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COMMENTARY

Encouraging Citizenship in Science Education: Continuing Questions and Hopeful Possibilities

David Blades
Department of Curriculum and Instruction, Faculty of Education, University of Victoria, Victoria, British Columbia, Canada

Abstract: This special issue of the *Canadian Journal of Science, Mathematics and Technology Education* invokes questions intended to further the discourse of citizenship in science and mathematics education, such as, How do we define *citizen* and *democracy*? Is our call for student action hypocritical? Does positioning school science through the work of Rancière present a "straw man" argument for change? To what extent does the ghost of John Dewey animate and inform a "wild pedagogy" in science education? Challenging the view of the science and mathematics curriculum as a barrier to overcome, this article argues that possibilities for developing citizenship and critical thinking can be found and developed in existing curriculum formations and practices of school science and mathematics education.

Résumé: Ce numéro spécial de la Revue canadienne de l'enseignement des sciences, des mathématiques et des technologies traite de questions visant à poursuivre le discours sur la citoyenneté dans le domaine de l'enseignement des sciences et des mathématiques, par exemple : Comment définit-on les mots « citoyen » et « démocratie »? Notre appel à l'action étudiante est-il hypocrite? Le fait de situer les sciences à l'école par rapport aux travaux de Rancière est-il un « argument épouvantail » visant à favoriser un certain changement? Jusqu'à quel point le fantôme de John Dewey alimente-t-il une idée de « pédagogie sauvage » en enseignement des sciences? Défiant l'idée qui veut que le curriculum de sciences et de mathématiques constitue une barrière à abattre, cet article soutient qu'on peut promouvoir la citoyenneté et la pensée critique dans le cadre des curriculums actuels et des pratiques courantes en enseignement des sciences et des mathématiques à l'école.

The articles in this special issue of the *Canadian Journal of Science, Mathematics and Technology Education* all advance the position that science and mathematics education has an essential role in the development of citizenship of students in school as well as for the general public. This is a reasonable responsibility because many of the issues facing humankind are the direct consequence

Address correspondence to David Blades, Department of Curriculum and Instruction, Faculty of Education, University of Victoria, P.O. Box 3010 STN CSC, Victoria, BC V8W 3N4, Canada. E-mail: dblades@uvic.ca

of scientific discovery and technological innovation and application. Consider, for example, the leaps in achievement in the development of humanoid robots, or androids. As of the writing of this article, androids can now climb stairs, carry a tray of hot drinks, remember faces, and interact with their environment, including us, in significant ways. It is technological development that has led to these creations and discoveries in materials science and kinesiology that made this development possible. But are we ready for machines made in our image? Should we control the role of these androids in society? *Can* we control technology or are we, as Heidegger (1977) warned in his famous essay on technology, in danger of inventing ourselves to death? These questions concern the ethics of our science and technology and applications of mathematics; though we might locate school science mathematics education as the site for examining such issues, our approach to this citizenship education presents difficult questions.

The first question we face as science and mathematics educators is whether it is fair to situate children as the hope for a more technologically careful, environmentally responsible, politically active future. This question was put to me directly at a conference where I presented on the importance of youth engagement in dealing with the social issues that require understanding of science, mathematics, and technology. The audience, composed mostly of students enrolled in senior secondary schools, received the presentation politely and, at the end, one young woman asked the first question: "Sir," she said, "What are you doing?" I asked her what she meant, and she replied, "Well, you're not dead yet. You are telling us that we need to do these things and I want to know what *you* are doing?" She was, of course, absolutely correct in her assessment of the situation: It is hypocritical to teach children to invest in active engagement as citizens if we are unwilling to do so ourselves. At the very least, science, mathematics, and technology educators should be living examples of the very values we espouse and encourage as well as demonstrate to students that hope is practical. Teaching students about the science of global climate change, for example, and examining possible alternatives to the combustion of fossil fuels is a barren pedagogy if we do not as well share how each of us is working to significantly lower our carbon footprint and how we are taking practical steps *now* to avoid or eliminate the use of fossil fuels in our lives. If we do not live our rhetoric, then the entire agenda of citizenship development becomes just one more theoretical topic to learn in school with little to no likelihood that students will become any more engaged in social action than we are.

The articles in this special issue generally adopt a social–critical view of citizenship that sometimes assumes that we know what we mean by *citizen* or *democracy*. This leads to another question we must face in science, mathematics, and technology education: What do we actually mean by *citizenship*? Of course, *every* student in our schools in Canada (and elsewhere) is *already* a citizen of some nation state and likely of Canada by virtue of birth or by becoming a citizen of this nation. So, as one paper points out, our students *are* citizens—the discussion we must have is what *kind* of citizen do we hope our students can be? This discussion is underexplored in science, mathematics, and technology education; we more or less assume that when we use citizenship we all know what this means. A more careful, critical examination of citizenship exists in the area of social studies education (e.g., Richardson's [2002] *The Death of the Good Canadian*); we might benefit from extended discussions with our colleagues in other fields as we try wrestle in science, mathematics, and technology education with concepts and approaches they have examined for a long time.

Moving toward a more democratically based pedagogy is a foundational assumption in the papers of this special issue. As with citizenship, democracy tends to be an unexamined concept

in science, mathematics, and technology education. As Patrick Watson ably demonstrated in his 1989 television series *The Struggle for Democracy*, what we mean by democracy is often vague and varies considerably in the world, even between Canada and the United States. What do we mean by democracy? Is democracy a universal ideal? Ethic? The issue of democracy is particularly problematic in the call in this special issue by papers that seek to encourage a politics of dissention to existing social structures and subsequent social action. But would not such action, unless highly individualistic, require even a local consensus on what actions might be effective? Would arriving at this consensus be a form of democratic decision making and, if so, how would this education serve those who voted *not* to engage in a certain action favored by the majority?

The work of Rancière seems promising in clarifying questions about citizenship and democracy, but we should be cautious about any dichotomizing discourse that positions existing pedagogies in science education as stultifying against proposals for an often ill-defined pedagogy that is emancipatory. Such positioning runs the risk of essentializing current science education curricula and student–teacher relationships, effectively becoming a straw man argument that is a fallacy in philosophical reasoning. Changes, it seems, are everywhere. For example, the current revisions to school science education in British Columba reduce content mastery in favor of learning science process skills, individualize learning, and recognize that high-stakes testing is not a useful way for students to demonstrate learning (British Columbia Ministry of Education, 2015); there are no provincially mandated final exams in this province in biology, chemistry, or physics. Though during my frequent visits to schools I still see content delivery by PowerPoint, I also observe increasingly less and less of this transmission of knowledge toward more student project work, much of which is concerned with social issues. In other words, calls to reform school science education may be out of tune and certainly out of date with the reforms that are currently underway worldwide; as educators we need to spend time in schools to ascertain whether, in fact, descriptions of education among theorists advocating a wholesale revision of the science and mathematics education curriculum continue to be accurate with the lived experience of these curricula.

The argument for a wild pedagogy in science education suggests learning in science free of the present institutional arrangements that begins with the interests of the child. This is precisely the form of education envisioned by John Dewey (1915) in *The School and Society*. Dewey proposed schools as permeable locations with the free movement of students and adults; his child-centered approach seems to haunt the articles in this special issue, even if his ideas are not named. I wondered if we might pay more attention to Dewey's proposals. Why are Dewey's ideas, now 100 years old, still so radical? To what extent might a science, mathematics, and technology education that encourages citizenship flourish in the approach and organization to schooling proposed by Dewey? I wonder, as well, how the notion of community in Dewey's work might be extended now to the world, thanks to Internet technologies? What would science, mathematics, and technology education be like, for example, if students examined with peers in other countries social issues such as food growth, delivery, and management or global climate change? In Dewey's work we have a precedent for many of the changes advocated in the papers of this special collection, but with Internet technology we now have the opportunity to engage in global discussions by redefining community in broader terms.

Animating all of the papers in this collection is a sense that hope is practical and that we can begin the long journey of reform in science and mathematics education despite the current structures of education. There is a tendency in some papers to consider the mandated curriculum

in science and mathematics education as a barrier to overcome but, as eloquently demonstrated in this collection, we may not be seeing the opportunity afforded by such curricula. Both papers in mathematics education, for example, demonstrate how establishing a context for learning makes a difference in what students learn. In science, for example, students might learn to calculate dilutions; as pointed out in one paper, such knowledge may be presented with vague promises that this information may be useful in the future. However, understanding dilution is essential in making decisions about sewage treatment that involves dumping into large bodies of water. Social issues such as the regulation of genetic engineering, establishment of pollution standards, or allocation of funds for human missions to Mars all depend on understanding the science, technology, and mathematics of these issues. It is not the science or mathematics content per se that is the issue in science and mathematics education reform but the inability of teachers to seize the opportunity to *use* this content to educate citizens. This suggests that the education of the next generation of science and mathematics teachers should enable beginning teachers to *interpret* curriculum opportunities presented by issues in society and afforded by the topics listed in the mandated curriculum: It is *how* we approach these topics that is important. Even the seemingly benign choice of units in business is a political act; imagine a mathematics education infused with such revelations, approached by teachers who understand that mathematics is *never* politically neutral or a science education where every teacher can explain why the topic is important *now* to the citizens in their classroom.

One way to encourage the next generation of teachers to adopt an interpretive approach to curriculum may be to emphasize critical thinking. As noted in the collection of papers, it is not enough to teach critical thinking as a skill, like tying one's shoes, because this skill, if adopted at all, simply becomes one of many that students might use to address issues. Instead, we should foster a *disposition* of critical thinking, one that science and mathematics educators model themselves in schools and in teacher education. Such a disposition is a spirit of constant questioning and being open to possibilities when approaching decisions. As pointed out in one paper, this disposition should also include social justice. For example, when examining a consumer choice regarding the purchase of a cell phone, the critically thinking purchaser might ask, "Is there sufficient evidence that cell phones cause brain damage?" To address this question, the purchaser would need to know and apply knowledge of electromagnetic radiation and an understanding of the mathematics of risk. However, though we might appreciate this level of critical thinking in the graduates of our schools, we can also encourage student thinking to include bigger questions, such as, "Why own a cell phone? What does it mean to be in constant communication? What is gained and what is lost with such purchases? What systems of thought do I support with this purchase? How are cell phones made—who is involved in their manufacture and what does this cost in terms of *their* lives?" With this sort of thinking, one surprising possibility that opens up may be the decision not to purchase a cell phone at all.

The world of science and mathematics is changing. I recently heard of how a secondary schoolteacher, after laying out in intricate detail the biochemical steps of cellular respiration on a whiteboard, was challenged by a student who noted, out loud, "You have it wrong." The student had just looked up the steps on a digital tablet and, examining the steps accessed via the Internet, found that the teacher has missed a step in the process of cell respiration. Clearly, ready access to information means that science and mathematics teachers can finally be liberated from the impossible burden of having to know everything; the possibilities exist now to truly play the role of mentor or guide, a role that Dewey (1915) articulates well in his work. Paradoxically, this role

will demand that teachers have a *greater* understanding of their subject areas in order to point students in certain directions and to encourage critical thinking and social justice. To be such teachers, all of us in science, mathematics, and technology education need ideas and examples of experiences that were successful, such as the eco-justice after-school program described in one of the papers. University and college professors of science and mathematics education could and should offer to serve in the collection and sharing of ideas for citizenship education, in formal and informal settings; we could serve as a "clearinghouse" of possibilities and a medium for connecting educators intent on fostering active, informed, and involved citizens through science and mathematics education. This special collection of papers in the *Canadian Journal of Science, Mathematics and Technology Education* is as an example of an initial sharing of what is possible when educators take up seriously the question of citizenship education in science and mathematics, and we hope that this collection provokes and continues this conversation.

REFERENCES

British Columbia Ministry of Education. (2015). *Transforming curriculum and assessment: Science*. Retrieved from https://curriculum.gov.bc.ca/curriculum/Science

Dewey, J. (1915). *The school and society*. Chicago, IL: University of Chicago Press.

Heidegger, M. (1977). The question concerning technology. In D. Krell (Ed. and Trans.), *Martin Heidegger: Basic writings* (pp. 283–317). New York, NY: Harper & Row.

Richardson, G. (2002). *The death of the good Canadian*. New York, NY: Peter Lang.

Watson, P. (1989). *The struggle for democracy*. Toronto, Canada: CBC Enterprises.