Based on an informal talk given by Bernie Madison at QL SIG

Over the past four years I have worked with a project on quantitative literacy (QL) that Bob Orrill directed from the National Council on Education and the Disciplines (NCED) at the Woodrow Wilson Foundation. In spring 2001 NCED published *Mathematics and Democracy* (edited by Lynn Arthur Steen), and that book was critical background information for a national forum on QL held at the National Academy of Sciences in Washington, DC, in December 2001. In 2003, we published the proceedings of that national forum, *Quantitative Literacy: Why Numeracy Matters for Schools and Colleges* and then the shorter, snappier version of the proceedings *Achieving Quantitative Literacy* summarizing the recommendations for achieving QL was published by the Mathematical Association of America in 2004. All three of those publications are available from the MAA. If you search the MAA web site, you can find them – or you can call them.

There is an international movement related to QL. I was just in Canada at the second half of the 'Numeracy and Beyond' workshop involving people from Europe, Canada, Australia and the US. But that's another story. Quantitative literacy is treated a little bit differently in different parts of the world. In Europe and Canada it is called numeracy rather than quantitative literacy.

Growing out of a project that Bob Orrill directed – along with Lynn Steen, Susan Ganter and others – was the National Numeracy Network. This was originally a network of centers on campuses but is now a member supported organization. We've organized it (we've actually incorporated it) and filed for 501 3C tax status and are looking to become a real organization. More on this later.

The various definitions of quantitative literacy are not something we should be troubled about. There are lots of writings (such as the work of Linda Sons and others) that have clearly outlined very thoroughly the elements of quantitative literacy. I think we are beginning to understand quantitative literacy as the ability to use quantitative information in everyday life as it comes to you in unpredictable and unimaginable ways.

What we do lack at the moment are standards for achievement in quantitative literacy and assessments to see whether those standards are achieved in a developmental way. Assessment in quantitative literacy is really 'double-trouble.' It is a very difficult area to understand. We actually have an NSF proposal pending which seeks to develop a foundation (or resources) for standards and assessments in QL at grades 10, 12, 14, and 16. Two of the states here, Georgia and Washington, are part of that proposal.

From the results of MeasuringUp2000, MeasuringUp2002 and then MeasuringUp2004 (where they assign grades to the higher education systems in all the states), it is very clear that there is considerable work to do in areas such as assessing for QL. MeasuringUp grades state systems in areas that include accessibility, affordability and things like that. But one of the areas is learning, that is, what learning is resulting. Almost all colleges across the country have something like quantitative reasoning or quantitative literacy as one of their learning goals, so assessing whether these goals are being met is one of the areas where MeasuringUp assigns grades. In this area, all states in 2000 and 2002 received grades of "incomplete." And in 2004, all except five still received "incompletes." Those five were designated as 'making progress.' I believe those are the five states involved with the American Diploma Project. But 'making progress' is not the same as 'being there,' and certainly a ways away from a grade of A.

So, determining what quantitative reasoning – quantitative literacy – is and how to measure it is a major national issue. The Program for International Student Assessment (PISA), organized by the Organization for Economic Cooperation and Development (OECD) is the closest thing there is in the world for measuring quantitative literacy. The US, in the most recent (2003) PISA examination, ranked 28th out of 40 in mathematics literacy, below international average – a really dismal performance. If that test is representative of US achievement in quantitative literacy, then clearly we are not there yet. I don't want to rain on anybody's parade in efforts to develop better education for QL through mathematics courses, but my feeling is that traditional – even modified traditional -- mathematics courses will not suffice to achieve quantitative literacy in our students. It's going to require more than that. It's going to require not only the cross-disciplinary cooperation, it's going to require much closer connections to real world conditions that dictate what QL is.

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Traditional mathematics courses tend to degenerate to the methods that are either derived or used in them. College algebra is a good example, partly because of who teaches it and who takes it. However, college algebra is heavily weighted toward methods and procedures anyway because the conceptual basis of the material is beyond the reach at this level. The old patterns in mathematics were efforts to build elementary courses that were more conceptual and less manipulative, but, these suffered even more than college algebra when they degenerated to the methods contained in them. QL-friendly courses will likely be less than acceptable if they are allowed to degenerate to methods. So basically, in methods courses, conceptual and mental frameworks are missing for students to organize the procedures and information. Consequently, it is very difficult for students to remember what went on in those courses. And mind you, I have lots of proof of that – as all of you do.

It is also the case that quantitative literacy – if anything else – is a habit of mind. It is a habit of mind like critical thinking and a lot of creative writing – like all of those basic proficiencies and competencies. Habits of mind are developed by practice: practice, practice, practice! And what happens when students leave college algebra? How often do they practice? When they leave calculus courses, how often do they practice?

So what we've got to do is develop courses that give students a venue where they can practice what they've learned in that course. Nobody can achieve quantitative literacy with just a course; nobody can achieve quantitative literacy with a dozen courses. What you have to do to achieve quantitative literacy is build foundations in courses, and then you have to practice, practice, practice. We have to give students the opportunity to do that.

Courses and textbooks tend to promote the degeneration to methodology. Once you put it into a textbook, it becomes structured: broken up into bits and pieces. Quantitative literacy requires students to encounter quantitative information in numbers and words, often ill defined and badly structured. And this combination of number and word is deadly difficult, as we know. QL requires students to encounter these things in unpredictable ways – in ways that they don't expect. So, it can't be broken up into bits and pieces; it doesn't come as 25 polynomials that we have to factor. It comes in ways that we can't readily say what it is. We have to figure out what it is and deal with it.

So we have to get students used to confronting mathematics and statistics in those ways. We have to get them to develop the confidence to believe that they can deal with the information: to read it, analyze it and then reflect their analysis back into what they've read.

That's very difficult. I spent the last semester teaching an experimental course where the course materials are newspaper articles and magazine articles. Now, I'm happy to talk about that for hours. And I'm going to teach it again next semester to 40 journalism majors. What we did was encounter the mathematics and statistics as it comes out of these articles. It (the material) is not organized by mathematical topics. It may be organized by some kind of structure, but I am yet to see what that might be. What I'm learning is that the students have a tremendous amount of difficulty with this. The math that sometimes comes out of this is fairly simple – QL mathematics. But let me tell you something: the math or statistics may be elementary but QL is very difficult. I will give you my reasons when we have time.

You should pick up a copy of the Summer 2004 Peer Review, an academic journal of the Association of American Colleges and Universities (AAC&U). I believe that one of the major achievements of the QL movement has been to get a national conversation started among educators and policy makers. This issue of Peer Review being dedicated to QL, and the fact that one of the articles in the issue was featured on the Chronicle for Higher Education's daily headlines, indicate that the conversation has made the big time, at least within the academic community Peer Review is dedicated to exploring emerging trends and key debates in undergraduate education. So read this issue! In the article I wrote for Peer Review I outline why I believe that quantitative literacy is very difficult – but it can be achieved. The experimental QL-like course that I'm now teaching is fascinating, but I talked about that the other day (Madison, 2005). So right now is not the time to do that. And now we are out of time.