Implementing a Quantitative Literacy Core Competency Requirement in the College of Arts & Science at Miami University

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1. Context and Introduction

Miami University: public university in Oxford, Ohio, USA - 16000 students - degrees in 5 colleges or schools.

http://en.wikipedia.org/wiki/Ohio

http://vdgsa.org/img/conclave-2014/MiamiU.jpg

Miami Plan: general education requirements

College-specific requirements (e.g. foreign language in CAS)

No explicit requirements for QL.

Faculty initiative: faculty from a variety of disciplines became interested in enhancing the quantitative literacy (QL) skills in our students.

RESULT: largest division at the university, the College of Arts and Science (CAS) has embraced a QL competency requirement.

How did we get here?

2. What do we mean by Quantitative Literacy (QL)?

Numeracy or quantitative literacy (QL) as "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" (National Numeracy Network - http://www.woodrow.org/nced/national_numeracy_network.html).

Steen (2001) described the promotion of QL as a call for "more meaningful pedagogy across the entire curriculum" that differed from advocating simply more mathematics. This sentiment resonated with a number of colleagues at Miami, and this led to action.

Vacher and Wallace (2008) advocated the promotion of these skills across all disciplines and levels

Madison and Steen (2008) provide a nice historical review of QL issues.

From these ideas, we characterized QL as being comprised of:

- understanding relationships
- number sense and/or
- evidence-based decision making/stat literacy.

3. A Little about what Miami University required

- Miami University has a number of academic divisions all of which host majors and may have specific requirements
- All share general liberal education requirements contained in the Miami Plan for Liberal Education or Miami Plan
- Miami Plan: emphasizes thinking critically, understanding context, engaging with other learners, reflecting and acting

- Miami Plan (continued): Included a set of foundation courses, a thematic sequence of courses and a senior capstone.
  - **Foundation course requirements** are usually satisfied in the first two years of study and includes foundation courses in: English composition; fine arts, humanities, social science; cultures; natural science; and mathematics, formal reasoning, technology.

  - **Mathematics, formal reasoning, technology foundation requirement**: could be satisfied by courses that included: linguistics, introduction to computer concepts and programming, mathematics for teachers, finite mathematical models, calculus, formal logic and, last but not least, statistics.

Observation:

- some of these courses will have a strong QL flavor
- not all courses will. It is clear that this category is too broad.
- In addition, many students were satisfying this requirement using Advanced Placement (AP) credit.
- This **requirement did not** address the goal of promoting "*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*" (National Numeracy Network) nor did it capture the sense of QL as a "*meaningful pedagogy across the curriculum*" (Steen 2001).

4. History of QL efforts at Miami.

- Formal start: Dec. 2006 meeting of academic administrators where the provost reported the teaching and use of statistics across campus.
- Center for Writing Excellence was beginning at Miami
- Timing seemed right to propose an analogous center for quantitative literacy
- CAS Dean: semester-long process meeting started to discuss the best mechanism for promoting QL
- **Who was involved?** staff from across campus (8 departments represented from 5 divisions, libraries and regional campuses)
- **What did they do?** group produced a proposal for a internally funded center for QL { not funded but QL discussion had momentum to continue }

- **What next?** meeting with the provost and director of liberal education emphasized:
  - need to articulate what features of QL should be appreciated by a student by the time they graduate
  - a proof-of-concept course was suggested, and a plan to develop this further was requested.

- **Faculty Learning Community (FLC):** formed to articulate features … populated by faculty from all divisions but included a set of individuals intrinsically interested in QL issues.

- **Proof-of-concept course?** A course on news and number was developed and delivered by a journalism professor (self-described "humanities canary in QL coal mine" and a statistician)

- The **formation of a cohort** of colleagues who are interested in promoting QL skills is a critical first step for promoting QL and for developing and implementing a QL requirement. The

  - Observation: **support of deans and provosts**, both through budget to support the FLC meetings and through encouragement, was a second key step to promote and develop QL.
  - While this was a faculty initiative, the success at an institutional level required central support.

FLC Year 1 (2008-2009)

- investigation into how QL was defined
- how other institutions promoted QL
- all participants explored enhancing QL in at least one course through a teaching project.

FLC Year 2 (2009-2010)

- charged with developing a QL core competency requirement
- Formal proposal to include a QL Core Competency requirement was approved in Fall 2010.

CAS Quantitative Literacy (QL) requirement:

- One course that *builds upon the Miami Plan V* requirement (Mathematics, Formal Reasoning, and Technology)

- Arguably, a QL course might be desired during every year of study; however, there were realities that needed to be incorporated.

- We thought that it was important to have a course beyond the foundation requirement, and this was affirmed

Implementation issues:

1. Implementation committee (some overlap with QL FLC) – liaison: associate dean.
   a. Formed QL subcommittee of CAS curriculum cmt.
   b. Strategic arm-twisting – making sure QL options available to all cognate areas (natural sciences, social sciences, humanities)
   c. Make sure that enough QL ‘seats’ available to go live
   d. Calls to chairs for proposals (May ’11)
   e. QL workshop - QL core requirement was presented, and then individuals or teams worked on developing a formal CAS QL proposal

2. QL curriculum subcommittee (Spring 2011-2013)
    a. What should requirement look like?
    b. Defining QL and communicating to CAS – help w/ proposals
    c. How much QL does a QL class have? % time? %SLOs? %assignments? [decision: 1/3 of course QL required]
    d. QL class may not satisfy a Miami Plan Foundation req.
    { dissolved in 2013 & QL rep. appointed to CAS curr. Cmt. }

- important to **help faculty and instructors** see this effort promotes a critical skill, and

- they already may be in a position to address many QL learning outcomes in their class

5. What are we doing now?

CAS (divisional) QL requirement now approved – incoming 2013 class has to satisfy the QL requirement

Candidate classes?

1. propose a new course to satisfy this requirement
2. revise an existing course.

KEY:

- must have at least 3 student learning outcomes that involve QL
- >1/3 of the student learning outcomes for the course are QL-related

Criteria that must be satisfied to be considered a QL class are (from CAS QL proposal form):

1. Include **at least 3** QL student learning outcomes (SLOs) from the following list of 6 (based on Bloom's Taxonomy + each link to one or more of the Lumina Foundation's outcomes).

Group A (Knowledge & Comprehension)

- SLO 1: Identify the quantitative aspects of a problem or situation
- SLO 2: Interpret numerical displays and information

Group B (Application & Analysis)

- SLO 3: Apply quantitative methods to a different situation
- SLO 4: Analyze, compare and/or contrast components of numerical information

Group C (Synthesis & Evaluation)

- SLO 5: Communicate or create an idea with numeric information using multiple forms of representation (words, graphs, tables and other displays)
- SLO 6: Evaluate, assess, or critique different forms of numerical evidence

2. Include graded QL assignments and activities at multiple points, distributed over the course of the semester.

3. Include graded assignments requiring students to ***translate*** a QL skill to a practical application or to solve a problem.

QL SLOs

- broad categories
- can be tuned to fit the goals and content of a variety of courses in different subject
- can be evaluated using a variety of assignments.

Proposal includes assessment plan

- Tier 1: Faculty Perceptions
- Tier 2) Student Perceptions
- Tier 3) SLO Assessment

Courses will be modified based on these assessments, and the assessment will be included in department program review.

Approval form:
http://miamioh.edu/cas/_files/documents/cas/literacycourseform.pdf

CAS-QL Quantitative Literacy (3 semester hours)

Liberally educated students learn the "habit of mind" associated with reasoning and solving quantitative problems from a wide array of authentic contexts and everyday life situations.

Requirement: Students must take at least one CAS course designated as QL beyond the MP V and CAS E. The same course may also be applied to the other MP and CAS requirements except for MP V and CAS E.

Quantitative literacy courses include: ATH 496; BIO/MBI116, BIO 161; CHM 111, 375; ECO 311; ENG 222; GEO 205, 242; GLG 111, 121, 141; HST 202; IMS/JRN/STA 404; JRN 412; MTH 435, 453; POL 101, 306; PSY 293, 294, 324*; SOC 262; STA/ISA 333; STA 363, 475; WGS 204.

* Only specific sections of PSY 324 are designated QL; see the departmental advisor for information.

http://www.units.miamioh.edu/reg/bulletins/CurrentGeneralBulletin/the-college-requirement-cas.htm

Former members of the QL faculty Learning Community members were leaders in generating proposals for this new requirement. (currently 27 courses approved):

6. Lessons Learned? … Conclusion

Recap:

- provide a sense of the effort and key ingredients needed for success when considering a the inclusion of a QL requirement
- case study of an institution where a QL requirement was developed and adopted
- broad coalition of faculty was the spark that started and maintained this process

Lessons Learned and Ingredients for Success

- start with **demonstration projects** to provide "proof of concept" – the QL FLC teaching projects provided important evidence
- make sure **administrative support** is secured early (not worth doing it if don't have support) – Provost at MU has underwritten ½ of the FLC and part of the recent workshop
- identify **partners** (Writing Centers)
- **build coalition** with breadth - QL can't be owned by a department or it will never succeed – this process would have failed if it was perceived as simply another statistics or mathematics course requirement
- **work to promote** - you need to work to sell this – this includes working on curriculum committees, providing workshops, serving as

a resources for colleagues, advocating for the effort in your department and beyond

- Need **broad engagement** - need broad engagement across divisions to make big changes – we influenced the CAS requirements but we did not in changing the university requirements [yet!]
- Make sure that you recognize & reward participation. Participation in projects, learning communities need to be valued (e.g. each FLC participant received a $1000 professional expenses account)
- Be **patient** – It was years in the making but success was achieved

Next up for QL? DATA!

- Assessment feedback - QL requirement is now in place for students who entered in the College in Fall of 2013.
- How are students satisfying the QL requirement? Compare majors / cognate areas?
- How many QL classes did students take before graduation?

Hopes?

- We hope this will be the first of many generations of students with stronger QL skills as a result of the college-wide efforts to promote this core competency.

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APPENDIX: Sample Questions Requiring QL Skills to Answer

The stimulus package involves a huge monetary investment by the U.S. 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). What climate, economic or health outcomes do each offer? Can the lifecycle cost of producing energy via these technologies be summarized and used to select a particular technology?

Two reports are issued summarizing the same political rally. One report says more than one 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 heavy coffee drinkers have higher rates of anxiety. Do you need additional information before you would believe this claim?

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 lowering your cholesterol level through diet change, exercise or by taking a statin drug. Will diet and exercise changes suffice? How would you decide? What did 10% risk mean?

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Examples taken (and slightly modified) from Appendix L of the CAS QL Core Course Requirement Proposal