Authentic Assessment: A Model for Pre-Service Middle School Teachers

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The new Assessment Standards for School Mathematics (draft, 1993) written by the National Council of Teachers of Mathematics (NCTM) are creating a stir in mathematics education circles. Many attempts are being made to replace routine evaluative tools with various performance tasks that give more accurate feedback on students' learning of mathematics. Several new assessment ideas include teacher observations, student journals, portfolios of sample work, cooperative group work, and open-ended problem solving tasks. A major concern for educators is how to sort through, absorb, and implement some of the new assessment tasks that have surfaced, while assuring that the tasks themselves do not detract from quality education. There is no easy answer.

Some traditional methods of assessment have been accused of being weak and inadequate in discerning whether students have actually learned. Tests often consist of repetitive, algorithmic chores that are not concerned with rich mathematics. New assessment rhetoric suggests that a test item like one which asks students to select the correct choice for the perimeter or area of a rectangle must be discarded. Such an item might be replaced by an item that asks the students to draw a polygon with x sides and a perimeter of y units. But without the underpinnings of strong test validity, it is difficult to know if a test item actually does assess a skill or concept that a student has supposedly constructed.

In order to follow the reform leaders, many teachers and supervisors have learned the proper buzz words and speak excitedly about "teaching the standards" or using "alternative assessment tasks." Unfortunately, they may have only a vague notion about where to go in the assessment maze. And some teachers who are using alternative assessment techniques may still relegate assessment to "test days" rather than to a central place in the process of learning.

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If assessment is designed around constructivist theories of learning, and if it is used to determine whether students can take new knowledge and use it in their environment, then it must become an integral part of a total picture. Each teacher must establish a strong, coherent activities, and c) the assessment are built into a unified structure. The curriculum must consist of non-trivial, rich mathematics developed through activities set in an environment in which students develop the mathematical power to communicate and reason about ideas. This can happen when teachers encourage critical thinking, and prompt students to develop good searching and probing techniques. The assessment tasks, which are constantly evolving, must be an integral part of the framework (see Figure 1) that drives the choices in curriculum and activities, which drive the selection of assessment tasks.

Our work with pre-service and in-service elementary teachers has convinced us to develop models of teaching that are based on such frameworks. It is critical that pre-service teachers see how assessment evolves from and guides the development of the curriculum and activities. They must also learn how to 1) choose the right tasks, 2) develop the tasks, 3) alter the tasks, and 4) score the tasks according to a pre-designed rubric. According to Shavelson and Baxter (1992), "short-circuiting this process leads to poorly constructed assessments" (p. 23).

Assessment Standards

According to the draft of the Assessment Standards (NCTM, 1993, p. 6), there are six criteria that assessment tasks must meet in order to be appropriate.

1. Mathematics

The successful teacher builds a unified framework of rich mathematics, student-centered activities, and varied assessment tasks. The task, initially determined by the teacher, may originally seem much like the boring, repetitive tasks that need to be excluded. But immediate feedback suggested by the student responses can direct the choices about what mathematics should be presented. For example, if students are asked to draw two angles that share exactly three points and they draw two adjacent angles sharing a side, then the teacher might discover that students think that only those things labeled with capital letters are actually points.

2. Learning

Authentic assessment tasks are not reserved for an isolated test day. In a student-centered classroom, assessment is a routine part of a continuum of activity. When new learning occurs, the teacher and students alter the activities. Those tasks that do not engage students in imaginative mathematics can be deleted or changed immediately. There is constant monitoring of student progress instead of putting off the students' fate until test day.

3. Equity

Assessment designed in a student-centered classroom is more equitable than paper and pencil tests. It presupposes high expectations for all students, but it highlights the fact that each student brings different experiences to the task at hand. If students think that points are only those which are labeled, it becomes very obvious as they discuss why certain points on one angle also lie on another. While authentic assessment tasks challenge the students, they also challenge the teacher to probe more and make judgments about altering activities that will lead to more learning.

4. Openness

When assessment tasks are an integral part of classroom dynamics, no task is a surprise to the students. At all times the students know a) what they should learn, b) how they will be evaluated on what they learn, and c) the consequences or grading system. Teachers can collaborate with each other to develop the curriculum, the tasks, and the scoring rubrics that generate good assessment tasks. Students should suggest some of the tasks, because those generated by the students give them a sense of ownership and power. Unlike standardized tests, good assessment tasks need not be under lock and key.

5. Inferences

If a strong framework of curriculum, classroom activities, and assessment tasks are in place, assessment tasks provide multiple sources of information and much supporting evidence that goals have been attained. The type of tasks that evolve from the student-centered classroom will not have the validity of certain types of standardized tests, but data collection and examination of results can provide evidence that valid inferences are made from the newly constructed tasks.

6. Coherence

As we invent new, authentic assessment tasks, we need more work on collecting and interpreting data. Much of what is being tried today will be thrown out, but it is imperative that we begin to find tasks that reflect classroom learning. One of the main reasons for the inconsistency in former assessment tests was that the designer of the tests (either standardized or pre-packaged by textbook authors) was unaware of the activities in the classroom. Unless a teacher was "teaching to a test," it was unlikely that classroom activities truly prepared students for success. When assessment tasks are a result of classroom activities, there is a greater probability of student success.

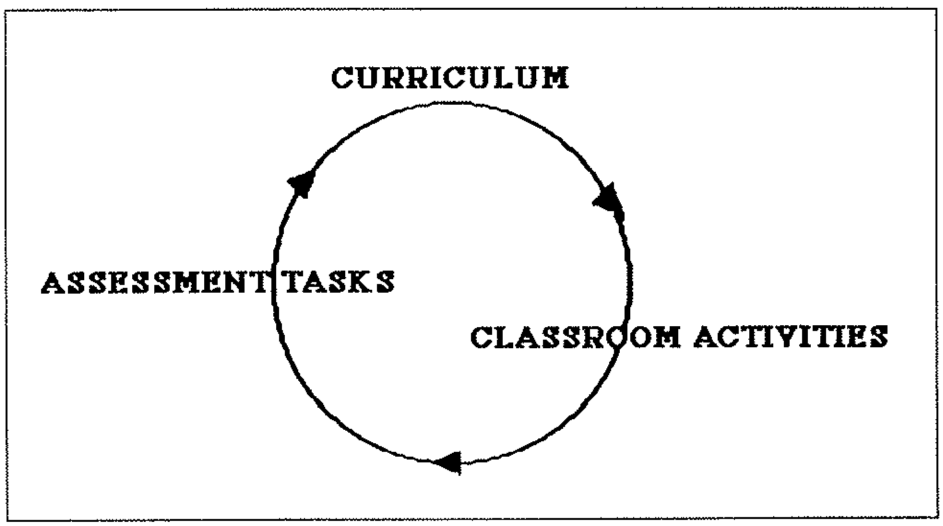

Figure 1: Assessment framework.

Description of the Project

In a geometry class for pre-service teachers, we developed a project that has been a model for developing assessment tasks. This occurred after we realized that we were asking our students to respond to test questions that were isolated from the real world. Outside of a mathematics classroom, it would be rare to find a sketch of a rectangle on a sheet of paper with directions to find its area or perimeter. We were asking our students to do this activity because it was a recommended question in a chapter test, and because that was the way we were tested in school. In the real world, we sometimes need to solve problems in which we need the concept of area and perimeter. But these concepts might be better formed when a teacher takes a class to the athletic field to measure for a fence and for artificial turf, not when the students find the area and perimeter of a rectangle drawn on a test sheet. That is not to suggest that a student should never be asked to do this type of problem, but rather that it should be one of many types of tasks the student is asked to perform.

The following model, which we believe captures the spirit of the Assessment Standards, will be referred to as the box-assessment. It is a tool that has been designed, implemented, and constantly refined by the authors in pre-service geometry classes for students seeking certification at the middle school level (who are required to take 12 hours of college mathematics). We use boxes that contain tasks involving geometry. Each box contains a card that describes the task to be performed and items that will be used to perform the task. This format is easily adaptable to changes and moves as the curriculum directs. Items are included that require oral comments to the teacher, written reports, drawings (e.g., draw two angles that intersect in exactly three points), computer generated models, and constructions.

Examples of some successful activities we have used are given here. The instructions are those written on a card inside of the box:

1. Use the 24 cubes provided in the box to build a rectangular solid that has the least possible surface area. Record the surface area and the volume of your solid.

2. The enclosed portion of a plate is all that was left after Julie and Ian had an argument. Find the diameter of the original plate in order that it can be replaced. Be prepared to defend your decision.

3. Consider the front view, side view as it appears from the right, and the top view of a three-dimensional figure as shown here. Use the cubes provided in the box to build the figure. Turn in your model for evaluation.

4. Josh is planning an unusual shape for his patio. It is modeled on the enclosed geo-board. Find the area of the figure using the square unit of the geo-board. If each unit represents two feet, how many bags of cement will Josh need? (One bag of cement is recommended for each 40 square feet).

5. Look at the enclosed box of cupcake liners. These "baking cups" are used in cupcake pans to prevent sticking. The manufacturer of this particular brand of liners has chosen a very unique shape for this container (i.e., hexagonal prism). Consider this shape as you answer the following questions. What is the geometric name of the "baking cups" container? What is the perimeter of the top? What is the measure of the angle formed by any two sides? What kind of angle is this? What is the sum of the measures of all interior angles? How many lines of symmetry does the top have? How many diagonals does the top have?

6. Use the enclosed centimeter grid paper to design as many floor plans as you can that contain five square centimeters. How many different designs can you find? Which of the designs would use the least amount of toe-molding around its edge?

As an example of how a box-assessment follows the Assessment Standards, we present Problem 2 (see above), which involves important mathematics in a real-life situation. Instead of drawing an arc of a circle on a sheet of paper and asking for its center, the piece of plate that is actually present in the box allows the student to see the usefulness of a process that finds the center of the missing circle. When the students begin to trace the edge of the plate on paper and attempt to find lines of symmetry by paper folding, or when they discuss with each other whether the pointed edge of the plate is actually the center, they enhance their learning of an abstract idea.

The fact that there are several ways to actually solve the problem makes the task more equitable. One student might trace an arc and use compass and straightedge to use a classical construction involving perpendicular bisectors of chords of the arc. Another who is less apt with the classical tools might use patty paper, the thin squares of paper used to separate uncooked hamburger patties, to find lines of symmetry.

The task is open and no surprise to the students. It is not necessary to hide the contents of a box-assessment. Whether or not students know what is in the plate-problem box, they still have to be able to construct the size of the original plate.

If students can demonstrate how they found the size of the original plate, the inference that they understand the process is at least as valid as the traditional test item that showed an arc drawn on a sheet of paper. Any doubt that students do not understand the process can lead to other classroom activities that provide a more complete indication of knowledge acquired.

An assessment task should be consistent with the types of tasks previously experienced in the classroom. The plate-problem appears in a box-assessment after classroom activities with construction tools and patty paper that suggest different methods of locating the center of a circle when it is not given.

Concluding Remarks

If future elementary teachers are to learn how to develop authentic assessment tasks, they must see how these tasks evolve from classroom experiences. One of our attempts has been the use of the box-assessment in geometry classes for pre-service teachers. It has worked well with small groups of students who suggest changes and new activities to sharpen developing concepts. This development involves the teacher and the student in an ongoing process of varying or extending topics in the mathematics classroom.

We hope that other instructors of geometry for elementary teachers will try the box-assessment. We welcome comments and suggestions as we continue to search for authentic assessment tasks in the learning of geometry.

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