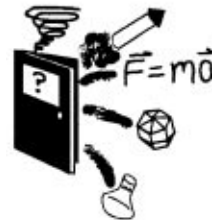


Proceedings of the
Conference on K-12 Outreach
from University Science
Departments: 2004

NC STATE UNIVERSITY



A Conference Hosted by
The Science House
North Carolina State University
Raleigh, NC

February 10-12, 2004
Research Triangle Park, NC

Sponsored by the
Burroughs Wellcome Fund
Research Triangle Park, NC

Dr. David G. Haase and Dr. Sharon K. Schulze, Editors
The Science House, North Carolina State University
Publication Date: August 2004

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The Pharmacology Education Partnership: Improving High School Biology and Chemistry

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Introduction

The Pharmacology Education Partnership (PEP) is a curriculum developed for high school biology and chemistry teachers, providing them with tools to teach biology and chemistry principles in the context of pharmacology topics (e.g., drugs of abuse). This partnership between Duke University Medical Center and the North Carolina School of Science and Math (NCSSM) began in 1998 with a four-year grant from the National Institute on Drug Abuse. The major premise of our project was that high school students might learn basic concepts in biology and chemistry better if the material was presented in the context of something interesting and relevant to their own lives. Forty-seven teachers across the US participated in the project, and after receiving an additional five years of funding, an additional 250 teachers are being trained in 2003-2004 to use the PEP curriculum. The PEP project includes several components, such as curriculum design, science content, and professional development. The PEP project has been tested nationally and has demonstrated significant student achievement in high school biology and chemistry in classrooms using the PEP modules. The results of the study were published recently in the *Journal of Research in Science Education* (Schwartz-Bloom and Halpin, 2003). Below, several of the features and our findings are summarized from the original and ongoing projects.

The PEP Modules

During our original project, we developed four pharmacology modules that were field-tested by 47 teachers throughout the US. [In our ongoing project, we have developed two additional modules.] The current curriculum is online at www.thepepproject.net and will be available to the public in June 2004. In addition to the web-based curriculum, each teacher has the entire website on a CD-ROM in case Internet access is not possible. Briefly, each module focused on a pharmacologic topic that integrates biological and chemical principles. The modules also integrated other subjects appropriate to the topic, such as mathematics, public policy, psychology, and social sciences. Each pharmacology module consisted of:

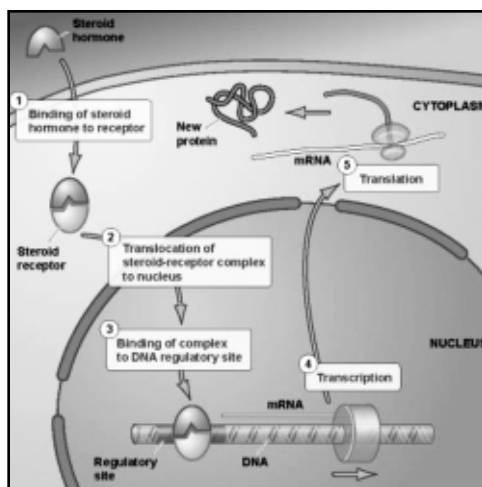
- A set of learning objectives.
- An inquiry-directed student handout (problem-based learning approach).

- A teacher's guide with background science content (containing answers to student questions) and illustrative graphics.
- A glossary of terms.
- A resource list.
- Student hands-on or "minds-on" activities and assessment strategies (these were developed by the teachers at the workshop and then added to the modules).

The six modules developed for the PEP curriculum are summarized in Table 1:

Table 1

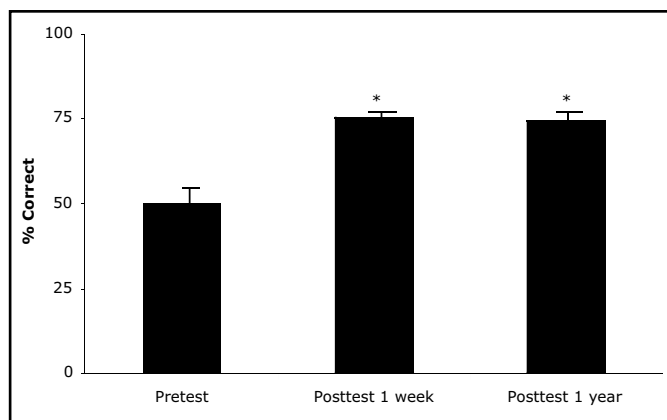
PEP Curriculum Modules	
Module Title	Module Content
1. Acids, Bases, and Cocaine Addicts	acid-base chemistry, molecular structure, circulatory system, membrane transport, cocaine formulations, addiction biology
2. Drug Testing: A Hair-Brained Idea	acid-base chemistry, molecular structure, cellular structure, anatomy, biology and chemistry of hair, nicotine, cocaine, heroin, racial ethics
3. How Drugs Kill Neurons: It's Radical!	oxidation-reduction, oxygen radicals, neuron structure, neurochemistry, cell death, methamphetamine, neurodegenerative diseases
4. Military Pharmacology: It Takes Nerves	covalent bonding, enzyme action, autonomic nervous system, physiology, behavior of gases, chemical warfare, Middle East and Japan current events/history
5. Why Plants Make Drugs for Humans	plant cell structure, acid-base chemistry, molecular structure, membrane transport, tobacco industry chemical "tricks"
6. Steroids and Athletes: Genes Work Overtime	chemistry of testosterone, molecular structure, muscle cell anatomy and physiology, DNA structure, transcription and protein synthesis, androgenic/anabolic steroids, drug testing



Professional Development: The Workshops

We have used three types of professional development workshops to provide teachers with the pharmacology background for implementing the PEP curriculum in their classes. In the original project, 22 teachers attended a one-week workshop at Duke University for training in preparation for field-testing the modules in their classrooms the following year. The second year, the remaining 25 teachers (“wait-listed” controls) attended the workshop. During the workshop, teachers learned basic pharmacology principles as they apply to biology and chemistry concepts. Teachers worked in groups to develop supplemental classroom activities (both inquiry-based and non-inquiry-based) for each module. Using a pre-test/post-test design (20 true/false questions), we found that teacher knowledge of biology and chemistry concepts increased at the end of the one-week workshop (as expected) and was maintained for at least one year (Figure 1).

Figure 1



In the ongoing project, the professional development includes the same instruction as a full day workshop at National and NC Science Teachers Association meetings (NSTA and NCSTA) or in a national Distance Learning (DL) program over three weeks. Analysis of the data from the 250 participating teachers supports our previous findings; teachers’ knowledge increased at the end of the one-day or DL workshops, and as before, knowledge was retained throughout the school year.

The professional development is an important component of the PEP curriculum. Analysis of the data revealed that student performance in biology and chemistry classes whose teachers attended the workshop was significantly better than student performance in classes whose teachers did not attend the workshop (see Schwartz-Bloom and Halpin, 2003).

Field-testing the Curriculum

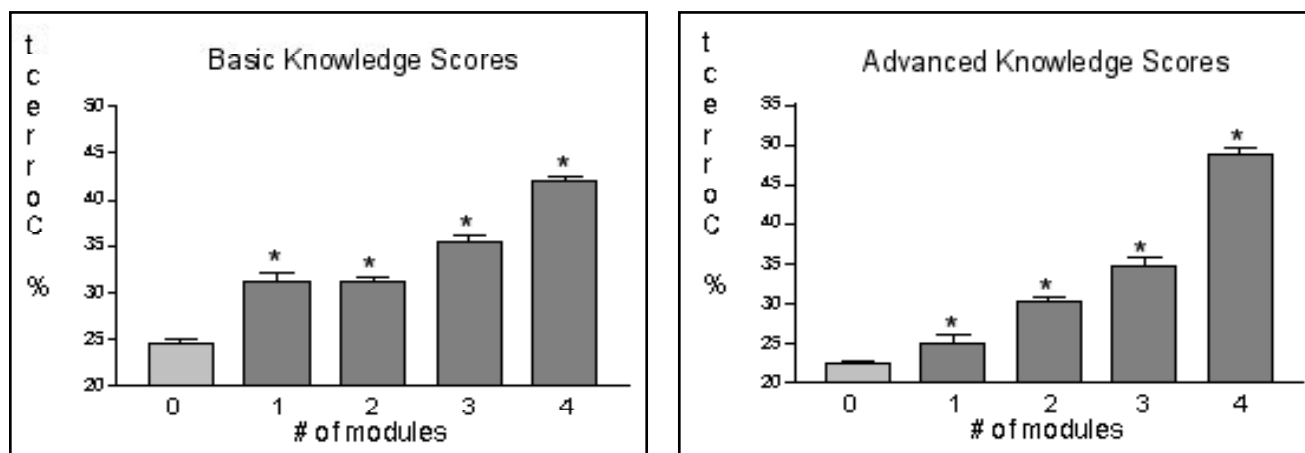
At the workshops, the teachers were instructed to incorporate the modules into their standard curriculum in a way that fit their own teaching style and time constraints. Teachers field-tested the modules in their classrooms consisting of beginning or advanced biology or chemistry students—all four grades were represented. At the end of the school year, we tracked the number of modules used by each teacher. In the original project, six of the 47 teachers did not use any modules, and of those who did use modules, 28 used more than one module. In the ongoing project, we are tracking the usage of the modules by both teachers and students online (but this does not include offline usage on the CD or the hardcopy manual). For the 2003-2004 school year, we have had hundreds to thousands of hits on each module by students.

Evaluation of the Curriculum

In the original project, approximately 3,500 students (in the control and experimental groups) were administered a 20-item multiple choice test of basic biology and chemistry principles (“basic knowledge”) and an eight-item test of their knowledge about drugs (“advanced knowledge”). Statistical analysis of the data collected using hierarchical linear modeling revealed that

the use of the PEP modules was a significant predictor of better performance in both biology and chemistry classes compared to standard curricula in which no modules were used (Schwartz-Bloom and Halpin, 2003). The more modules used, the better the students performed (i.e., a “dose-response” effect) in both the basic and advanced knowledge categories (Figure 2); there were gains of up to 28 percentage points when four modules were used compared to no modules. Other predictors of improved scores included the course level (i.e., advanced placement) and course type (i.e., chemistry vs. biology). The student year (9th/10th vs. 11th/12th grades) did not predict better scores. The degree of improvement obtained by using the modules is considerably greater than that reported in several science education studies of standards-based instructional practices (Von Secker and Lissitz, 1999; Kahle et al., 2000).

Figure 2



Performance of all students on questions of “basic knowledge” and “advanced knowledge” depending on the number of modules used during the course. Data are the mean \pm S.E.M. scores from biology and chemistry students in basic and advanced classes. Hierarchical linear modeling (HLM) revealed that the number of modules was a significant predictor of student scores (Schwartz-Bloom and Halpin, 2003).

In addition, we found that biology students increased performance on the chemistry questions, and chemistry students increased performance on biology questions when at least two modules were used. The findings supported our hypothesis that not only would biology students learn biology better, but they also learned chemistry better (and vice versa).

Conclusions

The substantial gains in biology classes on chemistry questions and vice versa highlight the usefulness of pharmacology topics, which have an inherently integrative nature, in science education. In addition, the real-world relevance of the content in the modules may have been a major factor in the successful outcome of this study. Topics on drugs and drug abuse are highly relevant and meaningful to high school students. If such topics can help capture student interest in science, then other features of science education reform may be more effective. One of the ultimate goals in science education is to help students use science to be critical thinkers and make good decisions in their daily lives (Yiping, 1996). It remains to be determined whether a program, such as the one we developed, will help teenagers make intelligent decisions about drug use. Nevertheless, the approach we have taken should be applicable to many areas of science that are part of students' daily lives.

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