UNIVERSITY OF ALBERTA

GFC Committee on the Learning Environment
For the Meeting of June 5, 2013
FINAL Item No. 6

OUTLINE OF ISSUE

Agenda Title: **GFC Committee on the Learning Environment (CLE) Subcommittee on Attributes and Competencies Final Report for Approval**

Motion: THAT the GFC Committee on the Learning Environment (CLE) approve the final Report of the GFC CLE Subcommittee on Attributes and Competencies, as submitted by the Subcommittee's Co-Chairs and as set forth in Attachment 1.

Item

Action Requested	☒Approval ☐Recommendation ☐Discussion/Advice ☐Information
Proposed by	Dustin Chelen, Member, GFC Committee on the Learning Environment (CLE) and Vice-President (Academic), Students' Union; Colin More, Member, GFC Committee on the Learning Environment (CLE) and Vice-President (Academic), Graduate Students' Association; Steven Dew, Member, Teaching, Learning and Technology (TLAT) Council and Associate Dean (Research and Planning), Faculty of Engineering
Presenters	Dustin Chelen, Co-Chair, GFC Committee on the Learning Environment Subcommittee on Attributes and Competencies; Steven Dew, Co-Chair, GFC Committee on the Learning Environment Subcommittee on Attributes and Competencies
Subject	Final Report of the GFC Committee on the Learning Environment (CLE) Subcommittee on Attributes and Competencies (for approval)

Details

Responsibility	Provost and Vice-President (Academic)
The Purpose of the Proposal is (please be specific)	To recommend to the Office of the Provost next steps in the adoption of student attributes attained upon graduation from the University of Alberta. This subcommittee, as *per* its Terms of Reference, has reviewed literature, consulted widely, determined common themes for attributes, and provided recommendations for possible models for implementation.
The Impact of the Proposal is	See 'Purpose'.
Replaces/Revises (eg, policies, resolutions)	N/A
Timeline/Implementation Date	Upon final approval.
Estimated Cost	N/A
Sources of Funding	N/A
Notes	N/A

Alignment/Compliance

Alignment with Guiding Documents	*Dare to Discover* Values (1 – 4): "1. Excellence in teaching that promotes learning, outstanding research and creative activity that fuel discovery and advance knowledge, and enlightened service that builds citizenship; 2. The centrality of our students and our responsibility to provide an intellectually superior educational environment; 3. Integrity, fairness, and principles of ethical conduct built on the foundation of academic freedom, open inquiry, and the pursuit of truth; 4. A diverse, yet inclusive, dynamic collegial community that welcomes change and seizes opportunity with passion and creativity." *Dare to Deliver, 2011-2015*: "Attributes and Competencies Upon

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	Graduation: Articulating and supporting the development of core sets of skills, attributes and values to be incorporated into graduate and undergraduate programs, while recognizing that each Faculty will best decide how to move in this direction, which could include reviewing and updating the curriculum."
Compliance with Legislation, Policy and/or Procedure Relevant to the Proposal (please quote legislation and include identifying section numbers)	1. **The *Post-Secondary Learning Act* (*PSLA*)**, Section 26(1), gives General Faculties Council (GFC) responsibility, subject to the authority of the Board of Governors, over "academic affairs." GFC has thus established a Committee on the Learning Environment (CLE).

2. **GFC Committee on the Learning Environment (CLE) Terms of Reference**: Section 3 (*Mandate of the Committee*): "The Committee on the Learning Environment is a standing committee of the General Faculties Council that promotes an optimal learning environment in alignment with guiding documents of the University of Alberta.

The Committee on the Learning Environment is responsible for making recommendations concerning policy matters and action matters with respect to the following:
a) To review and monitor the implementation of the University Academic Plan with regard to teaching and learning.
b) To review and, as necessary, recommend to the GFC Academic Planning Committee and GFC Executive Committee as relates to the development and implementation of policies on teaching, learning, teaching evaluation, and recognition for teaching that promote the University Academic Plan.
[…]
d) To nurture the development of innovative and creative teaching practices.
e) To encourage the sharing and discussion of evidence about effective teaching and learning.
f) To promote critical reflection on the impact of broad societal changes in teaching and learning.
g) To promote projects with relevant internal and external bodies that offer unique teaching and learning opportunities that would benefit the university community.
h) To consider any matter deemed by the GFC Committee on the Learning Environment to be within the purview of its general responsibility.

Notwithstanding anything to the contrary in the terms of reference above, the General Faculties Council has delegated to the Committee on the Learning Environment the following powers and authority:

To recommend to the GFC Academic Planning Committee and to the GFC Executive Committee broad policy directions for excellence in teaching and learning." |

Routing (Include meeting dates)

Consultative Route (parties who have seen the proposal and in what capacity)	Graduate Students' Association Council (discussion) – September 10, 2012; GFC Committee on the Learning Environment Subcommittee on

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	Attributes and Competencies (discussion) – October 22, 2012; Students' Union Council (discussion) – October 23, 2012; GFC Committee on the Learning Environment (discussion) – December 5, 2012; Graduate Students' Association Council (update from the GSA Vice-President (Academic), Nathan Andrews) – January 14, 2013; GFC Committee on the Learning Environment Subcommittee on Attributes and Competencies (discussion) – January 31, 2013; GFC Committee on the Learning Environment Subcommittee on Attributes and Competencies (finalization of the report) – March 8, 2013; GFC Committee on the Learning Environment/Teaching, Learning and Technology Council Joint Session (April 3, 2013) – for discussion; GFC Committee on the Learning Environment (May 1, 2013) – for discussion
Approval Route (Governance) (including meeting dates)	GFC Committee on the Learning Environment (June 5, 2013) – for final approval (of the Final Report of the GFC Committee on the Learning Environment Subcommittee on Attributes and Competencies)
Final Approver	GFC Committee on the Learning Environment

Attachments (each to be numbered 1 - <>):

1. Attachment 1 (pages 1 – 22): GFC Committee on the Learning Environment (CLE) Subcommittee on Attributes and Competencies Final Report Entitled "Graduate Attributes at the University of Alberta"

Prepared by: Dustin Chelen, Vice-President (Academic), Students' Union (and Member, GFC Committee on the Learning Environment (CLE)), vp.academic@su.ualberta.ca

Graduate Attributes at the University of Alberta

A report of the Committee on the Learning Environment (CLE) Subcommittee on Attributes and Competencies

Submitted to the June 5, 2013 meeting of CLE

DRAFT

Subcommittee Co-Chairs:
Emerson Csorba and Dustin Chelen, VPs (Academic), Students' Union
Nima Yousefi, Nathan Andrews and Colin More, VPs (Academic), Graduate Students' Association
Dr. Steven Dew, Faculty of Engineering

Introduction

Student attributes (used interchangeably with graduate attributes in this document) generally describe the qualities, values and dispositions that students have developed by the time they have completed their university degree program. While not dissociated from disciplinary knowledge, they are fostered in each student regardless of field of study. Student attributes are broader than (but include) skills or technical competencies and are integrated throughout a higher education experience. This understanding helps us to distinguish attributes from disciplinary skills, emphasizes cross-disciplinary commonalities and applies to both graduate and undergraduate students. Prior to engaging in the topic, it is necessary to establish a common definition for student attributes as a means to avoid ambiguous terminology and to encourage productive discourse from all members of the University community. In addition to defining student attributes is also a need to define how and who should assess whether students acquire these qualities through their university program.

Environmental Scan

Although there is no standard definition, generic attributes can be broadly defined as the qualities that assist individuals' ability to succeed in and contribute to society in general and the working world. According to Bowden et al.,

> Graduate attributes are the qualities, skills and understandings a university community agrees its students should develop during their time with the institution. These attributes include, but go beyond, the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future (cited in Atlay 2006, p. 212).

Depending on the institution's philosophy and values (e.g. citizenship- or society-centered values vs. work- and employability-centered concerns), different competencies can be espoused. They comprise learning content that are referred to as 'qualities', 'skills', 'competencies', 'understandings', 'attitudes', 'dispositions', 'values' and so on. Regardless of how it is referred to, having a description of graduate attributes (GAs) is one of the key ways through which universities have sought to articulate the outcomes of higher education (Barrie 2006).

In the current climate, in which universities seek to define their unique placement within the provincial, national and international education sector, and in which

governments, taxpayers and students seek greater accountability for investments in post-secondary education, GAs are becoming increasingly important to the strategic planning processes for research-intensive universities worldwide. From the Tuning Project in the European Union to quality assurance agencies in the United Kingdom and the Tertiary Education Quality and Standards Agency (TEQSA) in Australia, governments are asserting greater control and demanding an outcomes-based approach to post-secondary education standards (Barrie 2004).

The shift toward greater accountability of student development is driven not only by governments, but also by industry and by students themselves. Research universities are now being pressed to go beyond equipping students with knowledge and produce adults that are culturally aware, adaptive to change, and globally competitive. Within this context and regardless of government mandate, the development of GAs has clear strategic importance to universities who aim to not only educate contributing members of society, but also foster their holistic intellectual development.

The discussion of student attributes began in Australia during the early 1990s, using the term "Personal Transferable Skills". As a condition of funding, Australian universities now must include a statement on generic outcomes of education in their operational plans. In addition, TEQSA's initial audit recommendations of major universities have included considerable focus on student attributes (Burgess et al. 2012; Cooper et al. 2012).

Yet the aforementioned factors influencing the shift toward student attributes – massification of post-secondary education, increased investment accountability, and the development of the knowledge economy – are not isolated to universities in Australia. Certain Canadian accreditation agencies have already begun shifting towards an outcome-based approach and, while the creation of a provincial quality assurance agency is not a certainty, projects in other jurisdictions indicate a prevailing trend in this direction (Accreditation Board 2011; Liaison Committee 2012). In fact, the Ontario Council of Academic Vice Presidents created a report in 2005 that explicitly outlined expectations for undergraduate degree program graduates within its public post-secondary education system to monitor the effectiveness of instruction (Working Group on University Undergraduate Degree Level Expectations 2005).

For a better outcome, Anderson (2004) argues that among the responsibilities of academic and administrative university leaders is to be able to collect information about student performance indicators in order to "facilitate the development of conceptual frameworks and paradigms that are both discipline specific and that cut across academic areas" (p.19). Various stakeholders could be identified in working

with graduate attributes (GAs), but on a dichotomous paradigm: there is the course instructor on the one hand, and the students on the other hand. Models adopted by various universities differ substantially because of the uniqueness of institutions' mission, purpose and characteristics. However, when we take in consideration instructor/student feedback and input that is longitudinal and formative in nature, the model can be adapted easily to various institutions.

Many examples exist from institutions that have acted in haste to adopt student attributes as a response to quality assurance initiatives; the final product being poorly-conceived attributes that do not reflect the entirety of the institution's academic programs and struggle to achieve consensus and collaboration among faculty for comprehensive implementation. Successful implementation and articulation of attributes stem from an organic, collaborative development process that engages the university community in an introspective discussion. This is the approach that the Subcommittee on Attributes and Competencies has been committed to, and should continue to ground the process in the future.

The implementation stage of student attribute introduction is particularly crucial to the project's success. Significant comprehension and proper development of attributes depend critically on the explicit integration of attributes into the university experience. Once chosen, student attributes require widespread communication – through instructors, student leaders and administrators – and support for curriculum updates and instructional incorporation in order to permeate the university experience. Leaving student attributes as an implicit directive has been found to be ineffective.

A commitment to adopting this report's attributes will allow us to define the unique nature of a degree from the University of Alberta, a research-intensive institution. By elucidating what makes a U of A graduate unique, and integrating those attributes throughout each program, we are contributing to the creation of identifiable, cross-disciplinary links between our students that will serve as a distinguishing feature of our institution. The University of Alberta will be seen as a Canadian leader in preparing its students for an unknown future.

University of Alberta Context

In 2009, the Centre for Teaching and Learning provided a discussion paper on student attributes to the Office of the Provost and Vice-President (Academic) and the writers of the Academic Plan. This document was circulated for wider discussion, and with substantial support from the University Community, the development of student attributes was decided to be a key objective for the institution.

The University of Alberta's Academic Plan, *Dare to Deliver* 2011-2015, commits to "Articulating and supporting the development of core sets of skills, attributes, and values to be incorporated into graduate and undergraduate programs, while recognizing that each Faculty will best decide how to move in this direction, which could include reviewing and updating the curriculum." In October 2011, the Committee on the Learning Environment struck the Subcommittee on Attributes and Competencies. Its mandate is to review literature, define terms, consult, determine commonalities, and develop a model of implementation surrounding student attributes. (See Appendix A for the CLE-approved Terms of Reference) The subcommittee consists of a diverse group of representatives, including undergraduate and graduate students, administrators, and staff from the Faculties of Arts, Science, Education, Engineering, Medicine and Dentistry, Graduate Studies and Research, as well as Campus Saint-Jean and Augustana Campus.

Since its inception, the Subcommittee has held numerous meetings. It reviewed the literature and research on student attributes so as to better orient itself. Practices at other institutions were surveyed, including Ontario universities and the University of Sydney. Over 5000 undergraduate students provided their feedback on what attributes they developed during the course of their University of Alberta education. Students, both graduate and undergraduate, were consulted on a draft list of attributes via the respective councils of the SU and the GSA. The three co-chairs synthesized this data and presented it to the subcommittee for further discussion. Thus, the list of attributes and the suggested implementation models that follows is the result of a number of meetings and conversations. The aim was to ensure that attributes accurately reflect the needs and aspirations of students, the current academic programs of faculties, and the requirements imposed by accrediting bodies.

Attributes

Imparting advanced knowledge is inherently a core objective of a university education. However, there are additional outcomes of the educational enterprise that form the foundation of success for both students and society as a whole. The Subcommittee believes the list below reflects the values of the University of Alberta and captures the essence of the attributes and competencies expected of a student at the time of graduation. These qualities are interconnected and are developed in a variety of ways through the student experience on campus, paving the way for individual excellence and leadership. Seven attributes have been identified, each with four sub-attributes that have widespread applicability. While the list could certainly be lengthened, the Subcommittee felt these represented the core, essential elements required. These attributes are itemized on the next page.

It is understood that this list must be taken in the context of the individual program, the level of the degree (undergraduate or postgraduate), and the community and stakeholder expectations associated with it. Development of these characteristics should occur both through formal coursework as well as co-curricular and extra-curricular activities.

Possible Models of Implementation

The Subcommittee felt it had good consensus on the list of attributes. However, it recognized that approaches to implementing this list in some formal manner would vary by faculty and by program. Aspects of implementation range from program-level analysis and design to ensure suitable development opportunities exist, evaluation of student performance against these attributes, tools for students and instructors to reflect these attributes, and University-wide support for their role as part of our education. Potential users of such evaluation could be current and prospective students, faculties, university administrators, employers, accreditation bodies and government. Each of these stakeholders has slightly different needs. Ideally, the implementation of graduate attributes would add value to students' experience at the U of A, improve our programs, provide performance reassurance to government and accreditation bodies, yet not overload already very busy faculty members and administrative structures. Most importantly, implementation of student attributes should continue to be in the control of those who affect their development most: teaching staff and program planners. As acknowledged in the academic plan it is up to Faculties to determine the best route for implementation, but to provide some source for inspiration we have included a menu of possible modes in Appendix D.

List of Attributes and Sub-Attributes

1 Ethical responsibility
    a. Global citizenship
    b. Community engagement
    c. Social and environmental awareness
    d. Professionalism

2 Scholarship
    a. Knowledge breadth and depth
    b. Interdisciplinarity
    c. Life-long learning
    d. Investigation

3 Critical thinking
    a. Analytic and synthetic reasoning
    b. Interpretive proficiency
    c. Intellectual curiosity
    d. Information literacy

4 Communication
    a. Writing skills
    b. Oral Skills
    c. Visual communication
    d. Multilingualism

5 Collaboration
    a. Openness to diversity
    b. Interpersonal skills
    c. Adaptability and compromise
    d. Individual contribution

6 Creativity
    a. Imagination
    b. Innovation
    c. Divergent thinking
    d. Artistic sensibility

7 Confidence
    a. Leadership and empowerment
    b. Independence
    c. Initiative
    d. Resilience

Recommendations

Faculties, Departments, Deans, Chairs, instructional staff, and students should be engaged in the processes by which the attributes are integrated into graduate and undergraduate programs at the University of Alberta. However, given the turnover among the co-chairs of this committee, they wanted to propose the following centrally-supported actions in conclusion of this two-year reporting process. They are based on the principles supported within graduate student attribute literature: affirm, support, coordinate, and communicate.

- Include a listing of the student attributes and sub-attributes in an overarching University document. A potential revision to GFC Policy 111 may be the appropriate place to affirm the University's support of the above attributes.
- Appoint a Provost's Fellow to continue the dialogue on attributes in student programs, support Faculty in determining implementation methods, and provide faculty members with information and tools to integrate outcome or attribute-based teaching methods.
- Create a University-wide website in collaboration with CTL and University Relations on student attributes that will provide information, resources, and a channel of communication for best practices for faculty, staff, students, and other key stakeholders.
- Develop policy by which instructors list which attributes are fostered in their courses on syllabi, akin to and integrated with the listing of learning objectives in section 23.4 (2) a. of the Calendar.
- Survey students during the course of their programs on measures and personal perspectives on achievement of attributes. This information can inform a Department or Faculty of the strengths and weaknesses in their programs.
- Recognize instructors, departments, and faculties that excel at the fostering of attributes. This demonstrates to students the value of their degree and the interest of the university in the student experience.

References

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Appendix A: Subcommittee on Attributes and Competencies Terms of Reference

1. Committee Mandate:
Following the approval of the University of Alberta's 2011-2015 Academic Plan entitled *Dare to Deliver*, graduate attributes have become a subject of thoughtful discussion across campus. On April 7 2011, the Committee on the Learning Environment Subcommittee on Attributes and Competencies was struck at a joint CLE-TLAT meeting. The committee will work in accordance to the statement pertaining to graduate attributes in the Academic Plan:

"*Attributes and Competencies Upon Graduation: Articulating and supporting the development of core sets of skills, attributes and values to be incorporated into graduate and undergraduate programs, while recognizing that each Faculty will best decide how to move in this direction, which could include reviewing and updating the curriculum.*"

2. Committee Roles:

The subcommittee will play numerous roles:

- Engage in a review of graduate attribute literature
- Provide definitions to key terminology in the graduate attributes process in order to clarify committee discussions and consultations
- Consult widely across campus in order to learn about the distinct character of University of Alberta students
- Select several themes that are common to the graduate attributes described by members of different faculties
- Develop a model for the implementation of graduate attributes at the University of Alberta
- Report to the Committee on the Learning Environment on a monthly basis

3. Committee Membership:

The committee membership shall consist of a diverse group of representatives from across the Academy.
- Vice-President Academic, Students' Union – Co-chair: Emerson Csorba (2011-12), Dustin Chelen (2012-14)
- Vice-President Academic, Graduate Students' Association – Co-chair: Nima Yousefi Moghaddam (2011-12), Nathan Andrews (2012-13), Colin More (2013-14)
- Academic Staff representative – Co-chair: Dr. Steven Dew

- One (1) undergraduate student at-large representative: Dustin Chelen (2011-12)
- One (1) graduate student at-large representative: Ashlyn Bernier
- One (1) CLE graduate student representative: Anne McIntosh
- One (1) CLE undergraduate student representative: Erendira Cervantes-Altamirano
- One (1) representative from the Faculty of Arts: Dr. Daphne Read (2011-12), Dr. Mickey Adolphson (2012-2013)
- One (1) representative from the Faculty of Science: Dr. Arturo Sanchez
- One (1) representative from the Campus Saint-Jean: Dr. Donald Ipperciel
- One (1) representative from the Augustana Campus: Dr. Paula Marentette
- One (1) representative from the Faculty of Medicine and Dentistry: Dr. Fraser Brenneis
- One (1) representative from the Faculty of Education: Dr. Genevieve Gauthier
- One (1) representative from the Faculty of Graduate Studies and Research: Dr. Renee Polziehn

In addition to the members serving on the committee, numerous university stakeholders will be consistently invited to committee meetings so that a wide range of perspectives are heard and considered throughout the committee's proceedings.

4. Committee Meetings:

The committee will meet on a biweekly basis, with thorough stakeholder consultations taking place in between meetings when necessary.

Appendix B: Example of Faculty-Specific Interpretation of Graduate Attributes

Below is a table developed by Campus St.-Jean to provide a Faculty-specific context of how these attributes and sub-attributes might be interpreted. Given the many cultures within a large and diverse institution there will be a need to define a specific interpretation of the sub-attributes. The interpretation provided here is meant to serve as an example and it is not intended to be prescriptive.

Attributes	Sub-attributes	Interpretation
Ethical responsibility		Can adopt the perspective of moral principles rather than self-interest
	Global citizenship	Can consider issues from a global perspective
	Community engagement	Can actively contribute to improving communities
	Social and environmental awareness	Can adopt the perspective of the public good and take into consideration our embeddedness within society and nature
	Professionalism	Is eager to meet the level of expertise and deontological expectations of her profession
Scholarship		Can rely on a body of established knowledge to guide her action
	Knowledge breadth and depth	Can make use of a broad range of knowledge while displaying mastery in specific areas
	Interdisciplinarity	Can integrate knowledge drawn from more than one

		academic discipline
	Life-long learning	Is willing to engage in autonomous self-teaching in or outside the classroom
	Investigation	Can effectively conduct research with the help of established methods and tools
Critical thinking		Can contextually assess given information (incl. self-related) through reflection and debate, taking nothing for granted
	Analytic and synthetic reasoning	Can gather various detailed information and organize it for specific purposes
	Interpretive proficiency	Can convert data into meaningful information and knowledge
	Intellectual curiosity	Is eager to learn beyond what is readily available (in classrooms or in common knowledge)
	Information literacy	Can effectively identify and assess information within its broader societal contexts, including knowledge-dependent contexts requiring scientific, digital or technological literacy
Communication		Can exchange thoughts, feelings and information effectively in various situations

	Writing skills	Can write effectively in multiple formats
	Oral skills	Can speak effectively in various formal and informal settings
	Visual communication	Can convey ideas effectively through visual aid
	Multilingualism	Can communicate effectively in more than one language
Collaboration		Can complete tasks effectively by working jointly with others who share a common goal
	Openness to diversity	Can engage with people of different race, religion, cultures, classes, sex orientation and appearance
	Interpersonal skills	Can demonstrate skills necessary for effective interaction and communication (incl. empathy, active listening, respect)
	Adaptability and compromise	Can change or suspend a personal belief in order to further the realization of a common goal or to adjust to new circumstances
	Individual contribution	Can take an active role in collaborative work

Creativity		Can produce something new and valuable (incl. ideas, works or products)
	Imagination	Can conjure up new ideas and representations in a productive manner
	Innovation	Can devise novel and better ways of doing things through knowledge (scientific, technological, methodological)
	Divergent thinking	Can explore new avenues in a non-conformist and risk-taking fashion
	Artistic sensibility	Can be compelled by artistic work and, ideally, partake in expressive artistic production
Confidence		Can act and think decisively
	Leadership and empowerment	Can be the driving force behind a course of action
	Independence	Can work and think productively with no or little supervision
	Initiative	Can initiate a course of action without prompting
	Resilience	Can follow through on a course of action over time

Appendix C : Faculty of Engineering Model

As part of its procedures, the Canadian Engineering Accreditation Board (CEAB) has developed a set of 12 Graduate Attributes (GAs) for which it requires quantitative metrics of student performance. These are quite analogous to the 7 GAs developed by the CLE Subcommittee. These GAs are used to assess the effectiveness of the engineering programs being accredited. While likely more detailed and rigorous than is appropriate in many UofA contexts, this does serve as an example of a Program-responsible implementation model for GA assessment. The UofA Faculty of Engineering approach to the CEAB requirements is briefly outlined below.

Programs in the Faculty of Engineering are relatively tightly specified. For each course within its programs, the Faculty has assessed alignment with each of the CEAB Gas. A level (0-3) was assigned corresponding to the degree of development of the attribute within the course. From this, a map (see Figure C1) can be created showing the development across the curriculum. This serves as a useful GA development planning tool as well as helps identify courses where GA attribute performance can be measured. A philosophy of sampling has been adopted, and measurements are taken in only a small subset of courses.

Course	Title	Common or Program Core (Y/N)	Knowledge Base (1)	Problem Analysis (2)	Investigation (3)	Design (4)	Engineering Tools (5)	Indiv. & Team Work (6)	Communication Skills (7)	Professionalism (8)	Impact on Society (9)	Ethics & Equity (10)	Economics & Mgt (11)	Life-long Learning (12)
CHEM 103	Introductory University Chemistry I	Y	1		1									
CSOPT 100	Complementary Studies Elective	Y							1					
ENGG 100	Orientation Engineering Prof I	Y					1		1	3		2		1
ENGG 130	Engineering Mechanics	Y	2	2										
MATH 100	Calculus I	Y	3	2	1		2							
PHYS 130	Wave Motion, Optics, and Sound	Y	3	1	2			1						
CHEM 105	Introductory University Chemistry II	Y	2		2									
ENCMP 100	Computer Programming Engineers	Y	1	1	1	1	2	1	1	1	1			1
ENGG 101	Orientation Engineer Prof II	Y							1	3	2			1
EN PH 131	Mechanics	Y	1	2	1									
MATH 101	Calculus II	Y	3	2										
MATH 102	Applied Linear Algebra	Y	3	2	1		2							
MATH 209	Calculus III	Y	3	2										
MATH 201	Differential Equations	Y	3	2										
ENGL ELEC	English	Y*							3					1
ITS ELEC	Impact of Technology on Society	Y							1		3			2
STAT 235	Introductory Statistics for Engineers	Y	3	2	2		2							
MATH 300	Advanced Boundary Value Problems I	Y	3	2										
ENGM 310	Engineering Economics	Y				1	1				1		3	
ENGG 400	Practice Engineering Profes	Y								3	2	2	2	2

Course	Title	Y/N	1	2	3	4	5	6	7	8	9	10	11	12
MEC E 200	Introduction to Mechanical Engineering	Y					1	2		2		2		1
MEC E 230	Introduction to Thermoscience	Y	1	2										
MEC E 250	Engineering Mechanics II	Y	1	2										
MEC E 260	Mechanical Design I	Y	1	2	1	3	2	2	1	1			1	2
MEC E 265	Engineering Graphics and CAD	Y	1	1		1	2	2	2	1	1			1
MEC E 300	Mechanical Measurements	Y	1	1	1		1			1				
MEC E 301	Mechanical Engineering Laboratory I	Y	2		3	2	3	2	3					
MEC E 330	Fluid Mechanics	Y	2	2	1		1							
MEC E 340	Applied Thermodynamics	Y	2	3								1		
MEC E 360	Mechanical Design II	Y	1	3		3	2	3	2					1
MEC E 362	Mechanics of Machines	Y	2	3	1		2							
MEC E 370	Heat Transfer	Y	3	3		1								
MEC E 380	Advanced Strength of Material I	Y	2	2										
MEC E 390	Numerical Methods of Mech. Engineers	Y	1	1			3							
MEC E 403	Mechanical Engineering Laboratory II	Y		2	3		2	2	2					
MEC E 451	Vibration and Sound	Y	3	2			2							
MEC E 460	Design Project	Y	1	3	3	3	3	3	3	2	2	2	2	2
MEC E 463	Thermo-Fluids Systems Design	Y	3	3		3	2	3	1	1	1		1	1
MEC E 364	Manufacturing Processes	N	1	1	2	1	2			1	1			
MEC E 415	Busting Myths with Analysis	N	2	3			1							
MEC E 420	Feedback Contr Dsgn of Dynam Systems	N	3	3	3	2	3	1						
MEC E 430	Fluid Mechanics II	N	3	3			2							
MEC E 443	Energy Conversion	N	3	3			2							
MEC E 464	Design For Manufacture	N	2	1	3	2	3	2						
MEC E 466	Building Systems Design	N	3	3	1	3	2	2						
MEC E 468	Numer Sim in Mech Engg Design	N		3	1	1	3							
MEC E 480	Advanced Strengths of Materials II	N	3	2										
MEC E 537	Aerodynamics	N	3	3		1	2							
MEC E 539	Applied Computational Fluid Dynamics	N		3			3							
MEC E 541	Combustion Engines	N	3	2										
MEC E 553	Acoustics and Noise Control	N	3	2										
MEC E 563	Finite Element Method for Mech Engg	N		3	2	3								
MEC E 564	Design and Simulation of MEMS	N	3	2		2	1							
MEC E 569	Mech and Dsgn of Composite Materials	N	3	2		2								
MEC E 585	Biomed Mod of Human Tissue and Sys	N	3	3			1							

Figure C1: Map of CEAB graduate attribute development in the Mechanical Engineering program. The values (0-3) represent the degree of development of that attribute within each course.

 As with the approach developed by the CLE Subcommittee, Engineering has developed a list of subattributes for each CEAB attribute. These are indicated below in Table C1. For each subattribute a performance indicator has been developed. These indicators serve as proxies of a direct measure of the actual attribute. If measurements of the indicators are providing values that meet assigned targets, the Faculty can be confident that its students are acquiring the corresponding GA.

Table C1: Subattributes used to elaborate each graduate attribute. While most are common across all Engineering programs, those in italics are unique to Mechanical Engineering.

| GA	Description	Subattribute
3.1.1	Knowledge Base	Mathematics, Chemistry, Physics, Engineering fundamentals, *Thermal sciences, Solid mechanics, Fluid mechanics, Mechanics, Dynamics and control*
3.1.2	Problem Analysis	Understands the problem, Assembles knowledge, Applies models, Evaluates result
3.1.3	Investigation	Recognizes unknowns, Measures data, Analyzes data, Reaches conclusions
3.1.4	Design	Requirements, Creativity, Analysis, Iteration, Assessment
3.1.5	Engineering Tools	Computation, System description, System modeling, Analysis, Measurement
3.1.6	Indiv. & Team Work	Time management, Team work (understands roles, meets responsibilities, actively contributes, respects others, leadership)
3.1.7	Communication	Organized message, Writing, Reading, Speaking, Use of graphics
3.1.8	Professionalism	Legal responsibilities, Licensure requirements, Safety, Due diligence
3.1.9	Impact on Society	Aware of impacts on society, Impact assessment, Sustainable design, Assessment of the impacts
3.1.10	Ethics & Equity	Aware of ethical issues, Makes ethical choices, Aware of equity issues, Ethics in writing, Appreciation of socio-economic context
3.1.11	Economics & Project	Engineering economics, Economic assessment, Project management
3.1.12	Lifelong Learning	Curious, Able to assess needs, Resourceful, Discriminating

For each indicator, a specific task or activity within a specific course was identified for measurement of student performance. Then, a four level rubric was developed to aid in the acquisition of objective, reproducible quantitative data that can be compared against predetermined targets and year-over-year trends. The fraction of students meeting levels 3 or 4 of the rubric is used as the primary measure of program performance against that subattribute.

Typically, the measurement will involve a targeted final exam question or capstone design report section in a final year course. In general, course grades are not used as they aggregate too many aspects to be specific. As well, we have generally tried to include a self-assessment indicator (the measure is a question within a survey taken as part of a compulsory course) for each subattribute to corroborate this outcome, although we recognize that self-assessment is as likely to reflect confidence and attitudes as it is competency.

Subattr.	Indicator	Measure	Rubric			
			Unsatisfactory 1	Developing 2	Satisfactory 3	Excellent 4
Understand the problem	Able to state the essential problem to address	MEC E 370 final exam question	Unable to articulate the essential problem	Able to partially articulate problem but missing key details	Able to articulate the problem to be solved	Able to articulate problem and identify constraints on the range of solution
	Self-assessment of ability to understand the problem	ENGG 400 survey "How would you rate your abilities to identify complex engineering problems?"	"Very limited"	"Developing"	"Satisfactory"	"Good"
Assemble knowledge	Assembles the relevant models and formulae	MEC E 370 final exam question	Unable to identify key principles or models needed	Identifies some of the relevant models and formulae, but missing key elements	Able to assemble the necessary formulae and models	Able to derive necessary formulae from first principles

Figure C2: Example of the indicators and rubrics developed for one of the CEAB GAs (Problem Analysis)

Data for each subattribute is collected according to a multi-year schedule for analysis. The subattributes related to a single attribute (Communication Skills) is presented in Figure C3. The nominal target is that 80% of students reach levels 3 or 4.
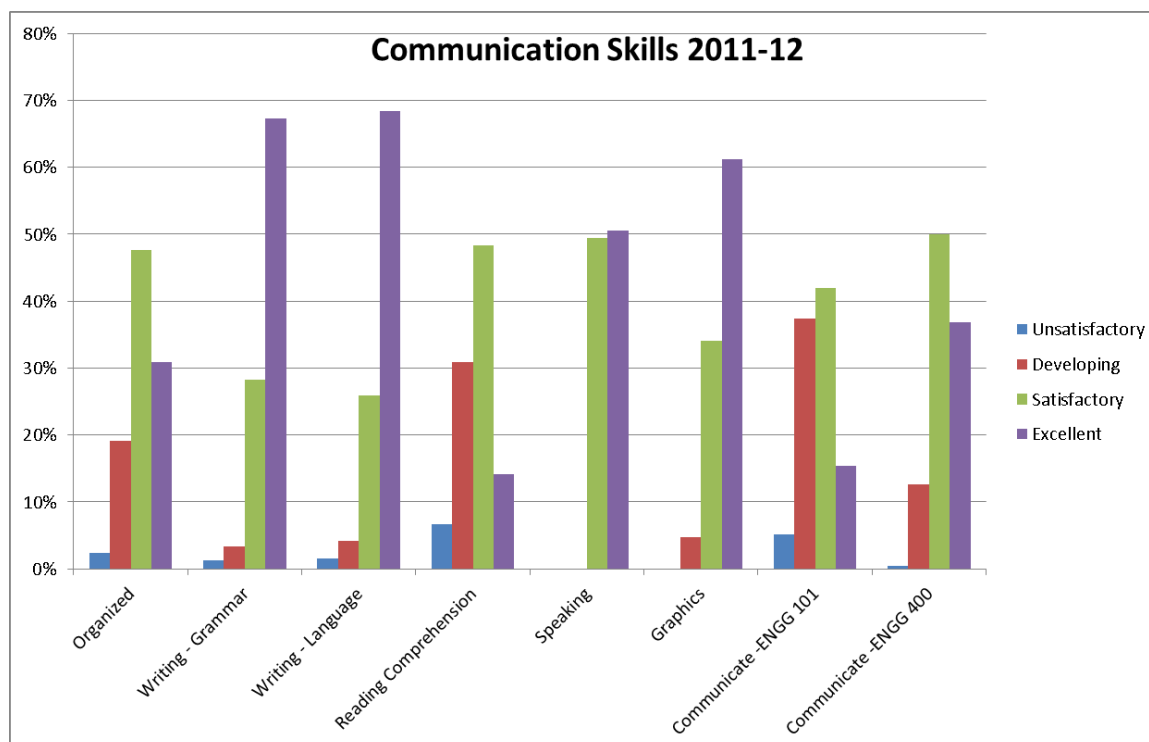
Figure C3: Example data for all the subattributes related to one GA (Communication Skills).

Appendix D: Possible Models of Implementation

Student-responsible model[1]

- Certain activities (courses, workshops, clubs, events, work experience, etc.) could have pre-determined credits assigned to them. Organizers of such activities can provide documentation of student participation as needed. Credits could come in different 'flavours' reflecting the different attributes to be developed.
- Other activities can be retroactively assessed by a designated office to determine credit values based on student-supplied documentation.
- Students must accumulate the required number of credits in various categories (likely one per attribute) to achieve success against the attributes list. Compliance could be either a mandatory requirement for graduation or a certificate of recognition.
    - o   Target levels should be set/customized by Faculties in accordance to University norms. This allows programs to provide a context and a standard appropriate to the discipline.
- A student information system could be developed for students to track their progress. Faculties/departments could also access this information (in aggregate) to understand gaps in their programs and needs for targeted activities. Accredited programs may require documentation of their performance/compliance.
- Student portfolios could be accumulated to provide auditable content (eg. for accreditation or government review) and concrete examples (e.g. for future job interviews)

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[1] In Ontario, the strategy Brock University has taken in dealing with the implementation of attributes and competencies (which they refer to as 'Experience Plus') is largely student-driven. There is an office that handles these issues and students are required to individually complete an online portfolio after which they will send proof (such as certificates, volunteering hours, professional development training, etc) to this office for a transcript to be completed. This transcript has the official University seal and students are allowed to use it for different purposes, including finding new jobs or entering into advanced studies. Although this is open to all students, only those who took the initiative to actually complete the online profile ended up with an *Experience Plus Transcript* - and the details on these transcripts vary from student to student.

Program-responsible model

- At a Faculty level, each Faculty or department could interpret the graduate attributes as relevant to their teaching mission. For an example, see Appendix B.
- At a program level, each Faculty could review their programs for development of student attributes.
- At a program level, Faculties or Departments could then structure or supplement the structure of programs to ensure the development of student attributes, so that students achieve the attributes by design of the program, rather than by student initiative. For an example, see Appendix C.
- Student achievement could be demonstrated by instructor assessment of targeted activities within courses or other formal activities. Students would get a course grade as always, but may also be assessed against more targeted criteria with specific indicators.
  - o   From a quality control perspective (eg. the perspective of government and/or accreditors), assessment may be attributed only to the program, not necessarily to the student. Measurements could even be done through sampling with students kept anonymous.
- For consistency, standardized tracking and documentation could be developed at the University level. Reporting on some interval basis (for instance, in every five years) could be done to the Provost and Vice President (Academic) by each Faculty.

Hybrid model

- The Faculty takes ownership of most aspects per the Program-responsible model, but some aspects (especially those tied to co-curricular and extra-curricular activities) are tasked to the student to demonstrate with some designated body or bodies authorized to review and approve student documentation.
  - o   The breakdown of who is doing what (i.e. the responsibilities above) is managed at the Faculty or department level.
- Every student must be assessed against every attribute (by the Faculty or at the initiative of the student) in order to generate a certificate or complete a graduation requirement.

Assessment - Pros & Cons of Each Model

Both Student- and Program-responsible models have pros and cons. The Student-responsible model is very easy to implement (incremental Faculty workload is minimal but resources are required for assessing student activities) and is robust in the face of very diverse and flexible programs. However, responsibility for ensuring outcomes are met (held by students) is separated from those with the authority and resources (the faculties) to create opportunities to demonstrably do so. This separation will limit the effectiveness of the initiative to improve these outcomes. It also does not fit well with the accreditation needs of many professional faculties. It does, however, create a very clear incentive for the student to develop themselves (especially if it's mandatory) and may empower them to be responsible for life-long learning. It also provides an additional credential (for example, a co-curricular transcript), which may be valued by potential employers.

The Program-responsible model is better suited for government assessment and/or accreditation since it is focused at the level at which those bodies are concerned. It forces Faculties to think holistically about their programs (rather than about individual courses), which could yield benefits for program enhancement. It can minimize and standardize assessments so they are highly consistent and most suitable for a continuous improvement system. In a program-responsible model, sampling can be employed so not every student need be assessed, nor every attribute examined every year. Assessments can also be highly targeted so precise indications of program shortcomings can be identified to inform remediation efforts. However, this approach has limited engagement of the student and provides no direction for individual improvement. It also fails to provide students with a distinct individual credential beyond the standard UofA degree (which may become more significant to an employer).

The Hybrid model delivers the most benefits, particularly if individual Faculties are free to set the balance of how much will be at the student level and how much will be the Program's responsibility. It also has the most potential to meet the distinctive needs of students, educators, potential employers, government, and accreditation bodies. However, it is also the most work, requiring the substantial involvement of both Faculty and student.