STEM Education and Sustainability in Canada and the United States

Dr. Don Herbert Krug
The University of British Columbia, Vancouver
don.krug@ubc.ca

Abstract: *This paper examines science, technology, engineering, and math (STEM) education as represented in North American educational contexts. I will discuss the general state of STEM education and sustainability mindsets in the United States (US), Canada, the Province of British Columbia (BC), and at the University of British Columbia (UBC). Currently there is very little research on the intersections and teaching of STEM education that integrates sustainability in K-12, teacher education and higher education. This exploratory and hypothesis generating inquiry asks if there is a need for conducting further research on integrated STEM education and sustainability curricula. The preliminary findings indicate persistent global economic uncertainty and development based on a competitiveness paradigm has fueled a return to technocratic education.*

Keywords: STEM, economics, sustainability mindset

1. Introduction

In 1957, the Soviet Union launched its first intercontinental ballistic missile. On October 4th of the same year they launched Sputnik I, the world's first artificial satellite setting off a technological and engineering race for space fueled by expertise in science and mathematics. A year later the US Congress adopted the National Defense Education Act, which increased funding for education with a focus on scientific and technical education. Even though educational historians (Kaestle & Smith, 1982) have argued there is no causal relationship between superior general education systems and the development of early Soviet technological development this did not deter President Obama in his 2011 State of the Union address to attempt to rally Americans by comparing the *challenge of competing* against emerging economic giants like China and India to the US space race against the Soviet Union in the 1950s and 1960s. Today military defense and economic competitiveness drives much of the reinvigoration of STEM education based on a technocratic model.

In Canada, institutions and government agencies did not immediately adopt STEM education under this acronym. One of the most comprehensive STEM related policy documents developed by the Federal government was the 2007 report *Science and Technology Strategy: Mobilizing Science and Technology to Canada's Advantage*. In this report, STEM and sustainability education are referred to but not specifically named. Rather the document posits from a restrained technological deterministic position that,

Science and technology comes into almost every aspect of our lives, helping us to solve problems and create opportunities. Scientific discoveries and new technologies provide solutions to many of the issues most important to Canadians, giving us the knowledge and the means to preserve the quality of our environment, protect endangered species, improve our health, enhance public safety and security, and manage our natural and energy resources. Scientific and technological innovations enable modern economies to improve competitiveness and productivity, giving us the means to achieve an even higher standard of living and better quality of life. (p. 7)

Technocratic education professes that "expert and procedural knowledge is the most important knowledge, and that good instructional choices and decisions are those made on the basis of purely objective and technical criteria[2]" (Giroux, 1997, p. 19). Young (1999) has argued, "concepts of knowledge are sanctioned in the curriculum through a process of *social stratification* that reflects the power of some groups to assert their view of knowledge as beyond dispute" (emphasis added, p. 468). In this case, STEM education when introduced through educational settings using a technocratic model is alleged by both Canadian and US governments to deliver economic competitiveness, a new view of knowledge as beyond dispute.

Under various names, STEM education has a North American educational history. It can also be traced back to a 1890s report by the Committee of Ten at Harvard University that mentioned STEM's absence in the agrarian school system of the time. The Committee of Ten recommended an education system that champions pursuing knowledge and exercising judgment but through specific subject domains like chemistry, physics, biology and so forth (Morrison, 2005). Their version of STEM education also advocated for the attributes of an industrial school system aimed at raising the standards of excellence for modern students. In the US, recent STEM education initiatives have been driven by global economic downturns and promoted by institutional, commercial, industrial, governmental and strategic market developments.

1.1. Economic Uncertainty and Bolstering Competitiveness

In 2007, the publication *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future* stirred employers to be more aware of the mounting concerns about educating enough scientists, engineers, and mathematicians to keep the United States in the forefront of research, innovation, and technology. In a world where advanced knowledge is widespread and low-cost labor is readily available, the advantages of the US in the marketplace and in science and technology had begun to erode. A comprehensive and coordinated federal effort was urgently needed to bolster competitiveness of the US in these areas (National Academies Press, 2007).

At the beginning of the 21st Century, and during a recent period of economic uncertainty, developed countries are placing greater pressure on global markets to grow and innovate production. *The Global Competitiveness Report 2012–2013* discussed the results of a Global Competitiveness Index (GCI), covering 144 economies from all regions of the world. The World Economic Forum organization developed the GCI to represent the complexity of national competitiveness and to identify different areas that affect the longer-term productivity of a country. Sustainable economic development is used in the GCR 2012-2013 to refer to longer-term productivity, a key factor affecting the growth performance of economies. In contrast, in the GCR 2012-2013, Klaus Schwab, Executive Chairman of the World Economic Forum emphasized that "The complexity of today's global economic environment has made it more important than ever to recognize and encourage the qualitative as well as the quantitative aspects of growth, integrating such concepts as social and environmental sustainability to provide a fuller picture of what is needed and what works" (p. xiii). The CGR 2012-2013 concluded by citing a need to better place competitiveness discussions in a societal and environmental context and suggested the World Economic Forum organization explore the complex relationship between competitiveness and sustainability as measured by its social and environmental dimensions. A sustainability mindset and skills will be needed to integrate concepts of social and environmental sustainability and to explore the complexity of competitiveness and sustainability.

1.2. STEM Curricula Organization

STEM education has been called a meta-discipline or the "creation of a discipline based on the integration of other disciplinary knowledge into a new *whole"* (Morrison, 2006, p. 4). This interdisciplinary bridging of academic disciplines is distinct from K-12 education subject area specializations. Typically in teacher education programs, elementary teacher educators are taught to be generalists and secondary teachers become specialists within specific subject areas. This is for the most part how British Columbia, Canadian, and US education is organized in the K-12 public and private school sectors. In higher education, elementary and secondary teacher candidates are instructed about a particular discipline area of knowledge (science, math, reading) through subject matter oriented methodology courses. This cycle of school subject isolation has a long history in educational institutions in the US and Canada.

For the most part, K-12 education systems in North America do not have the necessary educational structure or curriculum organization in place to teach using a multidisciplinary, interdisciplinary, or integrated approach to pedagogy.

STEM education combines four distinct disciplines but is still typically implemented through a single disciplinary course of study. In other words each discipline maintains its own unique expertise and knowledge when attempting to pose and solve problems. This form of curriculum is referred to as *multidisciplinary*. Drake (1993) contended multidisciplinary approaches encourage links between disciplines while the disciplines retain their own autonomy. Lantz (2009) writes, "Most implementations of STEM education in K-12 schools have centered on the "S and M" of STEM, and not the "S, T, E, and M". Examples of multidisciplinary curriculum resources have been produced with support from the National Science Foundation that relate to STEM education. A few of these include: Engineering by Design, a K-12 engineering curriculum from the Center for the Advancement of Teaching Technology and Science (CATTS), Engineering is Elementary (EiE) from the National Center for Technological Literacy (NCTL), and the Invention, Innovation, and Inquiry materials from the International Technology Education Association (ITEA). Jacobs (1989) defined interdisciplinary curriculum as "a curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience" (p. 8). Presently most interdisciplinary K-12 curricula exemplars in STEM do not necessarily fit neatly into current elementary and secondary school practices of educators. STEM curricula promote the "S and M" or the "T and E" in STEM, but they usually do not allow for "STEM" to be learned as an interdisciplinary course of study.

Boston (1996) pointed out that integrated learning "seeks to develop and build student competence by consciously applying and utilizing the knowledge, skills, and methods of more than one discipline or subject matter to inquire about and explore an object, central theme, concept, topic, problem, issue, or experience" (p. xi). Teacher education faculty are usually not adept at implementing curriculum organization based on a interdisciplinary or integrated curricular framework; and professional development has not been introduced in the US or in Canadian teacher education as a way to help alleviate this problem. I am inclined to believe the study of STEM could benefit by organizing curricular knowledge in a less technical and more democratic way to create meaningful experiences for students. According to Beane (1997), curriculum integration should be "concerned with enhancing the possibilities for personal and social integration through the organization of curriculum around significant problems and issues, collaboratively identified by educators and young people, without regard for subject-area boundaries" (p. x). How can an integrated curriculum structure provide the flexibility for students to articulate and study relationships between various forms of knowledge identified as relevant in STEM education and sustainability?

1.3. Sustainability Mindset

In 1987 the Brundtland Commission warned that sustainability would become more inaccessible without a dramatic change in peoples *mindset* and behavior (Lave, 1988). Five years later, Eagan & Orr (1992) argued the environmental crisis was symptomatic of a prior crisis of mind, perception, and heart (Orr, 1992). The most dominant North American mindset has been characterized by beliefs that: 1) humans are both separate from and the dominant species of nature; 2) that resources are free and inexhaustible; 3) that technological fixes are available to solve most problems; 4) that nature has an infinite capacity to assimilate human waste; 5) that progress, innovation, and consumerism must drive global markets and economic systems; and 6) that material acquisition and accumulation is the most important determinant of success. Bowers (1997) suggested, in the *Culture of Denial*, "This is a classic double bind situation where the promotion of our highest values and prestigious forms of knowledge serve to increase the prospects of ecological collapse" (p. 2). Bowers (1997) continued, warning that

> …as we learn more about changes occurring in degraded natural systems, as well as how human activities are changing weather systems that will in turn alter the distribution of species (and thus our patterns of dependence), framing the solution of the crisis in a way that does not involve a radical change in the conceptual and moral foundations of the educational process will only add to our problems. (p. 2-3)

In "Earth in Mind" Orr (2004) reminds us, the environmental crisis continues to be "not so much a problem *in* education but a problem *of* education." The environmental crisis is connected to inadequate and misdirected education that alienates people from *life-centered issues* for the sake of progress and human dominion over nature. It is a problem *of* education when young people learn they must work to *stoke the engines of innovation* and market economies in order to live. Through lifestyles that overemphasize success and careers, people begin to separate feeling from intellect and the practical from the theoretical, deadening a sense of wonder for the world. I agree with Orr that one of the problems that people face *of* education is a sustainability mindset.

In 2009, a research group from the University of Wisconsin–Madison formed the Mobilizing STEM initiative to: 1) Use the growing interest in urgent sustainability challenges expressed by STEM education faculty and students at large, and evidence that student learning benefits from engagement with real-world problems, to motivate and improve student learning of STEM concepts; and 2) Infuse sustainability education with rigorous science and teaching approaches that reflect what has been learned about how people learn the STEM disciplines. They were concerned with sustainability's omission from decades of research on teaching and learning of undergraduate STEM education in the US and that current practices did not educate a next generation of researchers motivated and prepared to address the urgent problems that we now face on our planet.

It is against the economic uncertainty and problems *of* sustainability education that I examined the purpose of STEM education and its introduction into Canadian educational institutions, particularly in British Columbia. I briefly highlighted the state of STEM education in the US, Canada, and the Province of British Columbia. However, my investigation has identified very little research on the intersections and teaching of STEM education and sustainability. My assumption is that STEM and sustainability are critical for teacher candidates to study as they begin to develop their professional, educational and sustainability mindsets and skills. As new teachers enter the profession they will undoubtedly influence their students beliefs and abilities about scientific, technological, engineering and mathematical innovation and their relationship with the world in which we live.

2. STEM Educational Initiatives

STEM education, as an initiative, has been only recently introduced into BC provincial and Canadian institutions of K-12 and higher education. Nevertheless, education in individual STEM disciplines has long driven industrial and technological innovation in Canada and the US. However, in UBC teacher education, STEM education is not taught as a required subject and typically is introduced into a teacher education program depending on faculty interests, and as individual or paired subjects (i.e., stand alone science, technology or math courses, or math and science, science and technology courses). So to begin my investigation of the current terrain of STEM education, I conducted an online review of STEM education initiatives from US and Canadian educational sites, scholarly literature, and provincial teacher education programs.

2.1. STEM Education in the US

Dr. Carl Wieman, an American Nobel physicist, University of British Columbia Professor, and the former Associate Director for science within the US White House Office of Science and Technology Policy (OSTP), provided a "blistering critique of the state of science and math education" at a September 2012 hearing by the US Senate's commerce and science committee. "There has been very little change in the level of interest in STEM or the mastery of STEM subjects by U.S. students in the past few decades," Wieman testified. Wieman admonished the congress that, "the dollars being spent by the federal government to improve STEM education are being wasted." Wieman's testimony called into question the purpose of STEM education and why the intended outcome has failed to raise career awareness and increase college and graduate level enrollment in science and engineering disciplines. Labov, et.al. (2009) provided a concise summary of recent STEM education developments in the US. "Since the publication of reports in the late 1990s by the National Science Foundation (NSF; 1996), the National Research Council (NRC; 1996, 1999), and the Boyer Commission on Educating Undergraduates in the Research University (1998) on the importance of improving undergraduate education in STEM, at least 13 other federal civilian departments and agencies have spent billions of dollars on more than 200 programs to realize this goal. Most of that spending has come from the NSF and the National Institutes of Health (Government Accounting Office, 2005). Many private foundations also have invested hundreds of millions of dollars in efforts to improve undergraduate STEM education. For example, since 1988 the Howard Hughes Medical Institute has awarded more than $1.5 billion in grants to improve science education at the precollege and college levels. As a result of this financial support and commitment from the public and private sectors, research into and implementation of numerous and varied promising practices for teaching, learning, assessment, and institutional organization of undergraduate STEM education have been developed in recent years. These practices range from improvements in teaching in individual classrooms to changes in departments." However this report is contrary to Wieman's statement to the US Senate earlier this year.

Forward to 2007, and the *Jobs for the Future: Education for Economic Opportunity* organization prepared a report called, "The STEM Workforce Challenge (SWC) and the Role of the U.S. Department of Labor in a National Solution" for the U.S. Department of Labor, Employment and Training Administration. The opening paragraph stated, "Science, Technology, Engineering, and Mathematics (STEM) fields have become increasingly central to U.S. economic competitiveness and growth. Long-term strategies to maintain and increase living standards and promote opportunity will require coordinated efforts among public, private, and not-for-profit entities to promote innovation and to prepare an adequate supply of qualified workers for employment in STEM fields" (p. 1). It is not a coincidence that the focus of these two reports is strikingly similar. Both adhere to a philosophy premised on societal changes driven by competitiveness, innovation, and economic growth. The STEM challenge, as outlined in the SWC report, also champions the "STEM fields and those who work in them [as] are critical engines of innovation and growth…" STEM fields according to one recent estimate, employ about only 5% of the U.S. workforce but accounts for more than 50% of the nation's continual economic growth (Babco, 2004). However, what is critically missing from both reports, and the SWC report in particular, is any mention of how these *engines of innovation and growth* have a negative impact on a world increasingly taxed by the desire for natural resources and the growing tensions between societal, economic, environmental and cultural conditions. Sustainability issues associated with STEM education and with innovation and economic growth are real and demand our attention.

2.2. STEM Education in Canada

At the national level there are only a few highly visible STEM initiatives. The most significant development in the past few years is the Natural Sciences and Engineering Research Council (NSERC) Collaborative Research and Training Experience (CREATE) programs and the Digital Economy Priority Research Area of the Social Sciences and Humanities Research Council. Other highly visible STEM financial support for research include: The Fulbright Canada STEM Award, sponsored by the Foundation for Educational Exchange between Canada and the U.S. (Fulbright Canada), in cooperation with the Department of Foreign Affairs and International Trade Canada and six of Canada's leading research universities and the Federal Economic Development Agency for Southern Ontario (FEDASO), a Federal development organization looking to invest in Youth STEM initiatives. Additionally, Partners In Research (PIR) is a network of Canadian professionals dedicated to educating the public, especially primary and secondary school students, in the fields of health and natural sciences, technology, engineering and mathematics. Actua is a national organization, reaching youth in every province and territory in Canada. Their aim is to build science literacy and confidence in all youth and to create a dynamic, competitive and diverse workforce to assist Canada in becoming a global leader in science literacy and innovation. Actua annually engages 225,000 youth from coast to coast, no matter their geographic location, socio-economic situation, ability or gender. Actua provides training, resources and support to a national network of local organizations offering STEM education programs. GE Canada has a strong partnership with Actua and supports their initiative as "a great investment in our future."

Even though the STEM education terminology has not been used across Canada until recently, most large universities have well-defined multidisciplinary science, technology, engineering, and math education programs in place. Slightly over 20 percent of Canadian students graduated with degrees in these fields in 2007, a number that has shown continued improvement over the last few years.

2.2.1. Sustainability and STEM Education at UBC

In 1990, UBC became one of 300 universities to sign the Talloires Declaration, which is an action plan for incorporating sustainability into higher education. In 2012 UBC received Canada's first Gold rating in the Sustainability Tracking, Assessment & Rating System (STARS), a new comprehensive university sustainability-rating framework in which over 300 post-secondary institutions across North America. In UBC's *2011/2012 Report: Place and Promise: The UBC Plan,* the university lists four broad sustainability goals: 1). Ensure UBC's economic sustainability by aligning resources with the University vision and strategic plan and deploying them in a sustainable and effective manner; 2). Make UBC a living laboratory in environmental sustainability by combining its sustainability leadership in teaching, research and operations; 3). Foster social sustainability through teaching, research and community engagement that promote vibrant human interaction and community cohesion; and, 4). Create a vibrant and sustainable community supported by exemplary governance. In November 2011, the Centre for Interactive Research on Sustainability (CIRS) opened on the Vancouver campus. Built to exceed LEED Platinum and Living Building Challenge standards, this $37 million living laboratory is helping to regenerate the environment and advance research and innovation on global sustainable challenges (Place and Promise, 2011).

In May, 2012 Stephen Toope, the President of the University of British Columbia and chairman of the board of the Association of Universities and Colleges of Canada and Arvind Gupta, a professor of computer science, at UBC and scientific director for Mitacs, a national research and training network lead a partnership excursion to Brazil. Toope stated, "Brazil is set to become one of the world's top five economies. It is pursuing a bold future, and a key part of its strategy is a commitment to invest significant resources in higher education and research, particularly in so-called STEM disciplines: science, technology, engineering and mathematics[3]." While STEM education has been implemented at UBC in undergraduate and graduate courses and through research since the 1990s, this was the first public endorsement of STEM from the President's office.

2.2.2. STEM Education for Youth in British Columbia

Searching the Internet for examples of STEM initiatives in British Columbia Canada for young people between 5-18 years of age, yielded the following examples: GEERing Up!, UBC, Vancouver; EUReKA! Science Program, Thompson Rivers University, Kamloops; Science AL!VE, Simon Fraser University, Burnaby, and University of Victoria's Science Venture program, Victoria, BC Canada. All of these programs strive to increase young peoples interest in and excitement towards science and engineering and conduct professional development to help teachers bring science into the regular classroom. These programs offer in-classroom workshops, summer camps, and community events that emphasize fun, challenging, hands-on, problem solving activities. They are a member of Actua and provide opportunities for young people to explore science beyond the textbook through hands-on, interactive discovery that engages youth interests and fosters confidence. These programs attempt to make science accessible to all youth, regardless of gender, culture or level of affluence, generate enthusiasm, and serve as positive role models to challenge stereotypes associated with scientists. Science Venture also partnered with seven Aboriginal communities to collaboratively engage over 400 Aboriginal youth in the areas of science, technology, engineering and math.

2.2.3. STEM and Teacher Education at UBC

In the UBC Faculty of Education, since 1998, the Computer Studies Education (CSED) and Technology Studies Education (TSED) areas of the secondary teacher education program have offered summer courses for teacher candidates interested in STEM education. Courses examined physical principles for engineering bridges, computers or robots? Student's asked, What technologies can be used in classrooms to demonstrate respect for sustainability?; and, How engineering can be used to interest people in science and technology? Working with faculty members from computer science, mechanical and civil engineering, students worked through a series of problems in engineering in order to integrate knowledge from STEM education. In effect, these courses introduce students to developing a sustainability mindset for dealing with the ecological-natural, existential-spiritual, ethical-personal, socio-political, and technical-empirical dimensions of STEM education.

2.2.4. STEM Education in Post Secondary Universities

Most STEM initiatives at universities in BC have multidisciplinary, interdisciplinary and intercultural affiliations. The Centre for Aboriginal Health Research (CAHR) collaborates with the UVic STEM Project to introduce a health component to the Songhees Nation after-school outreach activities while promoting interest in Aboriginal health research careers. The STEM Project encourages Aboriginal learners to explore possible career paths and mentorship opportunities. There are seven participating community partners: Tsawout, Songhees, LÁU, WELNEW Tribal School, Victoria Native Friendship Centre, Tseycum, T'Sou-ke and the Métis Nation. Medical, Human and Social Development, Science and Engineering faculty and students deliver programs and presentations for Aboriginal learners in these communities.

The *Carl Wieman Science Education Initiative* (CWSEI) is supported by UBC and is developing a scientific approach to teaching that addresses: what students should learn, what students are learning and what instructional approaches improve student learning. Their goal is to achieve highly effective, evidence-based science education for all post-secondary students by applying the latest advances in pedagogical and organizational research. The CWSEI has a broader purpose to benefit the community by enabling people of all ages to make informed decisions based on scientific understanding about complex issues such as genetic modification, choice of energy sources, resource extraction, and ecological diversity. The CWSEI website stated, "the modern economy is largely based on science and technology, and for that economy to thrive and for individuals within it to be successful, we need most citizens to be technically literate and have complex problem-solving skills. By establishing an educational system that produces far more students with these and other abilities such as communication and teamwork, the CWSEI will benefit local and national industry.[4]"

Over the last three years, several interdisciplinary NSERC CREATE programs at UBC received six-years of funding: 2009—Working on Walls (WOW) Training Program; 2010—Training Program in Atmospheric Aerosol Program; 2011—TerreWEB: Terrestrial Research on Ecosystems and World-wide Education and Broadcast, Sustainable Building Science Program; and, 2011— Quantum Electronic Science and Technology, Multidisciplinary Applied Geochemistry Network. These interdisciplinary programs employ and train students and postdoctoral fellows in the fields of science, technology, engineering and math. For example, Working on Walls5 (WoW), launched in 2009 with a focus on the biosynthesis of plant cell walls and the practical implications of cell wall research. WoW offers a small group of students and post-doctoral fellows a rigorous experience anchored in a wide array of transferable professional skills. This research collaboration argues in the coming decades, "human society will be faced with a dramatic transition as it moves from a fossil fuel-based economy to technologically sophisticated, sustainable bio-based economies. Making this transition successfully will depend in large part on the versatility and creativity of the coming generation of researchers, who will need to be prepared to work in a different world than that enjoyed by the current scientific workforce. 6

3. Concluding Remarks

It is widely recognized that we cannot afford to have "either/or" conversations about economics and society, society and technology – nor about society and sustainability. We must begin to see that economics is thoroughly embedded in society, technology and sustainability. It is reckless and dangerous to assume that it is okay to grow an economy by exploiting people and the natural world. This does not mean that sustainability is more important than the economy. But it does means that processes of social stratification are at play and there is directionality to the functions and purposes of what knowledge and whose knowledge is of most worth. It is important that we learn to consider both the functions and purposes of all living systems. That is, human societies need to change the functions of global economic markets driven by competitiveness, progress, growth, and innovation with economic systems that encompass the purposes of producing and sustaining a healthy community and livable natural world. What does this mean then with regards to STEM education?

From this review of literature and Internet information, it appears that there are at least three significant issues concerning STEM education initiatives and sustainability in need of further inquiry: employment and economic competitiveness; disciplinary and integrated studies, and innovation and sustainability education. There was very little evidence that STEM education initiatives also addressed sustainability issues. Education is needed that helps people develop mindsets that: 1) humans are both interdependent with other species of nature; 2) the earth is not a resource that is free and inexhaustible; 3) technological fixes will not solve most problems; 4) nature does not have an infinite capacity to assimilate human waste; 5) progress, innovation, and consumerism should not drive global markets and economic systems; and 6) material acquisition and accumulation is actually one of the least important determinants of success.

Further research is also needed on how and why STEM education should involve more than learning about isolated fragments of knowledge from the separate fields of science, technology, engineering, and math. How can STEM be developed within curricula that integrate rigorous content within the contexts of designing solutions to real-world problems? How can it involve authentic experiences, such as industry mentorships, field trips, and guest speakers, to further enhance project-based curriculum and curriculum relevance? In the process of problem solving, how can students engage in the application of science and mathematics through technological and engineering-design processes? How can they learn to conduct scientific experiments, gather and analyze data, draw and communicate conclusions, develop and evaluate prototypes, and think critically about sustainability? These are some of the questions I will pursue in future research.

4.Footnotes

[2] Under technocratic rationality, de-contextualized, reified and technocratized knowledge is regulated and distributed in ways that conceal issues of power and control that underlie all forms of knowledge (Hussein, 2007; Bentley, 2003).

[3] Retrieved from http://president.ubc.ca/2012/05/02/oped-building-bridges-from-b-c-to-brazil/

[4] Retrieved from http://www.cwsei.ubc.ca/about/index.html#Community

[5] Retrieved from http://wow.msl.ubc.ca/

[6] Retrieved from http://www. wow.msl.ubc.ca/

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