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Quantitative Literacy Across the Curriculum in a Liberal Arts Setting

Semra Kiliç-Bahi
Colby-Sawyer College

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
This material is replicated on a number of sites as part of the SERC Pedagogic Service Project

Related or Similar Projects



Quantitative Reasoning (QR) in the Contemporary World

Bernard Madison

For more Information

[none](#)

Summary

The ability to reason about issues that mix words and numbers is now an essential competency for US residents. The proliferation of quantitative data and analyses has reached all aspects of life in the US, including informed participation in democratic processes. Traditional education in mathematics and statistics is not sufficiently effective for the quantitative reasoning (QR) required, so innovations are necessary. This is a proposal to continue development of an educational infrastructure about an innovative QR course, created by PI Bernard L. Madison and evolved through its offering at the University of Arkansas over the past five semesters. The proposed project includes making the course transportable, adaptable, and more effective and creating assessments and scoring rubrics to both measure learning in the course and to compare that learning to the learning in two other courses, one somewhat similar and one traditional. Several research questions concerning QR will be investigated in the process. The innovative course, called QRCW in this proposal, derives from a collection of newspaper and magazine articles and is organized by processes of QR and not by mathematical or statistical topics. The project will produce a volume of case studies of QR-based media articles, an accompanying volume documenting the learning results, pedagogical strategies, and a guide for using the volume of case studies in a QR course, including classroom videos of students reasoning about quantitative situations.

Project Goals

- Produce a casebook of media articles for use in teaching QR
- Identify impediments for students QR
- Produce an instrument for assessing QR
- Identify unifying constructs in the use of units acrosss amthematics and the sciences
- Identify language issues in QR

Project Design/Elements

- Videos of the experimental class
- Videos of think aloud sessions with students
- Teaching class and modifying based on results

Evaluation and Assessment Strategies

- Pe- and post-testing results
- Student attitude surveys

Products, Key Findings, Publications

Case Studies for Quantitative Reasoning: A Casebook of Media Articles by Bernard Madison and Shannon Dingman, Pearson Custom, 2008

Second edition due in 2009 with added co-authors Stuart Boersma and Caren Diefenderfer



Advancing Assessment of Scientific and Quantitative Reasoning

Donna L. Sundre
James Madison University

For more Information

Summary

The project furthers the development of collegiate scientific and quantitative reasoning assessment tools and procedures. It would seem logical to expect that institutions would use direct measures of student learning to assess important collegiate outcomes; however, it is disappointing to note that direct measures are the least systematically used of available assessment techniques. Without appropriate assessment methods, the nation will continue to rely upon less desirable indicators such as: student self-reports, actuarial reports, and external ratings of institutional quality. These methods are not suitable for informing us about actual student learning or improving STEM teaching and learning. Through exploration of the generalizability of our instruments to other diverse institutions, this project will contribute to the knowledge of undergraduate STEM education, develop faculty expertise in assessment practice, and help to build an interdisciplinary community of scholars from five diverse institutions.

James Madison University (JMU) is uniquely qualified to contribute to the development and dissemination of psychometrically sound instruments and assessment practice due to its long-term commitment to this work via the Center for Assessment and Research Studies (CARS) (www.jmu.edu/assessment/). The proposed project builds upon highly successful work conducted over several years by CARS faculty with significant collaboration by JMU STEM faculty members through which objectives for scientific and quantitative reasoning have been carefully crafted, innovative items have been created and mapped to these objectives. The institution is currently using the ninth version of instruments designed to measure collegiate scientific (SR) and quantitative reasoning (QR) skills and knowledge. The proposed project will build upon our existing research base that has demonstrated the reliability and validity of scores. Our more recent research supports the hypotheses that the scientific and quantitative reasoning goals and objectives crafted, and the instruments developed will successfully generalize to other institutions in need of sound assessment methods and practices. Thus an expansion project is now appropriate for resubmission of an earlier exploratory project.

Project Goals

- Exploring the psychometric quality and generalizability of the SR and QR instruments to institutions having diverse missions and serving diverse populations.
- Building improved and scientifically based assessment plans for adoption at home institutions through consultation and participation in Faculty Institutes.
- Building assessment capacity at participating institutions through professional development in assessment practice, analytic methods, and data presentation to enhance curricular reflection and improvement.
- Developing new assessment models and designs for adoption or adaptation by other institutions.
- Documenting potential barriers to effective assessment practice and exploring solutions.
- Creating scholarly communities of assessment practitioners to sustain work at participating institutions and beyond.

Project Design/Elements

- The Natural World assessment instrument was designed by faculty and assessment specialists at JMU to

measure the objectives of Cluster 3 (CL3), the Natural World segment of JMU's general education program. To date, there have been nine forms of the Natural World test, designed to assess eight objectives in Cluster 3 (CL3) of James Madison University's General Education program. The current form of the test, NW-9, has 66 multiple-choice items and yields two scores: a Scientific Reasoning score (SR) and a Quantitative Reasoning (QR) score. The NW-9 is intended to assess a college student's quantitative and scientific reasoning skills. The test is administered to freshmen just before the start of their first fall term, and to sophomores in early spring.

NSF funding has improved the direct assessment of student scientific and quantitative reasoning for a growing number of diverse higher education institutions serving underrepresented subpopulations during the life of the project and beyond. Further, each institution's capacity and sustainability has been strengthened.

Evaluation and Assessment Strategies

- a) The reliability of the instrument has and will continue to be assessed following each administration.
- b) Each of the partner institutions will develop a set of research questions derived by their faculty teams and will collect data at their home institutions to answer those questions. The partner institutions are now analyzing the data from the 2008-2009 academic year. These results are being presented at several national conferences this year: NNN; NC State Assessment Symposium; ESA; and the International Assessment and Retention Conference.
- c) In addition, because representative samples of JMU students complete the QR and SR as incoming freshman and again as sophomore/juniors, the assessment strategy can be thought of as a pseudo pre-post design, with students completing the instrument both before any CL3 coursework experience and then following completion of some or all of the relevant coursework. These results have provided compelling evidence for the efficacy of our general education programs.

Products, Key Findings, Publications

Sundre, D. L. & Thelk, A. (2008, June). Advancing Assessment of Scientific and Quantitative Reasoning. A Symposium Presentation for the International Assessment and Retention Conference. Scottsdale, AZ.

We have many presentations that can be listed and papers that were distributed at meetings



Geology of National Parks: Spreadsheets, Quantitative Literacy, and Natural Resources

Len Vacher
University of South Florida

For more Information

Summary

Geology of National Parks: Spreadsheets, Quantitative Literacy, and Natural Resources (GNP) (DUE 0836566) is a three-year Phase-1 CCLI project that started in January 2009. It is an adaptation of Spreadsheets Across the Curriculum (SSAC) (DUE 0442629), in which workshop participants from institutions around the country made spreadsheet modules to use in a wide variety of courses at a variety of levels.

The GNP project aims to develop spreadsheet modules for the introductory-level, general-university course, Geology of National Parks, at the University of South Florida. The QL will make use of high school mathematics including some algebra, trigonometric ratios, and descriptive statistics. For many modules, the mathematics will be limited to sums and ratios.

Four geology faculty at USF (Co-PIs Len Vacher, Judy McIlrath, Mark Rains and Tom Juster) and four PhD students will collaborate with eight Research Learning Centers of the National Park Service to develop the modules. The partner RLCs are (1) Appalachian Highlands Science Learning Center (at Great Smokey Mountains NP); (2) Crown of the Continent Research Learning Center (at Glacier NP); (3) Great Lakes Research and Education Center (at Indiana Dunes NL); (4) Greater Yellowstone Science and Learning Center (at Yellowstone NP); (5) Mammoth Cave International Center of Science and Learning (at Mammoth Cave NP); (6) Old-Growth Bottomland Forest Research and Educational Center (at Congaree, NP); (7) Pacific Coast Science and Learning Center (at Point Reyes NP); and the Urban Ecology Research and Learning Alliance (at the Center for Urban Ecology, National Capital Region Parks, Washington DC).

Project Goals

The key goal is to develop a Geology of National Parks Collection for the SSAC Library. In addition to bringing QL into the introductory Geology of National Parks course, the intention is to align it with the Natural Resource Challenge. Funded since 2000, the Natural Resource Challenge is the NPS initiative to integrate science, park planning and management. The program now includes 21 Research Learning Centers (RLCs), 32 Inventory and Monitoring Networks, and 17 Cooperative Ecosystem Studies Units (CESUs). The program is producing a wealth of quantitative data on environmental conditions in the parks, much of it already online. This project aims to mine this resource to develop the collection of SSAC—Geology of National Parks modules. The modules will add an environmental-geology dimension to the course, which now focuses on geologic stories, plate tectonics, and scenic geology.

Project Design/Elements

As in other SSAC modules, the modules of the new collection will prompt students to develop one or more spreadsheets to answer a question that involves making a calculation, drawing a graph, or exploring an association. The plan of the project is for the USF team to travel in two- to four-person groups to the RLCs during Summer and Fall 2009 to formulate the questions and obtain the data for at least two modules per collaborating RLC. At least one of the modules per RLC will make use of Challenge-related data. This means, specifically, that the Geology of National Parks Collection of SSAC will consist of at least 16 modules, at least eight of which will be aligned with the Challenge.

Spring 2009, the faculty and graduate students in the project are participating in a graduate seminar course, SSAC Geology—NPS Challenge. The seminar is studying SSAC pedagogy and resources; the Natural Resource Challenge, Research Learning Centers, and Inventory and Monitoring Networks; and the geology of the parks served by the eight RLCs. The objective is for all students and faculty to be fully prepared module-making veterans before visiting the RLCs this summer and fall.

Evaluation and Assessment Strategies

Geology of National Parks is an online course at USF. It is taught every semester, including the summer. The instructor, Judy McIlrath, has created two SSAC-style modules that she rotates in the course. She uses pre/post questions to assess the module and will continue that during Spring and Summer 2009. During Summer 2009, the USF team with Ellen Iverson of the Science Education Resource Center (SERC) will develop a pre/post questionnaire to assess the course with respect to QL addressed by SSAC modules. In Fall 2009, while the new modules are being reviewed by RLC partners and edited by USF faculty and graduate students, the questionnaire will be used to provide baseline, pre-module implementation data. The new modules will be implemented in Spring 2010, at which time the pre/post-course questionnaire will be applied to provide post-implementation data.

Products, Key Findings, Publications

The Geology of National Parks Collection will include the following four modules that have been prepared before the start of the funding period. Two are by Judy Harden (now Judy McIlrath) who is using them in her Geology of National Parks course. Two are by graduate students Heather Lehto and Meghan Lindsey, who prepared modules to present at the George Wright Society Meeting in Portland, March 2009. These modules do not use Challenge data. The modules, which will be uploaded to this site at the workshop, are:

Harden, Judy, 2006. Vacation! – How Long and How Far: A Geologic Circuit of the National Parks of the Colorado Plateau. Spreadsheets Across the Curriculum module SSAC2006.G155.JAH1.1.

Harden, Judy, 2008. Achieve New Heights – Go to the Rockies: A Geologic Circuit of National Parks and Other Scenic Places in Colorado. Spreadsheets Across the Curriculum module SSAC2008.G155.JAH1.2.

Lehto, Heather, 2009. How Much Water is in Crater Lake? –Using Prisms to Calculate Volume. Spreadsheets Across the Curriculum module SSACgnp2009.GB1601.HL1.1

Lindsey, Meghan, 2008. Let's Take a Hike in Catoctin Mountain Park – How Many Calories Will You Burn Off By Hiking a Five-Mile Loop Trail? Spreadsheets Across the Curriculum module SSACgnp2008.RA776.ML1.1.

Related or Similar Projects

Spreadsheets Across the Curriculum