Examining the Benefits of Socio-Scientific-Issues Based Instruction In Science Classrooms

William G. Lacey
Undergraduate Intern, MADE CLEAR (climateEdResearch@umd.org)
University of Maryland

Abstract

In today's modern society, with technology and science developing rapidly, issues about scientific topics are recurrent. In general, high school and college-level based science classrooms presently do not teach issue-oriented science. However, in socio-scientific-issues classrooms, students can discuss global social issues that demand scientific knowledge such as climate change. Students can become more scientifically literate when learning in the context of socio-scientific-issues.

Introduction

Instruction in science that aims to be relevant to learners' lives by teaching about issues as compared to traditional instruction that seeks primarily to teach disciplinary knowledge has been the subject of debate in the field of science education in the past four decades. Only recently has the Socio-Science Issues (SSI) initiative been developed and applied in K-12 science curricula as a way to broaden the teaching of science beyond a primary focus on disciplinary knowledge. SSI has found some measure of success in the general science education system, especially in pre-Collegiate education. Despite SSI's success, it has not as yet been fully implemented in all levels of the education system, such as in undergraduate science courses. The purpose of this review paper is to review how socio-scientific-issues curriculums are applied to science classroom practice, and examine key elements of SSI responsible for increasing the quality of science education.

Background

SSI is an open-ended procedure to teach science. It places science knowledge within social issues to challenge students to negotiate, resolve, and develop ideal contexts to bridge science content and current socio-experiences of the students. Socio-scientific issues are usually controversial to promote debate amongst the students. However, it has an element that demands a standard of moral reasoning to arrive at decisions regarding possible solutions for the issues. SSI uses these issues to help students develop scientific reasoning to understand scientific information (Nielsen 2008). Zeidler (2004) views SSI as a conceptual model broken down into four elements to understand scientific literacy: “(1) nature of science issues, (2) classroom discourse issues, (3) cultural issues, and (4) case-based issues”.

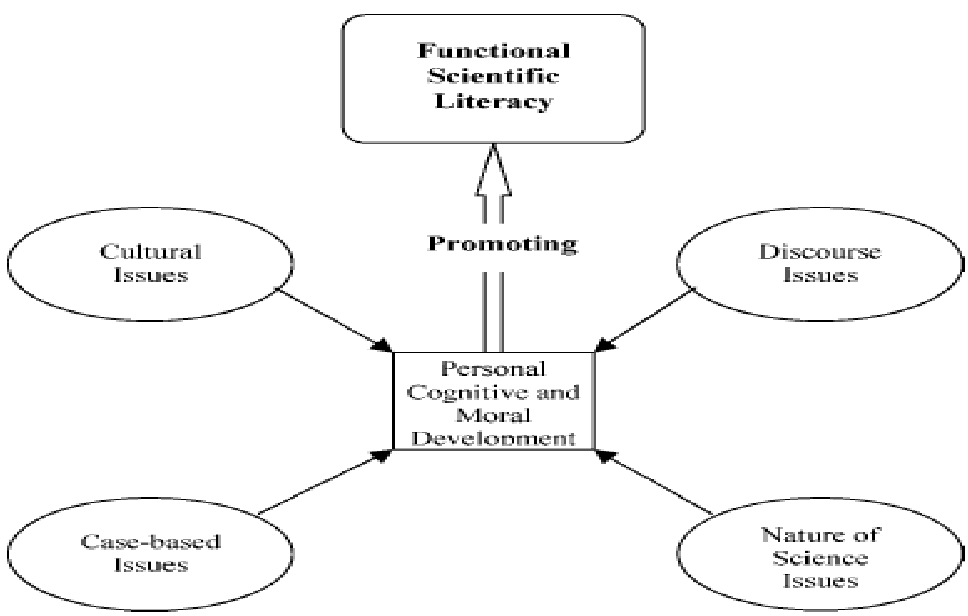

Figure 1. Socioscientific elements of functional scientific literacy.

Figure 1: Zeidler, D.L., Sadler, T.D., Simmons, M.L. (2004). Beyond STS: A Research-Based Framework for Socioscientific Issues Education.

Bridging Formal and Informal Education

Formal education uses traditional-based instruction in a standard school setting where students would learn from a specified curriculum with very little interaction with other sources. Informal education is learning concepts out of a standard school setting where students would learn from a specially made curriculum to expand their conceptualization of the scientific subject. SSI bridges these two types of education by allowing students to research the science content outside of the classroom setting and create arguments to share their knowledge with other students within the classroom setting. It is important to bridge formal and informal education because it has cognitive learning outcomes that can broaden students' knowledge beyond facts and increase awareness in their communities (Storksdiek, Robbins, & Kreisman, 2007). DeWitt (2008) and Storksdieck (2008) states that bridging education is "an extension and improvement of classroom teaching by exposing students to science in hands-on settings and introduce them to real world science".

Traditional-Based Instruction Viewed as a Factor in the Declining Performance of Learners in Science Education

The Organization for Economic Co-operation and Development (OECD) has released global rankings showing America has fallen its top places as leaders in science. Furthermore, the survey shows that America is below OECD average score for science. [see, http://www.businessinsider.com/pisa-rankings-2013-12]. Research have shown that students and up-and-coming professionals in science, technology, engineering, and mathematics (STEM) fields have been losing their competitive edge in science. A main factor that led to the decline of science education is the use of traditional-based instruction in classrooms. Because traditional-based instruction does not develop proper cognitive sciences for students, it leads to the lack of professional development. Since higher education systems, define how primary and secondary education systems should be managed, the higher education systems must implement socio-scientific-issues based instruction in their curriculums to change the general education system to increase the quality of science education.

In 1994, Aikenhead stated that traditional-based instruction .”emphasizes the basic facts, skills, and concepts of traditional science....” Research by Yager (1996) concludes, however, that traditional-based instruction leaves students unprepared for scientific issues. Over the past 50 years, traditional-based instruction has become incoherent and underdeveloped and teacher’s curriculums has diminished socio-scientific material (Yager 1996).

Develop Socio-Scientific-Issues Curriculums

SSI allows flexibility for teachers to be creative as much as they want to meet their needs as well as the students. Ziedler (2014) and Kahn (2014) worked collaboratively to develop a step-by-step lesson plan for SSI: “(1) identify topics, (2) collect resources, (3) introduce topic, (4) prepare students for discussion, (5) pose controversial questions, (6) provide formal instruction, (7) incorporate group activities, (8) provide guidance in evaluating primary and secondary resources, (9) assess knowledge and reasoning”.

Furthermore, Ziedler (2014) and Kahn (2014) explained that to implement SSI, teachers must apply key skills and strategies that can promote successful socio-scientific-issues curriculum. One strategy is for the teacher to instruct students how to evaluate sources of information regarding a socio-scientific issue. It is extremely important for students to understand their sources are credible, reasonable, and accurate. Another skill for learners to be taught is how to argue scientifically for solutions to a socio-scientific-issue. The socio-scientific issue of climate change would serve as an ideal topic in science classrooms for the application of these two strategies. Climate change is a scientific topic that frequently is represented in the media in conflicting ways, requiring learners to make decisions not only about its validity but also about actions (individual and societal) to take to reduce its impact or adapt to it. And, because students work collaboratively while learning about SSI topics, students develop cooperative skills (Johnson, 2002; Slavin, 1980).

Nature of Science

One main goal for science education is conceptual understanding of science content knowledge. Surprisingly, many students who learn science concepts, have difficulty applying their science knowledge (Sadler, et al 2004). Detterman (1993) and Haskell (2001) both concluded that applying learned science knowledge in new contexts [i.e., lab, lectures, private sectors, etc.] suggests that classroom learning is infrequently practiced in real world situations. This problem is ongoing because science teachers mistakenly assume that only understanding science content is enough for informed decisions regarding socio-scientific issues (Pedretti,1999).

To resolve this problem, research was conducted on SSI with positive results. Based upon the separate research of Zeidler (1984), Fleming (1986), Tytler (2001), and Hogan (2002), they all concluded that students' understanding of social issues has improved their cognitive abilities. In 2011, Callahan, Zeidler, and Orasky created a study about implementing SSI within a high school environment and analyzing many elements of the nature of science. The purpose of this study was to see if a SSI curriculum could change high school students' understanding of the nature of science (Callahan, Zeidler, Orasky 2011). As seen in Table 1, the scores under the treatment column from the pretest [before SSI was implemented] are less than those from the posttest [after SSI was implemented]. The researchers determined that students in classes using SSI understood the nature of science better than those who were taught with traditional-based instruction. (Callahan, Zeidler, Orasky 2011).

Table 2
Means and Standard Deviations using the VOSE test

	Pretest				Posttest			
	Comparison		Treatment		Comparison		Treatment	
Tentative nature of science	3.29	0.59	3.40	0.49	3.14	0.63	3.48	0.47
Nature of scientific observations	3.13	0.44	2.96	0.57	3.00	0.49	3.22	0.41
Imaginative nature of science	3.03	0.82	2.56	0.59	2.98	0.76	2.79	0.96
Nature and Comparison of Theories and laws	2.81	0.41	2.66	0.49	2.79	0.38	2.65	0.45
Total scores	3.06	0.27	2.90	0.27	2.98	0.25	3.09	0.51

Table 1: Callahan, B.E., Zeidler, D.L., Orasky, J., Nichols, B.H., & Burek, K. (2011). Using Socioscientific Issues to Enhance Reflective Judgment in High School Students.

Cross-Curricular Connections

SSI is particularly useful for developing interdisciplinary connections (Zeidler, et al 2009). Roberts (2007) describes scientific literacy as "the knowledge of science-related situations" where both science and non-science concerns are intertwined. Unlike traditional based instruction, SSI incorporates scientific and nonscientific curricula, which provides a real scientific framework to motivate students to learn science. Due to the development of cross-curricular connections through the study of socio-scientific-issues, the techniques to solve scientific problems can be applied for quantitative and qualitative courses.

Conclusion

SSI utilizes real society issues and scientific education to develop functional scientific literacy. It is posited that application of SSI will improve the quality of science education. SSI can easily be applied to teachers' curriculums through a developed step-by-step method [by Zeidler (2014) and Kahn (2014)] that bridges formal and informal education. After applying a socio-scientific-issues curriculum within a classroom setting, teachers can begin to see improvements in students understanding of the nature of science and developments cross-curricular learning. The success of SSI is to find social issues connected and relevant to the teacher's curriculum goals.

Research on SSI for the past four decades has laid the groundwork for teachers to implement it in their curriculum. Researchers have repeatedly shown that SSI increases students' retention of science knowledge. Only recently, have researchers successfully created methods for SSI to be applied in a broad array of science classes. For SSI to advance, researchers should create methods that can be easily implemented in college science courses for undergraduates.

Works Cited

Aikenhead, G. S. (1985). Collective decision making in the social context of science. Science Education, 69, 453 – 475.

Banks, M. W. (2002). Give science education the support it needs. Financial Times (London, England), 259.

Callahan, B.E., Zeidler, D.L., Orasky, J., Nichols, B.H., & Burek, K. (2011). Using Socioscientific Issues to Enhance Reflective Judgment in High School Students. Paper presented at the 84th Annual Meeting of the National Association for Research in Science Teaching April, Orlando, FL.

Detterman, D. (1993). The Case for the Prosecution: Transfer as an Epiphenomenon. In D. Detterman & R. Sternberg (Eds.) Transfer on trial: intelligence, cognition and instruction (pp. 1-24). Norwood, NJ: Ablex.

DeWitt, J. & Storksdieck, M. (2008). A Short Review on School Field Trips: Key Findings From the Past and Implications for the Future. Visitor Studies, 11(2), 181-197.

Fleming, R. (1986a). Adolescent reasoning in socio-scientific issues. Part I: Social cognition. Journal of Research in Science Teaching, 23, 677 –687.

Fleming, R. (1986b). Adolescent reasoning in socio-scientific issues. Part II: Nonsocial cognition. Journal of Research in Science Teaching, 23, 689–698.

Haskell, E. (2001). Transfer of learning: cognition, instruction, and reasoning. New York: Academic Press.

Hogan, K. (2002). Small groups' ecological reasoning while making an environmental management decision. Journal of Research in Science Teaching, 39, 341 –368.

Pedretti, E. (1999). Decision making and STS education: Exploring scientific knowledge and social responsibility in schools and science centers through an issues-based approach. SchoolScience and Mathematics, 99, 174 –181.

Roberts, D.A. (2007). Scientific literacy/science literacy. In Handbook of research on science education, ed.

Sadler, T.D. Chambers, F.W., & Zeidler, D.L. (2004). Student conceptualizations of the nature of science in response to a socioscientific issue. International Journal of Science Education, 26, 387-409.

Storksdieck, M., Robbins, D. & Kreisman, S. (2007) Results From the Quality Field Trip Study: Assessing the LEAD Program in Cleveland, Ohio. Summit Proceedings, Cleveland, OH: University Circle Inc.

Tytler, R., Duggan, S., & Gott, R. (2001). Dimensions of evidence, the public understanding of science and science education. International Journal of Science Education, 23, 815 –832.

Yager, R. E. (1996). History of science/technology/society as reform in the United States. In R. E. Yager (Ed.),vScience/technology/society as reform in science education. Albany, NY: State University of New York Press.

Zeidler, D. L. (1984). Moral issues and social policy in science education: Closing the literacy gap. Science Education, 68, 411– 419.

Zeidler, D.L., Sadler, T.D., Simmons, M.L. (2004). Beyond STS: A Research-Based Framework for Socioscientific Issues Education. Wiley Periodicals, Inc. Sci Ed 89:357-377.

Zeidler, D. L., Sadler, T. D., Applebaum, S., & Callahan, B. E. (2009). Advancing reflective judgment through socioscientific issues. Journal of Research in Science Teaching, 46(1), 74-101.

Zeidler, D.L., Kahn S. (2014). It’s Debatable! Using Socioscientific Issues to Develop Science Literacy.