

JSM 2008 Lunch Roundtable: HANDOUT (31 July 2008):

How do we promote quantitative literacy across the undergraduate curriculum and how will we know if we were successful?

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Outline:

0. Who wants to eat? Introductions.
1. What do we mean by quantitative literacy (QL)?
2. QL across the curriculum?
3. Local contexts for QL / QR / Formal Reasoning / ...
(a little about what Miami Univ. currently requires ... how about your school?)
4. Assessing QL?
5. Resources

0. Who wants to eat? Introductions.

1. What do we mean by quantitative literacy (QL)?

One of the broader definitions of numeracy, or quantitative literacy, now in use is "an aggregate of skills, knowledge, beliefs, dispositions, habits of mind, communication capabilities, and problem solving skills that people need in order to engage effectively in quantitative situations arising in life and work." (def'n from Numeracy Network, can be found on the NCED Web page at http://www.woodrow.org/nced/national_numeracy_network.html)

The promotion of "education that integrates quantitative skills across all disciplines and at all levels" is key part of the scope of Numeracy (see H L. Vacher and Dorothy Wallace (2008) "The Scope of *Numeracy*," *Numeracy*: Vol. 1 : Iss. 1, Article 1. Available at: <http://services.bepress.com/numeracy/vol1/iss1/art1>).

Nice historical review of QL/QR/numeracy including National Numeracy Network roots and officers (including Milo Schield) – see Bernard L. Madison and Lynn Arthur Steen (2008) "Evolution of Numeracy and the National Numeracy Network," *Numeracy*: Vol. 1 : Iss. 1, Article 2. Available at: <http://services.bepress.com/numeracy/vol1/iss1/art2>

2. QL across the curriculum?

[*] The case for numeracy in schools is not a call for more mathematics, nor even for more applied (or applicable) mathematics. It is a call for a different and **more meaningful pedagogy across the entire curriculum**. In life, numbers are everywhere, and the responsibility for fostering quantitative literacy should be spread broadly across the curriculum. Quantitative thought must be regarded as much more than an affair of the mathematics classroom alone." (Lynn Steen: **Writing in Education Week on the Web** [Wednesday, September 5, 2001, Volume 21, Number 1, p. 58]

[*] Quantitative Reasoning for College Graduates: A Complement to the Standards
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. [*editorial remark: some might argue that STAT depts. should provide this leadership!*]

A **required course or two is not sufficient**. A student becomes quantitatively literate through a broad program that instills certain "long-term patterns of interaction and engagement." The program, the central idea of these recommendations, starts with a "foundation experience" into which students are appropriately placed and in which a carefully chosen course or two can raise entering students to a level of proficiency where they can benefit from the next phase, which is the "continuation experience." (http://www.maa.org/past/ql/ql_toc.html)

Benjamin Steele and Semra Kiliç-Bahi (2008) "Quantitative Literacy Across the Curriculum: A Case Study," *Numeracy*: Vol. 1 : Iss. 2, Article 3. Available at: <http://services.bepress.com/numeracy/vol1/iss2/art3>

- * Described implementation of QL across curriculum at Colby-Sawyer College (1000 students; 63 faculty)
- * Commented on parallels to writing across curriculum
- * “Core method” – summer workshops with stipends (NSF funded)
- * Evaluated student progress with locally-developed scales/instruments
- * Success associated with: 1) involving as many people as possible early and informing entire faculty; 2) project interdisciplinary from beginning; 3) local culture of collaboration and innovation with strong interests in curriculum and student learning; 4) administration support and participation; 5) focused faculty time (support in summers); 6) Scholarship of teaching counted as part of the scholarship in P&T
- * Noted other programs including: Carleton College Quantitative Inquiry, Reasoning and Knowledge (QuIRK) initiative [serc.carleton.edu/quirk]; Wellesley [www.wellesley.edu/QR]; Hollins [www1.hollins.edu/homepages/hammerpw/qrcodepage.htm]

Spring 2008 National Study of Student Engagement (NSSE) – Assessing QL in writing

FIRST-YEAR STUDENTS and SENIORS 2007 NSSE, ADDITIONAL WRITING QUESTIONS (1 OF 25)

		FY Students		Seniors	
		Count	%	Count	%
WTX0802F In how many of your writing assignments did you: Explain in writing the meaning of numerical or statistical data	No assignments	2176	32.3	3885	24.1
	Few assignments	1697	25.2	4133	25.7
	Some assignments	1820	27.0	5031	31.2
	Most assignments	776	11.5	2398	14.9
	All assignments	277	4.1	663	4.1
		6746	100.0	16110	100.0

SENIORS 2007 NSSE, ADDITIONAL WRITING QUESTIONS (1 OF 25)

		<i>Arts and Humanities</i>	<i>Biological Sciences</i>	<i>Business</i>	<i>Education</i>	<i>Engineering</i>	<i>Physical Science</i>	<i>Professional</i>	<i>Social Science</i>
		%	%	%	%	%	%	%	%
WTX0802F2 In how many of your writing assignments did you: Explain in writing the meaning of numerical or statistical data	No assignments	51	10	13	35	7	14	23	18
	Few or some assignments	43	52	64	57	40	45	62	66
	Most or all assignments	5	37	23	8	54	41	15	16

Source: Paul Anderson, Director, Howe Center for Writing Excellence at Miami

3. Local contexts for QL / QR / Formal Reasoning AND QL across the curriculum (a little about what Miami Univ. currently requires ... ideas for implementation ... how about your school?)

Fast Facts: Public University of Ohio (14,265 undergrads; 1,501 grad students on Oxford campus); 2 regional campuses + LUX
(Established 1809; Named for the Miami Indian Tribe that inhabited the area now known as the Miami Valley region of OH)

Miami Plan for Liberal Education (<http://www.miami.muohio.edu/academics/miamiplan/>)
[also <http://www.units.muohio.edu/led/>]

I. Foundation

This requirement is met by taking 36 semester hours of Foundation courses. These courses, typically taken within the first two years, include the following areas:

- English Composition
- Fine arts, Humanities, Social Science
- Cultures
- Natural Science
- Mathematics, Formal Reasoning, Technology ***** *ok, so what is the foundation required?*

II. Focus

The focus requirement is met by a minimum of nine hours in a **Thematic Sequence** outside your department of major and a minimum of three hours in a **Senior Capstone Experience**.

Taken in your final year of study, the capstone serves to meld your broad, liberal learning with the specialized knowledge of your major. It could take the form of a workshop, research seminar, individual or group project, or creative work in a studio, laboratory, or field study.

Principles of the Miami Plan include: Thinking Critically, Understanding Contexts, Engaging with other Learners, Reflecting and Acting.

Foundation V. Mathematics, Formal Reasoning, Technology (3 hours minimum)

[ARC 212](#) Principles of Environmental Systems (3)
[ATH309/ENG 303/GER 309/SPN 303](#) Introduction to Linguistics (3)
[CSA 151](#) Computers, Computer Science, and Society (3)
[CSA 163](#) Introduction to Computer Concepts and Programming (3)
[MTH 115](#) Mathematics for Teachers of Grades P - 6 (4)
[MTH 121](#) Finite Mathematical Models (3)
[MTH 151](#) Calculus I (5)
[MTH 153](#) Calculus I (4)
[MTH 249](#) Calculus II (5)
[PHL 273](#) Formal Logic (4)
[STA 261/261.S](#) Statistics (4)

Notes:

1. MTH 151 and STA 261 are also “Top 25” (enrollment) classes and targeted for more inquiry driven learning.
2. Students might test out of this requirement with AP credit (can place out of at most 5 Foundation course)
3. Computer Science folk would like to talk about “technology literacy”
4. Category is too broad!
5. Essentially, this is a requirement that is often satisfied as part of most majors.

So, what are doing at Miami in response to these observations?

What should a Miami student know when they walk across the stage at graduation? What does it mean to be an educated citizen?

A quantitatively literate citizen should possess the ability to

1. **Consume and process information (quantitative and qualitative)** – We live in a world where the more and more information is accessible to us as citizens.
2. **Think critically about this information** – Not all of this information is of the same quality or relevance. Some claims may be based on a small number of individuals who were selected in some haphazard manner. Other claims may be based on a sample of individuals selected from a population that may not be representative or relevant.
3. **Make good decisions based on this information** – After you collect, consume and critically evaluate information, then you act. What action is best?

What is quantitative literacy (QL)?

One of the broader definitions of numeracy, or quantitative literacy, now in use is "an aggregate of skills, knowledge, beliefs, dispositions, habits of mind, communication capabilities, and problem solving skills that people need in order to engage effectively in quantitative situations arising in life and work." (http://www.woodrow.org/nced/national_numeracy_network.html)

QL skills include the ability to:

1. **Identify questions** – Frequently, competing options are available to address a particular problem. You might be identified as having a high cholesterol or high blood pressure rate. You can choose to do nothing, change your diet, exercise more, take medications or do some combination of these choices. What do the numbers mean? Which option should you select? What are the consequences of selecting a particular option?
2. **Collect appropriate evidence** – While you will not be conducting a clinical experiment to evaluate the options above, your physician may advise you based on such an experiment. Was this study conducted with a sample from a population of patients similar to you?
3. **Discover and apply tools to interpret data** – Your physician tells you that you have a 10% chance of a coronary event in the next 10 years if you do nothing. But this risk can be reduced dramatically with appropriate medications. What does this mean? Can you explore the risk reductions associated with dietary or exercise changes?
4. **Evidence-informed decision making** – You need to make decisions and act. Are you willing to accept the 10% risk associated with no action? Does the data presented lead you to choose medications?

5. **Communicate and exchange results** – In the scenario above, the physician communicated study results to you but did you understand the basis for the information presented? Did the physician understand the risk numbers?

What are some of the QL learning outcomes that should be realized in a graduate?

MU graduates should demonstrate that they are prepared to function as quantitatively literate citizens. Classes and other learning opportunities should prepare students for

1. **Evidence-informed decision making**

- Students should be able to determine which of two assertions is best.

2. **Critically assessing assertions**

- Students should be able to incorporate quantitative measures of uncertainty in understanding assertions, such as those found in popular media.

3. **Communicating with quantitative concepts**

- Students should be able to interpret graphs and multiple visual displays of information and data.
- Students should be able to communicate quantitative information in written or graphical forms.

4. **Qualitative dimensions of inquiry**

- Students should have strategies for making decisions in the face of uncertainty and incomplete data.
- Students should be able to write narratives interpreting quantitative data and their meaning.

So what are we doing at Miami?

Faculty Learning Community (FLC) in QL (in place ... funded by Provost and CELT)

Enhancing the quantitative literacy component of existing classes.

New interdisciplinary coursework related to QL

Team-taught journalism-stat news & numbers class being developed by Richard Campbell and John Bailer (Spring 09)

PAEA for QL

Originally submitted in Nov. 07. Many faculty participants from multiple divisions/departments. Rev. planned for Nov. 08.

QL in the Miami plan ... QL component in 100 level class? QL theme throughout higher level classes?

Should there be a greater emphasis on QL in the Miami Plan and/or CAS requirements?

... more than just one class in formal reasoning?

... replace Foundation V? Revolution? Evolution?

... add 5th principle? Develop thematic sequences, capstones, ...

For example:

- a. Students must take 3 QL courses, each at a different level (100, 200, etc.).
- b. Student must take 3 QL courses: 1 Miami Plan QL course plus one course designated QL in their major plus one additional QL course.
- c. Students take a Thematic Sequence designated QL (of a QL minor, which replaces the Thematic Sequence for the Miami Plan)

??? Center for Quantitative Literacy (analogous to Howe Center for Writing Excellence)

QL across the curriculum is as critical as writing across the curriculum.

Need to meet students and faculty at different levels of competency for training and support for QL. This includes enriching classes and supporting research.

QL workshop experience – faculty from other universities who have implemented QL programs across the curriculum.

Distant Future

Promotion and support of research by students, faculty and staff

Research support centralized and coordinated (SCC+RCS+CACR+...)

4. Assessing QL?

Changes to who? Changes to what?

4.1 Student QL skills

4.2 Student attitudes towards using QL skills

4.3 Faculty members QL skills and attitudes

Examples:

<https://app.gen.umn.edu/artist/> [Assessment Resource Tools for Improving Statistical Thinking] –PIs: Joan Garfield, Robert Del Mas, Beth Chance

<http://www.causeweb.org/research/guidelines/> [research guidelines and link to recent ASA Report]

Quantitative Reasoning Assessment Instrument we developed at Johnson State College and used in a large-scale (279 students) pilot in the fall of 2006 [Glenn Sproul]

Quantitative Reasoning instrument developed at JMU [Donna Sundre]

5. Resources

1. ASA Statistical Literacy Efforts
2. National Numeracy Network (<http://serc.carleton.edu/nnn/>) and the journal *Numeracy: Advancing education in quantitative literacy*.
3. Bressoud DM (2008) Quantitative Literacy and Teacher Education (see below)
http://www.maa.org/columns/launchings/launchings_07_08.html

