

Moving towards a quantitative literacy core competency requirement

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(Rough) Talk outline

- Current liberal education requirements
- Why it isn't QL
- Changing credit sources as catalyst
- A process for revision
 - We are not alone (with apologies to UFO hunters)
- How will we know this works?

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University Context/Current liberal education requirements

Miami University – Oxford, Ohio [SW corner of the state]

- Chartered 1809
- 14600 undergraduates / 2200 graduate students
- 1514 faculty members [961 full-time]
- 5 academic divisions [College of Arts & Science (CAS), Business; Education, Health and Society; Engineering and Applied Science; Fine Arts]
- CAS [440 continuing faculty in three cognate areas – humanities; social sciences; natural sciences]; 44% of MU students major in CAS.
- Miami Plan for Liberal Education (“gen ed” requirements) + layering of CAS requirements

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Miami Plan for Liberal Education

- (<http://www.miami.muohio.edu/academics/miamiplan/>)
- **I. Foundation**
- met by taking 36 semester hours of Foundation courses. Typically taken within the first two years, include:
 - English Composition
 - Fine arts, Humanities, Social Science
 - Cultures
 - Natural Science
 - Mathematics, Formal Reasoning, Technology

***** ok, so what is the foundation required?

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

Foundation V. Mathematics, Formal Reasoning, Technology

ARC 212 Principles of Environmental Systems

ATH309/ENG 303/GER 309/SPN 303 Introduction to Linguistics

CSA 151 Computers, Computer Science, and Society

CSA 163 Introduction to Computer Concepts and Programming

MTH 115 Mathematics for Teachers of Grades P - 6

MTH 121 Finite Mathematical Models

MTH 151 Calculus I (5) MTH 153 Calculus I (4) MTH 249 Calculus II

PHL 273 Formal Logic

STA 261/261.S Statistics

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But wait ... CAS requirements as well ...

CAS-E: *Formal Reasoning*

- Liberally educated students enhance their capacity to reason through the study in **inductive** and **deductive thinking**. Disciplines that employ **formalized languages** as the means to develop such thinking include mathematics, statistics, logic, and linguistics.
- Courses in formal reasoning explicitly develop a student's ability to:
 - **generate conjectures** and hypotheses inductively by examining patterns, trends, and examples and counter-examples;
 - confirm or reject these conjectures by **formal deductive logic**;
 - recognize that certain types of knowledge are dependent upon the application of systematic argument based on specific sets of assumptions; and
 - begin to apply skills of formal reasoning and critical thinking to different sets of assumptions to generate different systems of knowledge.

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Classes meeting CAS Formal reasoning

Requirement: complete ≥ 3 h chosen from the courses listed below. ... hours may also be used to fulfill MPF V.

- ENG/ [SPN 303](#), GER/ [ATH 309](#) Introduction to Linguistics
- [MTH 121](#) Finite Mathematical Models
- [MTH 151/153/249/251](#) Calculus I/II
- [MTH 222](#) Introduction to Linear Algebra
- [PHL 273/373](#) Formal or symbolic Logic
- [STA 261](#) Statistics

http://www.miami.muhoh.edu/documents_and_policies/bulletin10/programs_of_study/cas/index.html#TheCollegeRequirement

Observations:
Courses from outside CAS did not satisfy this requirement
Does this sound like QL? Should it?

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Why it isn't QL

- "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." *International Life Skills Survey* (Policy Research Initiative, Statistics Canada, 2000)
- Quantitative literacy* involves **understanding the role of numbers in the world**. It provides the ability to see below the surface and to demand enough information to get at the real issues. -- Ted Porter, historian
- Beyond arithmetic and geometry, *quantitative literacy* also requires logic, data analysis, and probability.... It enables individuals to analyze evidence, to read graphs, to understand logical arguments, to detect logical fallacies, to understand evidence, and to evaluate risks. **Quantitative literacy means knowing how to reason and how to think**. -- Gina Kolata, journalist
- Numeracy** is not the same as mathematics. It is an aggregation of skills, knowledge, beliefs, dispositions, habits of mind, communication capabilities, and problem solving skills that people need in order to engage effectively and autonomously in quantitative situations arising in life and work. -- Iddo Gal, cognitive scientist

(all defns from <http://www-math.cudenver.edu/~wbriggs/qr/whatsit.html>)

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QL definitions (ctd.)

- Important *quantitative competencies* are those that can be used to **solve problems people would frequently encounter on the job** or in their **roles as citizens or parents**. Quantitative competencies require identifying and solving problems not in algebra and geometry, but in the five SCANS competency domains such as planning, information, and systems analysis.
-- Arnold Packer, economist
- Quantitative reasoning as an interpretive activity* that takes place within a deductively structured framework. It involves a **tapestry of meaning** provided by a warp of abstract patterns and a weft of context and story line. In **quantitative reasoning, context provides meaning**. -- George Cobb, statistician

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Changing credit sources as catalyst

- State mandates ...
 - Credit received for any AP test result ≥ 3
 - Transfer and online credit
- So, GenEd (Miami Plan) + CAS Formal Reasoning (+ other requirements) could be satisfied outside of MU

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A process for revision

- We are not alone
- What we did
- What we have yet to do

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We are not alone

- 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>).
- 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]

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Current liberal education requirements

Schild (2010) reported on a 2009 SIGMAA-QL survey of QR requirements

- 26% response rate from 4 yr. schools (n=275)
- Requirement?
 - Traditional math. – sci. division req.(30%)
 - College wide quant. req. (87%)

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Quant. grad. Requirements (ctd.)

- Common courses?
 - Calc. – 92%
 - Stat/research methods – 74%
 - Math for liberal arts – 60% ...
 - Satisfy QR outside of math – 43%
- Assessment
 - pre./entry eval. – 32%
 - Post/exit eval. – 20%

>> Quant. support center – 68%

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What we did ...

- QL FLC met for two years
- Proposed revision to CAS requirements to address QL core competency (in addition to a proposed writing core competency)
- Current status – received by CAS with implementation plans evolving
- Details?

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CAS QL requirement-Working Assumptions?

- ...QL component of many existing courses could be enhanced to address this core competency requirement although departments may choose to introduce a new course in the major that uses QL to achieve course learning objectives. For existing courses, this reflects a documenting how course activities address QL learning outcomes.
- The range of the QL learning outcomes (LOs) is extensive. A single course is not going to address all the learning outcomes.
- As with many of the core competency requirements, we do not expect that every department or program in the college will provide a QL course as part of their course offerings.
- Departments and programs will decide if particular QL courses will be required as part of their programs.
- A course from another division that meets the CAS-QL requirements could qualify.

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What is the MU QL core competency requirement?

- one-course requirement (3+ h) above and beyond MPF V coursework satisfied while a student is in residence at Miami. Courses used to satisfy the MPF V requirement may not be used to satisfy the CAS-QL requirement.
- A student in a CAS-QL course will move from basic recognition of the quantitative elements of a story, report or argument to more sophisticated critical consumption of quantitative arguments and creation of reports / narratives where quantitative evidence is appropriately used.
- Alternatively, the QL class might satisfy the QL skills "Magnitude and measurement of numbers" and "Importance of functional relationships" or the QL skill "Summarizing information and making inferences.

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MU CAS QL core competency (ctd.)

- Ideally, students would take this QL course early in their academic careers so that upper level courses could build on this preparation; however, we expect departments may vary in their approach to this.
- QL reflects a "habit of mind" and breadth of application is critical for appreciating the importance of QL competency. Although it is desirable that this course will be taken in an area different from the student's major, it is not required.
- The requirement will be satisfied by multiple "pathways." The suggestions of satisfying the QL course requirement early in an academic career and across areas are not rigid requirements.
- Ideally, a student would encounter QL throughout their academic careers in introductory, intermediate and advanced coursework and across fields of study. While this is an aspirational goal, the revision committee has opted for a more modest, initial proposal
- NOT another mathematics or statistics course. In fact, many technical majors may be very quantitative and technical but are not promoting quantitative literacy.

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| Model for QL Learning Outcomes at Miami University | | | | | |
|--|---|--|--|---|--------|
| | | QL Skills Dimension | | | |
| | | Magnitude and measurement of numbers | Importance of functional relationships | Summarizing information and making inferences | |
| Learning / Narrative Dimension | Read a story with quantitative dimension | **Read a story and recognize quantitative content (Knowledge) | L.O. 1 | L.O. 2 | L.O. 3 |
| | | Understand a story and correctly interpret numeric information (Comprehension) | | | |
| | Generalize story and understand pieces of story | Apply the lessons from a story (Application) | L.O. 4 | L.O. 5 | L.O. 6 |
| | | Explain the lessons from a story (Analysis) | | | |
| | Critically evaluate story and make a decision | Compare and contrast multiple stories on the same topic (Synthesis) | L.O. 7 | L.O. 8 | L.O. 9 |
| | | Evaluate and judge conflicting stories on the same topic (Evaluation) | | | |
| Write a new story that goes beyond previous stories (Creation) | | 19 | | | |

Qualifying as CAS-QL course

- A course that meets any "2+ x 2+" configuration of the learning outcomes above (including non-contiguous groupings) may qualify as a QL course. Such a course will integrate multiple skills (columns) with multiple narrative levels (rows). For example, a class that worked toward competency in "Read a story with quantitative dimension" and "Generalize story and understand pieces of story" for skills "Magnitude and measurement of numbers" and "Importance of functional relationships" [Learning Outcomes 1, 4, 2, and 5] could qualify.
- Courses that meet all learning/narrative dimensions in a particular skill may also qualify. For example, a course that satisfies Learning Outcomes 3, 6, and 9 in "Summarizing information and making inferences" could qualify as a QL course.

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Examples of questions that might be explored in these outcomes

| | Magnitude of numbers | Importance of functional relationships | Summarizing information and making decisions |
|--|--|---|--|
| Conveying information / Tell Story with quantitative content | The stimulus package involves a huge monetary investment by the government. Can this be understood by an informed citizen? In a related question, how is this information effectively communicated? | What is the basis of claims that social security will become insolvent in a particular number of years? Does this involve a projection of future population growth? What is the basis of these projections? | Different energy producing technologies are available (e.g. coal-burning, nuclear, solar). Which technology is preferred? Can the lifecycle cost of producing energy via these technologies be presented to summarize and used to select a particular technology? 21 |

| | Magnitude of numbers | Importance of functional relationships | Summarizing information and making decisions |
|---------------------------|---|--|--|
| Critically evaluate story | Two reports are issued summarizing the same political rally. One report says over a million people participated while the other claimed fewer than 250,000. Which, if either, is correctly capturing the number of participants? | Global warming is accepted by the vast majority of environmental scientists. What are the models that underlie this belief? Why do we use models? Could these models be wrong? What is the uncertainty intrinsic in these models? | A newspaper article has reported that caffeine is bad for your health. An experiment was reported in which rates of anxiety are observed to be higher in heavy coffee drinkers. Do you need additional information before you would believe this claim? |

| | Magnitude of numbers | Importance of functional relationships | Summarizing information and making decisions |
|----------------------------|---|---|--|
| How do you make a decision | Millions, billions and trillions are all big numbers but they correspond to very different amounts of debt at a national scale. Parts per million (ppm), billion (ppb), trillion (ppt) are all small concentrations; however if chemical A kills 50% of organisms exposed to it at a concentration of 10 ppm and chemical B kills 50% of organisms exposed to it at a concentration of 15 ppb, then which chemical is more toxic? [Chemical B is relatively more toxic since it has the same effect at a much lower concentration. This requires an understanding that 15 ppb < 10 ppm (10 ppm = 10000 ppb).] | Is it worth stretching now to buy a house with a 15 year loan instead of a 30 year loan? Is it worth spending \$15K more for an electric car relative to a gasoline car? [You need to be able to calculate the expected cost of operation over the duration over which you own the cars.] | Your doctor says you have a 10% risk of heart disease at your current cholesterol level. You can reduce this risk by reducing your cholesterol level by changing diet, increasing exercise or taking a statin drug. Will diet and exercise changes suffice? How would you decide? What did 10% risk mean? 23 |

A QL course proposal will:

- Identify which learning outcomes are addressed by the course.
- Describe WHAT WILL YOU ASK STUDENTS TO DO? for each identified Learning Outcome.
- Describe HOW WILL YOU MEASURE THE QUALITY OF EFFORT? for each identified Learning Outcome.

(We believe that it is important to leave Learning Outcomes 1 – 9 for individual instructors to specify. Learning outcomes are most appropriately course specific. Top-level learning goals are described by this display. These learning goals will be evaluated by an appropriate metric of performance capturing milestones along the path to demonstrating full mastery of a learning outcome.)

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FAQs for the QL core competency

Q: Does my department have to offer QL courses?

A: No. We do not expect that every department or program in the college will provide a QL course as part of their course offerings.

Q: Does a QL course have to be a new course?

A: No. The QL component of many existing courses could be enhanced to address this core competency requirement although departments may choose to introduce new courses to address QL competency. For existing courses, this reflects a documenting how course activities address QL learning outcomes.

Q: What supports are available for developing a QL course?

A: The committee envisions the establishment of a Center for Qualitative Literacy (CQL) similar to the Howe Center for Writing Excellence to support these development efforts. The CQL would work in partnership with CELTUA to establish Faculty Learning Communities for these courses.

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FAQs (ctd.)

Q: Could courses from outside of CAS satisfy the QL course requirement?

A: Yes. A class from another division that meets the QL requirements could qualify.

Q: How would QL courses be approved?

A: Course approval would be by a revamped CAS Curriculum Committee that would include a representative from each cognate area in the College as well as representatives of each College competency area.

Q: How would QL courses be assessed?

A: QL courses would be assessed by the academic units offering them at the time of program review. The unit proposing the QL course would need to identify an assessment model at the time the course is proposed.

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How will we know this works?

- When departments propose QL courses (willingly?) ...
- When assessments show student QL development ...
- When student performance in upper level courses provide evidence of greater confidence and competence with QL skills ...

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Thank you for your interest and attention!

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