ISSN: 1597-5037

SCIENCE-TECHNOLOGY-SOCIETY (STS)
A Paradigm Shift in Science Education

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Abstract
This article argues the role of science-technology-society STS in science education and the importance of considering science teachers' beliefs about STS in implementing significant reforms in science education. Different numbers of journals, articles, conferences were consulted. The paper also shows STS as new paradigm shift on science education. Some recommendations among others were made; that there is need for adoption of science and technology in education, as a way to prepare individuals to use science for improving their own lives and for coping with an increasingly technological world. The paper concludes that, Science teachers are the most important key in shifting toward STS education. Therefore, for a successful shift to occur, a science teacher has to have a very complete understanding of what STS education is about and the philosophy behind it.

Keywords: Science-Technology-Society (STS), Science Teachers Beliefs,

Introduction

Changes in the past two decades of goals for science education in schools have induced new orientations in science education worldwide. One of the emerging complementary approaches was the science-technology-society (STS) movement. STS has been called the current megatrend in science education. Others have called it a paradigm shift for the field of science education. The success of science education reform depends on teachers' ability to integrate the philosophy and practices of current programs of science education reform with their

existing philosophy. Thus, when considering the STS approach to science education, teacher beliefs about STS implementation require attention. Without this attention, negative beliefs concerning STS implementation and inquiry learning could defeat the reform movements emphasizing STS.

What is STS?

Science, Technology, and Society (STS) is an interdisciplinary field of study that seeks to explore and understand the many ways that modern science and technology shape modern culture, values, and institutions, on one hand, and how modern values shape science and technology, on the other. Ziman (1980) identified STS as a kind of curriculum approach designed to make traditional concepts and processes found in typical science and social studies programs more appropriate and relevant to the lives of students. According to Yager (1990), STS may be defined as an integrated approach to science teaching; however, Wraga and Hlebowitsh (1991) have defined STS as a topical curriculum that addresses a broad range of environmental, industrial, technological, social, and political problems.

Science and Technology Society (STS) as a Paradigm Shift on Science Education

Based on the view of science as knowledge and the traditional educational view of cognitive learning, science education focused for a long time on imparting knowledge in the different branches of science. Teachers continued to use teaching methods that involved the memorizing by students of the largest amount of knowledge, and the science curricula continued to view the human cognitive heritage as the aim to which one should adhere. This traditional paradigm of the science curriculum began to take shape in the 19th century, and its form was highly influenced by the social and political realities of that time (Kliebard, 1979). This social and political influence on the institution of science had, in turn, a dramatic effect on the structure of our present-day science curriculum. In addition, the traditional paradigm

ISSN: 1597-5037

of science education is characterized by the professionalization of science. School science has been a collection of specific disciplines, such as astronomy, biology, chemistry, geology, and physics (Aikenhead, 1994; Yager, 1996). In this respect, Blades (1997) further describes how the revamping of the science curriculum was influenced by the "structure of the discipline" movement. From the perspective of curriculum theorists, the rationale of this movement was to have subject specialists creating curricula. Furthermore, the best method to encourage students' interest in a particular subject such as science was to "render it worth knowing, which means to make the knowledge gained usable in one's thinking beyond the situation in which the learning has occurred" (Bruner, 1960).

American educators demanded curricula that could help Americans achieve excellence. Therefore, viewing science as inquiry was central to most of the major curricula of the 1960s (Welch, 1981). This movement was rich in new ideas and in views of science and mathematics curricula. Thus, the aims of science education were changed from emphasizing cognition to ways of acquiring and developing knowledge. Accordingly, the roles of the teacher and the learner changed. The teacher was no longer seen as a store of knowledge, and by the same token, the student was no longer seen as a passive recipient of knowledge. The main role of the teacher changed and became the designing of students' thinking and activities, while the role of the student became the active search for knowledge. This was the so-called "discovery" or "inquiry" trend (Schwab, 1966), which called for developing science curricula that could make the students into young scientists who practiced science processes like old scientists. According to this, students performed the activities of identifying problems, collecting data, setting hypotheses, designing experiments, experimenting, deducing, generalizing, and other mental and experimental skills (Carin & Sund, 1989). With this new trend, too, it was expected that learners would develop the skills of observation, classification, measurement, communication, prediction, deduction, identifying problems,

setting hypothesis, designing research plans, and organizing and analyzing. It was also expected that they would develop positive scientific qualities such as curiosity, objectivity, and deliberate judgments (Carin & Sund, 1989). However, this emphasis did not affect teaching practice in any appreciable way (Welch, 1981).

It was suggested in the Keil discussions at the Fourth International Symposium on World Trends in Science and Technology Education in August 1987 that STS programs had the greatest potential for enabling students to attain the goal cluster of Project Synthesis (Hofestein et al., 1988). Project Synthesis, a comprehensive research project conducted in the United States, considered four goal clusters (Kahl & Harms, 1981)

i- *Personal needs*. Science education should prepare individuals to use science for improving their own lives and for coping with an increasingly technological world.

ii- *Societal issues.* Science education should produce informed citizens prepared to bear responsibility with science-related societal issues.

iii- *Career awareness.* Science education should give all students an awareness of the nature and scope of a wide variety of science-related careers open to students of varying aptitudes and interests.

iv- *Academic preparation.* Science education should allow students who were likely to pursue science academically as well as professionally to acquire the academic knowledge appropriate to their needs.

Science and Technology Society (STS) and Science Teacher

The Association for Science Education (ASE, 1981) in its policy statement "Education Through Science," argued that in planning and developing the curriculum, teachers should show that science can be explored from the viewpoint of its applications, leading to

development of an appreciation and understanding of the ways in which science and technology contribute to the worlds of work, citizenship, leisure, and survival. To implement STS in science education, the training and psychological preparation of the teaching force must be considered (Jegede, 1988). According to Za'Rour, the unfamiliarity of teachers with the required teaching models and approaches could hinder the introduction of STS education in schools. Similarly, Rubba (1991) suggests that STS has not attained the level of implementation recommended by NSTA because the majority of the science teachers are not prepared to teach STS. Therefore, before STS teaching practices can be fully developed and put into practice appropriately, science teachers' beliefs and values about science education must be restructured in such a way that they can fully appreciate the notion of responsible citizen action on STS issues as a goal of a school science education.

Another barrier for implementing STS in the class, as Aikenhead (1984) suggests, is the socialization process that science teachers go through during their preparation in the university. When studying science at university, teachers experience a process of socialization into a discipline (B. Barnes, 1985; Ziman, 1994). From experience, teachers develop deep-seated values about science teaching (Aikenhead, 1984; Pedretti & Hodson, 1995). Aikenhead (2000) mentions that preservice education socializes science teachers to believe that their responsibility is to socialize their students into a specifically scientific discipline. Therefore, to implement an STS science course successfully, from a teacher's point of view, the best way to initiate students into a discipline is the same way the teacher was initiated (Aikenhead, 1984). Aikenhead (2000) emphasized change in the deep-seated, personally cherished values of a number of teachers. In addition to that change, teachers must add new methods to their repertoire of instructional strategies. A new routine of instruction is best learned from fellow teachers who have practical credibility.

To implement STS in science education, the training and psychological preparation of the teaching force must also be considered (Jegede, 1988). According to Za'Rour (1987), the unfamiliarity of teachers with the required teaching models and approaches could hinder the introduction of STS education in schools. Similarly, Rubba (1991) suggests that STS has not attained the level of implementation recommended by NSTA because the majority of the science teachers are not prepared to teach it. Therefore, before STS teaching practices can be fully developed and put into practice appropriately, science teachers' beliefs and values about science education must be restructured in such a way that they can fully appreciate what the notion of responsible citizen action actually is on STS issues as a goal of school science education.

Teachers' Beliefs about Teaching and Learning Science Through STS

Researchers often categorize teacher beliefs as either behaviorist (transmissionist) or constructivist. It should be noted from the start, however, that such a dichotomy, while useful in terms of being able to clearly categorize beliefs, may be simplistic and misleading. Theories of learning, such as constructivism, are so diverse (Ernest, 1994) that it is questionable whether we can possibly categorize sets of beliefs in terms of a behaviorist/constructivist dichotomy. Not only are these theories of learning complex and open to a variety of interpretations, but teachers' beliefs themselves are also complex and sometimes contradictory and therefore resist a concise classification. In his review of literature on teachers' beliefs and knowledge, Calderhead (1996) summarized beliefs related to teaching and learning. He placed teachers' beliefs into two categories by arguing that some teachers view teaching as a process of knowledge transmission, while others view it as a process of guiding children's learning or as a process of developing social relationships. He also distinguishes between teachers' beliefs based on their experience. Preservice teachers

start with control-oriented belief systems that emphasize the importance of maintaining order and good discipline and guiding the activities of the children. During training, these attitudes become more liberal and child centered. However, when teachers enter full-time teaching, they revert to a control-oriented belief system.

A teacher who follows a transmission mode is one who:

- believes knowledge to exist in the form of public disciplines, which include content and criteria performance (this often means that they see themselves as "authorities" in a subject)
- values the learner's performances in so far as they conform to the criteria of discipline
- sees the teacher's task to be the evaluation and correction of the learner's performance, according to criteria of which he or she is guardian
- sees the learner as an uninformed acolyte for whom access to knowledge will be difficult since he must qualify himself through tests of appropriate performance. (D. Barnes, 1973; Bell & Gilbert, 1996; Trumbull & Slack, 1991)

Conclusion

Science teachers are the most important key in shifting toward STS education. Therefore, for a successful shift to occur, a science teacher has to have a very complete understanding of what STS education is about and the philosophy behind it. They also need support and help from other people involved in education. According to Heath (1992), many good STS units and programs result from individual teachers striking out on their own, filled with enthusiasm, ability, and dedication to the importance of STS but with little support. Without support, it is difficult to expend or maintain the quality of ongoing STS instruction. Technology, interdisciplinary teacher teams, and university partnerships could be sources for support. The success of STS education reform depends on the teacher's ability to integrate

the philosophy and practices of STS education reform with his or her existing philosophy. This article supported the notion that teachers' beliefs about STS education influence their behaviours in the classroom. Thus, when considering the STS approach to science education, teacher beliefs about STS implementation require attention.

Without this attention, negative beliefs concerning STS implementation could defeat the reform movements emphasizing STS. Teaching science within the STS paradigm is derived by both the students and the teacher working cooperatively together or from suggestions offered by students based on their interests and life issues confronting them. So it is very important to consider students' views, interests, and attitudes when developing the science curricula.

Recommendation

After intensive review of various research works, this paper made the following recommendations:

1- There's need for adoption of technology in education, as a way to prepare individuals to use science for improving their own lives and for coping with an increasingly technological world.

2- Special fund should be provided for research and development in science and technology education.

3- Science and technology teachers training and development should be continuous to keep teachers abreast of the global trend

4- It is imperative to incorporate the experience and voices of educators in planning for instructional continuity which may offer a foundational concept that can be built on to equip teachers with effective strategies for learning.

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