A NEW INTERDISCIPLINARY MATHEMATICS AND SCIENCE COURSE

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As Norfolk State University has been considering how to adequately prepare students to teach the challenging new mathematics and science called for the Virginia Standards of Learning [1], we have reached the conclusion that the student programs need to provide interdisciplinary experiences linking mathematics and science. We reached the conclusion for two reasons. First, even with the larger number of courses called for in the new licensure regulations, there are not enough course hours available to teach all of the different mathematics and science topics that future teachers need to have studied. Second, elementary and middle school students do not study science and mathematics organized in the same way as these topics are organized in universities. Rather, students are interested in, and study, broader topics such as the working of the human body or the structure of a broad ecological system. In order for teachers to teach these subjects in this way, making use of the appropriate mathematics behind these structures, they must have themselves studied these topics in this manner. The new course, *Interdisciplinary Mathematics and Science*, that has been developed at Norfolk State University, provides students with an interdisciplinary background, then requires each student to study a broad interdisciplinary topic as a member of a team, and then to prepare oral and written presentations on this topic. The course, and the experience of students with this course, will be described in this paper.

As institutions across the state of Virginia struggle with the problem of preparing students to teach the challenging new mathematics and science called for in the Virginia Standards of Learning (SOL), it is becoming clear that there are not enough course hours available to teach future teachers all of the different mathematics and science topics implied in the SOL. We at Norfolk State have concluded, therefore, that programs for intending teachers need to provide more interdisciplinary experiences linking mathematics and science. Moreover, students preparing to teach elementary and middle school will not deal with mathematics and science in their classrooms in the same isolated way that these topics currently are presented in university programs. Rather, students at these levels study broader science topics related, for example, to the human body or to the environment, in which mathematics tools and concepts emerge in a natural way. In order for teachers to teach these subjects from such an interdisciplinary perspective, they, themselves, should study these topics in a like manner.

One attempt to address the problem at Norfolk State consists of the development of a new

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course, *Interdisciplinary Mathematics and Science*, a course which integrates mathematics and science investigations in a mathematical modeling setting. In this course, students work in cooperative groups on solutions to real world science problems and then present their findings in oral and written presentations. The purpose of the course is to involve students in the basic tools and concepts of mathematics (graphing, equation solving, curve fitting, computational analysis, etc.) within the context of interesting and challenging science problems, and with a strong emphasis on developing students' writing skills. The course is team-taught by faculty from the mathematics and science departments and uses written modules developed under the Virginia Collaborative for Excellence in the Preparation of Teachers (VCEPT) program funded by the National Science Foundation. The prerequisites for the course are two semesters of college mathematics and two semesters of laboratory science. Thus, the course can serve as a lower level mathematics or science elective and can be particularly useful as a supplementary mathematics/science enrichment course for intending teachers.

The course begins with a brief introduction which provides students with an interdisciplinary background and an initial experience with mathematical modeling principles. Thereafter, students work in small groups on four investigatory modules, each dealing with a broad science topic, as described below, under the guidance of members of the teaching team. The modules provide background information on the topic, and they lead students, by way of a sequence of questions, to solve problems associated with the broad topic. Students use the Internet and the campus library, visit the science laboratory, or sometimes take a field trip in pursuit of answers and solutions. Their findings contain expositional, tabular, graphical, and symbolic elements, are typed on a word processor, and are presented orally to the entire class using modern technological aids. Each student is expected to demonstrate on written examinations knowledge of basic mathematics and science principles underlying each of the modules.

Description of Course Modules

Module 1: The Quality of Water. This module addresses some causes and remedies of water pollution in the Hampton Roads area. A lecture by a representative of the Chesapeake Bay Foundation (CBF) and a visit to a local water treatment plant provide background material and data for this unit. After their visit to the treatment plant, students go into the

chemistry laboratory and create scaled down models of water treatment processes that they witnessed at the water treatment plant. They also perform water-cleansing experiments on water samples that they collect from local waterways. Using data from an oyster harvesting experiment being conducted by the CBF, students use spreadsheet analysis to make projections concerning the future oyster population in selected tributaries around the Chesapeake Bay. The module concludes with an exercise in which students use regression analysis on data collected by the United States Geological Survey to determine PCB and turbidity levels in certain rivers as functions of river depth.

Module 2: Epidemics and the Spread of Diseases. In this module, students are provided background and data on some of the dread diseases which plague our society along with information on some of the epidemic outbreaks of the diseases. Students use the Internet extensively in this module to gather information about historical epidemics dating back to the 14th century and to catalogue recent outbreaks of E coli, Ebola, and AIDS. They are held spellbound as a faculty team member from the Biology Department presents a slide presentation telling the story of the initial outbreak of Ebola in Zaire. A similar lecture on the HIV virus is given by a faculty team member with expertise in health science. After students are introduced to the SIR model for the spread of disease, they apply the model to data relating to the Plague of Bombay in 1905 and the Ebola Outbreak of 1995. They also use data published by the Centers for Disease Control and curve fitting techniques to try to identify trends in the incidence of AIDS cases in the United States and to predict future trends. The module ends with an investigation on viral loading.

Module 3: Heat Loss and Gain. This module begins with a discussion of the problem of heat escaping from homes and other shelters and the use of thermal insulation to combat the problem. Students are introduced to Newton's Law of Cooling by way of experiments in the physics laboratory involving the cool down rate of hot water. The same experiment is modeled in the classroom using a Texas Instruments Calculator Based Laboratory and curve fitting techniques. In a final challenge, students create a model for insulating a house and then test a strategy for cost effectiveness in selecting insulating material.

Module 4: Human Genetics. In this module students are introduced to elementary principles of genetics and the application of these principles to the study of certain genetic

diseases and other genetically based phenomena. The genetics principles are introduced through individual examples using intuitive probability notions. This approach extends in a natural way to discussions of population genetics and illustrations of the Hardy-Weinberg Principle. Students examine case studies involving genetic diseases such as cystic fibrosis, Huntington's disease, Tay-Sach's disease, albinism, and sickle-cell anemia. They obtain firsthand information about the research efforts at Eastern Virginia Medical School to isolate a diabetes gene, and, after viewing a PBS video, they discuss the ethical implications of the discovery of a breast cancer gene. The module involves students in an experiment comparing blood type frequencies on Norfolk State's campus with established blood type proportions in the United States and elsewhere. Their final challenge is the gathering of information on the Internet about the Human Genome Project.

Results of Initial Pilot Testing of the Course

We began pilot testing our course during the spring semester of 1997. Getting a new course started is always difficult, but after some innovative advertising and some good natured "arm twisting", we were able to get 19 students enrolled in the initial offering of the course. The mix included 17 undergraduates and 2 graduates, of whom 5 were applied mathematics majors, 6 were mathematics education majors, 6 were computer science majors, and 2 were engineering majors. The composition of the enrollees, in effect, contributed to the interdisciplinary flavor of the course. Subsequent offerings of the course (two to date) have included elementary education majors and biology majors. One of our proudest accomplishments is the fact that no education major has failed or withdrawn from the course. This supports our belief that interdisciplinary courses like ours can be used to prepare intending teachers for the implementation of the SOL in mathematics and science.

Our initial evaluation of the course was based on three items: a) student participation in group activity, b) student performance on examinations covering basic mathematics and science skills, and c) student evaluation questionnaires. Student evaluation surveys were conducted after the completion of each module, and one final questionnaire was administered at the end of the course. Similar final questionnaires were administered in three traditional sophomore/junior level courses in mathematics, biology, and chemistry, each taught by a member of our teaching team.

We found that students, after an initial period of adjustment, adapted very well to working in cooperative groups. In order to discourage students from depending on one or two persons in the group to do all of the work, we required a "division of labor" statement to be included with each of their submissions. Students soon realized that each had to contribute his/her expertise in order for his/her group to successfully complete a module.

Relative to item b), we identified items on the final examination which appeared to deal with basic mathematics and science concepts and skills. We did the same in the three regular courses. We found that performance on these items in the interdisciplinary course was comparable to that in the three regular courses. Our conclusion is that the innovative, experimental elements in the course are not detrimental to the basic skill building that should accompany a mathematics or science course.

As a result of our evaluation surveys, we found that students in the interdisciplinary course displayed great enthusiasm for the course topics and methodology. They appreciated the relevance of our modules to real world problems and issues, and they were amazed at the interconnectedness of the disciplines. We discerned a definite increase in students' confidence in their ability to do mathematics and science as measured by their readiness to tackle challenging problems. By far, the field trips were cited as most enjoyable. The novelty of having more than one instructor was seen as very beneficial, especially in regards to instructor accessibility. The students in the interdisciplinary course were unanimous in citing as advantageous the working together in cooperative groups. On the negative side, the students thought that we attempted to cover too much material and thought that they could have gone into more depth on particular topics if time permitted. The latter judgement suggests that perhaps a follow up course should be considered.

Conclusion

The development and revision of the content and methodology of our new course is continuing under the umbrella of the VCEPT Program. We have obtained good exposure for the new course on Norfolk State's campus, and we have received some inquiries about the course from some neighboring universities. An indication that the course will be sustained after the grant period is the fact that the School of Science and Technology has included our course in its approved list of electives. Two departments in the School are permitting its

students to take our course in lieu of other requirements. Moreover, the School of Education is considering our course in a list of courses to be recommended for additional mathematics and science credits to meet the new state licensing requirements. We feel that the ultimate measure of the success of the course will be its ability to convince students, education majors and others, that they can do mathematics and science and that learning mathematics and science can be an enjoyable enterprise. By this measure, we think we have made a pretty good start toward success.   ■

Reference

[1] *Standards of Learning for Virginia Public Schools,* Board of Education, Commonwealth of Virginia, Richmond, VA, 1995.