

Foreword

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The socio-scientific issues (SSI) innovation belongs to a long history of rational attempts to improve science education for the vast majority of students (grades 6-12) who have not been well served by their school science, as documented by five key failures (Aikenhead, 2006, 2010):

1. There is an alarming and chronic decline of interest and enrolment in secondary science education, in spite of the fact that students generally continue to value science in their world outside of school (Schreiner & Sjøberg, 2007).
2. School science tends to alienate students whose cultural identities differ from the culture of science found in typical science classrooms.
3. Although students do grasp scientific ideas meaningfully (as needed) in out-of-school settings (Albright, Towndrow, Kwek, & Tan, 2008), they generally fail to learn academic science content meaningfully in school. For instance, only 20% of students achieved meaningful learning of the molecule concept over 10 years of school instruction (Löfgren & Helldén, 2009).
4. “Empirical evidence demonstrates how students and many teachers react to being placed in the political position of having to play school games [playing Fatima’s rules] to make it appear as if significant science learning has occurred even though it has not” (Aikenhead, 2006, p. 28).
5. Similar to the mass media, conventional school science conveys dishonest and mythical images of science and scientists, such as a positivistic ideology of technical rationality that supports the existence of “*the scientific method.*”

In light of such accumulated evidence one might ask: Why would students want to engage with school science in the first place? The question anticipates a mission of SSI school science.

With each new decade of innovation toward a more relevant school science, science education researchers have become more sophisticated and less naïve in both practical and theoretical ways, much to the benefit of those few students lucky enough to have been participants in their projects. However, this evolution has often been challenged by a country’s or school system’s culture of school science. The importance of this observation is its implication

that SSI innovations are first and foremost about *changing the culture of* conventional school science (Aikenhead, 2000; Sadler, 2009).

One way to characterize some features of school science culture is to consider the triad: content (the product of past or current learning), process, and context. This book offers a rich diversity of research into all three cultural components.

Potential success for student learning can best be understood in terms of how each of these three cultural components interacts with students' cultural self-identities (i.e., who they are, where they have been, where they are going, and who they want to become). "We need to consider how learning science can change students' identities by changing their ability to participate in the world" (Brickhouse, 2001, p. 288). In short, to learn science meaningfully is to engage in identity formation (Brown, Reveles, & Kelly, 2005; Calabrese Barton, 1998; Carlone, 2004; Sadler, 2009). "Students who do not feel comfortable taking on a school science identity (i.e., being able to talk, think, and believe like a scientist) represent the vast majority of any student population" (Aikenhead, 2006, p. 108).

In the following, I comment on the relationship between this student majority and SSI innovations with respect to school science content, process, and context.

Content

Some researchers recommend that teachers foster positive school science identities by getting students to talk, think, and believe like scientists (Brown et al., 2005). If students begin to talk, think, and believe like scientists, then others will identify them as competent academic science students. However, identity clashes between students' self-identities and a conventional school science identity can cause many students to feel alienated (Brown & Spang, 2008), and consequently they resist forming an academic science identity; that is, they resist meaningful learning. Rather than becoming scientifically literate, they become scientifically indifferent.

The science content encountered in the culture of conventional school science is invariably academically abstract and decontextualized, which serves such purposes as knowledge accumulation for standardized tests and gate-keeping for university science and engineering departments. Evidence demonstrates the negative impact of this academic science content on students' perceptions of SSI innovations: "Students saw the same activities [SSI innovations] as a simple extension of what ordinarily transpires in science classrooms" (Sadler, 2009, p. 36); a

conclusion verified by a very extensive study of students' and teachers' perceptions of what transpires in their science classrooms (Wood, Lawrenz, & Haroldson, 2009) and verified in a review of research into students' identity in science learning (Shanahan, 2009).

To be perceived by students as successful, an innovation needs to change the culture of school science. In the first place, school science must prioritize, throughout its science curriculum, scientific content primarily found *outside* of academic school settings – relevant science in the everyday world (Aikenhead, 2010). Conventional science content in schools and undergraduate university programs differs in cultural ways from the science content observed in everyday science-related occupations, events, and issues. These everyday contexts represent culturally different communities of practice compared with conventional school science (Sadler, 2009). Examples of *relevant school science content* appear in this volume and are emphasized in Aikenhead (2006, 2010) who offers a taxonomy of school science content based on the political question: Who decides what is relevant? Relevant school science includes, for instance, concepts and procedural knowledge for understanding and acting upon scientific evidence – “concepts of evidence” (Duggan & Gott, 2002) – in the world of work and in other everyday situations.

Process

From multiple perspectives, SSI educators have consistently given special attention to learning processes that engage students. In fact the innovative nature of these classroom processes is often perceived by teachers as a major challenge to implementing SSI school science (Aikenhead, 2006). Diverse learning processes revolve around instruction strategies such as decision making, reflective judgment, communities of practice, guided inquiry, citizen participation, moral and ethical reasoning and sensitivity, argumentation and reasoning, critical thinking, case-study analysis, and political action (Sadler, 2009).

Given the importance of potential cultural clashes that prevail in all science classrooms for most students, attention should be given to an emerging cultural perspective on school science instruction. Most students tend to experience school science (grades 6-12) as a foreign culture, but their teachers do not treat it that way. To be successful, these students must, without teacher assistance, learn to cross a cultural border between their own culture and the culture of academic school science (Aikenhead, 2006). An alternative process is for a teacher to treat relevant school science content as potentially foreign to students (epistemologically,

ontologically, and axiologically foreign) and to develop cultural responsive ways to help students cross cultural borders more smoothly (Aikenhead, 2006; Scott, Asoko, & Leach, 2007). SSI educators need to hone their culturally responsive processes so students can more easily appropriate the relevant science content dictated by everyday science-related occupations or everyday events and issues – the primary contexts for learning.

Context

Of the three cultural features considered here (content, process, and context), context is the hallmark of SSI school science with its situated learning and context-based instruction (Sadler, 2009). Contexts chosen by teachers and curriculum developers, however, are often at odds with most students' views of relevancy (Campbell et al., 1994), unless: (a) there is a shared view of purpose among teachers and students, (b) there are changes in the nature of the dialogue between teachers and students, and (c) students compare and contrast their personal understanding with scientific views (Rodrigues, 2006). Each point animates a dimension of school science culture.

Conclusion

When summarizing research in Europe, Osborne and Dillon (2008) lamented:

The irony of the current situation is that somehow we have managed to transform a school subject which engages nearly all young people in primary schools...into one which the majority find alienating by the time they leave school. (p. 27)

An answer to the pervasive question, “Why would students want to engage with school science in the first place?” requires an exploration into the intricate, culture-anchored, context-laden interplay between, on the one hand, students' self-identities, and on the other, relevant school science content, culturally responsive processes, and educationally appropriate contexts.

Some obvious ways for SSI school science to transform the culture of conventional school science include: (a) taking seriously the fact that many students will even experience learning *relevant* school science content as a cross-culture event; (b) dispelling myths and values associated with any academic science content incorporated into school science; and (c) insisting that educational soundness and relevancy be the main criteria for selecting school science content. Other transformative ideas emerge from chapters in this book.

Unfortunately, *educational soundness* often conflicts with *political realities* such as expediency, institutional expectations, customs, ceremonies, beliefs, routines, loyalties, and the power of certain societal stakeholders (Aikenhead, 2006, 2010). SSI research and development projects will be far more influential if their agendas not only embrace the educational soundness of SSI school science, but as well, produce a politically savvy plan for transforming the school science culture in the school system where the project takes place.

References

- Aikenhead, G.S. (2000). Renegotiating the culture of school science. In R. Millar, J. Leach, & J. Osborne (Eds.), *Improving science education: The contribution of research* (pp. 245-264). Birmingham, UK: Open University Press.
- Aikenhead, G.S. (2006). *Science education for everyday life: Evidence-based practice*. New York: Teachers College Press.
- Aikenhead, G.S. (2010). Towards a cultural view on quality science teaching. In D. Corrigan, J. Dillon, & R. Gunstone (Eds.), *The professional knowledge base of science teaching* (in press). New York: Springer.
- Albright, J., Towndrow, P.A., Kwek, D., & Tan, A-L. (2008). Identity and agency in science education: Reflections from the far side of the world. *Cultural Studies of Science Education*, 3, 145-156.
- Brickhouse, N.W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching*, 38, 282-295.
- Brown, B.A., Reveles, J.M., & Kelly, G.J. (2005). Scientific literacy and discursive identity: A theoretical framework for understanding science education. *Science Education*, 89, 779-802.
- Brown, B.A., & Spang, E. (2008). Double talk: Synthesizing everyday and science language in the classroom. *Science Education*, 92, 708-732.
- Calabrese Barton, A. (1998). Teaching science with homeless children: Pedagogy, representation, and identity. *Journal of Research in Science Teaching*, 35, 379-394.
- Campbell, B., Lazonby, J., Millar, R., Nicolson, P., Ramsden, J., & Waddington, D. (1994). Science: The Salters' approach -- A case study of the process of large scale curriculum development. *Science Education*, 78, 415-447.
- Carlone, H.B. (2004). The cultural production of science in reform-based physics: Girls' access, participation and resistance. *Journal of Research in Science Teaching*, 41, 392-414.
- Duggan, S., & Gott, R. (2002). What sort of science education do we really need? *International Journal of Science Education*, 24, 661-679.
- Löfgren, L., & Helldén, G. (2009). A longitudinal study showing how students use a molecule concept when explaining everyday situations. *International Journal of Science Education*, 31, 1631-1655.
- Rodrigues, S. (2006). Pupil-appropriate contexts in science lessons: The relationship between themes, purpose and dialogue. *Research in Science & Technological Education*, 24, 173-182.
- Sadler, T.D. (2009). Situated learning in science education: Socio-scientific issues as contexts for practice. *Studies in Science Education*, 45, 1-42.

- Schreiner, C., & Sjøberg, S. (2007). Science education and youth's identity construction: Two incompatible projects? In D. Corrigan, J. Dillon, & R. Gunstone (Eds.), *The re-emergence of values in science education* (pp. 231-247). Rotterdam: Sense Publishers.
- Scott, P., Asoko, H., & Leach, J. (2007). Student conceptions and conceptual learning in science. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp. 31-56.). Mahwah, NJ: Lawrence Erlbaum.
- Shanahan, M-C. (2009). Identity in science learning: Exploring the attention given to agency and structure in studies of identity. *Studies in Science Education*, 45, 43-64.
- Wood, N.B., Lawrenz, F., & Haroldson, R. (2009). A judicial presentation of evidence of a student culture of "Dealing." *Journal of Research in Science Teaching*, 46, 421-441.