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Review of *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education* by Bernard L. Madison and Lynn Arthur Steen (Editors)

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Abstract

Madison, Bernard L. and Steen, Lynn Arthur (Eds.). *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education.* (Washington, DC: Mathematical Association of America, 2009). 197 pp. Softcover. ISBN 978-0-88385-908-7. Available free on the MAA website at http://www.maa.org/ql/calcvscontext.html

The papers in *Calculation vs. Context* discuss the role of quantitative literacy in the K-12 curriculum and in teacher education. The papers present a varied set of perspectives and address three themes: the changing environment of education in American society; the challenges, and the necessity, of preparing teachers to teach quantitative literacy and of including quantitative literacy in the K-12 education; and cross-disciplinary approaches to quantitative literacy. While the conclusion reached by several of the authors is that the best place to teach quantitative literacy is at the college level, the book offers serious considerations of how quantitative literacy can and should inform the K-12 curriculum. The book also marks a turning point in the quantitative literacy movement as "QL explorers," as Lynn Steen calls them, move beyond issues of definitions and content to a discussion of how to bring quantitative literacy into a broader setting.

Keywords

Quantitative Literacy, teacher education, assessment, K-12 education, mathematics education

Introduction

"I just want my students to be able to make comparisons. I don't care if it's in math, or another subject, or in life...." A colleague of mine, an experienced high school math teacher, said this recently in a conversation about what math is taught and what math should be taught in high school. Her comments came to mind as I read *Calculation vs. Context: Quantitative Literacy and its Implications for Teacher Education*, edited by Bernard Madison and Lynn Steen. Would my colleague's students benefit more from a curriculum that teaches them to "understand, utilize, and react to quantitative information in their daily lives" (p. 5) than from a traditional math curriculum? Is it possible to honestly integrate this material into the current K−12 curriculum?

These questions and others were considered by the participants in a workshop on the role of quantitative literacy (QL—also called quantitative reasoning or QR) in the K−12 curriculum and teacher education. For two days workshop participants discussed the issues raised in preliminary versions of solicited papers that framed the discussions. The papers were revised in light of the discussions and presumably reflect some consensus around these issues; these papers form the bulk of the book. In short, the overall conclusion is a fairly bleak one: QL should be integrated into the K−12 curriculum but at this point it is more realistic, more practical, and perhaps more effective to focus on teaching QL at the college level. Despite this gloomy prognosis, there is much to consider in these papers. They provide provocative material for discussion, thought, and action and the book itself breaks new ground for the QL movement as it moves beyond issues of definition and content.

The papers in this book fit naturally into three categories. The keynote address by Richard Shavelson and the paper by Robert Orrill sketch the big picture of education in the United States. The papers by Frank Murray, Hugh Burkhardt, Alan Tucker, and Milo Schield directly address teacher education and the role that QL can play in K−12 education. The papers by Corrine Taylor, Neil Lutsky and Joel Best focus primarily on QL at the college level, with little or no discussion of the implications for teacher education (although the implications for K−12 education are hinted at). While not one of the conference papers *per se*, Bernard Madison's introduction carefully sets the scene, describes the relevant history, and outlines the motivation for the workshop. Lynn Steen's reflection on the workshop provides an excellent overview and analysis of the main discussions. One could get the main ideas of the workshop by reading just the papers by Madison and Steen—and indeed they provide an excellent starting point. But it is worthwhile to continue into the papers themselves with the perspective that this is the beginning of a long conversation about QL at the pre-college level.

Quantitative Literacy Education: The Big Picture

In his keynote address, Richard Shavelson focuses primarily on assessment at the college level. As background, Shavelson is the director of the Stanford Education Assessment Laboratory and one of the developers of the Collegiate Learning Assessment (CLA), a test that can be used by institutions participating in the Voluntary System of Accountability.[1]

Shavelson outlines three approaches to defining, and hence assessing, QL: the psychometric approach, which considers behavioral roots; the cognitive approach, which looks at mental process roots; and the situative approach, which studies social-contextual roots. He favors the situative approach, with possible input from cognitive analysis, putting QL within a social and community context. Writing about the situativists, he says (p. 34),

> They would begin by *not* assuming that QR resides solely within the person but would view QR within a *community of practice*—e.g., those individuals engaged in culturally relevant activities in which reasoning quantitatively is demanded and the various resources of the community would be brought to bear on those activities.

Shavelson argues that this approach is consistent with how QL is typically characterized; therefore, QL should be measured through context-rich assessments. He presents the CLA as an example of an assessment that illustrates the situative approach to QL, although he acknowledges that the CLA is not a test of QL. Since the CLA tests critical, complex reasoning—for example, students are given a collection of information (newspaper articles, data, etc.) and must weigh the information to arrive at a recommendation or solution to a problem—it may address QL in a broad sense.[2]

Shavelson makes another important point about assessment, this time in the K−12 curriculum. He argues that unless QL becomes a central part of what our society defines as mathematical achievement, it will not be taught in the K−12 classroom. The reasons are two-fold. The high-stakes testing environment at this level means that what teachers teach is determined by the test; and the social context within our society is that QL ability is not regarded as valuable or desirable (ironically, perhaps because it is perceived to be linked closely to

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[1] http://www.voluntarysystem.org/index.cfm (last accessed June 22, 2009).

[2] There is an increasing demand for accountability in higher education (e.g., Spellings, 2006) with recommendations that post-secondary institutions conduct, and make publicly available, "value-added" assessment. The CLA is one example of an approach to measuring "value-added."

mathematics!). Shavelson makes the point that we cannot attempt to solve the K−12 problem (regarding QL) until we better prepare college students in mathematics and in QL. He offers a "heresy", that "we should be talking about preparing QR in introductory college mathematics courses for the broad college audience, in general education courses, and in the mathematics major creating a pedagogy that gives the diversity of students access to both QR and the level of mathematics needed to teach it in high school" (p. 43). To a certain extent, this is happening as QL becomes part of general education programs. I suspect that some will see the real heresy to be the inclusion of QL in the mathematics major (but I agree that it's an important part of this approach).

Robert Orrill's essay discusses the "antipathy to quantification" in the history of education in the United States. He outlines the clash of perspectives: the humanists' view of the university as a small, enclosed, elite institution dedicated to the transmission of tradition and knowledge versus the utilitarian philosophy that the university should be open to all and so integrated with American life as to change with it. By the turn of the last century, higher education was grappling with increasing numbers of students, including many who did not view college as an "adventure of ideas" and who were not prepared for the demands of the university. At the same time, a creeping quantitative ethic emerged in which practical value became a consideration in determining what was taught (perhaps students were asking "will I ever use this outside of college?"). Paraphrasing the historian Carl Becker, this became a question of whether the university is a school of higher education or merely a higher school of education.

Orrill provides an entertaining history of this tension in higher education and a convincing explanation for the humanists' wariness of quantification (and hence QL). Admitting that he himself was once "quantitatively oblivious," Orrill argues that the humanists should be encouraged first to find QL within their own research as this could put them on familiar ground and lead to an honest engagement with QL. While he does not address teacher education directly, the case studies Orrill presents provide solid insights and strategies for widening the sphere for teaching QL.

Teacher Education … and Quantitative Literacy

Four of the papers in this volume directly address issues of teacher education and QL. Frank Murray and Hugh Burkhardt provide two perspectives on the question of how QL can fit in the K−12 curriculum and in teacher education, while Milo Schield and Alan Tucker discuss the teaching of fractions and the role of QL in this part of mathematics education.

Frank Murray's paper stands out for its comprehensive treatment of the teacher education system. Murray focuses on technical but important questions:

what kind of teacher education program would include QL? What course of study should the prospective teacher be exposed to? What type of licensing and certification, teacher exams, accreditation, and other bureaucratic mechanisms by which the state attempts to ensure teacher quality support this movement? The essence of the problem at hand is aptly summarized by an example Murray gives of a third-grade student who conjectures that some numbers are both even and odd. After discussing possible approaches a teacher could make (ranging from repeating the definitions to exploring the student's ideas in depth) Murray makes the important point that this type of unplanned teaching event

> represents the core of quantitative literacy – a capacity to tackle an uncharted quantitative matter, serviceable knowledge of mathematical procedure and knowledge, logical thought and problem-solving, an extension of the quantitative into the political and social, and so forth. (p. 166)

Murray's point reveals the levels of complexity involved in training teachers to teach QL: how do we give them that confidence, that knowledge, that ability to temporarily suspend the prescribed curriculum and journey into the ideas in the students' minds? Clearly this is not just a QL issue, but it is of vital importance in teaching QL.

Murray does his best to address how QL could fit into teacher education programs. He discusses assessment (and makes the cogent observation that what is tested on standardized tests is very different from what goes on in class), training, and certification. His conclusion is a daunting one. He writes (p. 182),

> The effort to increase levels of quantitative literacy in the schools will surely fail unless each of these elements in the quality assurance system is addressed and coordinated…. Lasting change begins with a clear conception of the measurable features of *numeracy*, the establishment of a course of study …, the specifications of new requirements for the teaching license, the redesign of license tests, recognition in the accreditation and state approval standards, and incorporation in the state's curriculum assessments.

This is no small task. But the point is an important one: unless the teaching of QL is systematically addressed within the educational bureaucracy, any movement to bring QL to the K−12 level will not go far.

Hugh Burkhardt's article also takes seriously the question of the place for QL in K−12 education and in teacher education. He emphasizes the importance of *situated learning*, noting "meaningful classroom experiences with sense-making produce engaged, empowered, effective learners" (p. 139). Burkhardt argues for good "engineering," that is, good design and development of teaching materials. He illustrates this by comparing the traditional teaching approach (essentially modeling a situation for students and asking them to extrapolate to a new situation) with an engineering research approach (which uses research-based

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methods). This is important in the context of teaching QL, he argues, because QL cannot be taught with the standard (and traditional) "explanation–example–exercises" approach. Instead, teachers need to embrace changes in their practice. This argument echoes Murray's and includes welcoming the world beyond mathematics (such as students' imaginations), allowing students to explore ideas and hypotheses, and guiding students rather than showing them.

What does this mean for teacher education? Burkhardt makes it clear that teachers need to have the same types of experiences of real problem solving that their students will have. He proposes a *sandwich model*, in which teachers *launch* an activity (go through it themselves); *teach* the activity (take their students through it); and *reflect* (share their experiences with other teachers). This constructive learning experience is necessary for teachers of mathematics to adapt to teaching QL, since it is unlikely that these teachers themselves are experienced with using QL. This is important: Burkhardt is not just talking about changing *what* we teach, but *how* we teach it. The supportive and reflective environment is crucial for this type of change to occur. (It's important to note here that Burkhardt makes a strong argument that mathematics teachers should teach QL; he cites the challenges of teaching QL well and the difficulties of establishing cross-curricular teaching as primary reasons.)

What are the benefits of making these changes? Burkhardt makes a clever argument by suggesting that "*a significant amount of work on QL can actually reduce the overcrowding* [in the curriculum] by reducing the large amount of time (up to 35%) spent *re-teaching* concepts and skills (an ineffective approach to remedying misconceptions)" (p. 150). His underlying point – that students will really learn the concepts when they learn them through a QL approach – is an appealing one. He provides a set of examples from the Shell Centre for Mathematical Education that reflects this perspective.

The papers by Milo Schield and Alan Tucker also give two perspectives, in this case on the much more focused issue of how to teach fractions and units.[3] Tucker takes the position that unit fractions should be used as basic building blocks for teaching fractions and that unit fractions arise naturally from representing whole numbers by lengths. He makes a strong argument that fractions are important for functioning in the workplace (and in life), and worries that "it is in the transition from whole number arithmetic to fractions that too many students fall off the ladder of mathematical learning" (p. 75). By working with unit fractions (for example, ¼ is a unit fraction), students will develop a

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[3] As background and context, I recommend the resources on the MAA's Preparing Mathematicians to Educate Teachers Web page, http://www.maa.org/pmet/resources.html (last accessed June 22, 2009). In particular, the papers "Preparation for Fractions" and "Ann Arbor Workshop Summary," authored in part by Tucker, provide a good overview of recent discussions on the teaching of fractions.

strong understanding of fractions as *numbers*; because of the emphasis on units, students will be more adept at performing unit conversions and using units-based reasoning to solve problems. Tucker outlines research into how students learn fractions and suggests that this could be a starting point for incorporating fractions into QL at the college level. He concludes that "more generally, fractions are a much richer mathematical construct than most people realize…. Today fractions arise frequently in daily life as percentages, rates and proportions" (p. 85). I agree that a good understanding of fractions can lead to a better understanding of percentages and rates. But I shudder at the prospect of explicitly teaching fractions at the college level, other than in an education course. Not only do students in QL not care about fractions (they fell off that ladder long ago), I doubt they would have the patience to re-learn fractions using Tucker's approach.[4]

Milo Schield agrees that common approaches to teaching fractions (essentially manipulating them symbolically, as a foreshadowing of algebra) turn off students. In his paper he "explores the possibility of delaying, minimizing, or eliminating the manipulation of common fractions as mathematical objects and of replacing it with a more applied study of fractions in the context of percentages and rates" (p. 87–88). From a QL perspective, the gain is significant: teachers would have a greater focus on percentages and rates, addressing both calculational and syntactical issues, and on ratios (with the benefit of greater statistical literacy).

The bulk of Schield's paper addresses what he calls "mathematics for the other 40%," school mathematics for the 40% of college graduates with non-quantitative majors. These students (typically liberal arts majors) are all too often quantitatively illiterate. They have difficulty reading tables and graphs, they cannot express percentages clearly and correctly, they do not understand weighted averages (in fact, I doubt that most college students understand that their grade point average is an example of a weighted average), and, most challenging, they have poor attitudes about math. While attitude is not a bullet point in any curriculum framework, it is an important part of the classroom experience. Schield suggests "student attitudes affect student choices and performance" (p. 96) and notes that "'attitudes' includes the attitudes of teachers and parents, which may account for much—if not most—of the difference in academic performance among K−6 school children" (p. 97). As a remedy for these issues, Schield suggests that teachers need to emphasize context and argues that "'mathematics in context' should focus less on going from mathematics to context and focus more on going from context to mathematics" (p. 105).

[4] Another issue is that QL is too often viewed (incorrectly) as 4th grade mathematics. Putting fractions into the content would further this (mis)perception.

Schield makes eight recommendations for modifying the mathematics curriculum to incorporate QL. These recommendations are broad enough that they could be incorporated at most levels of education; the one exception is his seventh recommendation, which calls for the establishment of alternatives (in the form of QL or Statistical Literacy) to Algebra II at the high school level. This is an excellent suggestion and is perhaps the most practical way to bring QL into the pre-college curriculum. Such a course is ideal for students in their fourth year of high school who are not planning to go into a quantitative-based major in college (or perhaps who are not even planning to go to college).[5]

While Schield's paper does not argue for a specific approach to teaching fractions, I don't mind. The overall focus on how to bring QL into the curriculum, and the arguments for why this is essential, is quite appropriate.

Quantitative Literacy … and Teacher Education

The articles by Corrine Taylor, Neil Lutsky and Joel Best all address QL first and the larger issues of QL in the K−12 curriculum and in teacher education second (if at all). Each of the authors presents different perspectives on what teaching QL at the college level could mean: Taylor focuses on business students and the QL skills that they will need after graduation; Lutsky proposes putting QL in the context of argumentation; and Best argues that QL should move beyond calculation and embrace the social construction of numbers and statistics.

Taylor's paper discusses how to best prepare students who will be the entrepreneurs and business people of the future to think critically, question assumptions, and evaluate quantitative information carefully. She writes, "how do we create a society of people who routinely *think for themselves* and do not follow the mob even when—especially when—the real world problems at hand are quantitative in nature?" (p. 110). While QL is often justified as an important tool for the student as consumer (personal finance is perhaps the most compelling example), discussions about QL for students as future businesspeople tend to be vague. In this paper, Taylor directly addresses the question of what QL skills are most important in the business world. This is a new perspective, different from, for example, Rosen's paper discussing how to bring QL into the business agenda

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[5] A number of states are developing alternative high school courses, some of which emphasize quantitative literacy. See the partial list at the University of Arizona Institute of Mathematics and Education Web site, http://ime.math.arizona.edu/2007-08/1013_fourthyear.html (last accessed June 22, 2009). A corresponding movement is the call for courses at the high school level that teach "Skills for the 21st Century." See the Partnership for 21st Century Skills Web site, http://www.21stcenturyskills.org/ (last accessed June 22, 2009).

so that business can advocate for better QL for all (Rosen, Weil and von Zastrow, 2003).

Taylor looks at the specific QL skills needed for the GMAT exam, business courses (both undergraduate and graduate), job interviews with business consulting firms, and owning a small business. Her conclusion is that the mathematics needed is not particularly advanced (algebra, basic mathematical modeling, some geometry, statistics—but not calculus), but that students need to know how to apply this mathematics to solve problems in context. More precisely, students need to learn how to "translate the language of the real world business question into the relevant mathematics problem, finding the information needed to answer that question, and understanding what the mathematical solution implies for the best decision" (p. 116). Her survey also indicates that students need to practice estimating, become facile with guessing-and-checking, and have confidence answering open-ended "Fermi" type questions (the classic being "how long would it take to move Mount Fuji?"). And they need to be able to sort information, synthesize data, evaluate answers, and communicate effectively. Taylor suggests that the case study approach (already used widely in business schools) is appropriate for teaching QL as it requires higher-order thinking skills and demands that students go beyond a calculation to make a decision. She advocates that we "move away from a fragmented teaching and learning approach to a more holistic one. In particular, we need to offer more opportunities for students to make *decisions* that involve information gathering and assessment, quantitative analysis, and communications about quantitative topics, not merely textbook *calculations* that use mathematics" (p. 119). She makes some recommendations for how this can happen (although these are fairly general) and notes that an interdisciplinary approach is needed for schools not just to teach mathematics, but to provide opportunities to learn and practice QL.

Neil Lutsky's paper explores how the teaching of QL across the curriculum can be "intertwined" with teaching writing across the curriculum. He argues persuasively of the necessity for teaching QL: "it is because numbers have the power to influence and the power to inform that we need to educate citizens to attend to numbers, to understand them, and to think thoughtfully and critically about them" (p. 61). Lutsky summarizes the standard approaches to teaching QL in a general education curriculum—either teaching it in mathematics courses and hoping that students can transfer their knowledge to other settings, or teaching it within disciplines that use QL as an investigative tool—and argues for a third approach, teaching QL in the context of argumentation.

Lutsky makes the distinction between the *interpretation* of quantitative information (itself a challenge for many students) and using quantitative information *in support of an argument*. He argues strongly that the latter approach can be a powerful and successful cross-curricular way to teach QL.

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Much of his evidence comes from the Quantitative Inquiry, Reasoning, and Knowledge (QuIRK) initiative at Carleton College. For several years, as part of this initiative, faculty have assessed selected student papers for QL. They observed that across the curriculum, QL is potentially relevant to central arguments and is underutilized for peripheral arguments. These assessments inform faculty discussions and professional development and ultimately feed back into classroom teaching; for more information, see the resources on the QuIRK Web site[6] and the article by Grawe and Rutz (2009).

Lutsky's paper is valuable, both for its placement of QL in the context of argumentation and for the insights into reasonable approaches to teaching QL across the curriculum. It is certainly natural to talk about writing, arguments and QL together. But Lutsky's perspective is unique in that he clearly articulates a broader interpretation of QL, one that honestly brings it into other disciplines. While he does not directly address the issues of QL in the K−12 classroom, or teacher education, his paper gives some ideas (and resources, through QuIRK) for how this can happen.

Joel Best also takes a broader view of QL, but in a different direction. In his paper he argues that QL must go beyond what he calls "calculation" to incorporate issues of social construction of numbers and statistics. Best has written several popular books on the social construction of statistics (Best, 2001, 2004); these books offer many examples of what he means by this term and its relevance. So what does he mean? There are two definitions to be careful of here. The first is "calculation." Best says that he is not using this term in a strict mathematical sense, but in a broader sense so that, "it encompasses all of the practices by which mathematical problems are framed and then solved" (p. 125). In his view, "mathematics instruction is a long march through ever more sophisticated techniques for framing and solving problems: that is, we first learn to count, then to add, etc., until different individuals top out at algebra, trigonometry, calculus or whatever" (p. 125–126). I agree that the vertical nature of mathematics instruction is often problematic (and the papers by Tucker and Schield reinforce this by suggesting that fractions may be a "drop-off" point for students), although I disagree with Best's characterization of mathematics instruction (and, by association, mathematics) as so much calculation. Nonetheless, it's fair to say that most students who go through K−12 education in this country share his perception.

Best's real point is that when we teach QL we need to teach critical thinking—and for him this means teaching the *social construction* of numbers and statistics. He uses this term in a specific and narrow sense: humans produce numbers and the process of determining numbers involves social phenomena that

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6 http://serc.carleton.edu/quirk/index.html (last accessed June 22, 2009).

need to be taken into account. This becomes very relevant when numbers are used in the public sphere. Best gives good examples of the general situations: numbers used to draw attention to a social problem; polling data; statistical indicators (e.g., poverty rate, crime rate); and medical news. While ideological bias and self interest are fairly obvious social construction issues, Best argues that there are other, often more subtle, issues that may shape the numbers that we see: statistics are used for rhetorical effect, sources may be questionable, results may be exaggerated, and so on. Individuals need to use QL to understand the numbers and, Best argues, to understand where the numbers came from.

Best is somewhat pessimistic that QL will ever truly encompass social construction and he returns to the emphasis he sees on calculation to argue his point. He writes (p. 134),

> It is likely to prove very difficult to incorporate this goal in quantitative literacy programs, because the people who teach math—who are, after all, the folks most interested in quantitative literacy, and the ones who will doubtless wind up teaching this material—have been trained to teach calculation, and they tend to define the problem of quantitative literacy in terms of people being insufficiently adept at calculation. They are likely to see the sorts of issues I have raised as, at most, peripheral to increasing quantitative literacy.

I find this to be a very controversial statement and as a mathematician who views mathematics as inextricably linked to philosophy and art, among other "non-calculation" fields, I don't fully agree with it. I don't think I'm alone. For example, Lynn Steen, writing the epilogue for *Mathematics and Democracy: the Case for Quantitative Literacy*, suggests that "more mathematics does not necessarily lead to increased numeracy…. numeracy and mathematics should be complementary aspects of the school curriculum…. they are not the same subject" (Steen, 2001).

One interesting aspect of these three essays is the set of opinions about who should teach QL and what that means. Best clearly wants to bring it out of the mathematicians' hands and position it (as its relates to critical thinking) across the curriculum; Lutsky agrees, with his own perspective that QL is central to building and evaluating arguments, and also sees a natural place for this in many different disciplines. In contrast, Taylor views the responsibility for developing QL skills as resting primarily on the mathematics teachers, but calls for reinforcement and support from teachers in quantitative disciplines and in English.

Conclusion

Where does the book under review fit among the QL books that have appeared in the past decade? I suggest that it signals a welcome shift in the QL movement. Previous publications focused on making an argument for QL, attempting to find consensus on issues such as definitions and content, and making strong, passionate arguments about the importance of QL in contemporary society (Steen, 2001; Madison and Steen, 2003). Robert Orrill's statement in *Mathematics and Democracy: The Case for Quantitative Literacy* that "if individuals lack the ability to think numerically they cannot participate fully in civic life, thereby bringing into question the very basis of government of, by, and for the people" (Steen, 2001) is an excellent example of the powerful, urgent call for QL that comes across in earlier books.

But *Calculation vs. Context* is different. It provides a beginning to a practical, concrete discussion of the role of QL in education. Yes, some authors in this book do define QL and make a case for its importance; as long as QL is "everybody's orphan" (Madison, 2001), those of us who believe in QL will spend some time and energy defending it. But there is much more in this book, enough to inspire many future discussions and, hopefully, action. As Madison writes in his introduction, "issues in QL and teacher education constitute an agenda for decades, and a two-day workshop … can only prompt and guide further work" (p. 9). Steen remarks on this shift in focus, writing "one noticeable change is that QL explorers have moved beyond debates about the definition of QL, not because they have reached consensus but because they recognize that development of QL programs is more important… Another change … is that individuals with broader experiences are now awake to the importance of QL…" (p. 13).

If the "QL explorers" are fully awake to the importance of QL, though, they are still not clear on how to proceed. Shavelson, for one, turns the question of incorporating QL into K−12 teaching by essentially dismissing it, arguing instead for the inclusion of QL more consistently at the college level; this argument is the most consistent among the papers. In contrast, Murray takes a top-down approach and makes it clear that without explicitly incorporating QL into the entire system of licensure, accreditation, QL will not become a part of the K−12 curriculum. Burkhardt's paper is the most optimistic, but concedes that teaching QL is sufficiently demanding mathematically that it would be difficult to establish across the curriculum. It would have been interesting to hear directly the voices of K−12 teachers in these discussions (there were some teachers at the workshop, but they did not write any of the essays).

An illustration of the challenges facing QL proponents can be seen in the growth of Achieve's American Diploma Project (ADP). As noted on their Web site,[7] this initiative seeks to "ensure that all students graduate from high school prepared to face the challenges of work and college." A central component of the ADP effort is an Algebra II end-of-course exam. This is a nationwide assessment, developed with participation from a number of states to align with Achieve's

[7] http://www.achieve.org/ (last accessed June 22, 2009).

mathematics benchmarks. Part of Achieve's definition of college- and work-readiness includes success in Algebra II (full disclosure: I have worked as a consultant for Achieve). And a recent report from the Carnegie−IAS Commission on Mathematics and Science Education recommends the establishment of national mathematics standards that are "fewer, clearer, and higher—along with high-quality assessments" (Carnegie−IAS, 2009). My concern is that QL supporters must do more than convince parents, teachers, school boards, education schools and others of the necessity of teaching QL at the pre-college level—we must argue nationally that a solid QL ability is an important part of college- and work-readiness (perhaps more important, for some students, than success in Algebra II). The Achieve example is a powerful one. QL proponents may not be able to form such a strong consortium, but it is worth studying and watching Achieve's movement.

As I think back to my friend the high school mathematics teacher, I worry that her students, among many others, will be left behind in the national march toward greater proficiency in algebra. Her students are among the "other 40%" that Schield writes about. Would they be better served by a curriculum that honestly includes QL? The essays in this book suggest that they would be, but not until QL becomes a real part of the national education agenda. Until then, these essays give us much to think and talk about.

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