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ABSTRACT

This paper describes the history of science education and the efforts of the Science, Technology and Society (STS) movement in the United States to develop scientifically literate individuals. The Iowa Chautauqua Program focusing on STS materials and strategies and the Constructivist Learning Model (CLN) described by Yager are reviewed. (KHR)

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Using a Constructivist Strategy and STS Methodology to Teach Science with the Humanities.

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With end of the cold war no-where in sight, and increasing dehumanizing social trend, in the year 1959, C.P. Snow coined a phrase that has become incorporated into modern speech in his Rede Lecture at Cambridge University. The phrase the "The Two Cultures" later became a title for Snow's book, a commentary on the scientific worldview and the literary, humanistic worldview tradition. Later Mr. Snow easily brought a third world in to view, technology, the technical view of applications and using science to solve problems. This division between the disciplines is ironic and unfortunate. The Latin word scienta simply means "Knowledge". What we call physics today was generally referred to as "natural philosophy" until the 19th century. "Human philosophy" or " the humanities" was reserved for those branches of learning that traditionally had been concerned with the human condition, e.g.: literature, philosophy and history (Schwartz, A. T. 1988). This is a shameful assumption, as science is concerned with the human condition. L. S. Kubie once went so far as to call science " the greatest of the humanities" because of the 'humility and honesty which it constantly corrects its own errors"(Lubie, L. S. 1962). Science implores its inquirers to tease the evidence, examine the observable and test the validity of the outcome. Science must stand the test of fallibility.

Science as defined has historical roots in ancient cultures especially that of Greece. Modern science is distinctively European in origin but has been advanced and

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augmented by contributions from other civilizations of the Middle East, India, and China. Modern science acquired its modern form in western Europe in the seventeenth century from the traditions of ancient Greece (Richter, M.N 1972). . This evolution of scientific thought from nature operating from hidden laws and myths was dispelled by systematic controlled observations that resulted from experimentation. The scientific process became separate from traditional education and religion. The Protestant reformation and the emerging rise of secular governments in Europe, allowed science to flourish in this new political and social climate. The discovery of the new Americas and application of new technologies broaden the human experience. Science was universal it claims, and processes of nature were the same in all countries, regardless of local cultural variations and values. Science has acquired its status from the western tradition due to the domination of European civilization's influence and importance placed on science in the society.

American schools modeled after our European "roots" segregated the sciences, from the vocational-technical studies, and the technical-vocational studies from the humanities. Science, technology and society (STS) efforts got underway in the United States in the 1980's. Interest in STS was stirred in a National Science Teacher's Association position paper that proclaim: "The goal of science education during the 1980s is to develop scientifically literate individuals who understand how science, technology, and society influence on one another and who are able to use their knowledge in their every day decision making. 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 individual both appreciates

the value of science and technology in society and understands their limitation"(National Science Teachers Association, 1982).

The state of Iowa, one of seventeen states in the United States, was the only state to focus on STS materials and strategies. A National School Chautauqua Program supported by National Science Foundation (NSF) and National Science Teacher Association (NSTA) was established for an interim period. The Teaching scheme, "The Chautauqua Model" was seen as one that could affect teacher attitude and behavior concerning exemplary teaching practice (National Science Teachers Association, 1990). The Iowa Chautauqua Program reached over 4000 teachers, and was active for over a ten-year period. The success of the Iowa Chautauqua Program included specific features that were shared by the schools:

- Student identification of issues with local, state, national and international interests and impact;
- The use of local resources (human and material) to locate information that can be used in the problem resolution;
- The active involvement of students in seeking information that can be applied to solve real world problems;
- Extension of learning going beyond the class period, the classroom and school;
- A focus upon the impact of science and technology on individual students;
- View that science content is more than concepts which students master for the exam; an emphasis upon career awareness- especially for science and technical careers.

- An identification of ways that science and technology are likely to affect the future.
- Finally, realization between "true" science and "pseudoscience". (National Science Teachers Association, 1990)

Many of our colleagues presented the concepts of STS in the Iowa Chautauqua Program in the terms of major societal and global problems. The STS teaching approach successfully incorporated all the curriculum concerns together in a scientific endeavor of using the humanities that assisted our young learners the skills to identify and solve problems. Research conducted at the University of Iowa by Yager, Mackinna, and Blunk (1992) has consistently confirmed that when science is approached in this method, meaningful, long-term learning had occurred and that the learners were confident in approaching new problems (Yager, R.E., Meyers, LH., Blunck, S.M., McCommas, W. 1992). Children must be encouraged to question, allowed to explain their hypothesis, and devise tests to determine the validity of their explanation. This approach does not follow the traditional classroom model, in which we present the information, expect the students to memorize the information, and then recite it to us, so we can determine if they learned. If we only expected from our students, the status quo, never to change the world, this would be acceptable teaching.

Teaching students in the STS method is natural and will encourage them to embrace science as an important and very applicable discipline.

STS means teaching and learning in the context of human experience. This does not free the student from classroom instruction. The teacher acts in the instructional role as a facilitator of learning. The classrooms become centers of teaching and learning in the

context of the human experience. Skills and knowledge that are learned are applied to current and future experiences when the students leave the classroom.

STS uses the Constructivist Learning Model (CLM) as described by Yager (1991) which requires certain teaching strategies, that include:

- Allowing student thinking to drive a lesson or an entire unit;
- Shifting activities and content plans to fit student responses, interest and ideas;
- 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 tactics;
- Encouraging adequate time for reflection and analysis; respecting and using all ideas that students generate, (Yager, R.E., Mackinna, & Blunck, S. 1992, Yager, R.E. 1991).

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

- The program will be largely local in scope, that is student and school-based because they are more effective than college- based or commercially produced programs produced by some one else for their needs;
- Teachers with the assistance of local experts will actively participate in planning as program objectives are developed;
- Self-instruction by the students with the assistance of "experts" will be often evident;

- Individualized instruction will be seen as more effective than is age-group instruction, learning at that student's level, rather than another's level.
- Teachers will have an active role as opposed to a passive role in all aspects of the program.
- Students, teachers, and leaders will share and provide mutual assistance;
- Programs will be directly linked to the general effort of the school, therefore enhancing the curriculum to the community. Community support of their schools is always vital and this program brings the community into the school.

STS means dynamic teaching and learning. Many communities in Iowa have taken STS into their classrooms. I have personally used STS in teaching secondary science. One STS unit that I share with my colleagues, which has been developed with the assistance of a science teaching methods class, is on a unit on Astronomy. This STS unit was entitled "Space, the Final Frontier or Another Adventure of Discovery".

I began the unit by posing a question to the class for "brainstorming". Brainstorming is a cooperative technique used to collect as many questions on a topic that can be generated by the students, without stopping to evaluate each one. Of course, the topic must be clearly stated with some boundaries. One member of the group will act as a recorder, responsible for writing all the responses on a chalkboard during this session. One rule that all students must adhere to is all ideas are acceptable, and no idea is to be criticized. Creativity will be evident during this process. Some of the questions posed by the students were:

- What has been the influence of humans curiosity of the heavens been on culture?
- Does the moon affect human behavior?

- What has been the economic of the space race been to the non-science community?
- How has social issues been reflected in science fiction literature and entertainment?
- How does Jules's Verne's "*The First Men in the Moon*", Arthur Clarke's novel "*2001, Space Odyssey* " compare in their interpretation of space travel and the human experience in space exploration.

As one can gather from the scope of these, a few questions were wide in scope and interestingly enough, many, a textbook would pose, too. Textbooks do make wonderful resources and bases to start student inquiry, but the questions posed by the students go beyond the classroom text. The difference between the textbook science method and the STS approach is that the students are asking the questions, and they are beginning to establish ownership of their learning. The next step of this process is looking for information, and presenting it to the their peers. The teacher is involved in this process; acting as the facilitator of information and coordinates the students so all the pieces begin to "fit together". Your role as a teacher becomes even more dynamic, and you are a learner with your students. I actually work harder, but I am able to apply my education and degree to my teaching.

My students began their investigation with researching the topics on space exploration. . The assessment during this time is based on their performance on short assignments, their journal or "log" of class activities, and their research project, which is presented as a "scientific paper" and poster paper which is open to the public. The student

report is reflective of what they had learned about astronomy and space exploration. Students learn science by doing science.

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). Science has entered the realm of the human experience that has not been matched since the discovery of the New World that unleashed the forces of the renaissance. Science knows neither boundaries nor ages. Science serves all, and like the-descendents of Prometheus, we are charged with the awesome responsibility of charting the moral fiber for a world we will not see, but our children will shape. Only with the inclusion of the humanities can science have a human soul or spirit to guide it. It is my hope that our new age truly ushers in a sharing of knowledge that will benefit all. STS can lead us in teaching responsibility with our applications of scientific knowledge.

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