Building the Engineering Mindset: Developing Sustainable Leadership and Management Competencies in First Year Engineering

Marnie V. Jamieson¹ and John R. Donald²

¹Department of Chemical and Materials Engineering, University of Alberta

²School of Engineering, University of Guelph

Author E-mail: mvjamies@ualberta.ca and jrdonald@uoguelph.ca

Abstract

The broad inclusion of sustainable engineering leadership and management concepts are increasingly recognized as necessary to ensure the relevance of an engineering education in a rapidly shifting world. Engineering leadership and management are integral to the engineering mindset and necessary to address the complex engineering problems faced by society. Examples of these complex problems can be seen in the UN Sustainable Development Goals (SDGs) adopted by all UN member states, including Canada, in 2015 [1]. The Canadian Engineering Accreditation Board (CEAB) identifies the need for strong non-technical skills with a majority of the Graduate Attributes focusing on non-technical skills such as communication, teamwork, ethics and lifelong learning [2]. The UN SDGs are well aligned with the CEAB Graduate Attributes [3] and could be very effectively operationalized in engineering programs through the use of a sustainable engineering leadership and management model.

To address these needs in the engineering curriculum, we suggest sustainable leadership and management concepts be implemented as core content in engineering programs, to develop non-technical competence to the same degree as technical competence. In our first “building the engineering mindset” paper [4], a Leadership-Management Development Matrix (LMDM) was created as a proposed mechanism for identifying and assessing the progression of non-technical skills through the undergraduate engineering curriculum and for relating these skills to engineering practice. Skills such as communication, self-regulation and empathy are typical in engineering practice and can be related to the full curriculum.. The LMDM can be used to clearly map leadership and management skills to design courses and other engineering year course activities. This mapping will provide students with a foundation to relate their subsequent courses to engineering practice and to their ultimate career path. In this paper we begin the application of the LMDM by examining first year course material at two Canadian universities and mapping these materials and activities to the LMDM and graduate attributes. We use the LMDM to develop and assess opportunities in the first year and to examine the engineering leadership aspects of sustainability, with integrated awareness and practice of the non-technical engineering skills alongside technical skills. Using the LMDM, the course materials will be mapped to leadership development levels from self, through team, organization and society. Also mapped will be non-technical skill domains of cognition, behaviour, management and leadership in the context of management roles within teams, organizations and society. The relation between these mappings and the connection to the CEAB graduate attributes and institutional graduate attribute indicators will also be examined.

The multi-dimensional mapping of engineering curriculum to the LMDM, CEAB and institutional graduate attributes will provide insight into the opportunities that exist for strengthening the relevancy of the non-technical curriculum from the view of both students and faculty. By starting with the first year engineering curriculum at two institutions in this paper, we will be able to extend the findings and analysis in future work by both progressing through the upper years of these two programs, and by expanding the view to additional engineering programs.

[1]Sustainable Development Unit, Government of Canada, “Towards Canada’s 2030 Agenda National Strategy,” Website and PDF format, 2019. Accessed November 25, 2020.

<https://www.canada.ca/en/employment-social-development/programs/agenda-2030/national-strategy.html>

[2] Canadian Engineering Accreditation Board, “Canadian Engineering Accreditation Board: Accreditation Criteria and Procedures,” Ottawa: Canadian Council of Professional Engineers, 2018.

[3] M. Jamieson, L.Lefsrud, F. Sattari, J. Donald ECE paper....

[4] M. Jamieson and J. Donald, "Building the Engineering Mindset: Developing Leadership and Management Competencies in the Engineering Curriculum," Proceedings of the Canadian Engineering Education Association (CEEA), Jun. 2020, doi: 10.24908/pcea.vi0.14129.