Non-Traditional Techniques in Teaching Science for General Students

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This report describes the instructional outcomes of the "Connecting With Science" project at Kennesaw State University. The project is designed to improve science instruction for general students by developing and implementing non-traditional approaches.

The four of us, with the help of many of our colleagues on the science faculty, have been engaged in a project designed to develop and implement non-traditional approaches and techniques in teaching science for general students. The "Connecting With Science" project, partially funded by an NSF curriculum development grant (DUE-#9354758), grew out of attempts to enhance the quality and value of science instruction for the non-science majors at KSU and to better coordinate the core science experience with KSU's general education goals and philosophy. We have focused on two non-traditional approaches — content integration and student-centered instruction. This report concerns our instructional methods. We hope to report later on the content integration.

Our approach to instruction has been to minimize lectures and to use essentially all class time in group work on structured activities. The primary criterion we have used in designing and evaluating an activity is whether it facilitates authentic learning. The activities are designed to help the student construct an operational and accurate understanding of a block of scientific principles. They are also designed to help the student develop and use problem solving and critical thinking skills. Many focus on developing skills in critically making decisions about real-world scientific issues and on developing mathematical and situational problem solving skills.

The activities we developed have four basic formats:

1. Constructing explanations for phenomena from data and observations.

This format requires individuals or randomly assigned groups to complete carefully designed work sheets that facilitate the systematic construction of explanations for observations made during laboratories, demonstrations, or other data collecting exercises. For example, the students are aided in coming to a basic understanding of entropy by constructing an explanation for why an engine turns when two pieces of metal attached to it are placed in beakers of water with different temperatures and stops when the water is mixed. Another example is an exercise where the students gain an understanding of the basics of natural selection by explaining why wingless flies predominate over winged flies in a mixed population exposed to suspended fly paper.

2. Analysis of readings.

For this format, we have developed three standard analysis work sheets.

One, an analysis of a scientific experiment is used for journal articles reporting on a single experiment or review articles on several experiments. The students are required to identify and evaluate the elements of experimental design, evaluate the author's analysis, and to make a decision about whether to accept the conclusions. A second work sheet, an analysis of a reading, is used when the reading is an essay, editorial, or opinion piece designed to convince the reader to accept a given position or interpretation. The students are asked to identify what the author is really saying, analyze the arguments in the article for bias, accuracy, and thoroughness, and to decide whether to accept the author's position. The third work sheet, an analysis of a claim, is used when the reading is an advertisement, a report of an unusual event or observation, or an article making a scientific claim. Students are asked to identify the claim, identify and evaluate the reported evidences, decide whether the claim violates scientific principles, speculate about what other explanations might apply, and decide whether to accept or reject the claim.

3. In-class simulations of complex natural situations.

In this format, complex natural situations are modeled in ways that allow the students to vary parameters and analyze the results. One example is a simulation of the spread of a disease through a population in which the students investigate the effects of varying the numbers of initially infected individuals and/or the probability of become infected after a contact. Another example is a simulation of the impact of competition for food on a population in which students investigate the effects of varying the method of food gathering and/or reproductive rates.

4. Group projects.

Examples of how we have used this format include having students develop and give class presentations, construct World Wide Web presentations, and design instructional displays.

Our assessments of the courses using these activities, Science 115 and Science 116, have been encouraging. We have done pre- and post-evaluation of student attitudes toward science and of science process skills. In both assessments, we have demonstrated significant improvement in these students. We are continuing our assessment efforts by developing performance assessments of the understanding of science principles, problem solving skills, and science process skills. •