SIGMAA-QL Newsletter

MAA Special Interest Group on Quantitative Literacy Volume 9, December 2014

SIGMAA QL Turns 10

A Discussion of the Past and Future of Quantitative Literacy

by Andrew Miller

To celebrate the 10th anniversary of the founding of SIGMAA QL, at MathFest 2014, I had the pleasure of moderating a panel of distinguished guests on the topic of the past and future of quantitative literacy. Our panelists were:

- Caren Diefenderfer (Hollins University), the Founding Chair Elect of SIGMAA QL
- Rick Gillman (Valparaiso University), the Founding Past Chair of SIGMAA QL
- Dorothy Wallace (Dartmouth University), a Founding Editor of Numeracy
- Bernie Madison (University of Arkansas), QL assessment developer and co-author of Case Studies for Quantitative Reasoning: A Casebook of Media Articles (now in its third edition)
- David Burns, Executive Director of the National Center for Science and Civic Engagement (NCSCE) and founder of Science Education for New Civic Engagements and Responsibilities (SENCER)

In the following, I present a brief summary of the questions and answers that filled our discussion. While I make all attempts to attribute comments to their source, errors and omissions are likely to occur. I apologize in advance for any oversights.

Question 1: Who or what constitutes the "community of practice" for QL?

While no consensus arose on the "who" or "what" of this question, there were many comments on the "why;" that is, the role a community of practice plays in promoting and shaping our ideas about QL. David pointed out that there is a need for a forum that welcomes people from outside the academy who can contribute their perspectives and expertise, referencing research on the notion of "cultural cognition." If we stick to our disciplinary areas, argued Dorothy, there is also a danger of "crystallization" of our notions of QL, when QL by needs must adapt to the ever-changing world around us. That being said, Bernie pointed out that we also need the structure that an established community provides. We need to know who the experts are when seeking advice. Caren noted that this expertise, as with most things related to QL, needs to be multi-disciplinary. QL will always need people with a real understanding of applications.

Question 2: What are the conceptual frameworks for QL?

First, Dorothy observed that there are several articles in *Numeracy* that address this topic. For example, I see that the current issue – Volume 7, Issue 2 – contains an editorial by Len Vacher on this very question. She also exhorted us to compare QL to traditional literacy (i.e., reading/writing), which focuses on core concepts like critical thinking and strategizing towards goals. David and Rick expressed the

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idea that a big part of QL is asking the right questions, using a famous Stephen Jay Gould article, "The Median Isn't the Message" (available online), as an example. Bernie pointed to the recent work that has been done on developing assessments for QL, some of which is reported on in the most recent issue of *Numeracy*. All panelists agreed that QL is not a pseudonym for mathematics and statistics, despite the fact that QL often "lives" in mathematics or statistics departments.

Question 3: QL is often promoted as an important skill for citizenship. How has the connection between QL and citizenship changed in the last ten years, if at all? How do you see it changing in the future?

David opened by observing that we live in a world of multidisciplinary problems which will necessarily have multidisciplinary solutions. In order to address these troubles, we need citizens with skills that reach across disciplines, like QL. He also pointed out the importance of general modeling skills in addressing 21st century challenges. Dorothy noted that QL skills arise in many aspects of spending money (individually or societally), and Bernie sees QL skills as helping us understand the democratic process in general. One member of our audience identified QL as a power issue: if you can't interpret numbers, you are giving up power.

Question 4: What are some new opportunities in QL education that we can take on in the next ten years?

Rick and Dorothy both argued that we can do more work instilling QL into STEM majors. Dorothy noted that we already missed an opportunity to integrate QL into mathematical biology curricula through the teaching of mathematical modeling. Bernie sees an important role for SIGMAA QL in promoting standards for QL education and in ensuring that QL courses do not degenerate into "methods" courses. David sees an opportunity for QL to build prediscipliinary skills, those skills necessary before one can truly engage with a broad range of disciplines. Dorothy noted opportunities for QL to address the affective skill domain, particularly promoting within students a willingness to solve problems. Finally, panelists and audience members pointed to a number of models that might be worth widespread adoption, including a number of "Quantitative Literacy Across the Curriculum" initiatives and the Community Research and Service Center at Valparaiso University.

The panel discussion was fruitful, with lots of insights from our panelists and our audience. With ten years now in the rear-view mirror, we should think about what QL will look like in 2024.

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Perspective on Quantitative Literacy from Across the Curriculum

Numeracy and an Estimation Crisis

by Paul Grawe

A numeracy assessment tool currently being developed by Prof. Neil Lutsky at Carleton College asks questions such as:

Which of the following represents the approximate percentage of the world's population living in the United States?

a) 4%, b)12%, c 20%, d) 33%

Ironically, some of us in academia are as incapable at performing such estimation as students.

America is facing many numeracy crises at present. Perhaps the most ubiquitous and central is the problem of estimation. We in academia are clearly failing to help our students master estimation. It will take many fields acting together as a team to make a dent in the problem. Mathematics has an important role to play, but so do fields like political science, sociology, economics, and my own field of composition and rhetoric.

In many fields, estimation is an applied technique – and often it is a technique left untrained. If we seek a common front in helping our students to estimate, we should realize that estimation is not a single skill. Rather, it is a complex, and failure in any part can

mean total failure to estimate.

Estimation for most of our students is about numbers. Mathematics can certainly take a leading role in helping with the numerical side of estimation. What is 497.3×3.1417? I submit that mathematicians should teach students to answer quickly, "about 1500." It is important for students to understand that the estimate is almost never exactly right, but exactitude isn't always what a situation requires.

Time and cost are equally part of the estimation complex. For example, note how quickly estimation helps us to find an approximate answer to the multiplication above. While "1500" is not the most precise response, in many situations the benefit of the speed of this calculation outweighs the time it would cost to calculate the exact answer (especially if a calculator isn't handy).

In many disciplines, time is an important dimension. An approximate answer in a short amount of time is worth gold. Imagine President Obama trying to calculate how many vetoes he can afford over the next two years with a Republican House and a Republican Senate. It is impossible to estimate how much time would have to be expended for an exact answer. The fact is that, as a rhetorician, President Obama needs to have a very good estimate, not an exact answer, before Congress convenes for its lame duck session. In other words, he needs an almost instantaneous estimate. House Speaker John Boehner and Senate Minority Leader (soon to be Majority Leader) Mitch McConnell need the answer just as quickly.

When time is not the important dimension, cost often is. Consider again how much money the administration could put into the question of an acceptable number of vetoes. We should teach our students to save money as well as time by having them provide back-of-the-envelope estimates followed by an assessment of savings in time and costs. Note that this assessment is itself an estimation problem!

Good back-of-the-envelope estimates are anything but slapdash. Instead, they are normally worth just about exactly what their methodology is worth. How many cars are there in Winona, MN? I don't know, but there are about 30,000 people in Winona. Assuming an average family size of four with two cars per family, that's 15,000 cars.

Math can also take the lead in teaching students to judge the accuracy and reasonability of answers. How accurate is 15,000 likely to be? Is it better to err on the high or on the low side? What degree of accuracy is needed for the purpose at hand? Examples like the number of cars in Winona are easy to generate to fit student knowledge bases. Our students will be blessed if you can help them make reasoned, quick estimates.

As you are doing all this, note what is blindingly obvious in something like a composition course: our students often are petrified to make an estimate of any kind. They believe that only a perfect answer is an acceptable answer. And they know they aren't perfect.

Please don't let your students quibble rather than make good-faith estimates when required. We should not be willing to accept responses such as "Ah , well I don't exactly know but then who does? I really don't think your question has a good answer and anyway, I'm not into that. . . ."

Every thirty-second estimation drill you assign and every time you approve a good-faith, quick estimation effort will be an additional giant step in meeting the numeracy crisis of estimation.

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Reality Math

A Quantitative Literacy Project

by Dorothy Sulock

Forty-five years of teaching math have led me to conclude that, generally speaking, poor math education is why much of our population is innumerate. Teachers tend to tell their students how to do mysterious things with numbers and letters and then ask the students to do what they showed them how to do. A few gifted students figure out what is going on, but the majority of the students do not understand.

Reality Math is a course I teach at the University of North Carolina at Asheville for majors in disciplines that do not require Precalculus or Statistics.

My goal is to help my students develop quantitative literacy by having them figure out how to solve applied arithmetic problems. These students are often troubled with the decision of whether to multiply or divide, troubled by percents and percent increase or decrease, and troubled by large numbers.

The students work on daily units about useful subjects such as nutrition, energy, the environment, personal finance, and sports. Each unit is several pages long. It turns out that careless reading also troubles some of the students. So this course should also help their reading skills.

The students work independently or in small groups. Sometimes group work is counterproductive for weak student(s), who will learn less because they are not figuring things out for themselves. On the other hand, the strong student in the group becomes stronger by explaining things to the weaker student(s). I do not teach anything, but do lead them to enable themselves to answer questions as they arise.

Each unit has about twenty to thirty little questions and the graded units are returned to the students in a timely fashion with complete solutions available on the web. Most of the course grade comes from tests and the final exam. Homework only counts for 1/8 of their grade, so there is little incentive to copy homework.

These units are posted on the website `http://www.realitymath.org` and are available to anyone. I also have an immense test bank of Reality Math questions, most of which are based on some type of real world article or graph.

I believe that mathematics education is failing most of its students, both in its curriculum and in its methods. We should be teaching everyone useful math in ways that force them to develop numeracy at all levels, from elementary school to college. Having everyone learn useful math is necessary for good mathematics education (although a minority of students will always require higher mathematics for STEM).

Reality Math Units

- Environmental:
  Ecological Footprint of Nations I & II, World Population, Electric Vehicles, World Oil I & II, CO2 and Gas Mileage, Your Acres and Your Cows I & II
- Electricity:
  Measuring Electricity I & II, Geothermal Electricity, Photovoltaic Solar Systems I & II, Wind Power, Wave Energy in Australia
- Personal Finance:
  Credit Cards, Income Taxes I, II and III, Personal Investing I & II, Mortgages I & II
- Miscellaneous: Real Percents, Exercise and Nutrition I & II, Voting, False Positives I & II, GPA, Persian Gulf Neighbors, Basketball Probability, Life Expectancy I & II, Chi-Square, Firearm Death Rates, Distance Rate and Time in Sports, Sugar Math, Orbital Speed of Planets, NC Education Lottery Pick 3

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What's in the Works?

Math and Social Justice in Your Classroom

by Gizem Karaali and Lily Khadjavi

Coming soon - a volume of mathematics classroom modules that you can pick and choose to adopt in your classroom, each focusing on a specific social justice issue!

Gizem Karaali (Pomona College) and Lily Khadjavi (Loyola Marymount University Los Angeles) are editing a volume of classroom modules focusing on social justice issues. Tentatively titled "Mathematics and Social Justice: Perspectives and Resources for the College Classroom," this volume will help mathematics instructors who wish to incorporate ideas and instances of various social justice issues into their classroom. The volume will include concrete examples of mathematics connected to a range of social justice contexts. An eclectic collection of modules will be accompanied by a handful of thoughtful essays on goals, methods, and possible implementation problems associated with the idea of incorporating social justice themes into the college classroom.

Many of the modules included will be aimed for

use with students in general education, calculus, and introductory statistics courses. The full range of materials will include more elementary and more advanced coursework, from Precalculus to Differential Equations, Multivariable Calculus, and beyond. Modules will incorporate a series of in-class activities, research assignments, problem sets, and other methods of engaging the students with the relevant mathematics involved. They will be self-contained, meaning that any background needed to understand the context of the issue will be provided, so that materials can be readily included into any class where the mathematics necessary is being covered.

Stay tuned!

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Editorial

Where Do We Go From Here?

by Victor Piercey

At the beginning of this year, Jack Rotman from Lansing Community College said to me that he wants to see quantitative literacy and quantitative reasoning courses that "a mathematician can be proud of." I have spent a great deal of time this year thinking about what that means, especially in the context of the 10th anniversary panel discussion summarized by Andrew Miller above. This should be a challenge that guides us over the next ten years. I posit that the heart of what this means is that QL and QR should not be seen as the "anti-algebra" option for students who do not want to (nor need to) master algebra.

Currently, QL and QR suffer from a perception problem. Many mathematicians believe that quantitative literacy and reasoning lack rigor. This perception is picked up by our students. As a result students who complete such courses are not likely to overcome their own doubts about their mathematical abilities.

While one answer to these objections is to point out that QL and QR involve a different kind of rigor, I believe we can go further. Algebra and quantitative reasoning are not mutually exclusive. Algebraic manipulations are traditionally presented as purely abstract, devoid of context. This does not have to be the case. I am working on a QR course for business students in which we spend a great deal of time constructing, deconstructing, and manipulating business formulas. Quantitative reasoning provides a framework based on meaning and context.

For example, in what contexts would one want to solve a formula for a specified variable? Our compound interest formula, known as the "future value formula" in business circles, tells us how to calculate the balance of an account at some point in time. What if we want to figure out how much to deposit in order to reach a predetermined financial goal? If we needed to solve this problem for a large number of clients, it would be helpful to solve the future value formula for the principal and program the result into a spreadsheet.

Another direction in which we can address Rotman's challenge is to consider what quantitative literacy and reasoning means for STEM students. One area this can be done in is calculus. The calculus reform movement was spawned by a desire for students to endow their work with meaning. This can be further enhanced with authentic and realistic contextualization, the heart of QL and QR. Social justice contexts from Gizem Karaali and Lily Khadjavi's volume or those found in Dorothy Sulock's Reality Math course (both described above) could be extended to calculus.

A QL and QR framework can be extended to other aspects of the STEM curriculum. One of the overriding themes of the 10th anniversary panel discussion was the need for multidisciplinary input. We should listen to our partner disciplines and collaborate with them to extend QL across the curriculum. For example, Paul Grawe's request above to include more estimation should not be taken lightly nor should this request be limited to mathematics classes.

There is no doubt that quantitative literacy has come a long way in the last ten years. Large organizations such as the Dana Center, the Carnegie Foundation, and AMATYC have devoted countless resources to develop and disseminate quantitative literacy and reasoning pathways for students. My own state

of Michigan recently adopted a pathways approach that includes quantitative reasoning in our statewide articulation agreement for public institutions. These developments enable community colleges to provide quantitative literacy options for their students, many of whom come from a population that sorely needs it.

However, if quantitative literacy is going to move forward and establish itself as a permanent feature of education, I think we should take Rotman's challenge seriously. The quantitative literacy movement is not about content but about context and process. To be sure, some basic mathematical modeling has been a part of QL since its inception. However, algebraic representations have been typically downplayed in favor of numerical and graphical representations. Quantitative literacy is a movement that seeks to endow numerical and mathematical reasoning with meaning and importance. We undermine that mission when we limit ourselves to being an alternative to as opposed to a partner with algebra and other traditional mathematics.

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Recent and Upcoming Events

Recent

MathFest 2014

Portland, OR, August 6–August 9, 2014 Hilton Portland

First Person Solvers: Using Video Games to Learn Mathematics and Solve Real Mathematics Problems
MAA Invited Address
Thursday, August 7, 8:30–9:20 AM

This invited lecture was given by Keith Devlin of Standford University.

The Magic of Martin Gardner
Martin Gardner Centennial Lecture
Saturday, August 9, 2:30–3:20 PM

This invited lecture was given by Persi Diaconis of Stanford University.

MAA Session on Project-Based Curriculum
Thursday, August 7, 8:50–11:25 AM, 1:00–3:55 PM

Organized by Emek Kose, Casey Douglas, and Angela Gallegos and with presentations by Ksenija Simic-Muller and Victor Piercey.

SIGMAA on Quantitative Literacy Reception and Panel Discussion
Thursday August 7, 5:30–7:00 PM

A panel discussion on "SIGMAA–QL Turns 10: A Discussion of the Past and Future of Quantitative Literacy" moderated by Andy Miller featuring panelists Caren Diefenderfer, Rick Gillman, Dorothy Wallace, Bernie Madison, and David Burns.

Science Education for New Civic Engagements and Responsibilities 2014 Washington Symposium and Capital Hill Poster Session

Washington, D.C., September 28 – September 30, 2014

More information can be found by clicking on this link.

National Numeracy Network 2014 Annual Meeting

Northfield, MN, October 10–October 11, 2014 Carleton College

In conjunction with the Alliance to Advance Liberal Arts Colleges. Slides can be found by clicking on this link.

Upcoming

Joint Mathematics Meetings

San Antonio, TX, January 10–13, 2015
Henry B. Gonzalez Convention Center

MAA Session on Humor and Teaching Mathematics
Saturday, January 10 8:20–10:55 AM
Convention Center Room 210A

Organized by Semra Kilic Bahi, Gizem Karaali, and Debra Borkovitz. Link to full description.

MAA Session on Infusing Quantitative Literacy into Mathematics and Nonmathematics Courses
Tuesday, January 13 10–11:55 AM
Convention Center Room 212B

Organized by Andy Miller, Aaron Montgomery, and Gary Francy, and with many presenters, including Rob Root, Victor Piercey, and Andy Miller. Link to full description.3

SIGMAA on Quantitative Literacy Reception and Business Meeting
Saturday January 10, 6–6:30 PM
Convention Center Room 213A

Our annual business meeting is usually followed by an informal reception at a local watering hole.

MAA Minicourse #10
Saturday, January 10 2:15–4:15 PM & Monday, January 12 1–3 PM
Convention Center Room 206B

Gizem Karaali and Eric Marland will present a mini course on Humanistic Mathematics.

MAA Minicourse #11
Sunday, January 11 1–3 PM & Tuesday, January 13 1–3 PM
Convention Center Room 207A

Theresa Laurent will present a mini course on Healthcare Applications and Projects for Introductory College Mathematics Courses

MathFest 2015

Washington, D.C., August 5–8 2015

The SIGMAA's contribution to the schedule will be determined at the business meeting in San Antonio listed above.

Science Education for New Civic Engagements and Responsibilities 2015 Washington Symposium and Capital Hill Poster Session

Further information, including dates and location, will be announced on this link.

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