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Quantitative Literacy and the Mathematical Association of America in the 2000's: QL Subcommittee of CUPM , SIGMAA QL, and MAA Notes #70

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Abstract

This Roots and Seeds article is a partial history of the quantitative literacy movement in the Mathematical Association of America in the first decade of the 21st century. It focuses on the inclusion of QL in the MAA Committee on the Undergraduate Program in Mathematics' *CUPM Curriculum Guidelines* (2004), the creation of the special interest group for MAA members (SIGMAA QL, 2004), and the work of that body in subsequent years, in particular, the MAA Notes #70, *Current Practices in Quantitative Literacy* (2006). I discuss some issues that were problematic in the QL movement in the MAA in those years that seem to bedevil us to this day. I end by noting there has been a parallel development of active learning pedagogies throughout the mathematics community and wonder if there is synergy between the two movements.

Keywords

Mathematical Association of America, SIGMAA QL, CUPM guidelines, quantitative literacy

Cover Page Footnote

Rick Gillman is currently Associate Provost for Faculty Affairs at Valparaiso University. Previously, he was chair of the Department of Mathematics and Computer Science. In addition to being the editor of *Current Practices in Quantitative Literacy*, he is also co-author of *Models of Conflict and Cooperation*, a QL-oriented general education textbook on game theory.

Introduction

In her Roots and Seeds essay in the last issue of this journal, Linda Sons (2019) described the early days (1989-1994) of the quantitative literacy movement in the Mathematical Association of America (MAA). When I read her essay, I realized that I might be able to contribute to the story of that initiative in the subsequent decade. Linda's essay describes the work of the Quantitative Literacy (QL) subcommittee of the MAA Committee of the Undergraduate Program in Mathematics (CUPM), the MAA committee that writes national recommendations for college-level mathematics programs.

In this essay, I hope to continue the story of the quantitative literacy movement by describing my small role, the succession of the QL subcommittee by the birth of the MAA's special interest group for quantitative literacy (SIGMAA QL) and the relation of the latter to the National Numeracy Network (NNN). One of the work products of the early SIGMAA QL was the MAA Notes #70 volume, *Current Practices in Quantitative Literacy* (Gillman 2006a). That volume, I would like to note, is a proud forebear of the recently published MAA Notes #88 (Tunstall et al. 2019; see papers in the "Book Corner" of this issue). I will end with a few words about what I feel are persistent – and ongoing – issues in the movement.

My Initiation

If you check the roster carefully in the report that Linda is referencing, *Quantitative Reasoning for College Students: A Complement to the Standards* (The Sons Report, Sons 1994), you will see that I am listed as one of the members of the subcommittee. This inclusion could be misleading in that it may seem that my contribution was larger than it actually was. I was assigned to the subcommittee only in 1994, very near to the end of the work cycle that produced the report. I was young, having just earned tenure at Valparaiso University, and had been a member of the MAA for only a decade and active mostly at the section level. However, the work of the subcommittee greatly interested me.

I suspect that I was assigned to the subcommittee because I had given a number of presentations that suggested I was interested in the topic. I was a strong advocate for the approach taken by the NCTM's *Curriculum and Evaluation Standards for School Mathematics* (NCTM 1989), which attempted to shift school mathematics from a rote memorization model to an integrated, problem-based learning experience with national standards by grade level. I was intrigued by the possibility of replicating these ideas by establishing meaningful, high-quality expectations for quantitative skills of college graduates.

Thus it was a synergy of the NCTM's *Standards* and the CUPM's Sons Report that led me to create Valparaiso's first explicitly QL course in 1996. The course is

described in a paper (Gillman 2006b) in the Notes #70 volume (Gillman 2006a). That essay, however, does not include the backstory, which still speaks to me as I think about QL today.

The course came into being at the insistence of science faculty who claimed that students were not mathematically prepared for their courses. The science faculty wanted to require that all students take *pre-calculus*, which the mathematics faculty opposed because that course, as its name implied, was intended – very traditionally – for students moving on to calculus. On the other hand, a member of the business faculty argued that all students should in fact take *calculus*; as a major idea contributing to modern western culture, calculus should be a fundamental element of any liberal education. Meanwhile, a careful analysis of the science faculty's concerns revealed the problem cut deeper: the students needed *intermediate algebra* skills, rather than *pre-calculus* skills. Yet matriculating Valpo students supposedly had mastered these skills. Further, the analysis revealed that students may have mastered the skills, but had not mastered using the skills to solve a contextualized problem. The outcome of the campus discussion was the creation of Quantitative Problem Solving, an active learning course focused on problem solving, rather than on manipulative skill development.

This course was a developmental (remedial) course with a quantitative literacy perspective. Our intent was that the course be the first tier of the three-tiered quantitative learning experience described in the Son's Report: remediation, foundations, application. Valpo has not yet fully implemented the application level after some twenty years.

The End of the QL Subcommittee

So what does an MAA subcommittee do when its major task has been completed? More exactly, once the QL subcommittee had articulated quantitative literacy requirements for college students, how would it proceed? The answer, of course, was to develop programming that promotes those standards and which offers faculty insights into how to teach to these standards.

And so the subcommittee moved forward. It sponsored contributed paper sessions at the 1999, 2000, and 2003 Joint Mathematics Meetings.[1] The last of these sessions was titled "Quantitative Literacy: What is it and what works?" The title suggests the truth: even a decade after the 1994 report, the field of quantitative literacy was still in its infancy.

I became chair of the QL subcommittee in 2002, but over the many years that I had been a member of the committee, I came to realize that a movement cannot be sustained by a committee with a rotating, appointed membership. A more

[1] JMM, the annual winter meeting of the MAA, held jointly with the AMS, the American Mathematical Society.

permanent inclusive structure was needed to maintain conversations and momentum. Thus I was to become one of the few MAA committee chairs who proposed disbanding his own committee, this time in favor of a more flexible, nimble organization. But before that was accomplished, the QL subcommittee had one more task to complete.

The 2004 CUPM Guidelines

The subcommittee needed to contribute to *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004* (Barker et al. 2004). As the CUPM was preparing the guide, the subcommittee prepared a white paper with the purpose of reminding the principal writers to think beyond the needs of students who are heavy users of mathematics. As a consequence, in a section on students taking general education or introductory collegiate courses, the authors of the *CUPM Curriculum Guide* wrote (Barker et al. 2004, 27),

> General education and introductory courses enroll almost twice as many students as all other mathematics courses combined. They are especially challenging to teach because they serve students with varying preparation and abilities who often come to the courses with a history of negative experiences with mathematics. Perhaps most critical is the fact that these courses affect life-long perceptions of and attitudes toward mathematics for many students—and hence many future workers and citizens. For all these reasons these courses should be viewed as an important part of the instructional program in the mathematical sciences.

And further (Barker et al. 2004, 28),

> All students, those for whom the course is terminal and those for whom it serves as a springboard, need to learn to think effectively, quantitatively and logically. Carefully conceived courses—described variously as quantitative literacy, liberal arts mathematics, finite mathematics, college algebra with modeling, and introductory statistics—have the potential to provide all the students who take them with the mathematical experiences called for in this section.

The subcommittee, by drawing on the Sons report, also helped the CUPM to articulate learning objectives that aligned with the young quantitative literacy movement (Barker et al. 2004, 28):

> All students meeting general education or introductory requirements in the mathematical sciences should be enrolled in courses designed to
>
> - Engage students in a meaningful and positive intellectual experience;
> - Increase quantitative and logical reasoning abilities needed for informed citizenship and in the workplace;
> - Strengthen quantitative and mathematical abilities that will be useful to students in other disciplines;

- Improve every student's ability to communicate quantitative ideas orally and in writing;
- Encourage students to take at least one additional course in the mathematical sciences.

The 2004 product was the first *CUPM Curriculum Guide* that was explicit about the quantitative learning experiences of all collegiate students, rather than only those in mathematically intensive programs of studies.

The Creation of the Quantitative Literacy SIGMAA

Fortunately, the MAA had recently established a structure that enabled members to gather into affinity groups: Special Interest Groups of the MAA (SIGMAA). The purpose of SIGMAAs is to support communities of members "who share a common interest that advances the MAA mission." These communities are intended to provide their members with networking opportunities, professional development opportunities, and the opportunity to promote their affinity theme. SIGMAAs gather professional resources and expertise which is then made widely available to the larger mathematical community.

SIGMAA QL was formed in 2004 to take up the work of the disbanded QL subcommittee of CUPM, with the intent of providing a more enduring home for the movement. Its charge called on the mathematics community to

> take leadership in (a) identifying the prerequisite mathematical skills for QL, (b) finding innovative ways of developing and implementing QL curricula, (c) assisting colleagues in other disciplines to infuse appropriate QL experiences into their courses, and (d) stimulating the national dialogue concerning QL.[2]

The initial leadership consisted of Judy Moran, Trinity College, as chair; Caren Diefenderfer, Hollins University, as chair-elect; John Bukowski , Juniata College, as secretary-treasurer; Matt DeLong, Taylor University, as webmaster; and myself as past-chair. We began with 81 members and quickly moved over the 100 member mark. It was one of the earliest of the currently 17 SIGMAAs organized, but remains one of the smallest with 189 members as of January 2019.

SIGMAA QL immediately leapt into its work, hosting an inaugural reception at the 2004 MathFest,[3] a contributed paper session at the 2005 JMM and an informal gathering at the 2005 MathFest. SIGMAA QL has hosted some element of the conference program at almost every JMM and MathFest for the past 15 years. These sessions included panels, contributed paper sessions, and plenary speakers on directing math centers, on the role of quantitative literacy in civic engagement, and on assessing quantitative literacy, among many other topics.

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[2]From SIGMAA QL website, http://sigmaa.maa.org/ql/ accessed March 28, 2019.

[3] The MAA's annual summer meeting

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SIGMAA QL continues to fulfill this mission today as it hosts receptions, organizes talks, panels, and paper presentations at MAA meetings, provides web-based resources about quantitative literacy, and encourages publication of current work related to quantitative literacy. It has allowed for a community of practitioners to develop, a crucial step in the growth of the QL movement. Many of the current leaders of the movement have been involved in SIGMAA QL.

Having the SIGMAA within the MAA has been very helpful to the growth of the movement. However, it is also limited in that members of SIGMAA QL must also be members of the MAA. While the MAA is a fine organization (a great one, if I might be so bold), quantitative literacy, by its very nature, transcends traditional disciplinary boundaries and involves people outside of the mathematics community. I have known many social scientists over the years who have worked diligently to develop quantitative reasoning skills in their students and digital media faculty who use quantitative approaches in their work and teaching.

In 2004, the National Numeracy Network (NNN) was organized independently, but concurrently with SIGMAA QL, in order to provide a home for this larger interest group. NNN promotes

> education that integrates quantitative skills across all disciplines and at all levels. To this end the Network supports faculty development, curriculum design, assessment strategies, education research and systemic change. The Network also strives to keep issues of quantitative literacy at the forefront of national and international conversations about educational priorities.[4]

The NNN hosts annual, now-standalone, Fall conferences (2017, Barnard College; 2918, Michigan State University). It also publishes the twice-annual journal *Numeracy* with the support of the University of South Florida. (With this issue, *Numeracy* has published more than 250 papers in its 12 years.)

The NNN and SIGMAA QL have, as one might suspect, overlapping membership and interests. The two organizations have also co-sponsored events, notably, in the formative years of the two groups, sessions at the 2007 Midwest Sociological Association meeting.

MAA Notes #70, *Current Practices in QL*

While Lynn Steen (Steen 2001) and others were writing eloquently about the value of quantitative literacy, it was clear in 2004 that there was still a need for a compendium of practice: how do we translate these conceptual frameworks and standards into courses that successfully prepare students?

[4] National Numeracy Network website, http://www.nnn-us.org/ accessed March 28, 2019.

This is not to say that textbooks were not being developed around the idea of quantitative literacy. *Mathematical Thinking in the Quantitative World* (Sons and Nicholls 1992) had been published much earlier. *Using and Understanding Mathematics: A Quantitative Approach* (Bennett and Briggs 2001) had just been published. The MAA was soon to publish *Understanding our Quantitative World* (Anderson and Swanson 2004). However, all three of these works still focused on developing mathematical skills within a traditional survey course context.

These textbooks, though, did not answer basic questions about how to design and implement a quantitative writing program, either at the course level or at an institutional level. Nor did they provide answers to questions about placement and assessment. *Current Practices in Quantitative Literacy* (Gillman 2006a) was intended to provide a baseline answer to these broader questions. Partitioned into three parts (see Appendix 1), the small MAA Notes #70 volume provided examples of quantitative literacy courses, programs, and initiatives at a variety of institutions large and small, including community colleges and those with baccalaureate programs. Part One described programs with significant curricular elements outside of mathematics departments – an essential concept since quantitative literacy requires transfer of skills across domains. Part Two narrowed the focus to particular course offerings, usually within mathematics departments, and spoke to questions such as curriculum and staffing. Part Three addressed the issues of placement, advising, and assessment.

Since the publication of *Current Practices*, scholarship published in *Numeracy* and shared at many mini-courses, panels, and contributed papers sessions have demonstrated the growth in understanding of quantitative literacy. Essays in *Shifting Contexts, Stable Core: Advancing Quantitative Literacy in Higher Education* (MAA Notes #88, Tunstall, et al. 2019) tell about the development of our ever-expanding progress in the teaching and learning of quantitative literacy (see papers about #88 in this issue).

Persistent Problems

As I have reflected back on the years that I was actively engaged in the QL movement, I realize that there were a number of issues that tormented us then and that members of the quantitative literacy movement in MAA continue to grapple with today. In this section, I hope to highlight a few of them.

One issue that SIGMAA QL grappled with over the years was the relationship between quantitative literacy, the liberal arts, and calculus. In 2007, it hosted a panel session at JMM to discuss this relationship. At the time, quantitative literacy was often defined as mastering elementary mathematical skills and applying them to immediate real world problems, both personal and social.

This approach leaves two questions unresolved, each implicit in my business colleague's argument for teaching everyone calculus. First, mathematics is a beautiful, intellectually fulfilling domain of knowledge, so why must the teaching and learning of it be focused on pragmatic skills associated with problem-solving? Second, there was – and still is – a common assumption that students who complete some portion of the calculus sequence of courses are quantitatively literate. This assumption is revealed in the many ways quantitative literacy courses are described as "our general education course."

These two issues are related to a third contextual problem that I have not seen resolved over the past twenty years. Which faculty own (i.e., are responsible for) helping students become quantitatively literate? At large institutions, instruction in quantitative literacy is usually assigned to departments of mathematics, who offer a course similar to those discussed in the previous paragraphs. But faculty in other disciplines may individually value quantitative literacy and strive to develop it in their courses; however, they have no mandate to do so. It seems that the mathematics community should take the lead in promoting and achieving quantitative literacy, but the mathematicians need to engage with the larger academic community in the matter. The shift in thinking required in both communities is large – and challenging.

Finally, the past fifteen years have seen a vast expansion of our understanding and use of active learning pedagogies. Teaching for quantitative literacy has consistently drawn on these pedagogies as core resources. Is our understanding and expanded use of collaborative learning environments, flipped classrooms, problem-based learning, inquiry-based learning, and technology-assisted instruction a consequence of a widespread, implicit belief in learning for quantitative literacy? The question might suggest that the QL movement is better established than many believe. Or, is QL instruction enhanced by the development of these active learning pedagogies? The parallel development of the two movements needs to be investigated and explored to establish connections between them and to advance both.

Conclusion

In closing, it is helpful to observe that as the quantitative literacy movement continues to find its path forward, key ideas will continue to propel the discourse. First, there will need to be consensus on the specific mathematical skills needed for literacy. Second, the community will need to continue developing ways of teaching these skills in meaningful contexts and that these contexts will change with time. Finally, those active in the quantitative literacy movement will need to articulate the value of quantitative literacy to the broader mathematical and academic communities.

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Appendix

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Current Practices in Quantitative Literacy

Rick Gillman, Editor

Mathematical Association of America, Notes Series, Vol. 70, MAA Press, 2006

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