TEACHING PHYSICAL SCIENCE THROUGH TECHNOLOGY: MIDDLE SCHOOL VCU PHY 591

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Teaching Physical Science through Technology is a new 3-credit laboratory-and-lecture based course designed to serve as an introduction to the teaching of physical science concepts at the middle school level. Physical science phenomena are presented through investigations of commonly known applications of technology and focus on the Virginia Science Standards of Learning for 6th Grade Science and the Physical Science courses. Topics include matter, gravity, mechanics, heat, optics, electricity and magnetism, and computers as seen in their roles in common devices. The development of the course includes assessment from six semesters, collaboration with other institutions including the Science Museum of Virginia, and an 800 page text written by Adam Niculescu.

Teaching Physical Science through Technology is a new course sponsored by the NSF-funded Virginia Collaborative for Excellence in the Preparation of Teachers (VCEPT). The course development is also a collaboration of the *Gateway 2000* Richmond Public Schools NSF project, a local systemic initiative, the Eisenhower Program for Professional Development through the State Council of Higher Education, and the Science Museum of Virginia's Center for Science Education. In its present form the course was designed in response to a request from Richmond Public Schools for support of middle school teachers preparing to meet the challenge of Virginia's Science Standards of Learning. It is being developed and tested for use by preservice teachers as a 3 credit lecture-and-laboratory-based course.

The original concept for the course evolved from a summer teacher workshop conducted by the authors and funded by Virginia's State Council of Higher Education Eisenhower program. The premise of this workshop, entitled the *Reality-Based Physical Science Teachers' Workshop*, was that physical science could be introduced effectively for teachers and students through examples seen in everyday life, using these familiar physical science applications as a pathway to understanding the underlying phenomena. The technology of

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modern civilization, including electrical, magnetic and electronic devices, transportation, computers, household appliances, and materials (including crystals and composites) all hold within them a story to be unfolded through investigation. The important essentials of physical science phenomena then become the focus of the class, and related to the Virginia Science Standards of Learning [1].

This approach avoids the traditional physics presentation: formulas displayed on a blackboard, followed by repeated problem solving, with the laboratory experience treated as a quite separate and isolated process – often with a fill-in-the-blank sequential laboratory worksheet.

Examples of the new approach can be found in the section on materials. Crystals are introduced by a photograph of the Hope Diamond and optical calcite crystals investigated by students before the geometry of the unit cell is introduced. The VCR, computer, aircraft engine, MRI, AM and FM radio, lasers in CD ROMS, light bulbs, concrete, and the pyramids are among the many hundreds of physical examples used to introduce core concepts in physical sciences. The "projects" or laboratory experiences of the course all present investigation of the phenomena in the context of these examples of technology.

All aspects of the physical sciences are treated: electricity and magnetism, mechanics, heat, optics, acoustics, and gravity, by depicting their role in commonly known devices and applications. The approach is specifically designed to equip teachers to meet the sixth and eighth grade (physical science) Virginia Science Standards of Learning, which are correlated to each class lesson.

The course is structured with lecture, experimental projects, and recitation integrated in a laboratory-type setting using the facilities of the Science Museum and the VCU Physics Department. At the museum, students use the interactive exhibit units of electricity and magnetism, the Crystal World, the large Foucault pendulum, the Digistar planetarium and the aerospace wind tunnel units.

The course text and laboratory manual was written by Adam Niculescu for the undergraduate version of this course *Wonders of Technology* (PHY107 at VCU) [2] and

presents the physical sciences in context with human endeavor: art, technology, architecture and engineering. The features of this text are:

- multidisciplinary approach
- emphasis on technological and real life applications
- exercises to enhance critical objective thinking, and design flexibility to allow for vertical curricular integration
- Unit format in this text stresses a project / laboratory / hands-on approach.

The text emphasizes the process of socializing scientific information and teaching students how to obtain additional information for life-long learning. Students are expected to strengthen science literacy by studying the processes, concepts, and significant details of modern experimental science and technology. By applying the material learned in class to every-day applications, science can become an integrated part of a student's grasp of the world around them. Activities and tests encourage development of the mental skills necessary to think scientifically; the ability to understand and respond critically to science articles and programs in the popular media, and give an understanding of the relationships of science to religion, ethics, politics, economics, and the arts. The central themes of the text are:

Balance, benefit and doubt, (the science process);
The nature of things (matter);
Symphony of Light and Sound (optics and acoustics);
Bridges over Space and Time (communications);
The Ultimate Ride (transportation); and
The Future is Here (human imagination).

The unit format stresses project/laboratory/hands-on components, with high student involvement.

Segment I is a Lecture component with multimedia and interactive participation. During this period students are introduced to topics from life-related experiences, using films, demos, simulations, etc.

Segment II is the Laboratory component, with students working on projects that have relevance to the problems raised during Segment I. Cookbook quantitative labs are avoided, conversation is encouraged, and speculation will be rewarded.

Segment III is the Development of Enrichment Components (Recitation). At the

conclusion of the hands-on project (lab), a general discussion of the topic, its relevance to personal life, technology, and other sciences follows. The discussions focus on the interdisciplinary nature of the phenomena. Interactive-computer programs are used.

The tests are designed as laboratory projects. The compulsory final exam will be given as projects that are pertinent to the focus of the student. To the extent possible, the homework is an extension of the experiments done in class and is assigned in the form of practical projects.

As part of the laboratory experience for the course, the class will participate in the seven, hour-long, hands-on activities under the Science Museum's leadership at the Mathematics and Science Day at the Paramount Kings Dominion Park. This involves the teachers in preparation for an array of physical science measurements and experiments from hand-held accelerometers to remote measurement techniques.

The class members produce projects as an essential course component. These EXAM-projects are to be presented in the last two class meetings. Instructors assist only with supplies, equipment, and safety issues. The exam-project options are outlined in the text-lab manual and are to be tested in the classroom. There will be 3 EXAM-projects during the semester as shown in the schedule of activities.

The final exam consists of two parts:

- A final project to be designed by the student under the supervision and with the assistance of the instructor, and presented during the finals week.
- A standard exam containing questions from the material covered during the semester, and to be taken at the end of the presentations.

This pilot version of the course at the graduate level was developed specifically for Richmond Public Schools, and is under evaluation for effectiveness as measured by the teachers' success in preparing students for the Virginia Science Standards of Learning tests.

Teachers participating in the course are provided classroom kits covering the science themes investigated, as well as the course text. The course runs on a school division schedule

in Spring 1999 and continues after the summer break for three meetings in which project presentations and exams are held. ■

Reference

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

[2] A. Niculescu, *Wonders of Technology*, (pre-publication text-lab manual). To be published by Wiley Publishing Company.