/she may complete GED requirements. But taking many tests requires many routes and discouragement may indeed set in.

States need to be very careful in the following areas:

1. standards and objectives are clearly written for teachers to use in teaching students. These need to be available on time for all teachers.

2. tests to measure student achievement in having achieved the standards need to possess high validity in covering what has been taught. Careful monitoring of the tests to see that they are valid is highly important. Tricky, vague multiple choice test items need to be eliminated/omitted or modified. Each multiple choice test item needs to be clearly written so

that the test taker knows what is wanted in terms of responses. Test items written need to follow standards determined by measurement specialists.

3. directions for administering the tests need to be on the understanding level of learners. The key or answers must be checked very religiously to have correct, not incorrect answers.

4. machine scoring of these tests by the involved state need to be monitored so that computer glitches do not occur. These have occurred and computers are not perfect.

5. hopefully, the teacher can use the available results for diagnosis and remediation in guiding students to do well on these tests.

There are selected assumptions which state mandated standards and tests operate on, including the following:

1. these are the "eureka" or "I have found it" in terms of what students should truly learn.

2. all teachers should emphasize these objectives in teaching students, regardless of the latter's abilities, talents, and interests. Individual differences among learners do not matter; "one size fits all."

3. multiple choice test items can truly ascertain student achievement. Multiple Intelligences Theory (Gardner, 1993) emphasizes that individuals possess unique abilities in learning, working, and showing achievement; verbal intelligence as shown in reading of test items is one among eight intelligences.

4. with good teaching, the gaps in achievement between rich and poor can be eliminated. Socioeconomic levels then do not enter in to how well a student can achieve.

5. teachers who fail to teach well will tend to have students with low test scores. Paying teachers for higher student performance may end the vicious cycle of low student achievement.

6. competition among students can foster higher achievement with revealed test scores. These scores will differentiate the sheep from the goats and indicate which ones truly try to achieve at higher levels.

7. report cards, published in the media, will indicate

which schools are doing well and which, perhaps, should even be closed due to poor student achievement. The low achieving schools will feel pressure to do better and reach acceptable test score results.

8. to reach state standards is a motivator for all students. Increased competition is like the market place of goods and services sold. Students who do not do well on tests should have the option of selecting other schools to attend, including the use of vouchers. School selection then is like choosing from among the many goods and services to buy; those schools which survive and are chosen for attendance are the better institutions of learning.

9. punishments can be meted out to teachers for failing to have students achieve at a higher level. Merit pay should be given only for improved student performance; vouchers for students to opt out of low performing schools regardless of low socioeconomic levels; as well as school bankruptcy laws.

10. states do not need to release test questions to interested groups, even if a high percentage of students fail a state test such as in Arizona when 12% of high school sophomores failed a mandated test.

The Arizona Republic newspaper had to sue to obtain release of some of the state mandated test questions (Education Week, (February 7, 2001).

The Portfolio Movement and Science Achievement Assessment

Portfolios are a rather recent assessment instrument added to the arsenal of student evaluation. Portfolios do not emphasize measurement methods to ascertain learner achievement, but rather use the everyday classroom products and process to ascertain how well a student is achieving. Thus, the following are considered as inherent facets of a students portfolio:

1. written work of the student in science such as reports, outlines, summaries, book reports, and journal entries.

2. art products relating directly to a science unit encountered such as a mural, pencil sketching, water coloring, and construction items. If these items are too large for a

portfolio, they may be added in snapshot form.

3. cassette recordings of oral reports and oral reading, committee work, as well as a video-tape of students involved in doing science experiments and demonstrations.

The portfolio does not stress external examiners such as test writers to determine what students are to learn and do. Rather, these decisions are made inside the classroom. The student with teacher guidance decides upon which entries to place inside a portfolio. Relevant items need to be inherent, so that the portfolio does not become excessively voluminous. When parents observe the contents of a science portfolio, they can evaluate how well their offspring is achieving in science. Teachers may evaluate each other's portfolios as well as their own. Evaluations here may be compared between the two teacher's appraisals for interater reliability. There are definite assumptions made by portfolio advocates to ascertain student achievement in science. Among others, these include the following:

1. it is the student's daily work in science which is important, not a single test score.

2. the observer of the science portfolio may notice progress of the individual student by viewing sequential entries.

3. daily work of students in science provides evidence of product and process achievement, not responses to multiple choice test items.

Hands on Approaches in Science Assessment

Since the major goal of science instruction is a hands on approach in teaching students, the methods of learning science should be central in the assessment process. Multiple choice test items will not measure student achievement in preforming science experiments and demonstrations. In the science laboratory, scientists do perform may experiments and demonstrations. Thus, it behooves the assessment process to consider these hands on approaches in learning. How might these learning experiences be assessed? A set of three to four

assessors may observe students in a group setting. A five point scale may be used to assess different criteria in how effective students are in using the methods of science in completing tasks to achieve objectives. Each of the following, as an example, may then be rated by observers on a five point scale:

1. identification of a problem area. The problem needs to be relevant in an ongoing learning opportunity. Thus, in context, students are to identify a problem. The problem needs to be adequately delimited so that solutions may be found. A problem may well arise directly within a science experiment or demonstration.

2. next, information needs to be gathered in attempting to find an answer to the problem. Deliberation and thought should go into the information gathering stage. Critical and creative thinking are needed.

3. the result should be an hypothesis directly related to the problem. Hypotheses are tentative and not an absolute. The tentative solution (hypothesis) then needs to be tested, through using a variety of reference sources, including a science experiment/demonstration.

4. the hypothesis may stand as is or be revised, based on evidence. Creative thinking is necessary to evaluate the adequacy of the hypothesis. Logical thought, also, is basic to reasoning about hypothesis adequacy.

5. additional problems and questions may arise during the entire learning opportunity, described in the flexible steps listed above.

To perform science experiments and demonstrations, the teacher needs adequate materials, either brought from home or commercially purchased. The later certainly is highly recommended. Each school should have ample science equipment at the teacher's finger tips without having to borrow from other teachers. Additional materials of instruction needed in problem solving include the following:

1. science and general encyclopedias, multiple series of up-to-date basal textbooks and workbooks, library books on a variety of topics in science and on diverse reading levels, laboratory manuals, and related printed materials.

2. cassettes, video-tapes, software for tutorial and simulation experiences, CDs, internet, and world Wide Web.

3. art supplies, water colors, colored pencils, construction paper, and other media to be used.

Assumptions pertaining to using a hands on approach in science teaching includethe following:

1. students are using methods and materials emphasized by scientists in a laboratory setting.

2. students are actively involved in identifying and solving problems in the science curriculum. External examiners are not determining the objectives, learning opportunities, and assessment procedures.

3. students may transfer methods and procedures used by scientists in a laboratory approach to their own individual classrooms as well as in the societal arenas.

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