Volume XXIV, Number 11

NISOD INNOVATION ABSTRACTS

Published by the National Institute for Staff and Organizational Development (NISOD) • College of Education • The University of Texas at Austin

MULTI-COURSE PROJECTS AS BRIDGES BETWEEN DISCIPLINES

Like most faculty in undergraduate education, we have been frustrated by students who seem to forget everything they have learned in a course a few days after the final exam. Even if they manage to remember vaguely some concepts learned, many students are unable to apply these concepts in a different context or discipline. Students are not the only ones to blame for this. Traditional education is designed so that each discipline has a curriculum that is independent of all others. This tendency to compartmentalize knowledge effectively negates the inherent interconnections of "real-world" problems and discourages students to seek out those connections. In today's information age, we need to teach our students to exploit the vast amount of information available by providing a global overview that stresses the importance of the interconnected parts. In other words, we, as faculty, need to demand that students engage in studying problems of a multidisciplinary nature.

An ideal-world solution would be to reform the curriculum completely by designing multidisciplinary, team-taught courses. The logistics to implement this approach, however, are overwhelming. So, a number of Science, Mathematics, Engineering, and Technology (SMET) faculty at Broward Community College (BCC), who were eager to change the "status quo," decided on an approach that would use the existing infrastructure, yet allow for interdisciplinary learning. In a nutshell, SMET faculty at BCC (with partial support from the National Science Foundation) designed multidisciplinary projects that served as bridges between existing courses. Each project consisted of various modules, with each module being more or less discipline specific. As the project was implemented, students in each discipline worked on a specific module; data and results obtained from one module were then shared with and used by students working on other modules. The project became the conduit by which faculty and students from different disciplines interacted and learned together.

Once the concept of multi-course projects was in place, some decisions had to be made regarding the following issues:

- *Would all courses in the SMET departments be involved, or only a selected few?* We decided to focus mostly on general education, "non-majors" courses that have more flexible course outlines.
- *Who would design and who would participate in each project?* Project topics were first solicited from SMET faculty. The faculty member that proposed a particular project topic became the "project leader." One of the project leader's responsibilities would be to seek faculty in other disciplines to form a team. The team would then develop and implement the various modules of the project.
- *What would be considered a "good" multidisciplinary project?* The project should be of *wide scope* (involving many areas of SMET), *wide appeal* (topics of interest to a large number of students), and *usefulness* (practical and pedagogical value).
- *Would all modules in a project be equally important?* We decided that different projects had different needs and called for flexibility. Course/module linking within a project could be established in either a *formal* or *informal* manner.

  a) In *formal course linking,* the links between modules were established prior to the start of each term with well-defined roles for each course. As in real group project work, formal course links could be *permanent* or *temporary*. Permanent course links last the duration of the project (sometimes over a period of many years). A temporary course link occurs when the *project course (or courses)* makes a request to a *support course* to develop tools for use in the multidisciplinary project. For example, in one of the projects developed at BCC, the "Molecular Modeling Project," physical science students submitted specifications to students in a computer science course who were to develop a software tool to perform molecular calculations. The temporary course link to develop a software tool established permanent links with other courses that then utilized the software tool in their own modules.

b) In *informal course linking*, students working on a multidisciplinary project create questions that fall outside the disciplines of formally linked courses. Students can then pose their questions to students in courses outside the network of linked courses.

- *How would we assess the success of multi-course projects in improving student learning?* We decided to evaluate success by indirectly comparing PBL and TLF courses. During the past two decades, educational research has resulted in a convergence of opinion regarding "good practices" in undergraduate education. A number of good practices are strongly correlated with good educational outcomes. Hence, good practices can serve as indirect measures of good outcomes—i.e., if the right practices are followed, good outcomes can be expected. A student assessment instrument, developed by Carey Witkov can be found on our web site (http://fs.broward.cc.fl.us/north/math/nsf/). Technology plays such an important role in implementing PBL courses that assessment of technology-related practices and outcomes seemed warranted. Questions for assessing good technology-related course practices and outcomes, thus, were included in the questionnaire.

Once the logistics of developing, implementing, and assessing projects were determined, BCC faculty developed a number of multidisciplinary projects, diverse in scope and nature. Brief descriptions of some of these projects, as well as disciplines linked by each, follow. More extensive details of these projects can be viewed on our web site.

1. The "Wetlands Project" links chemistry, environmental science, biology, physical science, geology, geographic information systems (GIS), and mathematics. This is an ongoing project that allows students to collect and analyze environmentally sensitive parameters from a wetland habitat. Conclusions about the overall health of the system are drawn periodically.
2. The "Shuttle Project" links astronomy, physics, engineering, chemistry, and biochemistry. This project engages students in the design and construction of experiments that will fly on the space shuttle.
3. The "Molecular Modeling Project" links chemistry, biology, physical science, computer science, and engineering. Desktop molecular modeling uses computers to calculate and display molecular properties. This modeling has applications in various professions (medicine, pharmaceutics and genetic engineering, environmental analysis, and the design of clothing and food).
4. The "To Ship or Not To Ship Project" links biology, environmental science, chemistry, geology, business, and law. Students are first presented with a scenario (e.g., shipping oil along the West Coast of Florida may endanger the ecosystem if an oil spill were to occur), then divided into groups (citizens, EPA, oil company, environmental group) that must research and eventually debate the fate of whether or not to ship the oil.

Since spring 1998, 120 SMET sections have participated in a multidisciplinary project (referred to as project-based learning or PBL courses) and served 3,252 students. When asked whether they would choose to register in a PBL or a TLF section in the future, most answered that they would choose PBL. Even more emphatic was the answer as to whether they would recommend courses that use project-based learning to other students: 93% of these students answered "yes."

Students rise favorably to the challenge of participating in a multidisciplinary project. While long-term studies are needed to assess the success of PBL students in academia and, ultimately, in their work careers, our initial evaluations seem to indicate that students participating in multidisciplinary projects learn to cooperate, reason, and use technology skills more effectively than do their TLF peers. These are precisely the skills that will enable our graduates to compete in a job market defined by complex, often interdisciplinary problems.

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[This material is based upon work supported by the National Science Foundation under Grant No. 9653672. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.]

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April 5, 2002, Vol. XXIV, No. 11

Innovation Abstracts (ISSN 0199-106X) is published weekly following the fall and spring terms of the academic calendar, except Thanksgiving week, by the National Institute for Staff and Organizational Development (NISOD), Department of Educational Administration, College of Education, SZB 348, Austin, Texas 78712-1293, (512) 471-7545. Periodicals Postage Paid at Austin, Texas. POSTMASTER: Send address changes to *Innovation Abstracts*, The University of Texas at Austin, SZB 348, Austin, TX 78712-1293. Email: sroueche@mail.utexas.edu