Quantitative Literacy Across the Curriculum in a Liberal Arts Setting

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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 nationals 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/

Kiliç-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

The Math You Need, When You Need It

Resources For Students in Introductory Geoscience

Eric Baer, Highline Community College, and Jennifer M. Wenner, University of Wisconsin Oshkosh
Funding provided by NSF Grant Numbers DUE-633755 and DUE-633402
Sponsored by the National Association of Geoscience Teachers

For More Information

The Math You Need When You Need It

Summary

The Math You Need, When You Need It modules cover quantitative topics that are important in introductory geoscience courses. Each topic includes a page for the instructor, quantitative information for the students, a set of practice problems and culminates in an on-line quiz that is automatically graded and submitted to the instructor. The project is designed to give introductory geoscience students the quantitative knowledge that they need, just before they need to use it in their concurrent geoscience course. This program includes pre- and post-testing and self-paced modules.

Project Goals

- Production and use of appropriate "the math you need, when you need it" modules
- Improving introductory geoscience students' mastery of, and comfort with quantitative skills.
- Increased retention and student success in introductory geoscience courses
- Facilitating the addition of more quantitative materials in introductory geoscience courses.

Our project is designed to increase quantitative literacy of geoscience students by facilitating use and transfer of mathematical concepts to multiple geologic contexts.

Project Design/Elements

This project is designed to include stand alone modules covering quantitative concepts that can be used in conjunction with a concurrent introductory geoscience course. The modular nature of this project makes it readily adaptable to any introductory geoscience course that involves quantitative concepts - instructors can choose which modules work with their syllabus and which subjects are covered on the final quiz. These modules are designed to be completed by the students who need them most, just before quantitative concepts are covered in class.

Each module consists of an explanation of the quantitative concept (e.g., unit conversions, rearranging equations), a number of sample problems for the student to work through (e.g., unit examples, equation examples), and a culminating exam testing whether the student understands the concepts. The explanation

and problems are written from the perspective of geoscientists who teach these concepts regularly. Each module uses best practices in teaching college level mathematics and are all in the context of the geosciences.

Instructors can readily adapt these modules for use in any geoscience course. The modules are designed so that they could be used in any order and have an instructor page explaining what is important on the page (e.g., calculating density, trigonometry). Questions on the pre-test and the post-module quizzes can be adopted from a bank of questions that address a given quantitative concept in multiple geoscience contexts. The multiple contexts speak to the issue of transfer of mathematical concepts to new and distinct topics. We also encourage instructors to author their own questions for the quizzes/tests.

What does the program do, why is it important, why was it designed this way. Challenges, great success, tips for others doing this? How is it done. Collaborating partners. Research questions

This is the place to tell us all about what you are doing, how you are doing, and why you are doing it that way. Also what is working, what is challenging, and what you have learned about doing it better or more easily.

Evaluation and Assessment Strategies

Project evaluation focuses on three outcomes:

1. the production and use of the modules in geoscience courses
2. student performance in modules and in geoscience courses
3. faculty comfort with the addition of quantitative content of introductory geoscience courses.

Formative assessment of the project relies on quantitative and qualitative measures of these outcomes in the form of pre-and post-module data collection, walk-throughs, surveys and interviews. Feedback from these assessment are used to modify our product during the development phase of the project and as summative feedback for final project evaluation.

Products, Key Findings, Publications

The Math You Need When You Need It modules

Assessing Quantitative Learning with The Math You Need When You Need It, AGU Annual Meeting 2008 (to be presented December 18, 2008, 12:05 pm)

The Math You Need When You Need It: Web-Based Modules to Help Students Succeed in Introductory Geoscience Courses, GSA Annual Meeting 2008, download poster (Acrobat (PDF) 41.8MB Nov14 08)

The Math You Need, When You Need It: Student-Centered Web Resources Designed to Decrease Math Review and Increase Quantitative Geology in the Classroom, AGU Annual Meeting 2007

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

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

Michael Catalano
Dakota Wesleyan University

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

NSF Native Cases Project

Barbara Smith
The Evergreen State College

For more Information

http://www.evergreen.edu/tribal/cases/home.htm

Summary

This project is an NSF CCLI Educational Materials Development (EMD) program as a Phase 2 Expansion Project. The lead institution for the project is The Evergreen State College. The project also involves two tribal colleges, Northwest Indian College, Salish Kootenai Tribal College), Grays Harbor College, and Washington Online, the distance learning consortium for the 32 colleges of the Washington State Community and Technical Colleges. The project focuses on creating new learning materials and teaching strategies, developing faculty expertise, and implementing educational innovations.

The project builds on a successful three-year pilot program (the Enduring Legacies Project) funded by Lumina Foundation for Education. The previous project developed an effective case format and field testing procedure, offered three successful four day summer institutes for faculty on writing and teaching cases, and produced and implemented 26 cases in both online and face-to-face classes. The cases were extremely successful with Native students.

Project Goals

In terms of intellectual merit, the project addresses a significant void in the literature in appropriate curriculum focusing on American Indians. Developing culturally relevant educational materials is important in improving the participation and graduation rates of Native American students and in supporting Native American efforts towards self-governance. We propose to develop at least 16 original teaching cases focused on issues confronting Native American people and communities. The content focus will be on the environment, natural and cultural resources, and health and wellness. Many of the cases will also be developed specifically to enhance student's abilities in quantitative reasoning. Teaching notes will accompany each case and include detailed information on how to teach interdisciplinary cases in different modes of delivery (face-to-face and online, large and small classes, etc.). Faculty development activities include an Annual summer institute as well as off-site workshops to reach out to other tribal colleges and colleges and universities with substantial enrollments of American Indian students. Web-based dissemination methods include a substantial website and dissemination through Washington Online's newly emerging online course repository which will produce materials to complement the more than 650 online courses it sponsors.

Project Design/Elements

This is a significant project for a number of reasons: first, it addresses a significant void in the literature and develops, field tests, and disseminates new learning materials and teaching strategies; second, it implements and assesses a new educational approach; third, it addresses the important issue of educating Native Americans, a population that is seriously under-served in higher education. Finally, it demonstrates how institutions can collaborate and work with Native American communities and leaders to improve higher education.

Evaluation and Assessment Strategies

The project will be subject to a rigorous formative and summative evaluation plan. Formative evaluation is critical to the iterative cycle built into a project that focuses on faculty development and the development,

implementation, and refinement of educational materials. It is also critical to team building and organizational learning. In our pilot project we used a continuous improvement process (described in our article "Effective Ways to Promote Learning and Program Improvement" see references) which was labor intension but remarkably successful. This same process will be used in this project with Barbara Leigh Smith acting as the internal evaluator playing this role.

Evaluation procedures will allow us assess progress against schedule, whether the steps of the grant were realized, and whether the goals of student learning and faculty development were accomplished. Measurable outcomes and evaluation procedures are described in the following table: [to be included later}.

Products, Key Findings, Publications

see project website for the cases written: http://www.evergreen.edu/tribal/cases/home.htm

Smith, B L. Understanding of Sovereignty and Identity Improved by Learning with Cases. Tribal College Journal. Vol 20, No, 1. Winter 2008, pp 38-41.

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

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 instuction.

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 competancy 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 κ= 0.611 and 0.693). A four-category measure of quality produced slightly less agreement (66.7 percent, κ = 0.532). Collapsing the index into a 3-point scale raise inter-rater agreement to 77.8 percent (κ = 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 visuality 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 or 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

Infusing Quantitative Literacy Throughout the Social Science Curriculum (QSSDL)

Lynette Hoelter
ICPSR, University of Michigan

For more Information

www.qssdl.org

Summary

The Quantitative Social Science Digital Library is a virtual repository of educational materials designed to improve quantitative literacy skills in social science courses. Built especially for faculty teaching post-secondary courses in such areas as demography, economics, geography, political science, social psychology, and sociology, QSSDL will provide a single portal where faculty can find and use real data in post-secondary classes. QSSDL will provide comprehensive links to teaching modules, social science data sources, applications for statistics and mapping, and research on teaching and learning. Extensive searchable metadata relevant to the needs of instructors will make finding resources easy.

Project Goals

The overarching project goal is to make it easier for faculty to bring real social science data into courses across the curriculum ranging from introductory classes to senior seminars. In doing so, we aim to:

- improve quantitative literacy among students, particularly those in undergraduate social science courses, thereby exposing them to the creativity and excitement of empirical research;
- assist instructors in the development of content by developing resource collections that support discovery of teaching materials, pedagogic resources, data sources, and data analysis and visualization tools;
- create tools that support discovery and extraction of data subsets of high utility for teaching;
- develop a community of faculty and librarians who use such resources and may be able to contribute to the collection; and
- collaborate with the NSDL, other libraries, and service providers as a representative of the social science fields.

Project Design/Elements

The project design has four major parts.

1. Creation of a virtual repository for quantitative literacy in the social sciences. This repository will include at least four types of objects. First, data-driven learning modules (DDLMs) will be catalogued and included. These standalone activities are meant to be uses with included or pre-packaged data/tables, generally for the substantive purpose of teaching a social science concept. DDLMs will also be linked to materials in the Pedagogy in Action service at SERC. Second, the repository will include links to important and interesting data sources in the social sciences (e.g., the Census Bureau, ICPSR, etc.). These resources currently exist, but including them in the repository will save time for instructors as they will not need to search each individual website. The third type of material is pedagogical resources such as journal articles and conference presentations (when available online) related to using data in the classroom or quantitative literacy. Finally, the repository will also include links to data analysis and visualization tools. Accompanying documentation will be created when possible to help

instructors take advantage of these tools.

2. Data translation services. As part of the digital pathway, services will be built to assist faculty with finding data relevant to their objective and paired with tools to make it easier to extract data from the identified source in a form appropriate for instruction. That is, we hope to design tools so that instructors can simplify the process of locating, downloading, manipulating, and using data for their classes. As part of this effort, some focus will be put on repackaging the American Community Survey so that using it for instruction becomes more straightforward.
3. Building community within the social sciences. QSSDL brings together representatives from the major social science professional associations to assist the project by serving on an Advisory Board and topical editorial committees. In addition to the professional associations' involvement, we will use Web 2.0 features in an attempt to build community among users of the materials. The main features discussed to date include the ability to tag, rate, and comment on materials as well as the creation of forums (blogs, community bulletin boards) for discussion among instructors. Finally, outreach for the project is designed to take place through papers, workshops, and exhibits presented at professional meetings as well as a series of Webinars on topics of interest to those using data in the classroom.
4. Creation of tools for developing additional data-driven learning modules. The repository will not only catalog existing tools for analysis and the like, but will work to develop a series of tools to make it easier for instructors to create their own learning modules. Such tools include templates and guides for writing materials in the style of existing modules in the Social Science Data Analysis Network and ICPSR Online Learning Center, a search capability to assist users in identifying datasets in the ICPSR collection that include a certain combination of variables, and tools to match data with analysis and visualization applications.

Evaluation and Assessment Strategies

The evaluation for this project centers around approximately ten focal campuses. We make use of ICPSR's Official Representatives on a diverse sample of campuses to collect both formative and summative feedback. A combination of surveys, focus groups, and analysis of Web-metrics will allow for evaluation of the scope and utility of the resource collections, satisfaction with the interface design and Web 2.0 features, the utility and usability of tools for discovering and extracting data from data sources, and the design and content of workshops and webinars. Additionally, the behaviors of a sample of social science faculty on the ten campuses will be examined to determine reach and penetration of the QSSDL repository, potential changes in the availability of resources to target users due to the introduction of QSSDL (e.g., are the collections comprehensive enough to satisfy the needs of many users), and whether faculty report an increase in use of data in the classroom to support quantitative literacy.

A partner project, funded by NSF under the CCLI mechanism, focuses on the assessment of quantitative literacy skills and the impact of materials such as those in the Social Science Data Analysis Network on students' achievement of intended learning outcomes relating to quantitative literacy.

Products, Key Findings, Publications

We are just in the first six months of our project, so there are no publications yet.

Related or Similar Projects

Social Science Data Analysis Network (www.ssdan.net)
ICPSR Online Learning Center (www.icpsr.umich.edu/OLC)

Spreadsheets Across the Curriculum

Len Vacher
University of South Florida

For more Information

http://serc.carleton.edu/sp/ssac_home

Summary

Spreadsheets Across the Curriculum (SSAC) (DUE 0442629) was a three-year Phase-2 CCLI project which had a one-year no-cost extension, and now (5/2009) has a second extension with supplemental funds to support "NSF Projects Supporting QL Education," the workshop producing this Web site.

The purpose of the SSAC project was to develop, test and disseminate a large, multi-course, multi-institution collection of educational modules patterned after those developed by Co-PI, Len Vacher, in a Phase-1 (Proof of Concept) CCLI project, DUE 0126500 Spreadsheet Exercises in Geological-Mathematical Problem Solving, which focused on one course (Computational Geology, an upper-division geology majors course), and one institution (University of South Florida).

The SSAC project was a workshop-based project. There were three annual (2005-2007), week-long workshops in Olympia WA, facilitated by Co-PI Emily Lardner of the Washington Center for Improving the Quality of Undergraduate Education (The Evergreen State College). Each attracted about 20 participants, who received stipends if they completed a draft of a module that they would use in one of their courses. After review and editing by the Co-PI and two PhD students at USF, and revision by the participants, most of the submitted modules have been accepted into the "General Collection" of the library of SSAC modules on the SSAC Web site. The Web site is part of the Pedagogical Services NSDL project [DUE 0532768] of the Science Education Resource Center [SERC]), which hosts the NNN Web site as well as this site for "NSF Projects Supporting QL Education."

The SSAC General Collection includes all the completed (reviewed, revised, and accepted) workshop-generated modules together with some by the USF Co-PI and members of the resource team, including graduate students, who helped facilitate the workshops. At present (5/2009), the general collection has 57 modules from 42 authors, from 21 institutions in11 states ranging from WA to AZ to NH to FL. Illustrating the broad range of contexts consistent with the "across-the-curriculum" title, they are classified into 28 Library of Congress categories ranging from DT (history, Africa) to WY (nursing), with many stops in the Q (science) categories.

Project Goals

The central goal of the project is to promote quantitative literacy by providing a resource to infuse problem solving involving mathematics into as many courses as possible. As indicated on the home page on the SSAC Web site, SSAC entails a pedagogy as well as a library. The Web page Teaching with SSAC on the Web site tells the what, why and how – students build spreadsheets (i.e., they do not import ready-made spreadsheets) to do a calculation or create a graph to solve and explore a problem in context. The intention is to enhance know-how in mathematics. "What is know-how in mathematics? The ability to solve problems." (Polya, Mathematical Discovery, 1962, p. xi-xii).

Project Design/Elements

The spreadsheet modules are the key element of the project. The modules have a rather prescriptive design, which is spelled out at SSAC Library page on the SSAC Web site. Briefly, a module consists of about

15-20 PowerPoint slides. The PowerPoint presentations are designed with the assumption that the students will work through the slides on their own, although instructors can certainly use them as parts of lecture or in laboratory settings; the modules are easily modified and adapted (a feature of the PowerPoint construction). The core of the module is a sequence of ~10 slides that take the students through the construction of the spreadsheets. The spreadsheets, which are embedded as pictures in the student version of the modules, are strongly color-coded. For example, numbers appear in yellow and orange cells – the yellow cells are for data or known values, and the orange cells are for cell equations. Students are instructed to construct the cell equations that go in the orange cells. They use the numbers that appear in the orange cells as checks on their equations.

Instructor versions of the modules are available on request. Instructor versions differ from student versions in that the spreadsheets are embedded as Excel sheets that can be activated to reveal the cell equations in the orange cells. Instructor versions can be obtained from the cover pages associated with the particular modules. To find the cover page, go to the SSAC home page, then General Collection, then SSAC General Collection Modules, and then use either the keyword or "narrow the view" search feature to find a module of interest. The student version can be downloaded from a link under Teaching Materials on the cover page. Click on "request" for a form to request the link to download the instructor version. As of 4/3/2008, the request statistics were: 36 requests for 19 modules, by 28 instructors (1 high school; 4 community colleges; 1 each from Canada, Italy, Mexico, Spain, Sudan, and Venezuela; and the rest from American colleges and universities).

Evaluation and Assessment Strategies

Rebecca Hartzler (Seattle Center Community College) and Jennifer Wenner (Department of Geology, University of Wisconsin – Oshkosh) evaluated faculty-development aspects of the project. Dr. Hartzler surveyed the SSAC workshop participants. She found it remarkable that 86% of faculty participating in the workshops completed modules that made it all the way to publication on the SSAC Web site. She reported that participants identified the opportunity to work with others on strategies for addressing students' quantitative literacy to be of greatest benefit. Dr. Wenner visited the home department (Geology at USF) to evaluate the local impact of SSAC and the preceding proof-of-concept grant. Consistent with the findings of Dr. Hartzler's evaluation for the NSF project overall, Dr. Wenner noted that both USF faculty and students were positive about the effects of using spreadsheets to develop problem-solving and quantitative literacy skills.

Data on the effect of modules on student learning of QL has been difficult to get from workshop participants who have used their modules in the classroom. One problem is that non-mathematics participants were slow to recognize that the purpose of the modules was to teach QL using context, and less so the context itself. QL assessment could not proceed in a meaningful way until a key, testable objective was identified; therefore, the workshops added specific sessions on identifying the single most important (key) QL skill (2006, 2007 workshops) in each module, and then assessing for student learning of that skill explicitly (2007 workshop). Products of the 2007 (last) workshop include a pre/post test for each module, based on a collaboratively designed template, and focused on the key QL issue in the module. Participants were offered additional stipends to submit the results of the pre/post tests, with other measures they may have developed. From the evidence gathered so far (3/2009), it appears that modules do facilitate student learning and improve attitudes about quantitative work, but there needs to be a match between the module and the skill level of the student. Absent such a match, the module is not helpful.

Year 3 (2007) also included a supplemental subcontract to Laura Wetzel (Eckerd College) for a summer-session test-bed project. Twenty-one undergraduate students were paid to work through 1-6 modules, complete pre/post tests and, in some cases, exit interviews. Results of that study showed that student learning of QL increased, and attitudes improved, as students did more modules. The implication is that if one teaches with SSAC modules, one needs to use several because of the high "start-up cost" for the student who is unfamiliar with Excel and possibly uncomfortable with math.

In the broad view, the student-learning assessments in the SSAC project are formative as they give suggestions about how to implement SSAC-style modules further. To the two lessons learned that we have mentioned – match the module to the skill level of the students, and use more than one module if you use

any – we can add a third due to a fortunate unexpected consequence of the project. The Chair of the USF Geology Department, Chuck Connor, a volcanologist, became so enthusiastic about SSAC-style modules that he instigated the creation of a set of modules for an upper-division course in physical volcanology. The resulting set of nine modules is housed in the SSAC Library as the Physical Volcanology Collection. Unlike the modules in the General Collection, the intent of these modules is to teach the disciplinary subject, volcanology, less so QL. The collection has been promoted by the International Association of Volcanology and Chemistry of Earth's Interiors. As of 4/3/2008, there were 10 requests for the entire set of instructor modules, from around the world (England, Germany, Italy, Iceland, West Indies). The large number of requests for modules of the volcanology collection compared to the modules of the general collection (~2 per requested module at the time) suggests the third lesson: create sets of course-specific modules, and they will be used.

The three lessons learned led the proposal of a derivative project, Geology of National Parks: Spreadsheets, Quantitative Literacy, and Natural Resources, which has been funded as DUE-0836555. The idea is to build SSAC-style modules for the introductory course, Geology of National Parks (Learned-lesson 3). The course will use 4-8 modules drawn from the collection of 16 developed in the project (Learned-lesson 2). The QL will involve foundational math, consistent with the ability of the preponderance of students taking freshman-level general-education service courses in universities and community colleges (Learned lesson 1).

Products, Key Findings, Publications

There are 57 modules published on the SSAC Web site. See associated file titled "Card catalog of SSASC modules." Card catalog of SSAC modules (3/13/2009) (Microsoft Word 273kB Apr14 09)

Related or Similar Projects

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

Preparing Students for Citizenship: Fostering Critical Thinking and Problem-solving Skills through Quantitative Reasoning and Scientific Literacy

James D. Myers
University of Wyoming

For more Information

http://www.gg.uwyo.edu/geol1600/

Summary

Through the creation of a new integrated science course entitled **Global Sustainability: Managing the Earth's Resources**, this project will prepare students for their roles as active and effective citizens in an industrialized democracy. This course, which is aimed at both STEM and non-STEM students in the first and second years of their academic careers, will create connections to the social sciences by presenting science in global context. In addition to integrating the natural sciences, i.e. biological, physical and Earth, it will focus on improving student critical thinking and problem-solving skills. To reduce or eliminate the barriers to student success posed by inadequate literacy skills, training in the literacies necessary to master scientific content will be an integral and explicit component of the course. Armed with improved quantitative reasoning and scientific understanding, students will be better prepared to apply their critical thinking abilities and problem solving skills to the multifaceted and complex issues of global sustainability, a topic critical to all inhabitants of the planet.

Project Goals

The primary goal of this project is to prepare students for citizenship by improving their critical thinking abilities and problem-solving skills while expanding their capacity to reason quantitatively at a variety of cognitive levels and in a range of real world situations. By focusing on societal issues routinely reported in the media, the project will also foster an understanding of the importance of scientific and quantitative literacies in making sound personal as well as political choices. Simultaneously, the project's sustainability focus will introduce students to the variety of perspectives (often conflicting and competing) that must be considered when devising solutions to the many facets of global sustainability. In this manner, the project will foster a sense of global community.

Specific Project Objectives:

Objective 1. Implement an integrated, interdisciplinary sustainability course.
Objective 2: Design, develop and construct learning materials to support meaningful learning.
Objective 3. Develop a catalog of sustainability case studies to create a meaningful lab experience.
Objective 4. Disseminate our learning objects for use by other science instructors.
Objective 5. Develop, test and distribute assessment tools for measuring scientific and quantitative literacy

Project Design/Elements

The likelihood of students achieving deep and meaningful scientific understanding, and applying it effectively to societal problems, is grounded on three sound foundations: mastery of literacy skills, contextualized scientific content knowledge and social relevancy. Like any other profession, science has a

set of literacies that must be mastered before scientific problems can be addressed in an effective and successful manner. The three literacy classes that students must master to achieve scientific understanding and their relation to each other is illustrated by the***literacy triangle*** (see attached file). At the base of the triangle are the ***fundamental literacies*** that allow individuals to interpret and manipulate facts, data and observations, i.e. read a table or interpret a graph; 2) make qualitative assessments; and 3) perform simple quantitative calculations. These tools are a subset of the larger quantitative reasoning skills (Steen, 2001) and important in the physical and social sciences as well as the real world. The ***technical literacies*** are those skills/abilities necessary to master the content of a particular scientific discipline. When combined with scientific content, the literacies lead to scientific understanding. Successful application of scientific understanding to societal issues requires ***citizenship literacies***. They permit an individual to use their scientific understanding to evaluate the impact of human activities from a range of perspectives (economic, social, cultural, etc.).

A sound factual knowledge basis is also important for understanding a scientific discipline (NRC, 2000). However to be useful, this knowledge must be organized or contextualize so relevant information can be retrieve quickly and applied effectively. This knowledge organization comes only with a deep subject understanding. The broad-brush, fast science coverage so common to introductory courses does not build this type of knowledge. Thus, lasting sciencific comprehension comes down to content depth vs. breadth. To help students build the type of factual knowledge a subject expert has access to, the student must be given sufficient time to explore a subject. Thus, material must be omitted from the course to produce long-term retention and use. Scientific content must be strained through a simple sieve. "Is a citizen likely to need to know this information?" Disciplinary breadth is sacrificed for meaningful depth.

Responsible citizenship is not an abstract concept. It is an active involvement in the issues and problems a democratic society routinely faces. Because many of these issues are scientific in nature, students must be scientifically literate to address them . Thus, introductory science courses should place scientific content in social contexts highly relevant to active citizen participation. Rather than providing fabricated contexts, students must encounter science in the economic, political, cultural and social settings they may encounter in the media. Active global citizenship requires students to be aware of, and capable of understanding other, situations in both their scientific complexity and their social dimensions.

Supported by a FIPSE grant at the University of Wyoming, Myers and Campbell-Stone (Geology & Geophysics) in collaboration with Professor Garth Massey (International Studies) used these three fundamental foundations to develop a new course paradigm: Literacies and Scientific Content in Social Context ($L(SC)^2$). $L(SC)^2$ redefines and expands the concept of the interdisciplinary course. It addresses scientific literacy while promoting mastery of fundamental quantitative and qualitative skills, as well habits of mind necessary for active civic engagement. Literacy (skills) training provides the quantitative and qualitative tools necessary to function in a numbers-oriented, technological society. Scientific content illustrates the limitations imposed by the natural world on what can be accomplished through science, technology and engineering. Science in real-world social context also explicitly reveals draws connections to students' everyday lives. At the same time, experience in addressing realistic, real-life problems instills a sense of social and political efficacy and responsibility. Case studies set in local, regional, national or international situations teach citizenship literacies while demonstrating the social relevance of science. By helping students acquire fundamental, technical and citizenship literacies in a scientific and social framework that engages them in discussions, role playing, negotiations and the formulation of alternative strategies, the $L(SC)^2$ paradigm encourages active citizenship extending well beyond students' academic careers.

During the first year of this project, we have developed four case studies. This first round of cases examines issues of water, energy (coal and petroleum) and metal mining and processing (gold). The four case studies currently in our sustainability catalog are: Water in Bangladesh: Tube Wells and Arsenic; Energy: Coal, China & Climate Change; Gold: Satisfying a Global Demand; and Energy: Petroleum – A Critical Resource. Each case study consists of two parts focused on different aspects of a sustainability problem. In most cases, the first part of a case study examines the geologic and scientific components of the issue. Building on this new scientific understanding, the second part normally examines a social or economic component of the problem. In both parts, students are assigned a role that a professional working for different organizations might carry out as part of his/her job. In this manner, students get multiple perspectives on different issues and explore some of the complexities and uncertainties

surrounding nearly all sustainability issues.

Evaluation and Assessment Strategies

Evaluation and assessment will be conducted on the: 1) digital content produced; and 2) learning materials developed. The latter includes, but is not restricted to: a) literacy tools; b) case studies; c) lecture activities; as well as d) the Global Sustainability course. We will also evaluate the impact of these teaching methods and activities on student learning. Finally, we will continually evaluate the effectiveness and progress of the entire Global Sustainability project throughout its lifetime.

Products, Key Findings, Publications

Myers, J.D., and G. Massey, 2008, Earth Resources: What's Sociology Got to Do with It?: in Hartman, H. (ed.), Integrating the Sciences and Society: Challenges, Practices, and Potentials, Research in Social Problems and Public Policy, vol. 16, pp. 76-98.

Campbell-Stone, E.A., and J.D. Myers, 2008, Teaching Sustainability from a Scientific Standpoint at the Introductory Level: Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract ED31A-0584.

Myers, J.D., E.A. Campbell-Stone and G. Massey, 2008, Redesigning Introductory Science Courses to Teach Sustainability: Introducing the L(SC)2 Paradigm: Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract ED21A-0609.

Related or Similar Projects

Energy: A Geological Perspective (http://www.gg.uwyo.edu/geol3650/)
Earth and Mineral Resources (http://www.gg.uwyo.edu/geol3600/)

Active Learning and Inclusion of Mathematics and Modeling for Biology Undergraduates at Everett Community College

Pamela Pape-Lindstrom
Everett Community College

For more Information

Summary

The three quarter biology series offered at Everett Community College is in the first phase of a major re-design. Guided-inquiry, problem-based learning activities and interactive computer simulations with reflective writing exercises will occur during "lecture" time. Lecture sections enroll 48 students and students will work in pairs on wireless enabled lap top computers during a majority of classroom sessions. Appropriate case studies2 including multi-media cases from the Case It! Website3 will be presented to students working in small groups. Students will be engaged in meaningful "active learning" during "lecture" time as opposed to the passive learning of listening to a lecture and taking notes. Mathematical problems with biological applications will be built into lecture and lab. Several computer simulation exercises from SimBioticTM Software4 will be used and STELLA1 modeling software will allow integration of wet labs, quantitative analysis and computer modeling. More sophisticated molecular biology labs will be added to the curriculum. New case studies and new STELLA1 modules will be designed, written and integrated into the curriculum.

Project Goals

The objectives of this proposal are to:

- Increase access to computers with modeling software in lecture mode and laboratories
- Integrate student-centered activities using interactive websites which provide guided-inquiry exercises and multi-media case-based learning
- Restructure the laboratory to include inquiry and significant student input into experimental design
- Increase student exposure to molecular biology techniques
- Incorporate mathematical problems, interactive computer simulations and modeling exercises in both lecture and lab
- Incorporate student use of STELLA software to quantify and model experimental results

The following student outcomes are expected to result. 1) Students will demonstrate scientific literacy, including implementation of experimental design. 2) Students attitudes toward learning science will improve. 3) Students will express and demonstrate increased a. retention of biological concepts b. increased ability to apply mathematics to biological issues c. comprehension and skills with regard to molecular biology techniques d. awareness of the connections between biology and mathematics e. confidence with mathematics, modeling and computer use f. awareness of the personal and professional usefulness of mathematics and modeling.

Project Design/Elements

Develop additional writing exercises for three quarter sequence to complement interactive content at textbook website.
Preparation of case studies for curriculum.

Create curriculum specific "biomath" application problems.
Develop additional STELLA modules.
Survey student attitude pre & post.
Evaluate results for further curricular changes & modify
as needed.

Evaluation and Assessment Strategies

Use of CLASS for Biology as pre-test and post-test for the majors 3 quarter series.
Comparison of specific exam items from old sequence to new.

Products, Key Findings, Publications

Improving Quantitative Reasoning and Inquiry-Based Learning in the Undergraduate Biology Curriculum

Doreen J. Schroeder
University of St. Thomas

For more Information

Summary

Student success in STEM courses is correlated with science reasoning ability, which requires advanced intellectual development. Intellectual development can be facilitated using inquiry-based teaching, whch incorporates exercises that encourage students to examine cause and effect relationships, make predictions, and evaluate responses. The goal of this project is to promote intellectual development in undergraduate biology students by increasing the emphasis on quantitative reasoning and inquiry-based activites in the laboratory experience. We propose to accomplish this by introducing digital microscopy and systems for the quantitative analysis of gas exchange within the introductory laboratory curriculum at the University of St. Thomas and North hennepin Community College.

Project Goals

Our project has four specific goals:

1. Integration of math and technology to promote higher order thinking skills; Higher levels of intellectual development are modeled in the inquiry-based lab, as students apply a procedure to a new situation, analyze the data, evaluate if it fits their understanding, and incorporate the new information to create a coherent whole.
2. Improve and expand inquiry-based laboratories; Research in STEM learning has indicated that an inquiry-based approach to learning lead to greater student engagement, better retention of knowledge, and promotes a positive attitude toward science.
3. Improvement in student understanding of biological diversity; We propose to improve student understanding of, appreciation for, and retention of information about biological diversity through laboratories that incorporate the utilization of digital microscopy and gas analysis.
4. Promotion of cooperative learning and community building within laboratories; The use of both technologies will requires that pairs or small groups of students work together. By incorporating technologies that require cooperative work, we hope to facilitate the establishment of student learning groups early in their undergraduate learning experience.

Project Design/Elements

We have implemented the technologies in four key areas:

1. Introductory biology course at St. Thomas
2. Mid-level plant biology course at St. Thomas;
3. Introductory and mid-level biology courses at North Hennepin Community College; At both institutions, the technologies have allowed students to make measurements, analyze data, and draw conclusions that were not possible previously. Additionally, students taking the mid-level courses are able to build on knowledge from their previous introductory course.
4. Other areas of the curriculum at St. Thomas; Already the technologies have been implemented in a non-science majors course and a mid-level comparative anatomy course where students are able to design experiments and collect quantitative data.

Evaluation and Assessment Strategies

A variety of assessment strategies are underway at St. Thomas. In the introductory bilogy course, we have pre- and post-implementation final lab exam scores for evaluation, pre- and post-implementation lab report scores for student-designed experiments, and attitundinal surveys given at the beginning and end of the course, combined with a science reasoning exam.

Similar assessments have been implemented in the mid-level plant biology course: lab report scores and attitudinal surveys. Additionally, a requirement that students demonstrate quantitative reasoning, beyond mere presentation of statistics, has been added to the final laboratory project.

Products, Key Findings, Publications

Publications are planned after three years of the project.

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

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

Project Design/Elements

a) 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

Enhancing Success in STEM by Building Skills and Intervention

Alicia Paul Thomas
Morehouse College - Funding provided by NSF STEP

For more Information

Summary

With NSF support, one of our main objectives is developing a Scientific Literacy course at Morehouse College. This program will identify at-risk students in their freshman year and then providing these students with skills that are necessary to overcome stumbling blocks in the majors. Skills such as quantitative literacy and critical thinking will be taught to these students in a one-hour credit/semester, three semester Scientific Literacy course designed for STEM majors.

Project Goals

1. Identify at-risk STEM students in their freshman year to enroll in the Scientific Literacy course.
2. Develop quantitative literacy skills.
3. Develop critical thinking skills through quantitative literacy exercises.

Project Design/Elements

The quantitative literacy component was offered in a pilot not-credit course in the 2007- 2008 HBCU-UP Pre-Freshman Summer Science Bridge program. A pre and post-test was given to students in the program. Analysis of the data showed that all students performed better on the post-test than on the pre-test. Eighty percent (80%) of the students showed improvement of 15-38% in test scores. It is predicted that the at-risk students taking Scientific Literacy will have a significantly higher post-test due to the added incentive of being graded for a credit course.

In the Scientific Literacy course offered in the fall of 2009, students will be divided into four separate groups (classes) of approximately 30 students each. Each group will represent a different set of skills that the students may need to develop as determined by the pre-test. The class period will be divided between the instructor and small PLTL subgroups of no more than eight students. These subgroups will then participate in quantitative literacy, guided-inquiry exercises designed to challenge the students in a way to develop critical thinking skills.

Evaluation and Assessment Strategies

Qualitative and quantitative measures will allow for the development of a goal based assessment plan. Designing of an evaluation matrix to address program objectives will include formative and summative assessments.

Products, Key Findings, Publications

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