Consistent Program Evaluation for Engineering Accreditation

Dr. Malcolm Reeves, FEC, P.Eng
Past-Chair Canadian Engineering Accreditation Board
March 2016

Presentation Outline

- What is accreditation?
- What are suitable standards?
- What are the essential elements to evaluate?
  - Administrative standards
  - Educational standards
    - Graduate attribute exemplars
    - Prerequisites for consistent assessment
    - GA/CQI assessment
- Program content assessment
- How can program content best be measured ?
- Why are learning-outcome based measures better tools than time-based content measures?

What is accreditation?

- **Accreditation** is the act of granting credit or recognition to an educational institution that maintains suitable standards.
- **Engineering Accreditation** is the act of granting credit or recognition to an educational institution that maintains suitable standards for engineering education.

What are suitable standards?

- For Engineering Accreditation there are a number of international agreements that attempt to define appropriate standards. Two examples are:
  - IEA-WA (International Engineering Alliance – Washington Accord)
  - ENAEE- EUR-ACE® (European Network for Accreditation of Engineering Education EUR-ACE®)

Administrative program-level standards

- Most standards include criteria for:
  - Program environment
    - Faculty, facilities, support-staff, finances …
  - Student-related processes
    - Student admission, progression, graduation, ….
  - Rules mandated by accreditation
    - Program naming, authority, responsibility, organization ….

Consistent objective evaluation of compliance with these criteria is generally straightforward.

Educational program-level standards

- Most standards also include criteria for:
  - Program outcomes
    - What competencies should graduates possess?
  - Program content and quality
    - What content should be mastered at what level?
  - Program improvement processes
    - What processes are in place to ensure continuous quality improvement?

Compliance with these criteria is much harder to measure in a consistent and objective manner.

Canadian accreditation criteria

- **Program outcomes** are measured by compliance with a set of graduate attributes consistent with the WA exemplar.
- **Program content and quality**: The total volume of learning is indicated by the statement that a program of study is typified by four years or more of post-secondary study identical to the WA statement.
- **Program improvement processes** require consultation with appropriate stakeholders and a data collection, analysis and decision-making process leading to actions.

Prerequisites for consistent assessment

- Standardized data collection
  - accreditation questionnaire
  - **HEI/program chair training**
  - Structured visit and team member roles
  - **Chair/vice chair training**
- Standardized review process
  - GA review rubric
  - CQI review rubric
  - **Program visitor/evaluator training**

Canadian course information sheets

- The heart of the CEAB questionnaire is a standardized course information sheet (CIS) which self-validates every entry
- Most tabular information is automatically extracted from the CIS
- **HEI staff/faculty entering information require training**
  - data is mostly selected from limited options in pulldown lists
- Typically 50-60 CIS per program can be filled in one or two days by a trained user
- CIS can change every cycle so there an auto-fill option from previous versions is a useful tool

Course content details

Appendix 6C - Course Information Sheet													
Instructions:		To be completed for every compulsory and elective course. Data used to validate input is stored in columns P-X of this worksheet. Macros are provided to add learning instructors, outcomes, texts and laboratory content. ADDING OR DELETING ROWS IN ANY OTHER WAY WILL INVALIDATE THIS WORKSHEET.											
Course number:													
Course title:													
Calendar web link:													
* Notes:													
* Provide explanatory notes on inconsistencies with calendar information (if applicable)													
CEAB course type		K-factor	Content category & elements	Math		Natural science		Complementary studies		Engineering science		Engineering design	
Compulsory	Elective group	AU %		0%		0%		0%		0%		0%	
		AU Total	36										
CEAB graduate attribute content** (content code):		1 KB	2 PA	3 Inv.	4 Des.	5 Tools	6 Team	7 Comm.	8 Prof.	9 Impacts	10 Ethics	11 Econ.	12 LL
** Enter content level codes for no more than three attributes													
Content level code (no more than three): blank = not applicable; I = introduced (introductory); D = developed (intermediate); A = applied (advanced)													

Instructor details

Appendix 6C - Course Information Sheet								
Instructions:	To be completed for every compulsory and elective course. Data used to validate input is stored in columns P-X of this worksheet. Macros are provided to add learning instructors, outcomes, texts and laboratory content. ADDING OR DELETING ROWS IN ANY OTHER WAY WILL INVALIDATE THIS WORKSHEET.							
First row professor-in-charge followed by all other instructor(s)								
Instructors	Family name	First name(s)	CC member	Hire date	Est. ret. date	L. status	Highest Degree	Acad rank
Professor-in-charge								
Other(s)								

Course delivery details

Appendix 6C - Course Information Sheet	
Instructions:	To be completed for every compulsory and elective course. Data used to validate input is stored in columns P-X of this worksheet. Macros are provided to add learning instructors, outcomes, texts and laboratory content. ADDING OR DELETING ROWS IN ANY OTHER WAY WILL INVALIDATE THIS WORKSHEET.

Course delivery and outcomes:	Acad credit	Hrs/wk		Number sections		students per supervisor		Average grade		Failure rate (%)
		Lec	Lab/tut	Lec	Lab/tut	Lab	Tut	%	Letter	

Major learning outcomes:	Learning outcome expectation for lecture and/or lab experience	
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	

Laboratory experience		Laboratory experience details
Lab type		Specify the predominant laboratory experience type for this course/learning activity
Number of labs		Specify the total number laboratory experiences for the course/learning activity
Laboratory safety taught ?		Are students instructed in safety issues associated with the laboratory space and the specific learning experience?
Laboratory safety examined ?		Is there verification, testing or checking that students have both received and understood safety issues?

Required text(s): *(required texts only not a reaading list)*	Author : Title : Publisher : Year	
	1	
	2	
	3	
	4	

Tables extracted from CIS

- Content by category (MATH,NS,CS,ES,ED)
- Faculty information summary
- Laboratory experience summary
- Curriculum committee membership
- Grades and failure rates by course

Canadian curriculum mapping

- The other major component of the questionnaire is a standardized curriculum map for graduate attributes by semester
- Course labels are linked to the CIS which can be opened from the map for reference
- **HEI staff/faculty entering information require training**
  - data links to CIS are automatically generated through the course ID
  - CIS provides GA content-levels (introductory, intermediate, advanced)
  - CIS provides AB content-category information (MATH,NS,CS,ES,ED)
- Typically 50-60 courses are mapped over four years

Tables extracted from curriculum map

- Full curriculum map by semester (user-filled)
- Assessed course curriculum map by semester
- Full GA content-level and AB content-category map by course-ID
- Assessed course GA content-level and AB content-category map by course-ID

GA assessment categories

- The GA assessment rubric has five assessment categories which must be marked as acceptable, marginal or unacceptable (A,M,U) by the visiting team
  - Organization and engagement
  - Curriculum maps
  - Indicators
  - Assessment tools
  - Assessment results

CIQ assessment categories

- The CIQ assessment rubric has three assessment categories which must be marked as acceptable, marginal or unacceptable (A,M,U) by the visiting team
  - Improvement process
  - Stakeholder engagement
  - Improvement actions

GA and CQI assessment rubrics

- The rubric quotes the formal criterion corresponding to each category for reference
- Space is provided for the team to enter notes for any category assessment.
- Notes are required for any assessment other than A (acceptable)
- Detailed descriptors for A,M,U are provided for each category

Program content assessment

- The total volume of learning required is four years or more of post-secondary study.
- **This apparently simple statement is where the problem begins!**
  - How much learning does a year represent?
  - How much learning does a semester represent?
  - What is a semester?
  - Why is time-spent in learning so important?

Back to basics

- Can we define the total learning we expect to take place to prepare an engineering graduate?

  This must be possible because we are (or at least claim to be) doing it!

- Can we describe that learning by a series of measureable activity/course-level learning outcomes?

  This must also be possible because again we are (or at least claim to be) doing it! For 50-60 courses perhaps 200-300 LOs?

First problem

- If course-level learning outcomes are achieved, do we care how long it takes, or how the learning is delivered?

  The answer should probably be no unless we are too lazy to construct courses to make efficient use of learning time!

- Can we package our required learning outcomes into standard length courses?

  We probably can't do this because some learning outcomes may require much more time to establish than others and time-required may vary for individual learners?

Second problem

- Are all courses (collections of LOs) equally important?

  It may be possible to encapsulate the learning to prepare an engineering graduate as a finite number of equally important courses – but is it worth the effort?

- Can we rank activities/courses in terms of their importance in preparing an engineering graduate?

  This should be possible and it has been done successfully in other disciplines?

Third problem

- What are the quantifiable factors that make one LO (or collection of LO's) more important than another?
  - Student workload
  - Foundational/support value for subsequent LOs
  - Complexity (Intellectual challenge/breadth)

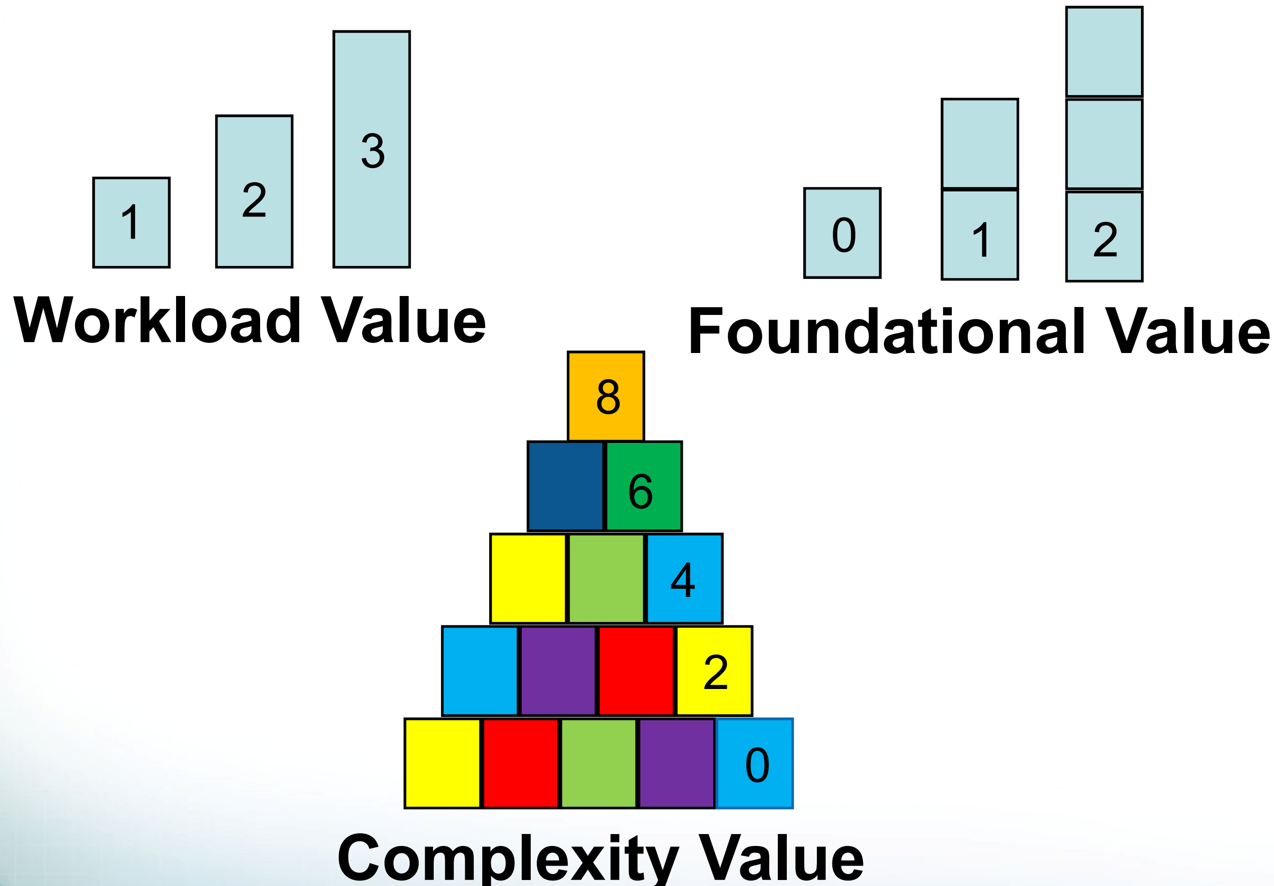
- How should the factors be weighted?
  - Workload only?
  - Equally?
  - Complexity>Support>Workload?

Lessons learned so far

- Programs can be expressed as a finite number of measureable course-level LOs.
- The four-year post-secondary requirement for an engineering degree is the minimum time required to deliver this set of LOs.
- Courses/learning activities are simply convenient collections of related-LOs.
- All courses (as collections of related-LOs) are not equally important to the preparation of an engineer.
- There is no (strong) relationship between the time-to-master LOs and the relative importance of those LOs.

Measuring course weights

- To effectively weight courses it is necessary to use some measureable characteristics



Relative course weights

- **Workload Value** (as indicated by HEI academic credit)
  - a typical one-semester course normally represents roughly 2% of a 4-year engineering program.
- **Foundational Value** (as indicated by the length of prerequisite chains)
  - courses typically have chain lengths of 0 to 6 (the total number of program courses that build on the course content).
- **Complexity Value** (as indicated by the WA definition of complexity)

  senior courses with significant elements of synthesis and design usually qualify as complex.

Why calculate course-weights?

- Using course weights based on learning outcomes breaks the link between time-of-study and value of learning.
- The "accreditation value" of a program can be thought of as the sum of "academic credit x course-weight" over all courses.
- It can be argued that "accreditation value" is a more appropriate measure of total volume of learning than a total academic credit.
- Program "accreditation value" can be increased by better structuring of content to increase foundational and complexity values.
- Changes in the "accreditation value" of a program can provide both a measure of program quality and an indicator of CQI.

Questions?