ENGAGING ALUMNI IN EESD CURRICULUM ASSESSMENT

Negar Roghanian [1,2], Jim Sibley [1] ,Susan Nesbit [1]
[1] The University of British Columbia (UBC), Canada
[2] negarog@civil.ubc.ca

Abstract: With the goal of continually improving the civil engineering undergraduate program at the University of British Columbia (UBC), the current, 2-phased, study assesses the level of graduating student achievement of two critical Canadian Engineering Accreditation Board (CEAB) graduating student attributes, namely "ethics" and "the impact of engineering on society and the environment". The first phase, which is reported here, involves deploying, at a small scale, a novel process of assessing the ethics attribute. The base-line data collected include both the self-evaluation by a small set of 4th year students respecting their development of the ethics attribute, and the assessment by a practicing engineers alumni panel of the level at which the students meet entry-level engineering ethics expectations. In addition to assessing student achievement of the ethics attribute, the alumni panel discussed possible refinements of the novel assessment process.

The second phase of the study, to be reported in a subsequent paper, involves a larger-scale deployment of the revised protocol in order to assess the CEAB "impacts of engineering on society and the environment" attribute. The objective of this study is to gain insights into possible gaps between lived curriculum and industry expectations by employing an authentic, and administratively manageable, assessment protocol.

1 INTRODUCTION

As engineering problems relating to urban infrastructure become increasingly complex, educating civil engineering students, as future designers and problem solvers, on "ethics" and "sustainable aspects of engineering activities" is of critical importance. The significance of this non-technical knowledge is underscored in Canada by the Canadian Engineering Accreditation Board (CEAB)'s specifications of 12 attributes (CEAB, 2010). But, measuring student achievement of the non-technical attributes, particularly those related to ethics and sustainability, requires the development of assessment processes tools that are novel within the engineering education context.

Although during the last few decades, interest in the ethics and sustainability learning outcomes has developed significant momentum in many countries including Canada; still, there are few ethics-related or sustainability-related learning pathways in Canadian programs. So, development of engineering curricula that integrate ethics and sustainable development throughout the program could potentially elevate the quality of education in civil engineering.

1.1 Quality assessment programs

Development of engineering education programs and teaching methods can be driven by many factors. Rogers et al., 2010 mention that continuous quality improvement (CQI) in engineering education includes five principles:

1. Constructive input
2. Clearly stated educational objectives and student outcomes
3. Arrangement of curricular processes which enable student learning
4. Collection of data through valid and reliable assessment methodology
5. The use of assessment results to drive decision making for improvement

So without measuring student's knowledge through a quality assessment program, improvement and growth are difficult.

In anticipation of "out-comes based" engineering program accreditation requirements, some universities across Canada and US have proposed different assessment programs through two major approaches: "course level assessment" and "program level assessment". The Schulich School of engineering at the University of Calgary, as well as the University of Manitoba's department of electrical and computer engineering, conducted a pilot study which involved assessment at the course level and extrapolation of the results to achieve a program level assessment (Brennan, 2010, Ferens et al. 2010). However, one of the disadvantages of course level assessment is that the measurements done at the course level will not be indicative to the same degree were the assessments done at the time of graduation.

On the other hand, the program level assessment is performed on new graduate students and it is more difficult to implement compare to course level assessment. In the program level assessment, assessors need to be identified (e.g. industry professionals, instructors, deans, alumni), evaluating tools need to be developed, and arrangements need to be made which require a great deal of administrative effort. The authors of this paper are performing a quality assessment on 4th year civil engineering students at the University of British Columbia that aims to evaluate the level of graduating student achievement respecting CEAB graduating student attributes related to both ethics and sustainability.

1.2 Integrating industry professionals into the program assessment process

Research on student learning outcomes at Monash University's faculty of engineering in Australia, on the perception of graduate attributes, indicates a missing link between graduating student skills (e.g. social ethics) and employer's expectations (Nair et al. 2009). So, it is important to investigate that the extent to which the attributes possessed by graduating engineering students are aligned with industry expectations.

Many institutions have struggled to integrate industry professionals into the quality assessment of their engineering programs to evaluate student learning and provide input about graduating student knowledge (MacMartin and MacGourty, 1999, Napper and Hales, 1999). University of Manitoba established an industry focus group forum for curriculum assessment of the undergraduate electrical and computer engineering program. The forum resulted in identification of the gap between industry needs and the actual abilities of recent graduates (Ferens, 2011). Rose-Hulman institute of Technology's (RHIT) department of civil engineering used assessment teams comprised of industry professionals and faculty members to investigate student's performances (Sutterer, et al.). They used two approaches; for the first one, the students were assessed by teams of four industry professionals. The assessments were conducted on senior capstone design projects from the prior academic year. The second approach was conducted on all other student work submitted for assessment of department-specific student outcomes. Each industry expert was teamed with one faculty member and the pair was charged with rating student submissions. According to the literature, collaborating with industry experts to assess student outcomes adds another dimension to the education program planning. Industry professionals may provide specific feedback that help bridge the gap that exists between the academic environment and the expectations and realities of the industry.

2 OBJECTIVES AND RESEARCH QUESTIONS

The current pilot study aims to assess the level of graduating student ability to demonstrate knowledge of "ethics". The objective is to gain insight into the alignment or gaps between civil engineering 4th year student understanding of engineering ethics and the perspective of young professional alumni. More generally, it may be that the novel assessment process provides an opportunity for the development of

curriculum strategic planning as well as teaching methods in integration of ethics and sustainable development in civil engineering education.

The following research questions are asked:

- How prepared do civil engineering forth year students feel regarding their careers in industry and respecting ethical issued faced in industry?
- What are industry's expectations for the engineering graduate just beginning the professional journey in terms of ethics?
- Is ethics effectively integrated into the civil curriculum?

To answer these questions, a three step small pilot study was conducted comprising of student's self-evaluation and the assessment by alumni working in industry regarding their needs and expectations of civil engineering graduates. Three sets of base-line data were collected through a staged quality assessment program at the University of British Columbia's (UBC) civil engineering department:

1. Student self-evaluation respecting their understanding of ethics
2. The assessment by a professional alumni panel regarding the level at which a sub-set of randomly selected 4th year students meet their expectations

3 METHODOLOGY

As described above, this study explores the gap that may exist between lived curriculum and industry expectations. The methodology developed to address the research questions is a three-step program of conducting a student's self-evaluation, student evaluation of brief descriptions of ethical dilemmas found in professional practice, and engaging professional alumni to evaluate the quality of the students' understanding of ethics.

Data was collected from three of approximately 130 Civil engineering fourth year students in University of British Columbia (UBC) and three practicing engineers who are Alumni working in both the public and private sectors in Vancouver. The students were recruited by a call for volunteers to the civil engineering undergraduate club. The three responding students were relatively strong, academically, placing within the top third of their graduating class. One was a mature student. The alumni were recruited via professional networks of one of the authors. The alumni had graduated at either a masters, or a bachelors, level with a civil engineering degree from UBC, awarded between 2006 and 2009.

3.1 Self-assessment and Case Analysis

Each student was asked to self-evaluate their ethics competency by agreeing or disagreeing with three belief statements via a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). The belief statements were

- I am able to analyze a situation involving ethical issues,
- I am able to recognize the unethical issues, and
- I am able to explain professional ethics guidelines.

Students were also asked to read three brief descriptions of ethical dilemmas, and then respond to a set of multiple-choice questions, thereby indicating the appropriate resolve of each dilemma.
A debriefing meeting was conducted at the end of this investigation to help evaluate the civil engineering program. The student's feedback will be used as an input to help assess and improve the pilot study for the second phase.

3.2 Engaging professional Alumni in the assessment

In the last step, three Alumni were invited to a two-hour workshop during which they reviewed student-generated presentations that were captured on video. The Alumni were helped to develop an

understanding of the ethical issue analyzed by students in their presentations and were guided through the assessment process of each student's presentation. They assessed the student presentations with the aid of a prepared guiding rubric. Their feedback was compiled and analysed to help identify the gaps and to help modify civil engineering curriculum at UBC.

More specifically:

1. Three volunteer 4th year students were each invited to prepare a video presentation

The students were asked to watch and analyze a case study on engineering ethics available from the United States National Institute for Engineering Ethics (NIEE) and prepare a video presentation (narrated PowerPoint, 5 slides/10 min) based on establishing the facts, recognizing the missing information, articulating the ethical issues and analyzing the case with clear arguments. The presentations were recorded at the Centre for Instructional Support at Civil Engineering department of UBC and presented to a panel of three alumni.

2. Young professional alumni were invited across industries

Three professional alumni were invited to give structured feedback on student's case analysis (video presentation). The alumni panel assessed each student's presentation by agreeing or disagreeing with a series of 25 statements, based on a likert scale ranging from 1 (strongly agree) to 4 (disagree) statements. Together, the statements constituted a guiding rubric. The rubric statements reflected both the "expected" and "observed" levels of ability of civil engineering graduates. The assessment rubric consisted of five sections:

Section 1: Evaluating the student's ability in recognition of the dilemma and understanding the problem

Section 2: Evaluating the student's ability in establishing the facts and recognizing the missing information

Section 3: Evaluating the student's ability in articulating and describing the ethical issues of the case and how they affect the individual, the company and the public. Also understanding the consequences of deviating from professional codes

Section 4: Evaluating the student's ability in analysing the case with clear arguments

Section 5: Evaluating the student's perspective and resolution and their ability to act ethically and demonstrate individual accountability

An orientation package was prepared and sent to the alumni panelists before the workshop. Upon completion of the student assessments, the panel provided the authors with an overview that included advice for improving both the assessment process, and curriculum. This feedback will be used as an input to help identify the gaps and to modify, shape and restructure civil engineering curriculum at UBC's civil engineering department.

4 RESULTS AND DISCUSSION

4.1 Alignment and Gaps between Student Self-Assessment and Alumni Assessment of Ethics Competencies

Qualitative analysis of the data collected from the student self-assessment and case analysis showed that students felt that they are very well prepared for work in industry in terms of being able to recognize and analyze situations involving conflicting professional ethics issues. However, they felt that they are not able to explain ethical guidelines such as the professional code of ethics and its application. None-the-less, all three students felt that they are well-prepared for the challenges they may face as practicing engineers.

The Alumni agreed that students were able to present their 'problem recognition' and 'decision making' abilities when describing how they approached the ethical issues in the case. One of the students showed better ability describing and framing the key ethical issues and considering all primary stakeholders in a clear and analytical way. However the other two students were more successful in showing their problem

solving and decision making abilities and analytical skills rather than establishing the problem. The Alumni appreciated conclusions that presented various options although felt that argumentation was weak at times.

Overall, and in contrast to the student self-assessments and case analysis, the Alumni panel agreed that two out of three students demonstrated adequate abilities as entry-level engineers and appeared to be adequately prepared for the ethical challenges of the workplace. One student minimally met expectations and none of the students exceeded industry expectations.

These early results of assessing student competencies provoke questions about the curriculum under investigation. For example, if academic performance is related to ethical competencies, then one might expect that students with academic ranks in the top third of their class might exceed the expectations of ethical competencies for entry-level engineers. However, the tentative results presented here suggest that even the most accomplished students may possess only adequate competencies.

The results also suggest that the engineering curriculum under investigation may be improved by providing opportunities for students to enhance their abilities to both frame ethical considerations in a given situation, and to identify primary stakeholders and stakeholder issues related to the ethical conundrums that an engineer can face.

While students were moderately successful at disaggregating the ethical issues and then making a decision leading to an ethical resolution, they were less successful at providing the rationale for their decision. It may be that a focus on ethical issues within communications courses could help students improve argumentation skills.

During the final debriefing session, students reported that there were few courses in the civil curriculum helpful in preparing them for analysing professional ethical issues. They particularly mentioned a deficit in the 3rd year of the program. The industry Alumni and students recommended to incorporate ethics into civil engineering project courses as well as a 4th year engineering economics course as assignments or projects rather than to offer a stand-alone, ethics-based, course. The assignments and projects could be more comprehensive where students work on ethics case studies. The alumni suggested that an ethics component to a design project proposal or deliverable would be very reflective of what's expected in industry.

4.2 Revising the Novel Assessment Process

The assessment process tested in this study consisted of three steps, namely, 1. student self-assessment, 2. student review and decision-making relating to descriptions of ethical dilemmas, and 3. a workshop wherein Alumni review student presentations of their analysis of a re-enacted ethical problem experienced by a young engineer. Feedback from alumni after they had reviewed student presentations during the workshop indicate that they felt the assessment process has the potential to highlight aspects of engineering practice to which students have little or no exposure, including articulating legal principals versus ethical issues and documenting disciplinary actions in the workplace.

Although the small sample size, short length of the student video presentations, and case study format might impact the results, the Alumni felt that, overall, the assessment process was effective in being able to assess the students in a relatively quick way, while still providing enough information that they meet expectations of a new junior engineer. They found the case material sufficient and realistic for evaluating student's abilities and relevant to the interactions that a new engineer would face in the workplace. It was mentioned by the alumni that students responding to the filmed re-enactment of a realistic ethical dilemma faced by a young engineer, rather than responding to a written description, realistically captures the dialogue and complexity similar to their own situations. The recommendation of the industry Alumni was to have student’s present in-person rather than video presentations, or have a face to face discussion following the video presentations so there would be an opportunity for Alumni to ask questions of the presenting students.

The authors were concerned that annual or perhaps bi-annual participation in a two-hour workshop would be too onerous for busy practicing engineers who are approaching mid-career. The panelists commented

that they felt their time was well spent and that they would gladly participate in future workshops. They commented that many of their colleagues and former class-mates would likely feel similarly.

4.3 Phase Two of the Study: Assessing the "Impact of Engineering on Society and the Environment" Attribute of 4th year Students

The second phase of this study focuses on the assessment of student competencies relating to the "Impact of Engineering on Society and the Environment" attribute described by CEAB. The assessment process to be followed will be a refined version of that described in this paper. For example:

- Ideally, the full graduating class will be given a self-assessment respecting their sustainability competencies.
- Ideally, summative assessments of 4th year student knowledge, skills, and attitudes relating to sustainability will be available as "course-based" data.
- A number of randomly selected students from the 4th year cohort will participate in preparing material that will be reviewed by an Alumni panel.

Comparing student self-assessments (i.e. what students think they know) with both course-based assessments (what students are able to demonstrate), and the assessments of the Alumni panel (i.e. a comparison between student performance and industry expectations) will evoke questions that may lead to the identification of sustainability learning gaps within the curriculum.

The protocol by which the Alumni review takes place will be improved during phase two:

- The number of students reviewed by Alumni is constrained by the resources required to support both students and Alumni in this review. We may be able to increase the number from 3 to perhaps 6 or 8.
- The number of Alumni involved in reviewing the student work could be increased to 4 or 5.
- The length of student presentations to the Alumni will be increased to 10 to 15 minutes.
- The format of the guiding rubric will be improved such that it will no long include a detailed list of likert scale statements. Instead, each of the five sections will include detailed descriptors of each section as well as a single, visually appealing, scale for each section on which Alumni can indicate each student's level of achievement.
- Short Alumni and student interviews will be tested to determine if face-to-face interviews provide Alumni with great insights into student competencies.

Ultimately, the goal of the study is to develop a process that can be used to help understand the gap that may exist between lived curriculum and industry expectations. It provides an opportunity for development of curriculum strategic planning as well as teaching methods in integration of ethics and sustainable development in engineering education.

5 CONCLUSIONS

This study was motivated by a desire to highlight the importance of both ethics and sustainability, and to compare industry needs with current civil engineering curriculum to help strategic planning with regard to courses. This study was also able to give a perspective and preliminarily highlight some aspects of work in industry to which graduate students have little or no exposure. However, the small sample size, short length of the video presentations and case study format might impact the findings.

Taken as a whole, the pilot study was effective in providing information about the gap between students' knowledge and industry expectations. It confirms the importance of student's knowledge of professional ethics as a basis of engineering practice, as well as student's abilities of problem-solving, decision-making, articulating legal principals versus ethical issues and documenting disciplinary actions in the workplace. It also points to the complex interactions between these different skills.

The decision to use video presentations in this study instead of questionnaires and face to face interviews which were used in previous studies was justified. The described pilot study has shown the potential of using video presentations for data collection. However, it should be noted that interviews and face to face conversations allows the Alumni to raise interesting questions, challenge the students and explore the context more which will be considered in the future studies and the second phase.

According to the study, the industry alumni desired universities to cover more ethics-related material in an undergraduate civil engineering program. Civil students and entry-level professionals need to be introduced to the importance of codes of ethics and regulations in the first year program and then build on this introduction via integration of ethics via case studies in subsequent years of study. The alumni stressed the need to learn and appreciate the differences between the legal environment of the workplace, and the professional and ethical obligations to which they will be held accountable.

This pilot study also has shown the advantages of running workshops by Alumni professionals to assess graduating students. The Alumni were impressed and enthusiastic that UBC expressed interest in industry input with regard to ethics and evaluation of curriculum.

It is imperative for universities to assess and modify curricula so that graduates are better prepared for career success. Closing the gap between industry expectations and the "lived" engineering curriculum requires the involvement of faculty members, curriculum experts, and engineering practitioners such that programs and courses effectively expose students to real-life, ethically messy, situations.

Overall, this study attempted to provide a preliminary, novel, example of what can be obtained from engaging alumni in assessing the curriculum in two phases. During the first phase, which is described in this paper, assessing for the "ethics and equity" graduating student attribute is piloted and refined. The findings and the improved protocol will now be employed to design the next phase of the investigation respecting the second graduating student attribute on the "impact of engineering on society". This second phase should include larger student sample size, longer video presentations and a series of face to face interviews. The proposed pilot study and the findings could have applicability to other engineering disciplines and other contexts.

ACKNOLEDGEMENTS

The authors would like to acknowledge the contribution of the Alumni and students who kindly participated in this project as well as the staff of the Centre for Instructional Support in UBC's Faculty of Applied Science. The author's also gratefully acknowledge the supported of the University of British Columbia's Teaching and Learning Enhancement Fund.

REFERENCES

Canadian Engineering Accreditation Board 2010. Accreditation Criteria and Procedures, Engineers Canada, ISSN 1708-8054, 86p.

Brennan, R.W. and Hugo, R. J. The CDIO Syllabus and Outcomes-Based Assessment: A Case Study of A Canadian Mechanical Engineering Program. Proc. Of the 6th International CDIO Conf., June 15-18

Ferens, K. 2010, Work in Progress: Are We Teaching The Right Stuff? Proc. of FECS'10 - International Conference on Frontiers in Education: Computer Science and Computer Engineering, Las Vegas, NV, July 11-15.

Nair, C. S. and Patil, A. 2009. Re-engineering graduate skills - a case study, European Journal of Engineering Education, 34(2): 131 – 139.

Ferens, K. and Friesen, M. 2011. Industry Focus Group Forum for Engineering Program Assessment. International Conference on Frontiers in Education: Computer Science and Computer Engineering, Las Vegas.

Napper, S.A. & Hales, P.N. 1999. Using design projects for program assessment. Journal of Engineering Education, 88 (2): 169 - 172.

Rogers, G. 2010. Continuous Quality Improvement in Engineering Education: Fact or Fiction. American Society for Engineering Education 2010 Annual Conference and Exposition, Louisville, 5 pp.

McMartin, F. & McGourty, J. 1999. Involving industry in the assessment process: Preliminary findings. Proceedings of the Frontiers in Education conference. San Juan, Puerto Rico, 7 pp.
Sutterer, Kevin G. 2012. Assessment of Student Outcomes Using Industry-Academia Assessment Teams. American Society for Engineering Education.