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“Journey to Success” - Helping International Co-op Engineering Students Succeed in the Workplace

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ABSTRACT: Recent years have seen the growth of Co-operative Programs in Faculties of Engineering across Canada. These programs are to equip undergraduate engineering students with direct experience in the working world they expect to enter after graduation. They facilitate the acquisition and development of relevant professional skills necessary to function successfully in the workplace. Increasingly, professional skills developed during work terms have become instrumental for students' post-graduate employment. This paper considers the professional skills relevant to employment in engineering in the context of undergraduate co-op programs. However, unlike mainstream research that studies professional skills as an outcome of successful co-op programs, here they are considered as a prerequisite. It is centred on *communication*, as the skill that researchers and employers regard as a core requirement of the engineering profession. It is established that most international students struggle, in some way and to some extent, to function and integrate in their new host-country and to succeed in their academic program. Insufficient language ability and deficiencies in interpersonal skills pose significant challenges to this cohort. This paper reviews solutions devised and implemented to date at the Faculty of Engineering and Applied Science aimed at maximizing international students' success in the co-op workplace. Employers' expectations against gaps and deficiencies in students' preparation are discussed drawing from the conceptual framework of *Communicative Competence* as conceptualised in the theoretical framework of the *Common European Framework of Reference for Languages* (CEFR), the internationally accredited scale of English language proficiency currently in use in Canada.

1. Introduction

Memorial University has a long standing reputation of providing excellence in Engineering Co-operative Education, starting in 1969. It was one of the first three undergraduate engineering programs in Canada following University of Waterloo (1957) and Université de Sherbrooke (1966) to offer a “mandatory” co-operative education approach to learning in its curriculum [1,2]. Co-operative education within Engineering originally began in North America at the University of Cincinnati in 1906 under the leadership of Dean Herman Schneider, who implemented a co-op plan “joining theory and practice, linking education and industry through knowledge and experience” [3].

Canadian undergraduate engineering degree programs are reviewed, evaluated and accredited by Engineers Canada, under the auspices of the Canadian Engineering Accreditation Board (CEAB) to ensure the education necessary for professional licensure in Canada. Meanwhile, co-operative education programs in Canadian universities and colleges fall under the policies and regulations of the Co-operative Education and Work-Integrated Learning (CEWIL) or formerly known as CAFCE. In 2016, the Faculty of Engineering and Applied Science (FEAS) was commended by CAFCE for its programs, student

participation rates, detailed student handbook, & innovative grading process, whereby work term students not only receive an overall grade, but also separate grades for performance and communications skill [4].

2. Memorial University’s Engineering Co-operative Education Program

Memorial University College (MUC) was founded in St. John’s, NL – the province’s capital, as a “memorial” to the Newfoundlanders who had lost their lives during the First World War. It was later rededicated to also encompass the province’s war dead of the Second World War. The college opened in 1925 offering the first 2 years of university training in arts and sciences. In 1930, the college launched its 3-year engineering diploma program, whose graduates completed their engineering degree in other institutions, typically Nova Scotia Technical College (now Dalhousie University), with whom the college had a formal agreement. In 1949, after Confederation, the college became a full-fledged university and was renamed Memorial University of Newfoundland (MUN) [5]. In 1969, this university began its degree-granting undergraduate engineering program and the Faculty of Engineering and Applied Science graduated its first class in 1974 in the original three disciplines (Civil, Electrical, and Mechanical).

In 1982, the Faculty graduated its first two naval architects in Canada in its Shipbuilding Engineering program (1982-1985), which was subsequently renamed Naval Architectural Engineering (1986-1996) and currently Ocean and Naval Architectural Engineering. This university offers the only Ocean and Naval Architectural Engineering undergraduate degree program in Canada, and it is the only mandatory undergraduate co-operative degree program of its kind in the world. Following this, its first class of Computer Engineering students graduated in 1991. The first class of Process Engineering students graduated in 2013, as the first university in Canada to offer a discipline of Process Engineering [6].

Students have six (6) work term slots (semesters) to gain practical paid work experience, of which four (4) work terms must be successfully completed to meet graduation(see Table 1). Students can gain the equivalent of up to two (2) years of practical engineering work experience by the time they graduate. Accordingly, co-op students are highly sought after by employers who value their strong academic background, diverse practical work experience and their competencies in communications and interpersonal skills. In co-operative education, “experience” plays a key role in the learning process, as per Kolb’s experiential learning cycle of active involvement in an experience, reflection on that experience, conceptualization (i.e., interpreting and making sense of the event), and active experimentation (i.e., putting into practice what is learned) [7].

Table 1: MUN ENGINEERING PROGRAM – ACADEMIC AND WORK TERM SEQUENCE

	FALL	WINTER	SPRING
YEAR 1	Academic Term 1	Academic Term 2	Work Term*
YEAR 2	Academic Term 3	Work Term	Academic Term 4
YEAR 3	Work Term	Academic Term 5	Work Term
YEAR 4	Academic Term 6	Work Term	Academic Term 7
YEAR 5	Work Term	Academic Term 8	
*Although denoted as <i>Work Term slot</i> , this could be an Academic Term as part of YEAR 1 studies			

The involvement of Co-op Coordinators to oversee the work term is one of the unique strengths of this universities’ engineering program. As experienced engineers, Co-op Coordinators develop work term opportunities, match students with appropriate work term experience opportunities, visit and evaluate students on their work terms, develop and deliver professional development seminars and provide individual and professional development counselling and implement appropriate reflective learning activities. Co-op Coordinators travel locally, nationally, and internationally to meet students at their workplace to ensure that the work students do is meaningful, is aligned with their academic studies, and

meet learning objectives and employer expectations [8]. This is all part of the overall mentoring and learning process that directly relates to this universities' Teaching and Learning Framework for experiential learning [9].

FEAS is undergoing a process of expansion and by 2020, the number of graduates of its undergraduate co-operative program is expected to grow significantly. Vision 2020 (the 2013-2018 Strategic Plan) of FEAS was developed and launched in 2012 to address future growth of the Faculty. Increasingly active collaborations with industry partners and other organizations, expanding needs of new program/course offerings, anticipated shortage of engineers and engineering capacity in the province, and the range expectations of new engineering opportunities have motivated expansion of the Faculty. As a result, the Faculty intends to increase undergraduate enrolment by about 50% (~500 additional undergraduates by 2020; about 100 additional students in each of the 5 years of the programs) and graduate student enrolment from 360 (2012) to 625 (2020). Faculty cohort is projected to grow from 58 in 2012 to 100 by 2020, along with necessary support staff and relative allocation of physical resources [10].

Despite being located in the most easterly province, MUN attracts a large number of international students who appreciate the friendly culture, rugged beauty and natural landscapes and the lowest tuition of any university in Canada (with the exception of Quebec). International student tuition (\$11,460 per annum) is about 4.5 times local (\$2,550) and 3.5 times domestic (\$3,300), based on two semesters of study [11]. The Canada International Education Strategy (2014) emphasizes the critical importance of internationalization of higher education by positioning the country so that talent is attracted globally. Newfoundland and Labrador has been experiencing declining local demographics and a relatively low success in attracting and retaining immigrants. This justifies the need to intensify university internationalization efforts as an integral part of the province's economic rebirth strategies [12].

3. Challenges Faced by International Co-op Engineering Students

The growth of international student population places significant demands on Engineering Co-operative Education and related academic and student service units. International students now comprise 20% of the undergraduate engineering students. Some of these students are ill-prepared to secure viable work term placements in Canada, or anywhere where English is used as the language of work. Anecdotal evidence suggests that by the start of a work term, about 25% of the students still seeking work are international. This may be attributed to the fact that some cultures hold high academic grades as a priority and place less focus on soft skills. While it may be difficult for some international students to understand, in North America, it is completely acceptable to ask for help when a student is having problems. Research conducted by Harvard University, the Carnegie Foundation and the Stanford Research Institute found that *"Technical skills and knowledge account for 15 percent of the reason you get a job, keep a job, advance in a job. 85 percent of your job success is connected to your people skills."* This includes character, personality and competence. The measure of one's success in developing soft skills is how well the student can manage relationships, with supervisors, coworkers, clients and their network.

Furthermore, some of the international students have negligible employability skills necessary for the mandatory co-op job competition. In addition to sometimes serious deficiencies in oral and written English communication skills, some students have minimal work and volunteer experience, very little extra-curricular activities, teamwork skills and very few have scholarships or awards that make them attractive to potential employers. These challenges negatively affect their chances of success in recruitment.

To assist students as they prepare to secure their first work term, all undergraduate engineering students must complete a series of professional development seminars (ENGI 200W) that are designed to further develop soft skills and techniques that can be used during their job search and throughout the co-op work terms. These seminars are delivered by Co-op Coordinators and invited guest speakers. The following is a listing of the topics covered [8,13]:

- Cover letters and résumés
- Co-op work permits (for international students only)
- Job competition process and how to use the on-line job portal
- Interview skills and techniques / Finding a job outside of the job competition
- Adapting to professional work environment and achieving exceptional performance

- Registration requirements and evaluation / promotion requirements of work term
- Work term objectives and communications requirements (work term deliverables)
- International work terms and associated requirements
- Technical writing skills
- Sexual harassment awareness and policies
- Counselling centre and stress management
- Professional ethics in the workplace

Students are required to prepare and submit relevant co-op documentation during each work term, such as work term (learning) objectives or report/presentation outlines. Learning objectives help guide students achieve maximum benefit from their work term and allow them to focus on their stated goals. As students' progress through their work term(s), learning objectives assist them to recognize, demonstrate and evaluate the learning taking place, outlining what will be learned, how this learning will be accomplished, and when the learning objective will be achieved.

Students are also encouraged to maintain personal job diaries during each work term. Diaries are fundamental to the development of sound written communication and good time management skills. The submission of a technical report and / or oral presentation at the end of the work term is a requirement that illustrates the understanding and experience that students have acquired. Reports develop good technical writing skills, whereas oral presentations provide practice in organizing and orally presenting the material to an audience of their peers. Both provide the ground for critical thinking, analysis and design, and for the development of relevant organizational, presentation, evaluation and prediction skills. The work term documents are used by the Engineering Co-operative Education Office (ECEO) to monitor and measure the learning that has occurred on a work term.

The key to achieving a successful work term is the student's ability (or openness) to accept constructive criticism, learn and / or further develop work-related skills. Feedback on skills and attributes development is reflected in the end-of-term Employer's Evaluation form where the supervisor provides written comments on a student's report / presentation technical content and communicative effectiveness. Any additional written feedback from the supervisor on the student meeting the planned performance and professional objectives and general comments about the students' strengths and weaknesses assist Co-op Coordinators in evaluating the learning that has occurred. Supervisors are also encouraged to conduct their own employers' mid-point assessment and review of the student's performance. The final work term performance grade is based on the Co-op Coordinators assessment of the completed Employer's Evaluation form, information gathered from the mid-term visit with the student and supervisor and the timely receipt of all work term documentation by established deadlines [8].

4. Canadian Engineering Accreditation Board (CEAB) – Graduate Attributes

The Canadian Engineering Accreditation Board (CEAB), under Engineers Canada; is primarily responsible for the accreditation of all Canadian university engineering programs. In 2008, the CEAB mandated the accreditation requirements for engineering schools to take an outcomes-based approach in the assessment of a comprehensive and defined set of Graduate Attributes (GAs), rather than taking a prescriptive approach to learning [14]. Engineering accreditation in Canadian universities had been traditionally input-based, with a focus on the number of contact hours, course content, lab hours, student-to-teacher ratios, etc. International agreements changed this approach shifting towards outcomes-based accreditation systems. In 2010, the CEAB started the process to review engineering programs to assess graduate attributes within the educational curriculum [15]. Since 2014, CEAB requires undergraduate engineering programs in Canada to actively work to develop the Graduate Attributes expected of graduating engineers by putting into place a system for the outcomes-based assessment of GAs. Curriculum enhancements must be developed to meet this mandate, as per CEAB Accreditation Sections 3.1 and 3.2, since the basic feature of outcome-based education is the implementation of assessment and reporting processes, followed by continual curriculum improvement [6,16].

To secure accreditation, every Canadian engineering school must document students' acquisition of Graduate Attributes. CEAB must be able to obtain substantial evidence that schools have been actively working toward GAs implementation and that the program in question is meeting requirements.

Graduates of Canadian engineering schools must possess the following twelve (12) Graduate Attributes related to essential knowledge, skills and abilities [6]:

1. Knowledge base for engineering
2. Problem analysis
3. Investigation
4. Design
5. Use of engineering tools
6. Individual and teamwork
7. Communications skills
8. Professionalism
9. Impact on society and environment
10. Ethics and equity
11. Economics and project management
12. Lifelong Learning

Co-op work terms significantly contribute to the development of all 12 Graduate Attributes by providing value-added benefits in the training and development of student engineers. This demonstrates that co-operative education is of significant benefit and of high value in student learning. With a co-operative education program providing significant mentoring and relevant work experience through work term placements, students have increased opportunities to develop GAs to the level expected by the university and the CEAB. Furthermore, students develop a greater appreciation of how their work term experiences contribute to their professional growth as an engineer. By placing students in professional work environments, which differ in many ways from academic studies, students interact with other employees and contribute to the workplace in a variety of ways that help them prepare for the school-to-work transition to permanent employment as graduate engineers. Skills learned in the classroom are tested in real life contexts and knowledge is expanded through related work experiences. In combining classroom learning with real world problems enhances the undergraduate experience and allows students to explore potential career options prior to graduation. For employers, this is an effective and efficient means of evaluating co-op students as potential future hires without the burden of a long-term commitment [8].

Co-operative education has been described as a three-way partnership between the employer, the academic institution, and the student. By hiring co-op students, the employer gains access to the latest theories and ideas from the academic world, the institution obtains practical input from the professional community, and the students receive hands-on experience in their chosen field of study [17]. As per Engineers Canada guidelines, after completion of one-half of their undergraduate academic program, students on work terms can voluntarily complete the Engineer-in-Training (EIT) Monthly Experience Logbook, which is available through the provincial and territorial engineering licensing associations. Up to 12-months of documented pre-graduation work experience in a Canadian work environment can be credited towards the 48 months of required post-graduation work experience, leading to the Professional Engineer (P.Eng.) designation. This positions co-op students well ahead of those students who do not secure formalized engineering work term experience prior to graduation. Some quantitative studies and significant anecdotal evidence indicate that successful co-op work term experiences help instill in students the choice to remain on the path to professional licensure [18].

5. What has been done to date at FEAS

Co-op Coordinators have recognized the issue of the “co-op readiness” of international engineering students and efforts have been made in recent years to help this cohort succeed in the program. To complement the ENGI 200W Professional Development seminar course noted earlier, international students were asked to enrol in the *Additional Soft Skills Training for International Students* as a means of helping them be as competitive as their Canadian counterparts. This program identified issues that were deficient in this cohort and the ECEO are working on techniques and strategies to integrate into the program to ensure international student success. Other available programs / strategies included:

1. Professional Skills Development Program (PSDP) – 8 week course
2. International Student Work Experience Program (ISWEP) – 40 hours per semester
3. Faculty participation – embedding int'l with domestic students for group projects
4. Multicultural training for Faculty & Staff – Dr. Lionel Laroche
5. Hiring In-house Technical Communications Coordinator
6. Creation of Cahill Engineering One Success Centre (Tutoring Centre)
7. Service/Research Learning Work Terms (10 week duration)

Often, there is a marked difference between what is expected in the international versus the Canadian labour market. Recently FEAS has investigated a long-term strategy to address the growing concern of English Language ability of incoming international students. It was concluded that TOEFL scores cannot be used for screening students for job-ready communication skills as required by a mandatory undergraduate co-op engineering program. Requiring candidates to provide a written essay as well as an on-site screening interview seems to be necessary, as pointed out by Dr. Lionel Laroche (President and Founder, MultiCultural Business Solutions Inc.) in his presentation to FEAS in 2011. A more quantitative test to determine suitability provides a more objective and consistent evaluation of applicants is currently under study as the most likely long-term solution. The design and implementation of international recruitment long-term strategies are necessary to ensure that the university maximizes benefits of its internationalization plan and international students succeed in the program.

6. The CELBEST Project

Demographic trends suggest that many future co-op engineering students will be recruited internationally. Ensuring that academic and professional success is attainable for its growing and diverse student population is a challenge that the Faculty has proactively embraced by launching the Canadian English Language Benchmarks for Engineering Students (CELBEST) Project in 2015. The CELBEST project, highlighted below, represents one of the important initiatives undertaken by the Faculty in response to that challenge. With this project, the Faculty has taken the leadership in pursuing a viable solution to the problem of ineffective communication skills as a significant obstacle to a successful transition to employment for new graduates as well as for undergraduate co-op students. Namely, the CELBEST project is tasked with transforming the nebulous Graduate Attribute of 'communication skills' (GA:07) into an explicit measurable outcome of engineering education at this university.

The aim of CELBEST is monitoring quality and progress of students' competence in co-op workplace communication from pre-admission to graduation, by targeting real-life English language demands of the co-op engineering profession in Canada. In its entirety, CELBEST was conceived on the need that emerged for an assessment instrument that would guarantee fluency of all students entering that profession. Consistent with existing literature, an interdisciplinary study conducted at FEAS on work term recruitment of international engineering students reported that good communication skills are consistently highly valued by employers yet frequently poorly developed by international students, particularly at the junior level. This is despite international students being certified by University- approved admission standardized language tests (e.g. TOEFL, IELTS, CAEL). The lack of assessment options available targeting the language and communication requirements of international co-op student candidates prompted the Faculty to seek to develop a tailored assessment instrument. The instrument had to be sufficiently rigorous yet flexible to adapt to needs and contexts of learners along the co-op program continuum.

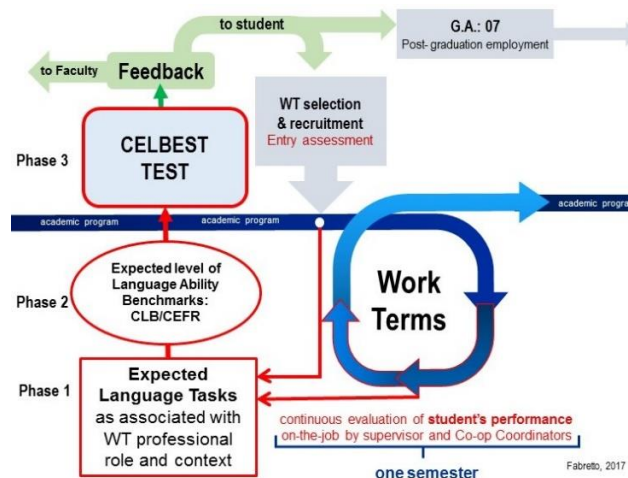


Figure 1: Phases of the CELBEST Project

CELBEST takes a novel approach to language and communication assessment in undergraduate co-op engineering programs. It is built on the premise that in each work term competition and placement, students communicate in a range of real-life professional scenarios and contexts that vary based on the type of job and the student's level of seniority. A student's (in)ability to communicate effectively is, therefore, observable as communication performance. Figure 1 depicts the 3 Phases that define the development of the CELBEST project.

In Phase 1 of CELBEST, language tasks have been identified and defined in consultation with representatives of the engineering sectors. Each language task describes what the student is expected to be able to do with the language to be considered adequately competent in communication while working in a specific co-op professional role and/or context. In the literature, language tasks are referred to as 'performance descriptors' or 'Can Do' descriptors and are grouped to reflect *performance* in each of the four language skills (Speaking, Listening, Writing, Reading) and in four specific areas of competence in which workplace communication takes place: interaction, information, instructions, suasion (getting things done). Can Do descriptors are readily transferable to pedagogical initiatives, particularly in the preparation of rubrics or as support in the creation of learning outcomes. An initial list of 30 language tasks has been compiled and grouped by main skill. The language tasks range from giving, or asking for, information, instructions, and directions to execute multi-step procedures, to understanding key points in an extended presentation, panel discussion, or a multi-party conversation.

Phase 2 entails the benchmarking of language tasks that comprise a work term language and communication competence expected of the student. The goal of the benchmarks is to provide the Faculty with a reliable set of discrete criteria for assessing the quality of students' communication for work terms along the program continuum, from pre-admission to graduation. To that end, CELBEST is developed within the theoretical framework of Communicative Competence, as applied in the *Canadian Language Benchmarks* (CLB) and in the *Common European Framework of Reference for Languages: Learning, teaching, assessment* (CEFR). CLB and CEFR are internationally accredited scales of English language proficiency. They indicate 'how well' the student can perform each language task. Accordingly, they function as framework of reference and source of common standards/ criteria for assessing language outcomes that are discipline- and context- specific [19-24].

The CLB and CEFR have been selected to inform the CELBEST project because of their strong theoretical underpinning and because they meet the requirements for rigor, structure and versatility dictated by the project. When completed, the project will produce the first engineering education-specific set of assessment tools (tests) for workplace communication: *Canadian English Language Benchmarks for Engineering Students* (CELBEST). Upon completion of Phase 3, CELBEST is expected to yield three tests: one pre-admission test and two in-program tests. To date, the pre-admission test has been developed and has become a program specific mandatory requirement for admission for the 2018 cohort of international applicants. Beginning in the Fall 2018, successful completion of this test has been added to the English language requirements set forth by the university in the admission of international students to the engineering program. Thus, the test is considered high stakes and structured on a pass / fail basis. The test has been administered in two possible formats: a written test (e-proctored to students located outside the province) or an oral test consisting of an interview (in person with students located in the province) with a Faculty member / committee.

The aim of the pre-admission test is to assess international student's language and communication potential to enter the co-op program and succeed. Namely, results from this test are expected to establish whether the international applicant has a sufficient command of the English language to be able to master, within the expected timeframe, the language and communication demands specific to a Work Term 1 position within the FEAS program detailed above. Based on findings from research conducted at FEAS, it was established that, at the time of work term competition, the English language ability of international applicants must be at level B2 (or higher) of the CEFR scale or above level 7-8 of the CLB scale. In addition to the assessment of language ability, the pre-admission test has been constructed as a set of probing questions designed to elicit from the applicant an adequate understanding of the additional requirements that are involved in the successful completion of a co-op program.

The two in-program tests are currently being designed to evaluate all co-op students' professional communicative competence at two key points over the course of the undergraduate program (i.e. pre-Work Term 1 and after Work Term 4 / Academic Term 8 or pre-graduation). Each test is expected to be highly relevant and context specific. Both in-program tests will have a written and an oral component in which all four (4) Skills will be assessed. As shown below, the first post-admission test is designed to determine if, over the course of the first year, students have acquired the mastery necessary to successfully compete for and complete their first work term. It will be administered as part of the ENGI 200W *Professional Development* seminar as prerequisite to Work Term 1 and, like the Seminar, it has been assigned a pass / fail grade. The second in-program test will be administered to all students as part of the ENGI 8152 course *Engineering Profession*. This test aims at establishing whether and to what extent the student has developed the professional communication competencies to the level expected having completed (at least) four work terms. It is intended to help the student identify deficiencies and areas of improvement requiring attention prior to graduation.

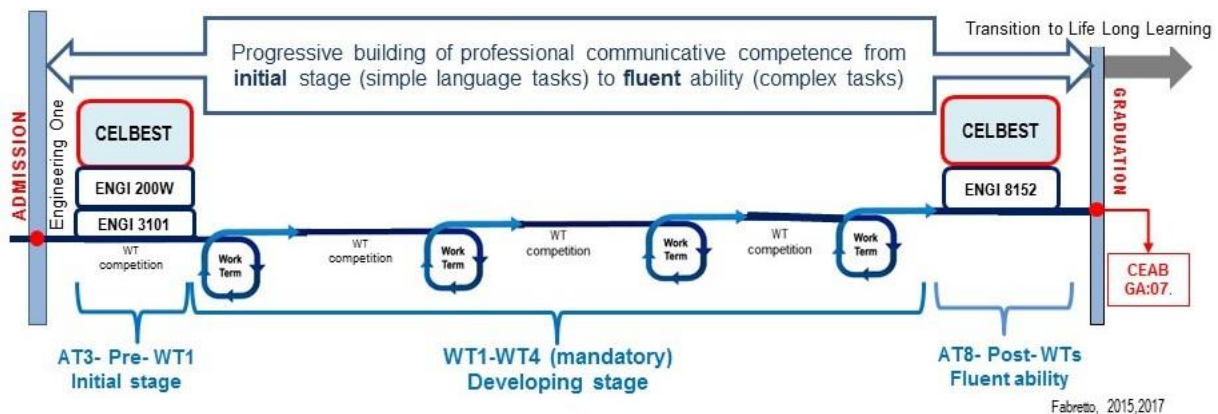


Figure 3: In-Program Tests along program continuum

The CELBEST tests are intended to complement, not substitute, existing language and communication assessment practices currently adopted by the Faculty at program, curriculum, and course level. Therefore, genres and content evaluations employed within existing courses (e.g. report writing) are not included in the CELBEST tests. This project is expected to significantly improve their knowledge of the subject of communication in engineering contexts and provide implications of interest to the engineering academic, student, and professional community. This project sets the foundation for the development and implementation of clearly articulated and measurable program outcomes for professional communication as Graduate Attribute. Results from each test will prove instrumental in providing the Faculty with reliable and tangible data and information essential to ensure the continual improvement of the program so that competency targets are reached and student's pre- and post- graduation professional success is strengthened.

7. Closing remarks

A co-operative education program helps students develop the necessary Graduate Attributes by providing an increased opportunity for the development of soft skills and knowledge based attributes through work experience and experiential learning. Studies have shown that co-operative education students gain employment sooner after graduation, have higher salaries and are more likely to find employment relative to their discipline over that of non-co-op graduates [25]. Through a co-operative education program, students are stronger in soft skills, which they oftentimes continue to improve through self-assessment and self-reflection. In summary, co-op work terms develop and refine students' employability and marketability skills, by expanding their appreciation of career opportunities and strengthening their understanding of the dynamics of the workplace.

Engineering schools experienced industry partners remarking that their graduates are not properly prepared and adequately equipped to enter the profession especially for what concerns soft skills, business skills, and communications skills [26,27,28]. The type of experiences that a co-op work term can provide are invaluable in this regard but access to a work term may be a challenge that some international students struggle to overcome. FEAS has continued to adapt to the changing demands of the profession and to the evolving needs of its students. It is to reconcile the two that projects like CELBEST are being developed. Although co-op work term placements are often affected by worldwide economic fluctuations, the Faculty recognizes its responsibility to help its most vulnerable cohorts have access to the many benefits that work term can provide and to aid in the transition into post-graduation employment. Initiatives like CELBEST represent a first step in that direction.

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