JASTE 11.1:

Stepwise Progress Towards More Widespread Altruistic Uses of Science and Technology

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It has been a pleasure to read this third school-based issue of JASTE focusing on promotion of students' educated, research-informed and negotiated action (RiNA) projects. As the originator of STEPWISE (stepwiser.ca), it is wonderful to witness progress that teachers and students have made, particularly over recent years, in helping to develop community members — through school science — who may critically analyse relationships among fields of science and technology and societies

and environments (STSE) and, where they perceive harms to wellbeing of individuals, societies and/or environments (WISE), develop and carry out personal and social actions to try to — *altruistically* — improve the world around them.

This issue of JASTE is particularly exciting, in that it includes contributions from a school district curriculum coach, school science teachers, educational researchers, secondary school science students, a university student who had completed a social action project

while in high school and one by me (a professor of education). This provides a much more holistic view of STEPWISE implementation. As indicated by comments made by teachers in this issue, they feel they have made great progress as professionals and, moreover, feel very positive about their contributions towards helping school students become much more critical and active in their civic engagement.

Our experiences as educational researchers (see Milanovic et al. article in this issue) suggest that many of these successes may be attributed — in part — to collaborations among coaches, teachers, researchers, and students. Indeed, in my work with Mirjan Krstovic while he developed (when he was a teacher) his expertise, confidence and motivation for helping students to develop and implement wonderful personal and social action projects (Krstovic, 2014), it became clear to me that his successes — and that of students in his courses — arose from cooperation among numerous factors (Bencze & Krstovic, 2017). Five such co-affecting factors are illustrated in Figure 1, with some commentary about each provided below (reading clockwise from upper left):

- Ontario Science Curriculum. Since about year 2000, Ontario governments have not only required students to learn ‘Products’ (e.g., laws, theories & functioning of technologies) and Skills (e.g., experiment and study design), but also to learn about STSE relationships and to develop plans-of-action to address problems they perceive in them. Many teachers have cited this curriculum priority as essential to their implementation of STEPWISE. Existence of such a balanced curriculum has, of course, been due to efforts of politicians, educational researchers, teachers, and others. It also has been of great help that administrators and others

within the Peel District School Board (from which all teacher and student reports in this issue arose) have been extremely supportive of full implementation of this curriculum.

- STEPWISE Pedagogy. Although, and rightly so, different teachers may use different teaching/learning approaches to get students to the point that they can self-direct RiNA projects, our research suggests that providing students with ‘apprenticeship’ teacher-led lessons and student activities can help students to build attitudes, skills and knowledge enabling them to more independently critique STSE relationships and develop and implement relevant personal and social actions to overcome harms they perceive.
- Teaching/Learning Resources. Because STSE education is (still) relatively new, teachers have benefited greatly from using or adapting curriculum materials — with suggestions for uses — provided by educational researchers and curriculum coaches. That school districts have employed curriculum coaches (and/or coordinators & consultants) and engaged university-based researchers in action research with teachers and students have greatly helped in ongoing STEPWISE-informed curriculum development and implementation.
- Control-of-Learning (Lock, 1990). Much success in implementation of STEPWISE has arisen from teachers’ decisions to balance teacher-directed (TD) and closed-ended (CE) instruction — for helping students to learn such complex and difficult-to-discover concepts as *compromise* in technology design (see Del Gobbo, here) — with more student-directed (SD) and open-ended (OE)

activities that help students to develop creativity, critical-thinking and socio-emotional intelligences. Encouragement for such balanced pedagogies may arise from many sources, but teachers in our studies often cite work with researchers, coaches, and colleagues as being helpful.

- Views About Science. Teachers' willingness to emphasize STSE education and, more particularly, teach about harmful influences (e.g., from financiers and corporations) in STSE relationships appears to be correlated with holding more *Naturalist-Antirealist* views about the nature of science (Loving, 1991); that is, believing that methods in the sciences are not just based on data and theory, but also are influenced by factors like culture, economics and politics and that science conclusions may always be somewhat uncertain (e.g., effects of cell phones on cancer rates). Teachers holding such views

often (although, not always) have learned about them through interactions with university-based educators, curriculum coaches, colleagues, and others.

From our interactions with coaches, teachers, students and others as we have encouraged uses of STEPWISE-informed pedagogies, it has become clear that education of students who may generate reports like those found in this issue is only likely to continue with ongoing — although, ideally, *increasing* — supports from politicians, government officials, school district personnel, university-based researchers, school district instructional coaches and many others. Ultimately, as well, efforts should be made to gain further (non-financial) supports for critical and proactive civic engagement from people and groups associated with finance, manufacturing and marketing of science-related products and services.

References

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