

Federal Research Funding for Post-Secondary Engineering and Science Education

A submission on from the Canadian Engineering Education Association
to the Pre-Budget Consultations in Advance of the 2019 Budget

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Recommendation 1: That the government implement two programs to transform how science, technology, engineering, and math (STEM) are taught and learnt at the post-secondary level, so as to promote Canada's competitiveness by modernizing how Canada's future technology innovators are educated.

Recommendation 2: That the government provide \$10M per year for five years of funding for research and people through the Canada Research Coordinating Committee Research (CRCC), to jump start building Canada's foundation of scholarship and research expertise in post-secondary teaching and learning of STEM.

Recommendation 3: That the government provide \$15M per year for five years of program funding, to create an Instructional Innovation in Post-secondary STEM (IIP-STEM) program hosted through the Future Skills initiative to co-fund centres, institutes or individual initiatives that pilot innovation in the instruction and assessment of the professional skills needed to mobilize technological development and translate innovation into competitiveness.

Rationale for the recommendations

Efforts to continuously strengthen capacity in science, technology, engineering and math (STEM) have earned Canada a reputation as a leader in science, research and innovation. These efforts have included a recent commitment by the federal government to provide over \$6 billion in funding to support both research and mobilization of innovation to change our lives¹. It is clear that the Canadian government recognizes the important role that technological innovation plays in Canada's prosperity and competitiveness in the global marketplace. However, progress goes beyond simply funding research; the foundation of progress is the development of people. Underlying our country's future competitiveness is our ability to educate Canada's future technology innovators.

STEM educators need to step up and modernize post-secondary teaching and learning, so as to better equip students to keep pace with this technological innovation. We can't hope to develop our future innovators using educational paradigms of the past and we need federal support in order to achieve the changes required. As such, we urge the federal government, as part of Budget 2019, to enable the next generation of engineers and scientists by funding critical research on how they are taught. This funding will help graduate engineers and scientists who can promote competitiveness while proactively designing employment considerations into Canada's technological future. Further the funding will solidify Canada's foundation of applied STEM education scholarship and develop our next generation of scholars, many of whom are women.

The need for education reform is certainly overdue in engineering. Our 300 members in the Canadian Engineering Education Association recognize that major shifts need to occur in how and what we teach the over 100,000 students in engineering programs across the country.² This shift is needed so as to better equip them with the skills they will need to become innovators and leaders who will drive the growth of the Canadian economy. Such a major shift in post-secondary education must be underpinned by evidence from education research.³

In Canada there is a conspicuous absence of federal funding for research on how to teach STEM at the post-secondary level; in this regard, rather than leading, Canada is falling further behind other nations. The United States, for example, has traditionally allocated approximately \$100 million annually through their National Science Foundation for research to improve undergraduate STEM education.^{4,5,6} At a time when the nature and role of post-secondary education is undergoing substantial transformation, no equivalent funding exists in Canada. Because this research is situated between traditional research domains, such as physical sciences and education, and thus outside the eligibility criteria of the federal Tri-council granting agencies,⁷ it has fallen between the cracks. This gap affects women more than men, who make up many of the junior faculty and the majority of the graduate students pursuing engineering education thesis research. Instead of providing a firm foundation for change, Canada's barriers to funding post-secondary STEM education research is hindering our ability to make evidence-based improvements to how Canada's next generation of engineers and scientists are taught.

¹ <https://www.newswire.ca/news-releases/budget-2018-investing-in-canadas-innovators-scientists-and-researchers-675994663.html>

² <https://engineerscanada.ca/reports/canadian-engineers-for-tomorrow-2016#introduction>

³ <https://engineerscanada.ca/sites/default/files/public-policy/STEM-Education-Research-Funding-EN.pdf>

⁴ https://www.nsf.gov/about/budget/fy2019/pdf/33_fy2019.pdf

⁵ <https://www.nsf.gov/pubs/2018/nsf18084/nsf18084.jsp>

⁶ <https://www.nsf.gov/eng/eec/about.jsp>

⁷ The federal tri-council granting agencies are the Natural Sciences and Engineering Research Council, the Social Sciences and Humanities Research Council of Canada, and the Canadian Institutes of Health Research.

Federal initiatives are underway in Canada that could help remedy this situation if reinforced through Budget 2019 support. The Future Skills initiative will examine the interplay between technological change, changing skills required for employment, and innovative approaches to education and training. The Canada Research Coordinating Committee Research (CRCC) is looking to reduce the barriers in funding from Tri-council granting agencies and thereby address gaps. We urge the federal government to leverage this opportunity for dramatic progress by including targeted funding across both of these initiatives in Budget 2019.

Recommended Funding

Funding for People and Research

Budget 2019 should provide \$10 million annually for five years directly to the Tri-council granting agencies, or through the CRCC, to build Canada's foundation for STEM education research. This funding will be used to pilot a new NSERC-SSHRC program, The Collaborative STEM Education Research Projects (C-STEM-ERP) program will encourage and grow collaboration between researchers in physical sciences (NSERC) and social sciences (SSHRC) through studies focusing on post-secondary STEM education. Its structure could be similar to the existing CIHR-NSERC Collaborative Health Research Projects (CHRP) which brings together investigators in health and physical sciences. The funding for people will also support graduate students pursuing STEM education research, the majority of whom are women. Finally, the funding will support piloting a new national program of Science and Engineering Teaching and Learning Post-Doctoral Fellows, based on the successful model created at the University of British Columbia⁸ and now being replicated at Queen's University. These Fellows will be appointed to academic departments to allow them to translate their discipline-specific knowledge to instructional innovation. The Fellows will then become the next generation of STEM education scholars so as to grow and diversify Canada's STEM education community.

Program Funding

Budget 2019 should provide \$15 million annually to create an Instructional Innovation in Post-secondary STEM (IIP-STEM) program hosted through HRDC's Future Skills initiative.⁹ Universities and colleges will apply to IIP-STEM to co-fund teaching and learning centres, research institutes, or individual initiatives that pilot innovation in the instruction and assessment of professional skills (e.g. teamwork, leadership, technical communication, management, business, ethics and equity, global fluency, and entrepreneurship). A cross-cutting focus will be on "learning how to learn" as a foundation for self-directed and lifelong learning because learning skills are essential to supporting Canada's transition to a learning-based economy. These instructional innovations will be integrated into existing traditional and online courses, extra-curricular activities, experiential learning opportunities, and continuing education programming.

Benefits from this Investment

This investment will help Canada to develop and promote modern approaches to STEM education. Specifically, the funding will:

- 1) Increase innovation in STEM education and create better learning experiences and classroom practices so as to produce STEM graduates better prepared to mobilise technology and navigate the transformational effects of technological change themselves. Specifically, the funding will create a

⁸ <http://www.cwsei.ubc.ca/resources/STLF-develop.htm>

⁹ <https://www.newswire.ca/news-releases/government-of-canada-launches-future-skills-centre-call-for-proposals-and-future-skills-council-call-for-applications-683600471.html>

stronger link between academic scholarship, education and training, and the evolving range of skills needed to leverage technological knowledge and promote Canadian competitiveness, by enabling more widespread and effective instruction of professional and life-long learning skills.

- 2) Translate knowledge about the employment impacts of technology innovations for Canadians. For example, employment skills do not need to only react to changes in technology such as artificial intelligence and machine learning; a more proactive approach can better enable a positive feedback cycle of innovation and new employment opportunities. Through new technology, a former truck driver might now monitor and navigate a small fleet of trucks or drones from a central “control tower”. The scientists and engineers who play central roles in developing next-generation technologies need to better recognize and address the employment implications of their innovations. Current engineering education provides little to no instruction on incorporating employment and lifelong learning as design considerations for technologies. Innovation in STEM education will create graduates better able to leverage these broader economic and social considerations.
- 3) Help attract and retain young academics and graduate students in STEM education research so as to build the Canadian community of scholarship needed to increase innovation in education. In fact, this movement is already underway. Despite the current lack of federal funding in this area, new faculty are being hired and graduate students’ involvement in engineering education is growing primarily through internal university funding. There are now over 40 students doing graduate work in this field. Many of the junior faculty are women, as are the majority of the graduate students pursuing engineering education thesis research, demonstrating the opportunity for further diversification in traditionally male-dominated fields. These students will become our next generation of engineering instructors and educational innovators.
- 4) Bring CCRC and the Future Skills initiative together in supporting research on skills and education in order to generate synergetic benefits and to increase the return on investment from each of these individual initiatives.

In summary, we are asking that Budget 2019 include funding to promote post-secondary STEM education research. This funding will support junior faculty entering this emerging field, foster research programs able to support graduate students in the field and help to improve gender balance in STEM. Further this funding will help graduate scientists and engineers better equipped to keep pace with technological change, mobilize new technologies, and shape a technological future full of new employment opportunities and career paths. Ultimately, this strategic investment should yield substantial returns by producing engineers and scientists who are better able to develop innovative science and technology that can advance Canada's competitiveness and enhance its economic and social well-being.