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# College Algebra in Context: A Learner-centered Approach Incorporating Data-driven Activities Related to Social Issues

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## For more Information

<http://myweb.dwu.edu/micatala/>

## Summary

This project involves the development materials, originally entitled College Algebra in Context: A Learner-centered Approach Incorporating Data-driven Activities Related to Social Issues. These will be designed for use in a learner-centered, inquiry-intensive, data-driven, activity-oriented college algebra course, incorporating realistic problem situations emphasizing social and economic issues, including hunger and poverty, energy, and the environment. The project seeks to address two national needs, namely a need for U.S. citizens with a greater level of quantitative literacy, and a need for improved mathematics education for K-12 teachers. The project is also intended to support the mission of the McGovern Center for Leadership and Public Service at Dakota Wesleyan University.

## Project Goals

The primary goal is to create a text that can be used in a data-driven course at the college algebra level as described above.

Student outcomes include:

1. Students will gain an appreciation for and understanding of how quantitative information and algebraic concepts and techniques can be used to gain insight into real-world situations including social issues, to help inform recommendations for action, and to contribute to public discourse.
2. Students will gain facility in using technology to model and solve real-world problems.
3. Students' attitudes towards mathematics and its applicability, and their abilities to apply mathematical concepts in a real-world context will improve.
4. Students' confidence in their mathematical abilities will improve.
5. Students will begin to develop into more intellectually mature, self-regulated, and intrinsically motivated life-long learners.

## Project Design/Elements

Major features of the project include:

1. Incorporation of a collaborative learning model informed by the GEMS (General Education in Mathematics and Science) at Hope College. Each chapter includes activities that are designed for students to work on in groups of two or three utilizing appropriate technology.
2. The activities and many examples in the text are data-driven, focusing on data related to social issues like hunger and poverty, energy, the environment, literacy, etc.
3. Although most activities can be done using graphing calculators or a spreadsheet program, we have primarily been using Fathom Dynamic Data software. This software is fairly intuitive and

easy to use with many unique dynamic features. Although designed more for teaching introductory statistics, it also works well in the algebra setting.

4. Many activities involve the students in creating models (functions) for a real-world situation. The text covers the usual set of function families, including linear, exponential, quadratic, logarithmic, and power functions.

## Evaluation and Assessment Strategies

The evaluation of the project has consisted of the following components.

1. To help assess outcomes 3 and 4, most pilot sections of the class have been asked to complete the SALG (Student Assessment of Learning Gains) instrument at least once during each semester. SALG has served as a diagnostic tool to determine the perceptions of students regarding the effectiveness of the materials and pedagogical strategies being employed in the course, and to assess student attitudes regarding how well they are meeting course goals.
2. To help assess outcome 5, students have taken the LASSI (a learning styles inventory) at the beginning and end of the course over the first two project years. This instrument was selected because it will be easy to use, and provides national norms for results.
3. To assess outcome 3, selected items from previous college algebra final exams (before implementation of the new materials) have been included on the final in pilot sections. These items were selected for their relation to conceptual understanding and application of algebraic concepts to real-world situations. Mean scores for each pilot section on each selected item will be compared to the means for sections from previous years to see if the revised course results in improved learning. Other variables (e.g. previous math courses, ACT scores, etc.) will be taken into account.
4. As an indirect measure of the effectiveness of the revised course in improving student motivation and confidence, the percentage of students in each section who drop, withdraw, or fail the course will be compared to sections from previous years. As confidence and motivation play a significant role in student success and retention in a course, this will be a measure of outcomes 3-5.
5. During the first project year, we convened focus groups of students who had completed the course in order to get more robust input for improving the course and the materials.
6. We are in the process of completing a follow-up survey of former students of the course.

## Products, Key Findings, Publications



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## Quantitative Inquiry, Reasoning, and Knowledge (QuIRK)

Nathan D. Grawe, Carleton College

Funding provided by NSF Grant Number DUE-0717604 and a grant from the W. M. Keck Foundation with prior support from the US Department of Education's Fund for the Improvement of Post-Secondary Education (grant number P116B04081).

### For More Information

[serc.carleton.edu/quirk](http://serc.carleton.edu/quirk)

### Summary

With NSF support, QuIRK is refining and adapting for dissemination a rubric for assessing quantitative reasoning (QR) in student writing. The project includes feasibility studies at four diverse partner institutions (Iowa State University, Morehouse College Seattle Central Community College, and Wellesley College) to determine how our assessment protocol can be adapted to other contexts. To ensure a rich sample of papers for assessment, the project also includes support for revisions of courses and assignments to enhance QR instruction.



### Project Goals

*Audience:* Teachers of undergraduate students make up QuIRK's primary audience, although our work could easily be applied to high school or graduate students.

*Our conception of QR:* QuIRK understands QR to be the habit of mind to consider the power and limitations of quantitative evidence in the evaluation, construction, and communication of arguments in public, professional, and personal life.

#### *Project Goals:*

- Refine and adapt a rubric and protocol for assessing the relevance, extent, and quality of QR in student arguments
- Equip professors to teach QR to undergraduates through campus workshops and by supplying examples of QR-rich assignments and courses
- Increase QR competency among students
- Develop a research agenda to assess the effectiveness of alternative approaches to curricular reform (e.g. the relative effectiveness of taking a single course like statistics versus taking a larger number of QR-rich courses spread across the curriculum)

### Project Design/Elements

#### *Rubric Refinement:*

In the pilot project, the reliability of rubric items was tested by a single pair of readers. These readers achieved roughly 80% agreement in a reading of around 100 papers. Following some revision, the rubric was tested by a group of about a dozen readers. The larger group came to similarly strong levels of

agreement when assessing relevance and extent of QR. But evaluations of the quality of implementation, interpretation, and communication (three separate scores in that version of the rubric) were far less reliable.

To address this, we have refined our approach in three ways. First, we simplified quality assessment to a single holistic score. Second, we improved our reader training processes. Finally, we expanded and revised the rubric language describing the various levels of proficiency.

The revised rubric produced reliable measures of QR use and proficiency in a sample of student papers. Readers agreed on the relevance and extent of QR in 75.0 and 81.9 percent of cases respectively (corresponding Cohen's  $\kappa = 0.611$  and  $0.693$ ). A four-category measure of quality produced slightly less agreement (66.7 percent,  $\kappa = 0.532$ ). Collapsing the index into a 3-point scale raise inter-rater agreement to 77.8 percent ( $\kappa = 0.653$ ).

In the next step of our project, we will apply the rubric at other institutions to learn how the tool might be adapted to other institutional contexts. Feasibility studies will be completed at Wellesley College in June 2009 and at Morehouse College in December 2009. Two more studies will be done in 2010 at Seattle Central Community College and Iowa State University.

#### *Professional Development:*

Our professional development program begins with assessment. Few activities more effectively motivate faculty to change teaching patterns than the assessment of student work. What is more, by situating QR in the context of argument, we have made it relevant to a wide range of faculty--including those from traditionally non-quantitative disciplines. When these same faculty read papers from their own students and see the way in which QR was used (either effectively or ineffectively), they become aware of the many ways in which they might better achieve their course's goals by attending to QR.

At the end of the assessment session, participants discuss what they saw in the writing samples and how we might address identified concerns. These conversations inform the design of subsequent faculty development workshops. Where possible, we seek out intersections with other campus initiatives (e.g. the writing program, the ethics program, and the visibility initiative) to reach a broader audience. The goal of these equipping workshops is that each participant will leave with a draft of an assignment (or an assignment revision) that will enhance QR instruction.

Finally, we provide small summer grants supporting faculty to follow through on course revisions.

The project has been successful in engaging faculty from all four divisions of the college. In the first year of NSF funding, 67 percent of faculty in the sciences and social sciences participated in the project. Perhaps more notably, 41 percent of faculty in the arts, literature, and humanities took part. Our collection of QR writing assignments has grown to 22 activities. (These are part of an inter-institution [collection almost twice that size which is part of the NNN site](#)).

## **Evaluation and Assessment Strategies**

The evaluation of our approach to QR assessment will be based on the four feasibility studies.

The effectiveness of course and assignment revision will be based on data generated from our assessment that has been linked to student transcript data.

The power of our professional development workshops will be evaluated using participant surveys and focus groups.

## **Products, Key Findings, Publications**

- Key papers and publications
  - Lutsky, Neil. "Arguing with Numbers: A Rationale and Suggestions for Teaching Quantitative Reasoning through Argument and Writing," in *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education*, Madison and Steen eds., Mathematical Association of America, 2008.

- [A full list of project-related publications and presentations](#)
- [Our rubric and protocol for assessing QR in student writing](#)
- Feasibility studies documenting the usefulness of our assessment protocol at a variety of institution types (coming soon)
- [A collection of QR-rich writing assignments](#)
- [A collection of syllabi for QR-rich courses](#)

## Related or Similar Projects

Professional Development

Assessment

Products

Research Focus

Disciplinary

Audience



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## Quantitative Literacy Across the Curriculum in a Liberal Arts Setting

Semra Kiliç-Bahi  
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### For more Information

<http://www.colby-sawyer.edu/academics/experience/quantitative/index.html>

### Summary

The project's goal is to incorporate Quantitative Literacy (QL) across the curriculum to improve students' abilities to use quantitative information. QL learning materials and teaching strategies will be developed for the college's liberal education program and throughout the curriculum. Faculty expertise with QL educational innovations will be developed through two workshops (involving nearly 50% of the faculty) and the participation of national QL experts. Project investigators will work with a consultant to evaluate student learning. Classroom materials that are developed and results of the project will be disseminated through regional and national conferences and through the College's web site.

### Project Goals

The goal of this project is to develop an across the curriculum quantitative literacy (QL) program that will strengthen students' ability to use basic mathematical concepts in their majors, future careers and personal lives. We have goals for students, faculty, curriculum, and the greater academic community.

#### Students

- Improve students' understanding of the value and importance of QL.
- Improve students' ability to use simple mathematical skills to solve real problems.
- Involve students in the implementation of the project.

#### Faculty

- Improve faculty understanding of the value and importance of QL.
- Increase faculty participation in QL related faculty development events.
- Improve faculty members' confidence with quantitative skills.
- Increase the number of QL related classroom material developed and implemented by faculty.
- Promote QL as a collective, across-the-college issue and responsibility.

#### Curriculum

- Increase the mathematical content across the curriculum.
- Implement change in the liberal education program by including a QL component in addition to the current one-course requirement in mathematics.
- Create a formal administrative structure of QL representatives to ensure sustainability of QL components in the curriculum.

#### Greater Academic Community

- Develop materials and ideas that will be made available to other institutions through existing QL websites.
- Publish and present project results at conferences.

## Project Design/Elements

### Faculty development

- Two, 4 day summer faculty development workshops in which 28 faculty from Colby-Sawyer and nearby institutions develop QL modules for their classes. Sixteen of these are published on the Colby-Sawyer web site.
- Annual faculty development workshops on QL topics
- Publication of QL resources on an internal Blackboard site

### Curriculum Design:

- Redesign existing mathematics courses to be QL courses, including Liberal Arts math, Statistics, and College Algebra
- Design a new course in Quantitative reasoning using higher level math skills
- QL components will be added to other classes as a result of the workshops described above. We plan to have at least 24 faculty members add QL modules to one of their courses and increase the QL content of the entire curriculum by 10%.
- We have changed the current mathematics proficiency to a QL proficiency with appropriate learning outcomes.
- We may be able to incorporate a requirement for QL learning beyond the one- mathematics course requirement.
- We hope to add a QL element to the electronic portfolio that is required of every student.
- We plan to form a permanent oversight committee charged with sustaining QL.

### Student participation

- Through the Academic Development Center we have trained peer (student) tutors to help faculty delivering specific QL modules.
- Student volunteers helped present evening programs on QL topics in residence halls.

## Evaluation and Assessment Strategies

### 1. Students

- a. We have developed a test to assess (1) basic mathematical skills and prerequisite mathematical skills, (2) basic QL skills, and (3) students attitudes towards mathematics. These tests are administered to about 90 percent of the first year students in their pathway seminar or at orientation and then again to seniors in their capstone classes.
- b. As a pilot of a program that might make use of the students' liberal education portfolio to assess QL abilities, students in math classes have been presented with a complex problem solving question (e.g., a major issues we face as a society) that they will respond to. We hope to have students expand on this first response in future years as their critical thinking and QL skills develop.
- c. Individual classroom projects are assessed with pre and post tests
- d. QL assessment is embedded in assessments of some majors.
- e. Some of the questions in the National Survey of Student Engagement (NSSE). Address QL issues. This instrument is given to first year and senior students. We will analyze responses to these questions

### 2. Faculty

- a. We survey faculty in the first year of the project to learn how many of their courses include quantitative components, what skills are involved, and how much of the course and the grade is based on the quantitative component and how important quantitative literacy is to individual faculty members and their courses.
- b. We document attendance at QL information sessions and workshops to assess faculty

buy-in to increasing QL at the college.

3. Curriculum

- a. We evaluate syllabi at the beginning and at the end of the project to see the extent of the quantitative content is explicitly included in courses.
- b. We evaluate learning outcomes for majors as cited in the academic catalogue.

### **Products, Key Findings, Publications**

Steele, B. and S Kılıç-Bahi. 2008. Quantitative Literacy Across the Curriculum: A Case Study. Numeracy 1 (2). <http://services.bepress.com/numeracy/>

Kılıç-Bahi, S. and B. Steele. 2008. What is the main issue we face as a society? Quantitative writing classroom project. Available at [http://serc.carleton.edu/nnn/quantitative\\_writing/examples/24121.html](http://serc.carleton.edu/nnn/quantitative_writing/examples/24121.html)  
This material is replicated on a number of sites as part of the SERC Pedagogic Service Project

### **Related or Similar Projects**