INTEGRATING NANO SCIENCE AND TECHNOLOGY INTO NON-STEM COURSES TO RECRUIT STEM MAJORS

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Abstract

The goal of this study was to investigate the effectiveness of integrating four-week nano science and technology modules as part of a science and technology related general education course for freshman. This study is based on the Science/Technology/Society (STS) guided-inquiry approach which uses current issues in the lives of students as the foundation of study. STS advocates recognize that context gives science and technology its meaning and relevance. Guided-inquiry is based on the understanding that students learn through constructing their own knowledge. All other things — terminology, equations, and procedures — are sought out on a need-to-know basis. The modules were designed to integrate the theory and applications of nano science, essential to a variety of disciplines like biology, chemistry, physics, engineering, and technology. The purpose was to allow students to identify issues and explore solutions to resolve the problems. Research tools like simulation software were made available to the students, in addition to demonstrations that helped them understand fundamental concepts. The study used a pretest posttest control group design. The Attitudes toward Science and Technology scale (Gokhale, 2009) was administered to the participants. Based on quantitative data, it was concluded that integrating nano science and technology modules in a general education course created positive attitudes toward STEM (Science, Technology, Engineering and Mathematics). Additionally, it was found that the STS guided-inquiry approach made technical content more widely accessible to populations of students who otherwise would not be receptive.

Introduction

In a recent issue of Science magazine it was reported that "an annual survey of incoming freshmen shows that nearly one in three declares an interest in STEM fields… but only about 5% of students actually graduate with a STEM degree." [Mervis, 2005, p 1752] One key is to stimulate that interest with teaching methodologies to nurture and cultivate the young scientific detective. One such approach is the guided-inquiry STS instructional pedagogy.

Review of Literature

According to the National Science Teachers Association (Gabel, 2003) students who experience an STS methodology have better attitudes toward studying science and careers in science and improved ability to apply science concepts to their daily lives. Moreover, they exhibit more equitable achievement outcomes in science across gender and ethnic lines. The STS method uses current issues in the lives of students as the foundation of study (Bauer, 2009). STS advocates recognize that context gives meaning and relevance. All other things — terminology, equations, and procedures — are sought out on a need-to-know basis. Guided-inquiry is based on the understanding that students learn through constructing their own knowledge (Polman, 2000). The technique also acknowledges the importance that John Dewey placed on problem solving and reflective inquiry as mechanisms of

learning. According to the National Academy of Sciences (2001), effective science learning is achieved by the generation and development of analyzing abilities and inquisitive reflection that are able to adapt to the needs and changes of modern society. Guided-inquiry is designed to accomplish that type of learning.
This project utilized nano science and technology material infused with the STS approach to teach four-week 'topical excursions' in a general education science and technology course for freshman.

Description of Course Modules

The students learn that new levels of performance in electronics that are necessary to meet the rising demand for increased computing power and information storage requirements depend, to a great extent, on advanced materials, especially advanced ceramics and metals that enable higher performance and further miniaturization. Increasingly, critical dimensions and performance criteria for high-speed electronic pathways and dense platforms are measured in nanometers (typically 1 to 100 nm), and even in angstroms (tenths of nanometer). In this regime, dimensions "disappear," with zero-dimensional dots or nanocrystals (NCs), one-dimensional wires, and two-dimensional films, each with unusual properties distinctly different from those of the same material with "bulk" dimensions. These NCs exhibit unique optical and electrical properties that are controlled by modifying their composition, particle size, and shape, creating promising building blocks for future nanotechnology devices, such as mini-computers and high storage density batteries. The students used simulation software available at no cost on NSF, university, and federal research lab websites. One project involved the growth of NCs on different substrates that are geometrically symmetrical to the deposit. In the selection of substrates, the criteria are geometric compatibility and symmetry between the substrate and the deposit. The products are then tested for electrical and thermal conductivity and other properties of a NC.

Results and Discussion

Both experimental and control groups of students were administered an attitude scale at the beginning and end of the semester to determine their attitude toward the study of science and technology. The STS guided-inquiry students exhibited a significantly more positive attitude on two factors: 1. Interest in gaining science and technology knowledge, and 2. Science and technology are beneficial to humankind. Students' performance on a content-based test revealed that STS approach is effective in enhancing student understanding. Based on students' comments, it can be concluded that the STS approach makes technical material more widely accessible to populations of students who otherwise would not be receptive.

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