The Mathematics Educator
2003, Vol. 13, No. 1, 15–21

Assessment Insights from the Classroom

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Reform efforts in mathematics education challenge teachers to assess traditional forms of assessment and to explore and implement alternative forms of assessment. Empowering all students with mathematical literacy demands methods of assessment that reflect and enhance the present state of knowledge about learning, about teaching, about mathematics, and about assessment. This discussion highlights insightful perspectives on assessment strategies and techniques currently being addressed and implemented. A cohort of middle school mathematics teachers reveal their experiences and reflections in addressing current assessment practices and ventures in innovative and alternative approaches to assessment.

The activity which is the subject of this publication was produced under a grant from the Texas Higher Education Coordinating Board and the U.S. Education Department under the auspices of the Eisenhower Grants Program (ID# 97053UH), titled the University of Houston/Southeast District (HISD) Mathematics Project for Teachers (Grades 6-8).

Assessment is the central aspect of classroom practice that links curriculum, teaching, and learning. (NCTM, 1995). In the Principles and Standards for School Mathematics (NCTM, 2000) assessment is designated as one of the six underlying principles of mathematics education. The Assessment Principle states: "Assessment should support the learning of important mathematics and furnish useful information to both teachers and students" (NCTM, 2000, p. 22). The emerging theme in assessment reform is to do more assessment than evaluation; to become assessors rather than evaluators.[1] The aim is better assessment, not more. Standards were created to provide guidelines to improve mathematics education and to value the importance of alternative[2], as well as authentic[3] assessment procedures and protocols.

Traditional forms of assessment have been utilized in mathematics classrooms for many years. However, reform efforts in mathematics education challenge teachers to reconsider traditional forms of assessment and to explore and implement alternative approaches. Assessment of school mathematics is addressed in some manner in all of the NCTM documents (1989, 1991, 1995, 2000). It is essential that mathematics teachers be informed and proactive in addressing issues of assessment in mathematics classrooms. In response to the call for changes, a cohort of middle school mathematics teachers in a large metropolitan area in Texas reflected on their current assessment practices and ventures in alternative forms of assessment in the classroom. These teachers were participants in a grant focusing on the strengthening of mathematical content knowledge, the improvement of instructional strategies, and the implementation of new curricula fulfilling national standards and state-mandated guidelines. In the light of education reform along with the looming accountability of state-mandated guidelines, these teachers began to realize the vision of achieving mathematical power for all students. This discussion highlights middle school mathematics teacher's new perspectives as they implemented alternative assessment strategies and techniques.

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Research Methodology

I have chosen to present my experiences with these teachers as a case study, as it is better suited for this context-specific inquiry (Lincoln & Guba, 1985). Data collection from the grant's workshop participants spanned an academic year. These participants were fifteen middle school mathematics teachers from five different middle schools in the same urban school district. Grant workshops were held on an urban university campus with site visits and observations conducted at individual teacher campuses throughout the year. The workshops were conducted as a graduate level course with each teacher receiving three semester hours of credit upon completion.

A hands-on/minds-on, standards-based (NCTM, 2000) approach to learning and teaching (model, observe, discuss) was implemented in the workshops. The goals of the course were to explore mathematical representations through content, instructional

strategies, and authentic assessment. In order to initiate change in assessment strategies, workshop instructors focused the middle school teachers on three objectives while examining the following questions:

1. Set goals for student learning: What are the important learner goals? What types of problems are students able to solve? What concepts and principles should students be able to apply?
2. Build an instructional program that reflects NCTM's Principles and Standards (2000) and appropriate state-mandated objectives, include alternative and multiple assessments, and include a system for documentation and reporting: What strategies best assess student understanding and achievement?
3. Continually review and share classroom assessment and its effects: What collaborative supportive system in the mathematics learning community and within their school administrative personnel must be developed to change, alter, and improve the assessment in the classroom?

Participants engaged in tasks such as developing mathematics, teaching mathematics, and designing and implementing instructional materials as well as alternative forms of assessment. As the workshop instructor and researcher, the author developed multiple perspectives through participant observations, random interviews, journal entries, reflections, and course artifacts. Required products from the workshops were used as data sources, including written assignments, anonymous session evaluations, assessment projects and surveys, classroom student examples, and a presentation project as a final assessment. Various workshop tasks included: evaluation, synthesis, and implementation of teaching strategies, learning strategies, and national standards; participation in inquiry and discovery activities (as learner and as teacher); and implementation of alternative forms of assessment in participants' classrooms.

Here, as instructor and lead researcher of the grant program, I report findings of the research agenda as a narrative to weave together the responses from the cohort of teachers in a collective manner. This narrative draws most directly on data taken from the teacher responses in individual and small group discussions on assessment topics. The trends reported below were validated through multiple sources through the data collection and analysis that occurred throughout the year-long workshops.

The Workshop Design

Assessment is sometimes viewed as simply a numerical value, a scale of student achievement. Values of grades may vary from state to state, from district to district, and, yes, even from classroom to classroom. What measures of learning are really represented in the assigned and recorded values? Reform efforts such as the *Principles and Standards for School Mathematics* (NCTM, 2000) provide needed guidance and direction in changing the face of classroom assessment.

Implementing new ways of doing assessment is not an easy task, but no longer can mathematics teachers afford to rely strictly on traditional formats. Alternative forms of assessment offer more opportunities to reveal a student's perceptions and conceptions of mathematical knowledge. Most forms of alternative assessment ask students to perform, create, produce, or do something; tap high-level thinking; and involve problem-solving skills (see Table 1). These forms use tasks that represent meaningful instructional activities, involve real-world application, are scored qualitatively, and require new instructional assessment roles of teachers (Herman, Aschbacher, & Winters, 1992).

As the workshop instructor modeled new assessment strategies during monthly workshops, teachers had opportunities to explore the assessments as learner and as teacher. Group activities involved planning new classroom assessment and practicing with peers before implementation in their own classrooms. In these sessions, teachers reported that change could be successfully implemented as they appreciated the collaborative efforts involved in their experiences.

The use of models and manipulatives in teaching, learning, and assessment encourages alternative forms of assessment. Teachers in this program learned that alternative assessment encourages the use of active hands-on learning. Learning experiences such as these create classroom activities and learning environments that are accessible to all students. The teachers in this project investigated and implemented innovative approaches to alternative assessment in their own classrooms.

Table 1
Workshop Participants' Identification Of Alternative Forms Of Assessment

Product / Process	Purpose	Workshop Participant Insights
Journal writing / writing prompts	to assess development of mathematical concepts; writing activities show more of how the students are thinking	*Journals are quite informative, but very time consuming. …* [Yet] *more informative than just a number on a piece of paper. Another method, which I have not used, is self-evaluation.*
Projects	to develop and apply concept/scoring rubrics	
Performance assessments / use of manipulatives	to demonstrate concept attainment through the use and mastery of manipulatives	*Turning in performance assessments to mathematics department (in our school district, this is a regular procedure).* [This is done] *so they can analyze concepts being taught and relate them to curriculum standards. Manipulatives, exploration through questions, make them work on becoming independent thinkers, bring outside experiences into the classroom. Show the application or necessity. Try to assure students they can do the work if they just try. Not looking for 100% accuracy, but risk taking. Talking to and challenging students, competitions – mini games.*
Concept mapping	to provide insight into students' mathematical thinking	
Problem solving	to motivate interest; to promote critical thinking	
Diagnostic activities	to determine student readiness for learning a particular concept	*… allows the student and teacher to see the objectives mastered and objectives not mastered, particularly TAAS objectives.*
Class discussion	to assess learning informally	
Student conferences / conversations	to assess student's ability to relate subject to areas outside classroom	
Classroom challenges	to motivate interest and assess learning	
Integration with other subjects	to use projects to integrate other subjects and involve a variety of math concepts	
Rubrics	to customize assessment to individual needs of tasks	*I believe a rubric is most informative, but as a new teacher, I find it very difficult to manage that in a classroom of students vying for attention.*
Questioning combined with instruction	to understand depth of students' understanding through questioning during activities	
Cooperative learning groups		*Cooperative grouping/learning encourage students to help each other, games for competition, discovery learning/exploration, problem solving, and logic thinking activities.* *Cooperative groups* [are being used]. *When student do projects, they really enjoy working in groups and like to do their best.*
Portfolios	to represent learning through samples of student work	
Warm-ups	to assess problem solving strategies; to get students into a mathematical framework	
Homework	to assess transfer of learning; to demonstrate application; to look for understanding and comprehension of objectives	*Problems* [that I have] *encountered* [include] *students do not study, do not do homework, do not ask questions. These are addressed in parent conferences and student-teacher conferences.* [However], *some kids realize objectives, concepts or skills they need to work on. For "lower" level kids, it* [TAAS] *may serve as a motivator, but for especially bright students, TAAS tends to limit what a teacher* teaches. *It tends to bring the high lower, and may frustrate the low into apathy.*
Tests: Term – Cumulative Short answer Standardized & state-mandated Practice Quizzes – pre & post	to compare for growth from previous tests to develop higher order thinking skills to assess mastery/transfer of concept and skills; to track yearly growth as a diagnostic to diagnose areas that cause difficulty	*We displayed TAAS benchmark results visually* [bulletin board displays] *so students could see where they stand related to other students.* [I] *try to align TAAS objectives with the TEKS. Post results of TAAS benchmarks…the students love to compete with each other. Since I work in a low-performing school, TAAS gets emphasized over preparing the students for algebra, something which is hard to resolve. Sometimes students don't see any correlation between what they are learning in class and what is tested. I think in a way it has discouraged studying.*
Notebooks	to assess student's study habits, completion of classwork, and concept understanding	

The Results: Insights from Teachers

The series of workshops was conducted over the academic year and provided teachers opportunities to implement, observe, and revise many assessment strategies. The workshop design created assessment strategy experiences for the teachers in planning, practicing with peers, implementing in their own classrooms, and collaborating through thoughtful mathematical discourse – both positive and negative experiences were shared. As the instructor, I worked to create a community of mathematics learners and leaders by emphasizing these communication opportunities. This interactive professional dialogue was created and supported by access to peers and the instructor during monthly grant sessions as well as via a website between sessions. At the end of the grant program, each teacher responded individually and in small groups to a variety of assessment topic issues. These teacher's responses are presented in this section in italics, enclosed and in boxes. These reflections-in-the-moment are direct citations from the teachers' responses.

What Assessment Tasks were Explored and Implemented by the Middle School Teachers?

Teachers used a variety of traditional and non-traditional approaches to student assessment. The teacher-developed chart (Table 1) represents the span of assessment strategies explored and currently in practice in the classrooms of these middle school teachers. The third column indicates the teacher's reflections on the uses of these assessment strategies.

Teachers found that short answer tests, journal writing, manipulatives, projects, concept mapping, and performance assessments revealed a broad range of capability, understanding, and communication of mathematical concepts. Many different tasks were used to create a complete picture of the students' mathematical knowledge. Strategies for evaluating performance on assessment activities also varied. Teachers used rubrics quite extensively, as they became comfortable with this system through the workshops. In addition, concept maps, journal entries, textbook assignments, and worksheets were very informative. Teachers identified sources of feedback such as group grades, participation grades, praise, peer evaluation, and self-evaluation.

What Mathematics was Assessed? How Did State and National Guidelines and Accountability Affect Assessment Strategies?

The mathematical skills and concepts assessed by the middle school teachers in the workshop were typical for grades 6-8. As with many other states, Texas has state-mandated curricula objectives, as do many districts. Texas guidelines are called the Texas Essential Knowledge and Skills (TEKS). For each grade level and each subject area, there are specific learning objectives and goals for Pre-K through 12th grade. These curricula guidelines are correlated to the statewide student test, the Texas Assessment of Academic Skills (TAAS).[4] The TAAS test is taken based on grade level and subject matter. The final TAAS is an exit test that must be passed as a prerequisite for high school graduation. Within this framework of curricula are thirteen TAAS objectives that are assessed in mathematics. These have been determined by the state, but are also related to the national standards identified by the NCTM (cf. 2000). These objectives were created to help ensure quality and consistency. Learning accountability, in some school districts, is even more defined by specific objectives and goals for the grade levels.

> [I use a] *mastery tracking sheet, standardized tests, TAAS, computer programs, independent practice manipulatives, projects, and worksheets. We also review and practice test-taking strategies. I feel this has helped students become a little more confident because they at least know what to expect.*

Direct test preparation for the TAAS is widespread. Many teachers used the item analysis from the previous year's TAAS test to determine the areas of strengths and weaknesses to improve on the objectives that were deficient. Practice tests, six-week tests, quizzes, and a section of the student's daily homework are formatted so students can practice on how the questions are structured as well as practicing and applying the objectives. Teachers and students review and practice test-taking strategies to develop more confidence. Many of the workshop teachers felt that too much focus was placed on the standardized test, thus limiting the time available for alternative assessments. Even so, teachers valued the need for change and explored the potential of other forms of assessment. Tutoring, motivation techniques, and parental involvement were common efforts.

How Can Information from Alternative Assessment be Integrated into Grading and Reporting Progress?

> *Weekly reports to parents; scheduled progress reports; promoting ways parents can help students at home; tutorials after school; TAAS data used to group students by abilities work with parents on skills students need; math make-and-take sessions* [as a] *parent workshop; parent conferences; phone conferences/conversations; parent involvement in schools; display example work for the school; student/teacher conferences; Saturday school; students are able to track themselves by objective using TAAS data; award certificates; honor pictures taken and put on the wall; and, TAAS classes.*

> *… kids grade in groups. [I use] class participation grades.*

The teachers shared strategies to integrate information from alternative assessment into grading policy. Alternative assessments were sometimes counted as a test grade and sometimes as a daily grade, depending on how much time was required. For example, some teachers used notebooks as test grades. It was common for teachers to offer extra credit opportunities when implementing new forms of assessment. Extra points were given for creativity and originality, hoping to build student confidence. Most of these teachers used homework to determine the depth of student understanding and which concepts needed re-teaching. Projects and journals offered students opportunities to express their ideas, understanding, and concerns. Some students worked better with manipulatives; others with pen and paper.

The teachers reported a creative variety of alternative forms of assessment implemented into traditional protocol. Each type of assessment determined a certain percentage of the grade. Discussion of the variety of assessment practices and grade recording encouraged all teachers to try more alternative forms of assessment as well as developed increase confidence in this endeavor.

The teachers communicated the types and importance of assessment strategies and approaches to students and parents through many venues. Some of the ways used by the teachers include weekly reports to parents, scheduled progress reports, promoting ways parents can help students at home, tutorials after school, and Saturday school. As a result, parents and teachers participated in workshops, conferences, and conversations to encourage and support student learning. Positive reinforcements included special privileges at school and at home, award certificates, and other classroom and school acknowledgements.

Teachers reported that sometimes students do not see any correlation between what they are learning in class and what is tested. Teachers tried to address these issues by using real-world problems and scenarios. Typical problems encountered involved students that do not study or complete homework, or that do not ask questions. These were addressed in parent conferences and student-teacher conferences. Through these many approaches, students were able to ask questions about concepts they had not mastered.

What Results Did the Teachers See as they Used Assessment to Improve Curriculum And Instructional Practices?

> *I use concept maps, journal entries, textbook assignments, and worksheets. These methods are very informative [One method I use is to have the] whole class solve their problems, [but] only take one solution from [the entire] class on chalkboard. This encourages total class collaboration, a step beyond small group work.*

> *I try to celebrate different learning styles. Let students explain to me what was just taught, if they are having difficulties this means that I have to use another strategy. Assessment does alter instruction.*

The teachers studied and shared strategies to improve mathematics curriculum and instructional practices. They found that different assessment instruments helped to take the focus off the "computation and accuracy" aspect of mathematics, and helped to encourage mathematical thinking. New sorts of tasks in classrooms created a more complete picture of the students' mathematical knowledge. The workshop teachers reported that assessment informed re-teaching, addressed students with math anxiety, and identified students' need for more instruction and/or reinforcement. Students were able to see the objectives mastered and not mastered, as well as their own strengths and weaknesses. Alternative assessment took the emphasis away from right/wrong answers and concentrated students and teachers on thought processes.

What Assessment Encouraged Mathematics Learning?

While addressing curricula objectives, the teachers made high priority of planning relevant activities that connect mathematics with the real world and creating a rich learning environment. The teachers tried innovative approaches and teaching strategies to address the mathematical content in a hands-on, minds-on manner. Teachers used a variety of assessment approaches in a traditional and non-traditional manner

for student assessment. Different learning styles were more easily addressed by alternative assessment.

> *[Using] assessments that make them have a feeling of self-fulfillment, to develop confidence... [have] students write their opinion on a problem, ... [and] let students show different ways of solving a given problem, let them justify why they did it.*

> *It is a slow process to get our students to do in-depth work. I have not quite figured out the right formula to motivate them. Motivation is a real challenge for me. Students don't seem to have the confidence to try. I'm working at it...*

These teachers developed and implemented some effective approaches to alternative assessment that fostered student learning and helped to address motivation concerns. Some strategies that encouraged students to learn math were: doing extra credit assignments, using peer tutoring, valuing classroom discourse, and finding ways to justify their answer. Teachers used manipulatives and exploration through questioning to assist students in developing as independent thinkers. Showing the application and necessity of mathematics while bringing in real-world scenarios was also an effective and valuable strategy. Teachers reassured students that they can do the work and encouraged risk taking. Students developed self-confidence as they were asked to provide their opinion on problems in classroom discourse and in writing. This created a safe learning environment more conducive to learning. Motivation appeared to be the ultimate goal for ensuring student encouragement and interests. Challenging students with competitions and games was a good motivator for the middle school student. Teachers also reported that cooperative grouping encouraged students in problem solving and logic while they learned to help each other. Teachers encouraged students to justify why they did what they did, focusing on the thinking processes rather than just the answer.

Conclusion

The teachers' learning experiences focused on developing and promoting better classroom assessment. Initially, the teachers explored the recent trends in changes from behavioral to cognitive views of learning and assessment, as well as changes to authentic, multi-dimensional, and collaborative assessment. Teachers learned about the constructivist perspective of teaching and learning school mathematics that is predominant in the NCTM Standards documents (NCTM, 1989, 1991, 1995, 2000).

Teachers confronted their own perspective of the nature of mathematics by participating in learning activities that encouraged deep reflection and discourse. Davis, Maher, & Noddings (1990) believe that this perspective has a direct bearing on the ways reform can be approached. Unveiling or developing one's own conception of the nature of mathematics was an enlightening experience that promoted a deeper understanding of reflective teaching and learning mathematics. Teachers developed a better conceptual understanding as they explored mathematics topics as learners and teachers to better inform instruction and assessment. Teachers examined and explored reasons for evaluating and assessing student achievement. Being aware that teachers evaluate and assess in order to enable decision-making about mathematics instruction and classroom climate was a critical aspect of these teachers' learning. The protocols presented above communicate important tensions for the middle school mathematics teachers among testing expectations, assessment of student understanding, and the need to assign grades.

Appreciating the need for reform was another area of study for the teachers. For the teachers, this meant acknowledging that current testing procedures are inadequate and realizing the need for further research. Through the workshop experiences and the teachers' own personal classroom action research, teachers discovered why there is a need for reform in assessment. It was apparent that using multiple assessment strategies was a significant step toward creating a more complete picture of the student's mathematical understanding and achievement. New evaluation models and technologies that utilize assessment procedures that reflect the changes in school mathematics are needed. Ultimately, the middle school teachers demonstrated a belief that classrooms should be active learning environments where instruction is interactive and multiple forms of assessment are interwoven with teaching.

Looking Forward

Multiple forms of assessment are being advocated as we come to understand that traditional means of assessment have not addressed the needs of all learners. Richard Stiggins estimates that educators spend about a third of their time involved in assessment-related activities that guide the instructional and classroom decisions which directly affect learning (1993). A time investment such as this demands that teachers examine their current assessment practices. Simply testing student

achievement with traditional instruments and protocols is insufficient. Empowering all students with mathematical literacy demands methods of assessment that reflect and enhance the present state of knowledge about learning, teaching, mathematics, and assessment. Implementing improved assessment in the mathematics classroom begins with combining instruction with assessment to better meet the needs of the learner.

In order to plan and implement new strategies for assessment, mathematics teachers should have opportunities for professional development, as did these middle school teachers. It is crucial that a support system in the mathematics learning community be developed along with any efforts to change, alter, and improve assessment in the classroom. Mathematics teachers must personally explore alternative assessment strategies. They should be involved in creating and implementing tasks that are exemplars of mathematics instruction as envisioned by the NCTM. As part of this effort to develop tasks, teachers should have opportunities to observe students doing mathematics and to examine the their products. A solid basis for mathematics teaching, learning, and assessment is created when teachers value and comprehend recent trends, perspectives towards mathematics teaching and learning, evaluation and assessment, and the need for reform. The informed mathematics teacher has the ability and the tools to offer the best learning environment for improving student achievement and understanding.

In this paper, I have attempted to present a multi-perspective approach toward understanding and implementing assessment reform. The middle school mathematics teachers encountered many problems on this journey from traditional classroom assessment to implementing alternative assessment strategies. Some problems were unique, but many were common among all teachers. Some problems were collectively resolved, while others, such as student motivation, remain as ongoing obstacles to address. These teachers learned about assessment and implementing innovative strategies in a collaborative environment. As a result, the need for a strong support system to implement change was revealed and valued. The experiences and insights of these teachers may promote and encourage other middle school mathematics teachers to move outside the comfort zone of traditional assessment protocols and begin implementing innovative and alternative approaches to assessment.

REFERENCES

Davis, R., Maher, C., & Noddings, N. (1990). Introduction. In R. Davis, C. Maher, & N. Noddings (Eds.), Constructivist views of the teaching and learning of mathematics. *Journal for Research in Mathematics Education Monograph no. 4* (1-3). Reston, VA: National Council of Teachers of Mathematics.

Herman, J., Aschbacher, P., & Winters, L. (1992). *A practical guide to alternative assessment*. Alexandria, VA: Association for Supervision and Curriculum Development.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry.* Newbury Park, CA: Sage.

National Council of Teachers of Mathematics (1989*). Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics (1991). *Professional standards for teachers of mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (1995). *Assessment standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

Stiggins, R. (1993). Teacher training in assessment: Overcoming the neglect. In S. Wise (Ed.), *Teacher training in assessment and measurement skills* (27-40). [Buros-Nebraska Series on Measurement and Testing]. Lincoln, NE: Buros Institute.

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[1] Drawing upon NCTM's Assessment Standards for School Mathematics (1995), I make the following distinction between assessment and evaluation. Evaluation is the process of determining the worth of, or assigning a value to, something based on careful examination and judgment. Assessment (as a noun) is used to emphasize understanding and description of both qualitative and quantitative evidence in making judgments and decisions. Assessment (as a verb) is the process of gathering evidence about a student's knowledge of, ability to use, and dispassion toward mathematics and making inferences from that evidence for a variety of purposes. Evaluation is one use of assessment information.

[2] "Alternative", as well as "traditional", forms of assessment may be less clearly demarked. There are common characteristics in alternative assessment, most ask students to perform, create, produce, or do something; tap higher-level thinking and problem-solving skills; use tasks that represent meaningful instructional activities; involve real-world application; are scored qualitatively; and, require new instructional and assessment roles of teachers. Traditional assessment efforts seem skill or process-oriented, such as common practices of end-of-the-unit testing. These efforts present a clear line of distinction between instruction and assessment.

[3] Authentic assessment is a type of alternative assessment, emphasizing practices that are relevant, real-world and focused on meaningful learning.

[4] Beginning in 2003, this test has been renamed the Texas Assessment of Knowledge and Skills (TAKS).