Assessment

Chapter 5

> *…the act of teaching should be founded on dialogues between teachers and students, each responding to the other on the basis of what has been said or done. Assessment refers to the process of trying to understand what meanings students assign to the ideas being covered in these dialogues; as such, it is an integral element of effective teaching. …Ultimately, it offers a foundation for any meaningful dialogue between teacher and student.*
>
> NCTM Curriculum Standards

In *Visual Mathematics*, assessment is the ongoing process of seeking insights about the development of each student as a mathematician. This involves continuously monitoring the development of students' thinking about the mathematical ideas explored in the lessons, students' views of themselves as mathematicians, and the extent to which students understand and value the mathematical process and integrate this process into their own way of approaching new problems or ideas.

How we assess is determined by our philosophy and understanding of the learning process (see Chapter 1). We pose situations for investigation and then carefully listen to students' elaborations, questions, and self-assessments. Such listening occurs during one-to-one interviews and conversations with students, as we "eavesdrop" on small and large group discussions, and when we examine and interpret students' written explanations. All *Visual Mathematics* lesson activities provide a context for eliciting mathematical dis-

course — oral and written — as do the sample assessment activities included in this section of *Starting Points*.

What we assess is determined by the goals of the course (see Chapter 1) and the big ideas of the lessons. Because learning about an idea is ongoing and the big ideas in *Visual Mathematics* resurface across time, assessment also needs to be ongoing and must emphasize growth over time.

> *Assessment should reflect what we understand about how students learn mathematics. Learning is an active social process in which students construct their mathematical knowledge from experience. This process is individual — no two students "learn" exactly the same thing from the same activity. Learning takes time — different students require different amounts of time and experience. And learning is not linear. With this view of learning, the essential assessment question becomes "Where are these students in the process of making sense of the mathematics?" rather than "Which students have acquired concept X or skill Y?*
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> *This view of learning also influences the assessment of students' progress in making sense of a particular aspect of mathematics. In the traditional view, where the teacher's role is to dispense knowledge and the students' role is to absorb it, assessment is to be done after, and perhaps before, instruction. When learning is viewed as a sense-making process, assessment is something to be done on an ongoing basis, before, during, and after instruction, for the purpose of monitoring students' progress. Also, "after instruction" refers to a much longer time than it does in the traditional view, in which "after" generally means "immediately after." From the sense-making viewpoint, immediate assessment can be quite misleading because students may not have had adequate time and experience to integrate new ideas into their previous learning.*
>
> NCTM Assessment Standards

Please use the following discussion of assessment as a basis for thinking further about assessing and documenting the development of student thinking in your classroom. Note that although the strategies we describe are ones we have found fruitful in our classrooms, they are not all necessarily used simultaneously, and they are not all implemented identically with every class. Gaining comfort with their use *took us time!* Let us know if you have other ideas or adaptations of these ideas that we could share with the growing community of *Visual Mathematics* teachers.

PURPOSES OF ASSESSMENT

In *Visual Mathematics*, all assessments — whether embedded as a part of the instructional approach during lesson activities or explicit assessments such as Follow-ups, extended projects, or journal and other writing activities — are intended to serve the following major purposes, listed in order of priority:

a) provide students with encouragement and an opportunity to grow mathematically;
b) promote students' reflection about their own thinking and progress, hence enabling their development as independent learners;
c) give the teacher information about students' knowledge and thinking as a basis for instructional planning and improvement;

d) monitor student progress for the purpose of reporting to students, parents, administrators, and the community outside the school.

CRITERIA FOR MEANINGFUL ASSESSMENT ACTIVITIES

We have found that the preceding list of four major purposes of assessment is a meaningful filter for determining the usefulness of assessment activities that we develop. In addition, we use the following criteria as a basis for deciding whether assessment activities reflect the spirit and goals of the program.

- Do problems or activities emphasize understanding and engage students in thinking deeply about important mathematical ideas?
- Are problems "open?" That is:
  - are they accessible by students at many achievement levels?
  - is there potential for *all* students to learn and be challenged by the problems?
  - although the problems may have one or many right answers, are there many ways to approach each problem?
  - are there many possible directions for extending thinking about the problems (i.e., is there potential for many student "I wonder" and "what if" thoughts to emerge from the problems)?
- Is there emphasis on student elaborations about their understandings, methods, and reasoning?
- Is the setting for the activity (take-home or in-class, small-group, whole class, or individual) appropriate?
- Does the activity allow and encourage the use of manipulatives, models, diagrams, and sketches?
- Does the activity allow appropriate time?
- Are concepts or ideas sometimes cast in unfamiliar settings, providing opportunities for students' conceptions to be challenged and/or for students to see connections among ideas?
- Is student reflection encouraged during and after the activity?

A TIMELINE FOR CHANGING ASSESSMENT METHODS

Viewing assessment as a dynamic process of interaction between teacher and students — a process that is integral to teaching — is in sharp contrast to the more traditional view of assessment as an isolated event that occurs after teaching is "completed." Unfortunately, most of us were schooled in traditional assessment methods, and so changing our assessment philosophy and practice is yet another challenge.

For us, meeting this challenge without becoming overwhelmed, meant starting slowly, focusing first on shifting emphasis to drawing out students' thinking rather than sug-

gesting a way of thinking. The Actions and Comments of each activity are intended to reflect this emphasis, as is each lesson's Follow-up. Making this shift revealed a wealth of information about our students' development and our own teaching practices.

Our next step was to create a guide and procedures for encouraging student reflection about their work on Follow-ups and other written assignments. Then we implemented student journals, conducted student interviews, and explored ways to document our observations about students' thinking. Finally, we introduced our students to portfolios and extended projects. (Note that student self-assessment plays an important role in each of the preceding steps.) A similar gradual process may be useful for you. This process may span several years, as illustrated by the following example of one teacher's timeline:

Year 1 Focus on becoming familiar with the lessons, emphasize questioning and listening practices (see pages 19-20) during the lesson activities, and introduce Follow-up Assessment Form (see page 39).
Year 2 Emphasize journals (see pages 43-47).
Year 2 and/or 3 Experiment with observational notes and checklists (see pages 48-50), and explore the use of student interviews (see pages 50-52).
Year 3 Implement growth-folios (see pages 52-57).
Year 4 Assign 1 or 2 extended projects (see pages 58-61).
Ongoing With each new school year, continue and/or adapt the strategies implemented previously and increase the extent of student self-assessment; by the end of year three, students play a major role in their own grading (see pages 61-62).

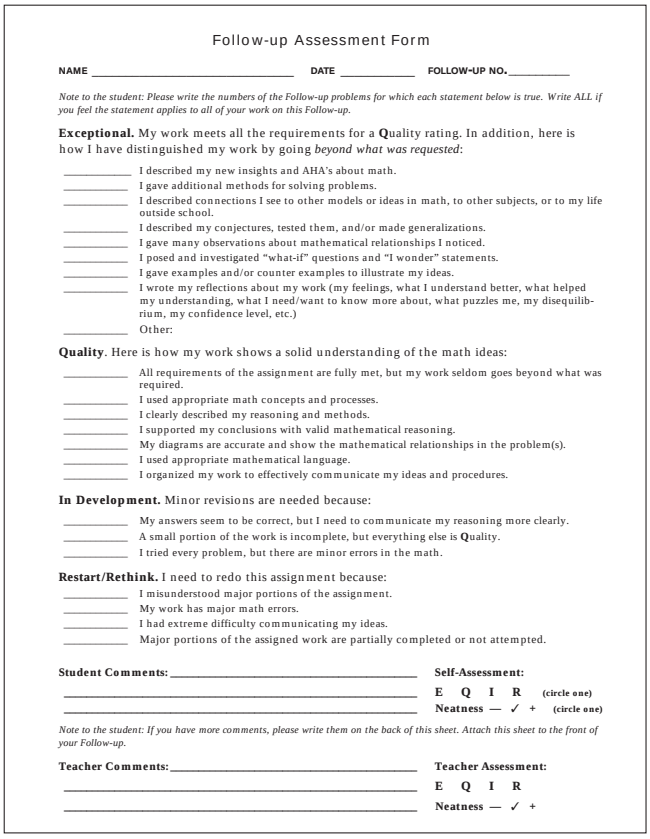
USING FOLLOW-UPS

All Follow-ups are designed to satisfy the preceding criteria for meaningful assessments. Follow-ups give students opportunities to reflect and grow mathematically, provide documentation of students' mathematical thinking at a given point in time, and inform instructional planning.

We prefer to assign Follow-ups over an extended period, distributing them at the start of a Focus activity and collecting them after the lesson is completed. This gives students time to explore, discuss, question, and refine their ideas.

■ Procedures for assigning and assessing Follow-ups.

Step 1 At the beginning of Lesson 2 or 3 of each *Visual Mathematics* course, provide each student a Follow-up Assessment Form, shown on the next page, and explain the procedure for using this as the basis of self-assessments (see Step 3) and teacher assessments (see Step 4) of their work on Follow-ups.



Follow-up Assessment Form

NAME _____ DATE _____ FOLLOW-UP NO._____

Note to the student: Please write the numbers of the Follow-up problems for which each statement below is true. Write ALL if you feel the statement applies to all of your work on this Follow-up.

Exceptional. My work meets all the requirements for a **Q**uality rating. In addition, here is how I have distinguished my work by going *beyond what was requested*:

_____ I described my new insights and AHA's about math.
_____ I gave additional methods for solving problems.
_____ I described connections I see to other models or ideas in math, to other subjects, or to my life outside school.
_____ I described my conjectures, tested them, and/or made generalizations.
_____ I gave many observations about mathematical relationships I noticed.
_____ I posed and investigated "what-if" questions and "I wonder" statements.
_____ I gave examples and/or counter examples to illustrate my ideas.
_____ I wrote my reflections about my work (my feelings, what I understand better, what helped my understanding, what I need/want to know more about, what puzzles me, my disequilibrium, my confidence level, etc.)
_____ Other:

Quality. Here is how my work shows a solid understanding of the math ideas:

_____ All requirements of the assignment are fully met, but my work seldom goes beyond what was required.
_____ I used appropriate math concepts and processes.
_____ I clearly described my reasoning and methods.
_____ I supported my conclusions with valid mathematical reasoning.
_____ My diagrams are accurate and show the mathematical relationships in the problem(s).
_____ I used appropriate mathematical language.
_____ I organized my work to effectively communicate my ideas and procedures.

In Development. Minor revisions are needed because:

_____ My answers seem to be correct, but I need to communicate my reasoning more clearly.
_____ A small portion of the work is incomplete, but everything else is **Q**uality.
_____ I tried every problem, but there are minor errors in the math.

Restart/Rethink. I need to redo this assignment because:

_____ I misunderstood major portions of the assignment.
_____ My work has major math errors.
_____ I had extreme difficulty communicating my ideas.
_____ Major portions of the assigned work are partially completed or not attempted.

Student Comments:_____ **Self-Assessment:**
_____ **E Q I R** (circle one)
_____ **Neatness — ✓ +** (circle one)

Note to the student: If you have more comments, please write them on the back of this sheet. Attach this sheet to the front of your Follow-up.

Teacher Comments:_____ **Teacher Assessment:**
_____ **E Q I R**
_____ **Neatness — ✓ +**

Step 2 After each day of a Focus activity, assign one or more problems from the Follow-up as homework, or let students pick problems. (Note that sometimes, instead of assigning problems from the Follow-up, we assign problems from another Student Activity, Connector Master, or Focus Master that wasn't completed in class; these are not turned in with the completed Follow-up, rather they are usually done in students' journals and provide a basis for thinking about Follow-up problems.) Here are a few suggestions for supporting students as they work on a Follow-up:

- Instead of giving answers or having students demonstrate homework problems in class, regularly ask students to tell about the places they are stuck and invite other students to give clues to help them get unstuck, without revealing the answers. This usually takes, at most, 5-10 minutes of class time.
- Emphasize that each student's initial work on a problem is a "draft" and that revisions and refinements are ongoing parts of the process of completing Follow-ups. Encourage students to refer to the Follow-up Assessment Form as they work on the Follow-up. This will remind them of ways to extend their thinking.
- Occasionally give time (say 10 minutes) for students to discuss with groupmates their questions about and drafts of certain Follow-up problems (it is helpful to announce this a day ahead).
- Periodically discuss strategies for dealing with stuckness — such as setting a problem aside and coming back to it later, writing down what was done so far, trying to identify what one needs to know in order to solve the problem, drawing a picture, asking for clues but not solutions, etc.
- Depending on students' needs, on some occasions assign only selected problems from

a Follow-up; use the remaining problems later as warm-up, review, or challenge problems.

- If the class seems especially unsettled about a problem, ask groups to discuss and compare their responses and to write down any questions that the group cannot explain. Discuss these as a large group.
- To encourage more detailed responses, have students write final drafts of the Follow-up problems on other paper and encourage the use of word-processors.
- Collect Follow-ups after the lesson is completed; on other days have students complete a Daily Report (see page 47) telling what they did and what they have questions about. Note that in some cases a Follow-up for one lesson may be due a day or two after starting the next lesson.

Step 3 Before turning in final drafts of completed Follow-ups, students each complete the Follow-up Assessment Form by indicating which criteria on the form are satisfied by their work and recording their comments and self-assessment. These forms are stapled to the front of the assignment.

Step 4 While reading each student's Follow-up, we make notes (in the margin of the Follow-up Assessment Form of problem numbers that illustrate exemplary work or that need revision or rethinking. Comments often include suggestions for revising work (we allow students to submit revisions within an agreed-upon time frame). When recording assessments in a grade book, we include their assessment, our assessment, and any assessments of revisions.

On some occasions, to assist the review process and enhance the quality of student work prior to collecting Follow-ups, we have the students:

a) Trade Follow-ups with another student and then review one another's work and provide written feedback to each other on Follow-up Feedback Forms.
b) Spend 5-10 minutes conferring in pairs about their observations from a) above.
c) Use the information gleaned from a) and b) as a basis for revising and refining their work.

Although we may still choose to review and give feedback about students' work, this peer review process generally results in higher quality work and diminishes the need for our feedback.

Allowing students to work on assignments over an extended period encourages revisions and reinforces the idea that understanding and problem solving take time. Not revealing answers or demonstrating solutions for students to mimic reinforces in students our belief in their ability to do mathematics and does not rob them of the joy and satisfaction of solving the problems themselves. Students report that our informing them of assessment criteria before they begin their work, involving them in the assessment process, and encouraging revisions makes them feel "trusted, confident, proud, and respected."