COMMENTARY

Socio-Scientific Issue-Based Instruction in Science Education Necessitates Unconventional Approaches

Xiaoqiao Cheng

Nanjing Normal University, Nanjing 210024, Jiangsu, China

"Science is magic that works."
-Kurt Vonnegut

SOCIO-SCIENTIFIC issues (SSIs) are real-world questions that are scientific in nature but also involve social, ethical, economic, political and other concerns. Decision-making for these issues, typically contentious and lacking easy solutions, requires multi-dimensional evidence and judgements. Common SSIs include the possibility of banning disposable plastic products, legitimacy of further developing nuclear energy, appropriateness of legalizing euthanasia, etc. Incorporating SSIs in the science education curriculum is deemed of vital significance in that it not only assists students in developing scientific literacy but also helps foster their morality, character, and senses of social responsibility (Zeidler, 2014).

For effectively integrating SSIs into science education, researchers have created various instructional frameworks to direct curriculum design and teaching practices. Presley et al. (2013) advanced a well-structured SSI-based instructional framework and argued that successful SSI-based instruction should be composed of three core aspects: design elements, learner experiences, and teacher attributes. Peripheral Influences impacting these include the classroom environment, school and community, state context, and national policy. "Design elements" should have four basic features: building instruction around a compelling issue; presenting the issue first; providing scaffolding for higher-order practices (e.g. argumentation, reasoning, and decision-making); and providing a culminating experience. Necessary "learner experiences" include engaging in higher-order practices (e.g., reasoning, argumentation, decision making and/or position taking); confronting scientific ideas and theories related to the issue being considered; collecting and/or analyzing scientific data related to the issue being considered; and negotiating social (e.g., political and economic) dimensions of the issue being considered. Essential "teacher attributes" for supporting SSI-based instruction include familiarity with the issue being considered

(knowledgeable about the science content related to the issue and aware of the social considerations associated with the issue); readiness to act as learners (honest about knowledge limitations and willing to position self as a knowledge contributor rather than sole authority; and willingness to deal with uncertainties in the classroom. This framework provides clear, structured, and actionable guidelines for SSI-based instruction and science education research. Sadler et al. (2017), drawing on four existing design-based research projects, developed an SSI-TL (Socio-Scientific Issues Teaching and Learning) model for classroom practice. The model highlights the learning experiences that students should undergo in SSI-TL and the learning objectives that they should achieve. The sequence of student learning experiences includes encountering a focal SSI; engaging in science practices, disciplinary core ideas and crosscutting concepts as well as socio-scientific reasoning practices; and synthesizing key ideas and practices through a culminating exercise. Categories of learning objectives that SSI-TL should target are outlined as awareness of issue, disciplinary core ideas, crosscutting concepts, scientific practices, epistemology of science, socio-scientific reasoning, and identity. Sadler et al. (2017) emphasize that these objectives are not separate but interconnected and mutually reinforcing.

Despite the availability of multiple frameworks for SSI-based instruction design and classroom practice, science teachers still have difficulties with the implementation of this type of instruction. Bossér et al. (2015) documented the reflections of two Swedish teachers over a year of implementing SSI-based teaching to find that issues like reliance on prior learning habits and resistance to the new instructional approach are pervasive among students. At the same time, the teachers had to struggle to balance maintaining student autonomy in learning with achieving the prescribed learning objectives. In Nida et al.'s (2020) questionnaire survey of nearly a hundred Indonesian science teachers and the subsequent sampling interviews, teacher participants noted that the lack of necessary competencies in the students, insufficient teacher expertise, the content in the established curriculum, inadequate facilities, and insufficient time for lesson preparation and implementation are the main obstacles to implementing SSI-based pedagogy. In the face of these challenges, science teachers may be in a more eager need of concrete teaching strategies than general instructional frameworks.

University Students' Reasons When Deciding on Genetically Modified Agricultural Products in this issue is an analysis of diverse factors influencing college students' views about production and use of genetically modified agricultural products, a typical SSI. According to the study's findings, among science-, environment-, ethics-, economy-, and policy-related considerations, scientific and environmental concerns are primary factors in shaping the decision-making of the subjects, regardless of their majors and stances on genetically modified agricultural products, while the other three are secondary ones (*Okan & Güven*, 2025). This implies that SSI-based instruction design should incorporate more dimensions, including the ethical, economic, and policy-based ones, in addition to focusing on scientific and environmental issues, so as to foster a more comprehensive decision-making capacity for SSIs in students. Despite the study's limitations, such as the insufficient representativeness of the sample, a lack of longitudinal investigation, and the absence of a control group, its research findings can still serve as valuable empirical evidence for SSI-based instruction design and practices.

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***Correspondence to**:*
Xiaoqiao Cheng
Nanjing Normal University
Nanjing 210024
Jiangsu
China
E-mail: xqcheng2008@vip.163.com

***Conflict of Interests**: None*

***Doi:** 10.15354/sief.25.co508*