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Making Interdisciplinary Courses Work with Constructivism and Science, Technology and Society (STS)

by James E. Hollenbeck

Abstract

Educators expect students to question, explain, hypothesize, and devise tests to determine validity concerning science and its applications. The traditional approach of presenting individual courses concentrating on single disciplines and ignoring linkages to other disciplines is abysmal. If we expect students to understand how science is related to the humanities, it is important to provide the links and bring the disciplines together in a coherent interdisciplinary course using Science, Technology, and Society together in a constructivist methodology. Science, Technology, and Society and constructivism recognize that science does not operate in a vacuum nor does student learning. Knowledge is continuing being assembled by learners and science learning must be taught in the scope of the human experience and understanding.

Undergraduate Science, Interdisciplinary Studies.

Science has been separated from the humanities over the years. Public perceptions have represented science to a “feared” discipline that only few students willingly attempt to study. Although science is regarded as an important endeavour, it is segregated from its impact on the human experience. We study history, literature, sociology and such disciplines and sometimes include a brief description of how science may have affected an event or lead to a decision. More needs to be done. Interdisciplinary studies permit the examination of all disciplines in the development of a liberal arts education that focuses on the relationships among all disciplines. As courses are developed, the basic nature of each discipline must remain intact if the student is truly to learn. Science courses and concepts can be integrated in interdisciplinary courses successfully if the methodology as well as the content of science is taught.

As students examine science and controversies about science, they often fail to ask the simple question “what is science”. The very question “what is science” would eliminate many false debates concerning pseudoscience and other fantasies. One such current debate, created by the general public’s lack of understanding what science is and how it influences our lives is the “intelligent design argument.” The scholars and theologians who proposed this “argument” fail to understand the nature of science, scientific reasoning and scientific methods. (Hoffman, JR, and Weber, 2003; Alters, JB, and Nelson, CE, 2002). Science is based on observation, evidence and the ability of data to be replicated by others.

Evidence of the failed argument of intelligent design and other pseudoscience is reflected in the observation of L. S. Lubie (1962), who described science as “the greatest of the humanities” because of the “humility and honesty with which it constantly corrects its own errors”. Science implores its inquirers to tease the evidence, examine the observable and test the validity of the outcome. Science must stand the test of falsifiability. Since intelligent design failed to meet the criteria described by Lubie and traditional scientific methodology, it is not science.

It would help the public to understand science and its role in the human experience to involve science as a discipline in more integrated and interdisciplinary courses.

Too many educational institutions teach their science courses as independent, specialized classes that barely address other sciences, much less how they impact society. Science should be viewed as a part of the human experience. Students are always observing and constructing their understanding of science and its application in their lives simply to try to make sense of their world. In this constructive process of learning about their world, students, often without knowing it, apply principles of science that they have acquired their science education to solve observations.

Teaching science in constructivist teaching methodology recognizes that students have developed scientific process and application skills, and have used creativity in approaching science problems in their terms of their thinking. Being able to apply their experiences in problem solving will influence their attitudes towards science (Hollenbeck, 1999; Yager, R.E., Meyers, LH. Blunk, S.M., McCommas, W. 1992: National Science Teachers Association. 1982). Teaching in the constructivist/STS method is natural, and will encourage all learners to embrace science as an important and practical discipline. Teaching an interdisciplinary course with science and the humanities is a dynamic process of teaching and learning. Constructivism encourages the student to explore, interact, and construct their understanding of science as it is applied in their world by providing them a “foundation” of knowledge. The learning process stressed in STS is that learning must be an active process, engaging the mind and the physical senses of the body.

It is important for the learner to be able to apply science to technology and evaluate its worth to the human experience. Learning is an active process of building and reshaping previously learned material and systems of meaning. The learning involved in STS requires that learner reflect on their activities and organize the acquisition of newly learned information. Learning is also a social activity in which one is engaged with others, and the social aspect of learning is critical to the student’s learning success. The learning process must be given time for the learners to assimilate the new information, and bring it into the personal context of their worldview.

An integrated science/humanities course dedicated to STS learning can be enhanced by applying the Constructivist Learning Model (CLM) defined by Yager (1991) and Yager, MacKinna, and Blunck (1992). Many successful educators use constructivist teaching strategies in preparing lessons and learning experiences without knowing it. The CLM learning experience makes explicit the need for:

- Encouraging student initiation of ideas, greater participation in student learning, displays of leadership, and autonomy in planning and doing;
- Encouraging students to expand and follow up on their ideas;
- Using cooperative learning strategies that emphasize collaboration, respect for individuality, and the division of labor;

When the CLM is used in conjunction with the STS method, the following statements will characterize successful programs:

- Instructors, with the assistance of local experts, will actively participate in planning as program objectives are developed;
- Students, teachers, and leaders will share and provide mutual assistance;

Many institutions are including STS/Constructivism approaches into new courses and programs by weaving science and the humanities together to form new integrative science courses (Hollenbeck, J.E. and Reiter, W.S. (2006); Carstens-Wickham, B. 2001, Flower, 1999). Generally, these courses utilize interdisciplinary faculty teams, themes, and resources. The difference between the traditional science course and humanities course method is that the new course is one in which the separate disciplines are linked in a coherent strategy that enables students to question, and establish student ownership of learning. These new courses encourage the student research and presentation of their results to their peers. The instructor is involved in this process, acting as the facilitator of information and coordinator of the students' work, so all the pieces "fit together." The role of the instructors becomes more dynamic, and allows them a greater opportunity to demonstrate research and scholarly activity with their students.

One example of an interdisciplinary course that takes advantage of STS learning concerns the "The Dirty Thirties." The Dirty Thirties introduces the students to the 1930s American Dust Bowl through science, social studies, literature, and mathematics. The science disciplines that addressed are climatology, meteorology, ecology, and geology. The songs of Woody Guthrie, stories from John Steinbeck and historical documents from the New Deal are all used in developing knowledge about how the climate and weather affects us. The course uses a multi-media content approach to integrate reading and critical thinking skills into the class. Students are given a variety of activities, reading assignments and research topics to help them understand the causes and effects of the dust bowl, and learn about differences between life in the United States in the 1930s and today.

A second example cited is the examination of an event that will challenge the learner to research topics in history, social customs, geography, climatology, economics and microbiology is an interdisciplinary course on the "Black Plague of Europe". This course introduces the learner to the biology of the bubonic plague as they research communicable diseases and the effect that the plague had on Medieval European society. Students discover that the same public health issues (e.g., etiology, diagnostics, finding appropriate treatment, societal concerns) confront us today in terms of coping with tuberculosis, HIV/AIDS and influenza. The prospect of studying science with an interdisciplinary connection to history, sociology, psychology and literature is rich. Science becomes the focus that brings the other fields of study together.

Assessment schemes used for an interdisciplinary course can involve student achievement on short assignments, their journal or “log” of class activities, and their research project, which is presented as a scientific paper or a poster paper. In this constructivist course, the instructor should be able to determine the students’ prior knowledge and assess what the student had learned about the topic. The University of Iowa researchers and applications by the author of such courses, found the constructivist methodology allowed for authentic assessments, such as measuring student attitudes, constructing a rubric for scoring assignments such as group projects, student journals, portfolios, and performance based assessment instruments which accurately measured student learning (Hollenbeck, J.E. and Reiter, W.S. 2005; Bunce, D, 1996).

Research conducted at the University of Iowa by Yager, Mackinna, and Blunk (1992) has consistently confirmed that when science teaching is approached in the constructivist method, meaningful, long-term learning occurs and the learners gain confidence in approaching new problems (Hollenbeck, J.E. and Reiter, W.S. 2005; Hollenbeck, 1999; Yager, R.E., Meyers, LH., Blunk, S.M., McCommas, W. 1992). To assure that learning has occurred, students must be encouraged to question, allowed to explain their hypotheses, and devise tests to determine the validity of their explanation.

James Rutherford and Andrew Ahlgreen, authors of Science for All Americans, state that "The world has changed in such a way that scientific literacy has become necessary for everyone, not just a privileged few; science education will have to change to make that possible" (Bruder, I. 1993). Constructivism and STS can lead us in teaching responsibility with our applications of scientific knowledge in a holistic learning experience that will appeal to more students and provide a greater understanding of the nature of science.

The scientifically literate person has a substantial knowledge base of facts, concepts, conceptual networks, and process skills that enable the individual to continue and learn logically. This knowledge base provides an appreciation of the value of science and technology in society and understands their limitations (National Science Teachers Association, 1982 and Miller, 2002). Students taught using in the method of STS will learn science (knowledge and methods), technology (application of science to solve problems) and society (how science and technology effects humans and life) in one course. Students learn best through relevancy. STS interweaves and demonstrates cause-effect responses. Incorporating science taught in a STS methodology with the humanities will engage students. Science with relevancy employs the students’ experiences and creates an interesting course.

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Dr. James E. Hollenbeck, Ph. D. teaches at Indiana University Southeast, New Albany, IN 47150. He can be reached by e-mail at jehollen@ius.edu

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