DETERMINING THE CONTENT VALIDITY OF A BIOSYSTEMS ENGINEERING PROGRAM

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Abstract – This study was designed as an exploratory case study to determine the relative importance and dependencies of the CEAB graduate attributes as perceived by engineering stakeholders of the University of Manitoba. The findings were used to examine the content validity of the Biosystems Engineering program. The overarching objective was to explore how well the emphasis on graduate attributes development in the Faculty of Engineering at the University of Manitoba reflect the graduate attribute importance reported by key stakeholders. Findings showed that all stakeholders ranked Individual and Teamwork and Communications Skills as the top engineering competencies, and all CEAB graduate attributes were perceived to be between 6.1% and 10.9% relatively important. This was in sharp contrast to the Biosystems Engineering program, which is comprised of approximately 50% of the graduate attribute, A Knowledge Base for Engineering. In this paper, the methods and findings in the determination of the content validity of an engineering program are presented and discussed.

Keywords: program evaluation; content validity; relative importance; CEAB graduate attributes; exploratory case study.

1. INTRODUCTION

There is global agreement on the critical role of engineering competencies for engineers of the 21st century. Attributes have been identified by engineering stakeholders around the world that represent the knowledge, skills, attitudes, values, and behaviours [1][2] intended to prepare engineering graduates more completely for professional practice [3]. However, little research has been conducted to ascertain how to prioritize these competencies. As stated by [4], ‘Under Washington Accord or ABET accreditation requirements, faculty must envision, collectively articulate, and prioritize the competencies that students should gain from their educational program to prepare for life and myriad career paths’ (p. 475). In Canada, we have the CEAB graduate attributes. [5] emphasizes that understanding required competencies in context is essential, which include specifically attending to the geographical location: ‘The

accreditation criteria are significant to the decisions made by people driving change in engineering education programs, evaluation methods, and even the foci of benchmarking exercises. Therefore it is critical that the nature of generic engineering competencies required by engineers graduating in [name of country] is understood well by accreditation developers, accreditation panels and engineering educators’ (p. 147). Supporting Canadian engineering students to effectively develop the competencies required for 21st century professional practice is a critically important endeavor. One way to do this is through program evaluation.

This engineering education research paper reports on a portion of an exploratory case study conducted to explore how well the emphasis on graduate attributes development in the Faculty of Engineering at the University of Manitoba reflect their reported importance by key stakeholders for supporting graduating students’ transition into professional practice. The purpose of the study was to inform the improvement and development of authentic outcomes-based engineering curricula by: (i) determining the relative importance of the CEAB graduate attributes; (ii) evaluating the content validity of the engineering programs; and (iii) developing a conceptual understanding of the CEAB graduate attributes to inform engineering curricular design. The study was executed in two phases. The first phase was designed to determine the relative importance and levels of dependencies of the CEAB graduate attributes for an Engineer-in-Training (EIT) at the beginning of her/his career as perceived across three engineering stakeholder groups in this case, i.e., students, faculty, and industry members. The second phase was to evaluate the content validity of an engineering program as measured by the mean relative importance of the CEAB graduate attributes determined by stakeholders. The second phase was guided by this research question: *In the Biosystems Engineering program, how do the percentages of course content coverage and course assessments of the CEAB graduate attributes compare with their perceived relative importance by all engineering stakeholders?*

This paper will present the findings from the content validity evaluation of the Biosystems program using the mean relative importance findings from all stakeholders. Findings, such as the differences in relative importance ratings between stakeholders will be presented in other work.

2. METHODS

2.1 Index of Relative Importance

A closed-ended rating survey was designed to determine the relative importance and the dependencies of the CEAB graduate attributes as perceived by engineering stakeholders at the University of Manitoba. The relative importance was calculated as follows: Data were collected on the perceived frequency of a graduate attribute for an Engineer-in-Training (EIT) in engineering practice (i.e., *how often an EIT at the beginning of his/her career will perform a task that clearly requires a graduate attribute*), and the perceived criticality of a graduate attribute (i.e., *the potential effect on workplace performance for an EIT at the beginning of his/her career if he/she does not have a sufficient level of competency for this graduate attribute*) each on a five-point scale (see [6] for a detailed account of survey development). The mean perceived absolute importance of each graduate attribute for each stakeholder was calculated by multiplying the frequency and the criticality data, i.e., $I_i = F_i C_i$ [7][8]. The mean percentage of each graduate attribute's absolute importance to the total absolute importance of all graduate attributes was computed to develop an index of relative importance [8]. The index of relative importance from the collective perceptions of all engineering stakeholders (i.e., students, faculty, and industry members) was used as a measure for the content validity of the Biosystems engineering program. This was determined for a first pass as the relative importance ratings between all stakeholders compared to individual stakeholder groups or a combined faculty/industry stakeholder group were not largely different. A more nuanced analysis could certainly be done looking comparatively at individual stakeholder groups. (For a detailed description of this study in its entirety, see [9].)

2.2 Biosystems Program Data

The second purpose of this study was to evaluate the measure of content validity of an engineering program in order to inform the improvement and development of authentic outcomes-based engineering curricula. [10] describe content validity within the domain of validity:

Evidence based on test content refers to the extent to which a scale's items, in the aggregate, constitute a representative sample of the topic's content domain. Do the items reflect what has been defined as "contextual competence" (Suen, 2008; Trochim, 2006)? To answer the question, content experts are consulted and their professional judgment is taken to reflect the degree of what was traditionally called "content validity." (p. 37-38)

Content evidence shows whether or not the content within the instrument is demonstrative of the intended concept to be measured [11, p. 166]. In this research, the content validity of an engineering curriculum is being measured by comparing the overall percentage that each CEAB graduate attribute is taught and assessed in the core Biosystems Engineering program to the mean relative importance of the graduate attributes as determined by all engineering stakeholders in this case. The assumption is that the more relatively important a graduate attribute is, the more 'representativeness' it should have in the curriculum, thereby establishing a measure of content relevance [12, p. 136].

Faculty teaching courses in the Biosystems Engineering program were asked to identify, in their judgment, what percentage of time they spend teaching and assessing the targeted graduate attributes in their course. For this purpose, the *Teaching Faculty Course Content Questionnaire* was developed (see Appendix A). Prior to collecting these data, the Department Head and Associate Department Head of Biosystems Engineering piloted the questionnaire to evaluate face and content validity, i.e., what the questionnaire appeared to measure to their 'untrained eye' [13, p. 13] (face validity), and whether the content within the instrument was demonstrative of the intended concept to be measured [11, p. 166] (content validity). As a result, the questionnaire underwent numerous iterations.

There are thirty-five courses that are considered core in the Biosystems program. All faculty members teaching courses in the Department of Biosystems (N=14) as well as faculty from other departments in the Faculty of Engineering who taught courses required by the Biosystems Engineering program (N=7) were asked to fill out the *Teaching Faculty Course Content Questionnaire*. The data collected from the questionnaire delineated both the percentage of time spent teaching and assessing the graduate attributes based on faculty members' professional judgment. These data, with the exception of a few cases, were accepted at face value. In a few instances, the data were unclear, and either the instructors were contacted again for clarification, or the researcher referred to faculty curriculum documents and/or faculty experts (i.e., Department Heads and faculty managing accreditation efforts) for substantiation.

For the other courses taught outside the Department of Biosystems (N=14) – courses offered either within the Faculty of Engineering or in the Faculties of Arts or Sciences – the researcher used Faculty of Engineering accreditation documents to ascertain which CEAB graduate attributes were taught and assessed in each course, and to estimate the percentage of time spent on each. It was found that the percentage of assessments for each graduate attribute was delineated in these documents; however, the percentage of time spent teaching these

graduate attributes was not. If the researcher could not determine from additional documentation (i.e., course syllabi) the percentage of time spent teaching the graduate attributes, the researcher assumed that the percentage of time spent teaching the graduate attributes was equal to the percentage of assessments for each.

The data were analyzed to calculate the total percentages of course content coverage and course assessments for each of the 12 CEAB graduate attributes in the Biosystems Engineering program. The data for course content coverage were compared to the data for course assessments to establish how similar they are. These data were then compared with the mean perceived relative importance findings of the CEAB graduate attributes for all engineering stakeholders to evaluate the content validity of the Biosystems engineering program.

2.3 Research Ethics and University Approval

Ethics approval for the study was granted through the Education and Nursing Research Ethics Board (ENREB) at the University of Manitoba. Additionally, permission to survey the university's faculty and students was approved by the Office of Institutional Analysis, and by the Dean of Engineering. Participation for all stakeholders was optional and confidential, and recruitment was sought following all ENREB and University of Manitoba regulations.

3. FINDINGS

3.1 Mean Perceived Relative Importance of CEAB Graduate Attributes

For all engineering stakeholders in this case (i.e., students, faculty, and industry) (N=207), the mean perceived frequency of a task that clearly requires a CEAB graduate attribute ranged from 2.7 – 4.3 on a 5-scale with a mean of 3.5. This translates to a perception for frequency of use between *Regularly* (1 – 2 times/week) to *Quite often* (once per day). The mean perceived criticality of the potential effect on workplace performance for an EIT at the beginning of her/his career if she/he does not have a sufficient level of competency for a graduate attribute ranged between 3.1 – 3.7 with a mean of 3.4. This translates to a perception of criticality between *Moderate* (notable harm, damage or inconvenience, may need help to correct) to *Major consequences* (serious harm, damage or disruption, likely need help to correct) (see Table 3.1).

Table 3.1

Mean perceived frequency and criticality of the CEAB graduate attributes across all stakeholders (N=207) ($p < .05$)

CEAB Graduate Attributes	Frequency Mean (SD)	Criticality Mean (SD)
Knowledge Base	3.8 (1.0)	3.5 (0.9)
Problem Analysis	3.7 (1.0)	3.5 (0.9)
Investigation	3.1 (1.1)	3.2 (1.0)
Design	2.9 (1.1)	3.3 (1.0)
Eng. Tools	3.6 (1.0)	3.3 (0.9)
Ind. & Teamwork	4.3 (0.9)	3.6 (0.9)
Communication	4.3 (0.9)	3.7 (0.9)
Professionalism	3.8 (1.2)	3.5 (1.0)
Impact of Eng.	2.7 (1.2)	3.2 (1.1)
Ethics & Equity	3.4 (1.3)	3.6 (1.1)
Eco. & Proj. Mngt.	2.8 (1.0)	3.1 (0.9)
Lifelong Learning	3.2 (1.2)	3.1 (1.1)

For all engineering stakeholders in this case (i.e., students, faculty, and industry) (N=207), the mean perceived absolute importance of the graduate attributes ranged from 9.0 – 16.1 with a mean of 12.3. In absolute terms, the graduate attribute, Individual and Teamwork, was perceived as the most important, and Economics and Project Management as the least important. The relative importance ranged from 6.1% - 10.9% (see Table 3.2).

Table 3.2

Mean absolute and relative importance of the CEAB graduate attributes across all stakeholders (N=207) ($p < .05$)

CEAB Graduate Attributes	Mean (SD) Absolute Importance	Mean (SD) Relative Importance
Knowledge Base	13.4 (5.5)	9.1%
Problem Analysis	13.3 (6.1)	9.0%
Investigation	10.7 (6.0)	7.2%
Design	10.3 (6.1)	7.0%
Eng. Tools	12.2 (5.6)	8.3%
Ind. & Teamwork	16.1 (5.8)	10.9%
Communication	15.9 (5.8)	10.8%
Professionalism	13.9 (6.9)	9.4%
Impact of Eng.	9.3 (6.2)	6.3%
Ethics & Equity	13.0 (7.3)	8.8%
Eco. & Proj. Mngt.	9.0 (5.0)	6.1%
Lifelong Learning	10.5 (6.7)	7.1%

3.2 Biosystems Course Content Coverage and Assessments

The core course content taught in the BIOE program was found to be comprised of just under 50% A Knowledge Base for Engineering, 13% Problem Analysis,

just over 10% Design, 7% Communication Skills, approximately 4.5% each of Use of Engineering Tools and Investigation, 4% Impact of Engineering on Society and the Environment, and just over 1% each of Individual and Teamwork, Professionalism, Ethics and Equity, and Economics and Project Management. There were very similar percentages for the assessment of each graduate attribute in the BIOE program, with the largest discrepancy between the teaching and assessing of the graduate attributes found for A Knowledge Base for Engineering and Use of Engineering Tools, which are taught approximately 1% more than they are assessed, and Problem Analysis, which is assessed 1.5% more than it is taught. Every other attribute is taught and assessed in the curriculum with a difference of less than 1%.

With two exceptions, the ranked order of emphasis of the graduate attributes based on the course content coverage and course assessments in the BIOE program closely reflects the CEAB's linear list of the 12 graduate attributes. Albeit the order of what some consider the 'technical' skills and the 'professional' skills are varied. The exceptions include the relatively larger emphasis on Communication Skills, which is ranked before Use of Engineering Tools and Investigation, and the relatively larger emphasis on Impact of Engineering on Society and the Environment, which is the top 'professional' skill aside from Communications Skills, and is assessed more than Engineering Tools (see Table 3.3).

Table 3.3
Comparative view of percentage of course content coverage and percentage of course assessments in the BIOE program.

CEAB Graduate Attributes	Course Content Coverage	Assessment Coverage
Knowledge Base	48.8%	47.7%
Problem Analysis	12.9%	14.4%
Investigation	4.6%	5.1%
Design	10.7%	10.8%
Eng. Tools	4.7%	3.8%
Ind. & Teamwork	1.3%	1.3%
Communication	7.5%	7.3%
Professionalism	1.3%	1.3%
Impact of Eng.	4.1%	4.1%
Ethics & Equity	1.3%	1.4%
Eco. & Proj. Mngt.	1.2%	1.7%
Lifelong Learning	1.5%	1.2%

3.3 Biosystems Course Content Coverage and Assessments Compared to the Mean Perceived Relative Importance of the CEAB Graduate Attributes by all Engineering Stakeholders

The range between percentage of course content coverage and assessments across the CEAB graduate attributes in the Biosystems program was from 1.2% – 48.8% for teaching, and 1.2% – 47.7% for assessing. This is in sharp contrast to the range of mean perceived relative importance of the graduate attributes ascribed by all engineering stakeholders, which was between 6.1% and 10.9%.

The graduate attribute, A Knowledge Base for Engineering, comprises almost half of the Biosystems program, as compared to its 9% relative importance attributed by stakeholders. This is the attribute that is most skewed in relation to the relative importance data. Following that, both Problem Analysis and Design are taught and assessed approximately 4% more than its relative importance attributed by stakeholders.

The remainder of the graduate attributes are given less weight in the program than their relative importance. The largest of these discrepancies is found for Individual and Teamwork, which is the relatively most important attribute for stakeholders at approximately 11%, and is given just over 1% of attention in the Biosystems curriculum. The same holds true for the attributes, Professionalism, Ethics and Equity, Lifelong Learning, and Economics and Project Management, which are given 8%, 7%, 6%, and 5% less attention respectively than their relative importance suggests. Engineering Tools is emphasized approximately half the time in the Biosystems curriculum compared to its mean relative importance as attributed by all stakeholders. Communications Skills and Impact of Engineering on Society and the Environment are each given approximately two-thirds of the curricular attention compared to stakeholders' perceived mean relative importance for each. Generally, Investigation, Design, Communication Skills, Impact of Engineering on Society and the Environment, (and to some extent Use of Engineering Tools and Problem Analysis, in terms of teaching content) are the graduate attributes that are given somewhat analogous attention in relation to stakeholders' mean perceived relative importance. For these comparisons, Problem Analysis and Design are given more emphasis in the BIOE program than their mean relative importance ratings warrant, and the rest are given less (see Table 3.4).

Table 3.4

Comparative view of mean relative importance of the CEAB graduate attributes by all stakeholders (N=207) with percentage of course content coverage and assessments in the BIOE program.

CEAB Graduate Attributes	Relative Imp.	Course Content Coverage	Assessment Coverage
Knowledge Base	9.1%	48.8%	47.7%
Problem Analysis	9.0%	12.9%	14.4%
Investigation	7.2%	4.6%	5.1%
Design	7.0%	10.7%	10.8%
Eng. Tools	8.3%	4.7%	3.8%
Ind. & Teamwork	10.9%	1.3%	1.3%
Communication	10.8%	7.5%	7.3%
Professionalism	9.4%	1.3%	1.3%
Impact of Eng.	6.3%	4.1%	4.1%
Ethics & Equity	8.8%	1.3%	1.4%
Eco. & Proj. Mngt.	6.1%	1.2%	1.7%
Lifelong Learning	7.1%	1.5%	1.2%

4. DISCUSSION

Overall, the rated order of importance in the Biosystems program as established by percentage of time spent teaching and assessing the graduate attributes is varied from the rated order of mean relative importance for all engineering stakeholders (i.e., students, faculty, and industry) in this case. For all engineering stakeholders, the rated order of mean importance can be roughly viewed in low, medium and high absolute importance groups to aid interpretation. All stakeholders rated Individual and Teamwork and Communication Skills in the highest group of importance; Professionalism, A Knowledge Base for Engineering, Problem Analysis, Ethics and Equity, and Use of Engineering Tools could be considered a second group of importance; and Investigation, Lifelong Learning, Design, Impact of Engineering on Society and the Environment, and Economics and Project Management a third group of importance. Even though the order changes slightly for each individual stakeholder group, the composition of the low, medium and high groups of importance do not; these three groups are found across all, and for each individual (i.e., student, faculty, and industry) engineering stakeholder groups.

There is a different composition for the Biosystems engineering program when considering groups of emphasis. For time spent both teaching and assessing the graduate attributes, four groups can be discerned to aid interpretation. Firstly, A Knowledge Base for Engineering is alone in the highest group of emphasis, far removed from all the other graduate attributes with almost 50% of the program course content coverage and course assessments. The next group could be perceived as

comprised of Problem Analysis, Design, and Communications Skills, although there is over a 5% range of discrepancy in this group, from 7.5% – 12.9%. The third group could be perceived as Use of Engineering Tools, Investigation, and Impact of Engineering on Society and the Environment, each with just over 4% emphasis in the program. The fourth group can be interpreted to encompass Lifelong Learning, Individual and Teamwork, Professionalism, and Ethics and Equity, each with between 1% – 1.5% of program course content coverage and course assessments (see Table 4.1).

Table 4.1

Comparative view of ranked order of mean relative importance of the CEAB graduate attributes for all engineering stakeholders with percentage of course content coverage and course assessments in the BIOE program.

Ranked Mean Relative Imp. For All Stakeholders (N=207)	BIOE Program Ranked % of Course Content Coverage	BIOE Program Ranked % of Course Assessments
IT 10.9%	KB 48.8%	KB 47.7%
CS 10.8%	PA 12.9%	PA 14.4%
PR 9.4%	DE 10.7%	DE 10.8%
KB 9.1%	CS 7.5%	CS 7.3%
PA 9.0%	ET 4.7%	IN 5.1%
EE 8.8%	IN 4.6%	IE 4.1%
ET 8.3%	IE 4.1%	ET 3.8%
IN 7.2%	LL 1.5%	EP 1.7%
LL 7.1%	IT 1.33%	EE 1.4%
DE 7.0%	PR 1.29%	IT 1.27%
IE 6.3%	EE 1.26%	PR 1.27%
EP 6.1%	EP 1.2%	LL 1.2%

Note. KB=Knowledge Base for Engineering; PA=Problem Analysis; IN=Investigation; DE=Design; ET=Use of Engineering Tools; IT=Individual and Teamwork; CS=Communication Skills; PR=Professionalism; IE=Impact of Engineering; EE=Ethics and Equity; EP=Economics and Project Management; LL=Lifelong Learning.

When further considering these groups of importance, discrepancies are found with the emphasis of Individual and Teamwork, which can be perceived as relegated to the fourth group of importance in the Biosystems program (i.e., the ‘bottom’ group of emphasis), whereas Individual and Teamwork is found in the highest group of importance for engineering stakeholders. Professionalism and Ethics and Equity are in the bottom group of emphasis in the BIOE program, and in the second highest group of importance (quite close in relative importance to the top group) for engineering stakeholders. Attributes that are more closely aligned in regards to the groups of importance include Investigation and Impact of Engineering on Society and the Environment, which are both found in the third group of emphasis in the BIOE

program and in the third group of importance for engineering stakeholders. Interestingly, Design and Communication Skills have inverse values of emphasis, at 10.7% (2nd group) and 7.5% (2nd group) respectively in the Biosystems program, and at 7.0% (3rd group) and 10.8% (1st group) mean relative importance for engineering stakeholders. Both however, as shown, are in different groups of importance, with engineering stakeholders placing less importance on Design and more importance on Communication Skills, and the BIOE program placing more equitable emphasis on each.

Largely, with the exception of Communication Skills, the Biosystems program emphasizes what have been called the ‘traditional’ skills in engineering, followed by descending emphasis for what have been called the ‘professional’ skills. Engineering stakeholders, on the other hand, place more initial importance on the ‘professional’ skills, i.e., Individual and Teamwork and Communication Skills, followed by a mix of the graduate attributes that does not delineate a clear division between these two binary labels (see [9] for an expanded discussion of the conceptualization of the CEAB graduate attributes). The findings of perceived importance by engineering stakeholders in this study echo the findings in the literature, where communication and teamwork skills are shown to be top engineering competencies by engineering stakeholders, including engineers in practice [3][4].

Despite this discussion, it is important to consider that although the Biosystems Engineering program content coverage and course assessments of the CEAB graduate attributes were largely different than stakeholders’ relative importance ratings, this is not a surprising finding. Outcomes-based assessment was only introduced to accredited Canadian engineering programs in 2009. Engineering programs have long historically focused on the knowledge-based and skill-based aptitudes required for engineering. The content validity evaluation of the Biosystems program resulting from this study should be viewed as one tool in which to align the curriculum more closely with the graduate attributes rated as relatively important by key engineering stakeholders as part of the continual improvement process required of CEAB accredited programs. As such, the following suggestions could be considered.

Important deliberations for the BIOE program include the minimal emphasis on the ‘affective’ attributes, Professionalism and Ethics and Equity, and the attribute, Lifelong Learning, which are not only rated comparatively higher in relative importance by all engineering stakeholder groups, but are more relatively important particularly to the student stakeholders in this case. Contemplating increasing the emphasis on these attributes would potentially benefit the program in attracting an even more diverse student population. By appealing to a broader range of potential applicants via the diversification of the competencies perceived as valuable to engineering,

the department can enlarge the understanding of what engineering is, and can be [14].

Additionally, although Communications Skills is receiving relatively more weight in the BIOE program than the other affective attributes, students would benefit from increased emphasis according to the research in this case and the literature [3][4]. Critical to these findings is the minimal attention given to Individual and Teamwork in the BIOE curriculum, particularly in view of its prominence as a top engineering competency in the literature [3][4][15]. It is vital going forward that content coverage of this attribute increases.

Finally, it is evident that Knowledge Base for Engineering has imbalanced impact on the BIOE curriculum when considering the mean relative importance given it in both this case and in the literature. How to de-emphasize the weight of Knowledge Base for Engineering in a curriculum so heavily loaded with this attribute while maintaining the knowledge base necessary for the profession is a fundamental problem that requires solving if the other attributes are to be given the weight that stakeholders attribute them (see [9] for a complete discussion of these findings).

5. CONCLUSION

This engineering education research paper accounts a portion of an exploratory case study conducted to examine how well the emphasis on graduate attributes development in the Faculty of Engineering at the University of Manitoba reflect their reported importance by key engineering stakeholders. This is essential for supporting graduating students’ transition into professional practice. The purpose of the overarching study is to inform the improvement and development of authentic outcomes-based engineering curricula. This paper discusses evaluating the content validity of the Biosystems Engineering program in the faculty, and makes suggestions for improving it.

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Appendix A: Teaching Faculty Course Content Questionnaire

1. Based on the Graduate Attribute table that was developed for BIOE 2790, these CEAB graduate attributes are taught and/or assessed in your course:

Graduate Attribute	Weight	Level I/D/A
A Knowledge Base for Engineering		I
Problem Analysis		I
Investigation		I

Is the list correct? Yes _____ No _____

(If no, please cross out any graduate attributes that are listed but aren't associated with your course and/or add any graduate attributes that are missing.)

2. In your judgment, when you consider the content covered in this course (i.e., through teaching, readings, homework, and other methods of course content delivery), approximately what percentage of the content is allocated for each of the graduate attributes listed in question 1?

Graduate Attribute	Percentage of <u>content</u> coverage (where total does not exceed 100%)
Total:	<= 100%

3. In your judgment, when you consider all of the assessment tools used in this course (i.e., any work that students will receive a mark/grade for, including lab reports, homework, tutorials, quizzes, tests, exams, projects, etc.), approximately what percentage of these assessments is allotted to each of the graduate attributes listed in question 1?

Graduate Attribute	Percentage of <u>assessments</u> (where total does not exceed 100%)
Total:	<= 100%