Assessment Notes

Here are a few useful links in regards to assessment in Mathematics.

The MAA guidelines for departments
Especially see Appendix A on QL skills

What quantitative literacy requirements should be established for all students who receive a bachelor's degree? Over the years, the Mathematical Association of America (MAA) has approached this question in various ways, most recently by establishing, in 1989, a Subcommittee on Quantitative Literacy Requirements (henceforth called the Subcommittee) of its Committee on the Undergraduate Program in Mathematics. The work of the Subcommittee has been similar in some respects to the efforts of the National Council of Teachers of Mathematics (NCTM) that led to its celebrated Curriculum and Evaluation Standards for School Mathematics (1989) and related publications. The recommendations from the Subcommittee can be considered to complement those in the Standards. They also should be viewed as a reasonable extension of a Standards-based high school experience to the undergraduate level.

The Subcommittee began with the perception, supported by many recent studies and reports, that general mathematical knowledge among the American people is in a sorry state. It assumed that colleges and universities would welcome some suggestions on what they might do about the situation.

The discussions and investigations conducted by the Subcommittee led to four primary conclusions. The conclusions embody a vision that goes well beyond present practice in most places.

Conclusion 1. Colleges and universities should treat quantitative literacy as a thoroughly legitimate and even necessary goal for baccalaureate graduates.

Conclusion 2. Colleges and universities should expect every college graduate to be able to apply simple mathematical methods to the solution of real-world problems.

Conclusion 3. Colleges and universities should devise and establish quantitative literacy programs each consisting of foundation experience and a continuation experience, and mathematics departments should provide leadership in the development of such programs.

Conclusion 4. Colleges and Universities should accept responsibility for overseeing their quantitative literacy programs through regular assessments.

Supporting Assessment in Undergraduate Mathematics (SAUM)
The MAA has been serious in promoting assessment in undergraduate mathematics. Several case studies linked to this report are worth examining.
Arapahoe CC used a common final already in place and tied questions on the final to benchmarks in the course and performance on that final to pedagogy. Using the BC cycle, they plan to use performance on the final to improve pedagogy and thus learning. (See http://www.maa.org/SAUM/cases/johnson-berg-heddens1105-saum.pdf)
Allegheny College examined their Intermediate Algebra course to see if it was meeting the needs of students. They examined performance on subsequent courses by students who placed into and took IA and students who placed into and did not take IA. They also interviewed client departments and students. Their findings indicated that it was of little value to many students and did not meet the needs of specific programs. Their findings led to more options for students – rather than an algebra-intensive course. (See http://www.maa.org/SAUM/cases/harrell-lakins1105-saum.pdf)
Cloud County CC has seen a shift to the vast majority of students having to take developmental classes, and then college algebra. Their assessment reviewed the contents of their developmental courses and then the format of college algebra. They found that courses that met longer (rather than one-hour a day) met with greater long term success. College Algebra was offered in three different formats and the results on tests and then on the common exam were compared. (See http://www.maa.org/SAUM/cases/warkentin-whisler1105-saum.pdf)

The MAA subcommittee on Assessment promotes a five-phase assessment design:
1) articulation of goals and objectives,
2) development of strategies for reaching goals and objectives,
3) selecting instruments to evaluate the attainment of goals and objectives,
4) gathering, analyzing and interpreting data to determine the extent to which goals and objectives have been reached, and
5) using the results of assessment for program improvement.
When the final phase is reached, the assessment cycle begins again. This conceptualization of the assessment process is consistent with other literature on assessment and is applicable at classroom, departmental or university level.

Assessment of Student Learning for Improving the Undergraduate Major in Mathematics, Mathematical Association of America, Subcommittee on Assessment, Committee on Undergraduate Program Mathematics, 1995.

Steen, L, "Assessing Assessment," in Gold, B., Keith, S.Z., and Marion, W., eds., *Assessment Practices in Undergraduate Mathematics*, 1999, pp. 1-6.

Assessment Standards for School Mathematics, National Council of Teachers of Mathematics (NCTM), Reston, Virginia, 1995.

Moskal, B. "An Assessment Model for the Mathematics Classroom," *Mathematics Teaching in the Middle School*, 6 (3), 2000, pp. 192-194.

Beyond CROSSROADS, AMATYC, Memphis, TN, 2005

Lynn Steen suggests that we "ask the right questions!" Inferring that many times in assessment we (in mathematics) do not. Here are a few questions Lynn encourages us to ask:

- *Do students in introductory mathematics courses learn a balanced sample of important mathematical tools?*
- *Do these students gain the kind of experience in modeling and communication skills needed to succeed in other disciplines?*
- *Do they develop the kind of balance between computational skills and conceptual understanding appropriate for their long-term needs?*
- *Why can't more mathematics problems employ units and realistic measurements that reflect typical contexts?*
- *Do students learn to use mathematics in interdisciplinary or "real-world" settings?*
- *Are students encouraged (better still, required) to engage mathematics actively in ways other than through routine problem sets?*
- *Do mathematics courses leave students feeling empowered, informed, and responsible for using mathematics as a tool in their lives?*
- *Do program offerings reveal the breadth and interconnections of the mathematical sciences?*
- *Do introductory mathematics courses contain tools and concepts that are important for all students' intended majors?*
- *Can students who complete mathematics courses use what they have learned effectively in other subjects?*
- *Do students learn to comprehend mathematically-rich texts and to communicate clearly both in writing and orally?*

Lynn closes with: "Rarely does one find faculty begging administrators to support assessment programs. For all the reasons cited above, and more, faculty generally believe in their own judgments more than in the results of external exams or structured assessments. So the process by which assessment takes root on campus is more often more top down than bottom up." (See http://www.maa.org/SAUM/cases/steen1105-saum.pdf)

Curriculum Foundation Reports – The 20 or so reports that make up the vision were created after considerable discussion with partner disciplines.

Emphasize problem solving skills.

- *Develop the fundamental computational skills the partner disciplines require, but emphasize **integrative skills**: the ability to apply a variety of approaches to single problems, to apply familiar techniques in novel settings, and to devise multi-stage approaches in complex situations.*

Emphasize mathematical modeling.

- *Expect students to create, solve, and interpret mathematical models.*
- *Provide opportunities for students to describe their results in several ways: analytically, graphically, numerically, and verbally.*
- *Use models from the partner disciplines: students need to see mathematics in context.*

Emphasize communication skills.

- *Incorporate development of reading, writing, speaking, and listening skills into courses.*
- *Require students to explain mathematical concepts and logical arguments in words. Require them to explain the meaning — the hows and whys — of their results.*

Emphasize balance between perspectives.

- *Continuous and discrete*
- *Linear and non-linear*
- *Deterministic and stochastic*
- *Deductive and inductive*
- *Exact and approximate*
- *Pure and applied*
- *Local and global*
- *Quantitative and qualitative*

Use a variety of teaching methods since different students have different learning styles. In particular, encourage the use of active learning, including

- *in-class problem solving opportunities*
- *class and group discussions*
- *collaborative group work, and*
- *out-of-class projects.*

Emphasize the use of appropriate technology.

Emphasize the use of appropriate assessment.

The important relationship between assessment and student learning was discussed extensively at the workshops; i.e., how and what you assess directly affects how and what students learn. Because assessment can be difficult, time-consuming, and tedious, instructors often put less thought and effort into this aspect of course design. However, since effective assessment is critical to learning, instructors must invest in the development of a variety of assessment strategies to measure achievement of course objectives.

WYTIWYG ("What you test is what you get") was adopted at the final Curriculum Foundations Conference as a central message about assessment. For example, discussions focused on the need for conceptual questions on examinations as opposed to only algorithmic computations and problems that can be solved mechanically with a calculator. It underscores the importance assigned by colleagues in partner disciplines to the development of conceptual understanding.

Indicators of Quality Undergraduate Mathematics Education

This NSF-funded project was designed to develop statistical measures (Indicators) that might be useful to help mathematics departments monitor the quality of their mathematics courses in the first two years.

The full report looks at the department, classroom and student. Regarding the classroom, the key issues and indicators are

→Use interactive teaching strategies

Indicators:
1. Instructors use a variety of interactive teaching strategies.
2. Instructors promote active engagement with mathematics content.

→Use technology effectively and appropriately

Indicators:
1. Classrooms must be equipped for using technology in instruction.
2. Technology is used in teaching a variety of mathematics courses

→Instructors use a variety of assessment methods routinely

Indicators:
1. Instructors seek student feedback to monitor progress
2. Instructors use a variety of criteria in determining final grades.
3. Instructors assess core student proficiencies using common items.

MAA CUPM report

In arranging experiences teachers must concentrate on the important mathematics. What and how we teach must reflect what is important and how it is important. Recall the image of the residue. The procedural and conceptual knowledge that remains is a result of what is learned and how it is learned. Therefore, what and how we teach must also be reflected in what and how we assess. Classroom assessment serves several purposes in the learning environment. Assessment should provide feedback at several levels. First, assessment provides feedback to the student. It also provides feedback to both the instructor and the program. Finally, assessment can be used for evaluation purposes to assign a value to the work. In any case, all assessment instruments should focus on the important mathematics and require demonstration of procedural and conceptual understanding that reflects how the mathematics was experienced. The important mathematics is that which is critical to the objectives of the course. How the mathematics was experienced dictates how the assessment should be designed. For example, few inferences about knowledge can be made if classroom activities stress purely theoretical or procedural approaches and then the assessment requires modeling and problem solving, or vice versa. An assessment plan designed to provide inferences about student knowledge should include a variety of instruments. Examples of instruments include quizzes, exams, applied or interdisciplinary projects, problem solving activities, essays, journals and problem sets. These instruments should include a variety of requirement types addressing both procedural and conceptual knowledge. These types may include fill in, short answer, calculations, graphical analysis, numerical analysis, explanations and modeling. Assessment instruments can be done both in- and out-of-class and should appropriately integrate technology. In order to most accurately infer student understanding, assessments must include a variety of problem types and presentations

Kathleen Snook (USMA):
I recall a visiting professor in my department once saying, “Knowledge is the residue that remains after the facts are forgotten.”[1] This phrase comes to mind often as I think about teaching and learning. I visualize a glass container or vase filled with a liquid substance. The substance is made up of many different ingredients whose individual identities have been lost by being soaked or dissolved in the liquid. This filled vessel perhaps represents information in a student’s mind toward the end of the semester, integrated and coherent. After a summer or semester break the liquid seems to evaporate leaving a residue on the inside walls of the vase. As educators we must concerned ourselves with the content and quality of the “residue that remains.” If the appropriate residue remains, when this knowledge is again needed students can add liquid, shake, and reconstitute the original mixture.

60 CUPM Discussion Papers about Mathematics and the Mathematical Sciences in 2010

	Student	Instructor	Department
Student evaluates	Classroom Assessment Techniques [1], surveys, homework summaries, projects, writing assignments, autobiographies, portfolios, journals, post-test self-evaluations, student-created goals and reviews	Teacher evaluation forms, quick surveys (e.g. fold a paper vertically and write in the columns the positives and negatives of your learning), writing assignments, journals	Web page, newsletters, exit interviews, alumni surveys, enrollment data, focus groups, general surveys
Instructor evaluates	Tests, homework, written work with revision, ,CATS, surveys, projects with technology, board work, group quizzes, etc.	Portfolio, comparisons, focus groups, committees, peer reviews, mentoring	Committees, focus group, data reports, surveys to client disciplines, team teaching, forums
Department evaluates	Placement, data, comprehensive exams, capstone courses, advising, mentoring, counseling, tutoring, appropriate goals, newsletters, welcoming pamphlets	Data, committees, clear goals and expectations, mentoring, counseling, shared information, and the usual (research, grants, etc.)	Data, committees, focus groups, surveys with client disciplines, external reviews, comparison with other institutions, national organizational data, literature from other organizations