Continuous program improvement processes for **accreditation**

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http://egad.engineering.queensu.ca

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Workshop outcomes

1. Be able to define and use terminology in graduate attribute assessment
2. Be able to work collaboratively with colleagues to apply methods and tools for the continuous program improvement

Material from this workshop

Slides and online resources are posted on the EGAD website http://egad.engineering.queensu.ca

More detail at the end of the session

Feel free to ask questions throughout the session

Who we are: Engineering Graduate Attribute Development Project

- Collecting and developing resources and training for faculty and administration on continuous program improvement processes
- Composed of engineering educators and educational developers across Canada, and sponsored by deans of engineering (NCDEAS)
- Working collaboratively with CEAB

Context:
CEAB Criterion 3.1 & 3.2

3.1: Demonstrate that graduates of a program possess the 12 attributes

3.2: Continual program improvement processes in place using results of graduate attribute assessment

Starting point:

We're starting from the question

"How do we create a process to improve our program that demonstrates what our students can do?" (which CEAB requires)

12 Graduate Attributes

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

CEAB requirements include:

a) ***indicators*** that describe specific abilities expected of students

b) A **mapping** of where attributes are developed and assessed within the program

c) Description of ***assessment tools*** used to measure student performance (reports, exams, oral presentations, …)

d) **Evaluation** of measured student performance relative to program expectations

e) a description of the **program improvement** resulting from process

Graduate Attribute Assessment

- Outcomes based: In general, the term *outcomes assessment* is used to answer questions like:
  - What can students *do*? How does their performance compare to our stated expectations?
- It **identifies gaps** between

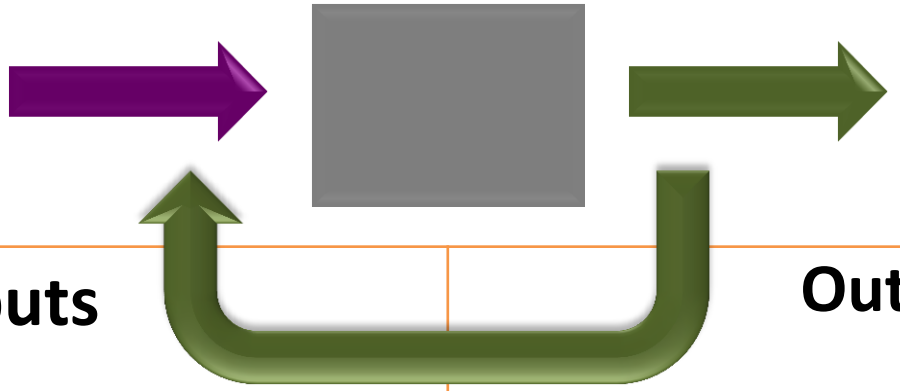
our perceptions of what we teach

actual knowledge, skills, and attitudes students develop program-wide.

Inputs and Outcomes

Inputs	Outcomes
Course materials (text, notes) Student pre-university background Faculty education, professional status Ongoing faculty development Class sizes Content Campus resources Contact hours Laboratory equipment Support services	Demonstrated abilities (cognitive, skills, attitudes)

Inputs and Outcomes



Inputs

Student pre-university background
Faculty education, professional
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Laboratory equipment
Support services

Outcomes

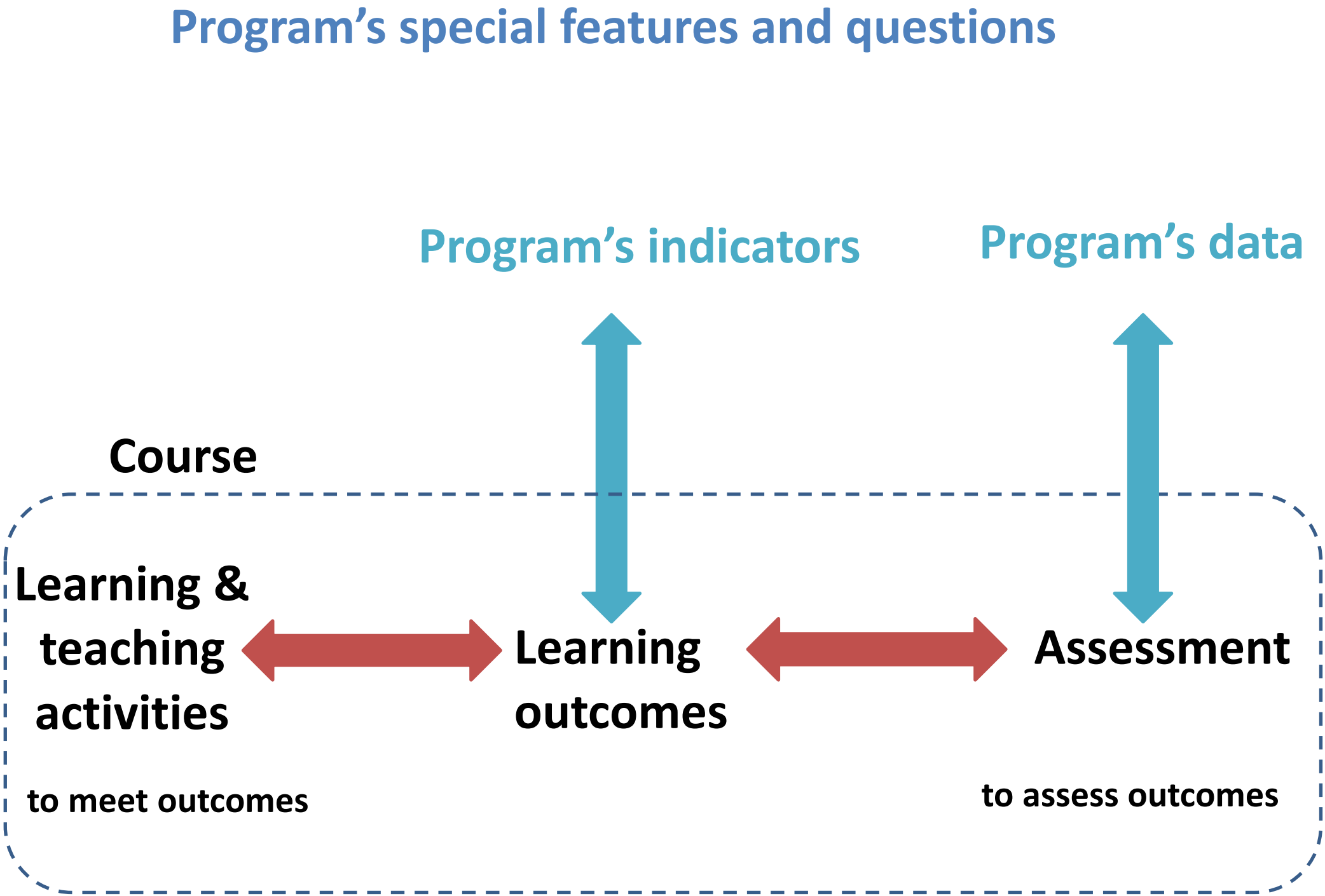
Demonstrated abilities
(cognitive, skills, attitudes)

Current CEAB Accreditation System

Remains in place (for foreseeable future)

Graduate Attributes Accreditation

Emphasis on continuous program improvement


Program's special features and questions
Program's indicators
Program's data
Course
Learning & teaching activities
Learning outcomes
Assessment
to meet outcomes
to assess outcomes

Why continuous program improvement?

- Required by CEAB
- Outcomes-based assessment becoming expectation by the province

What does it offer?

- Improved program coordination
- Improved curricular planning
- Quality data about student performance
- Improved graduating student capacity
- Improved relationship with stakeholders

WHAT WORKS to improve learning?

A study involving

800 meta-analyses

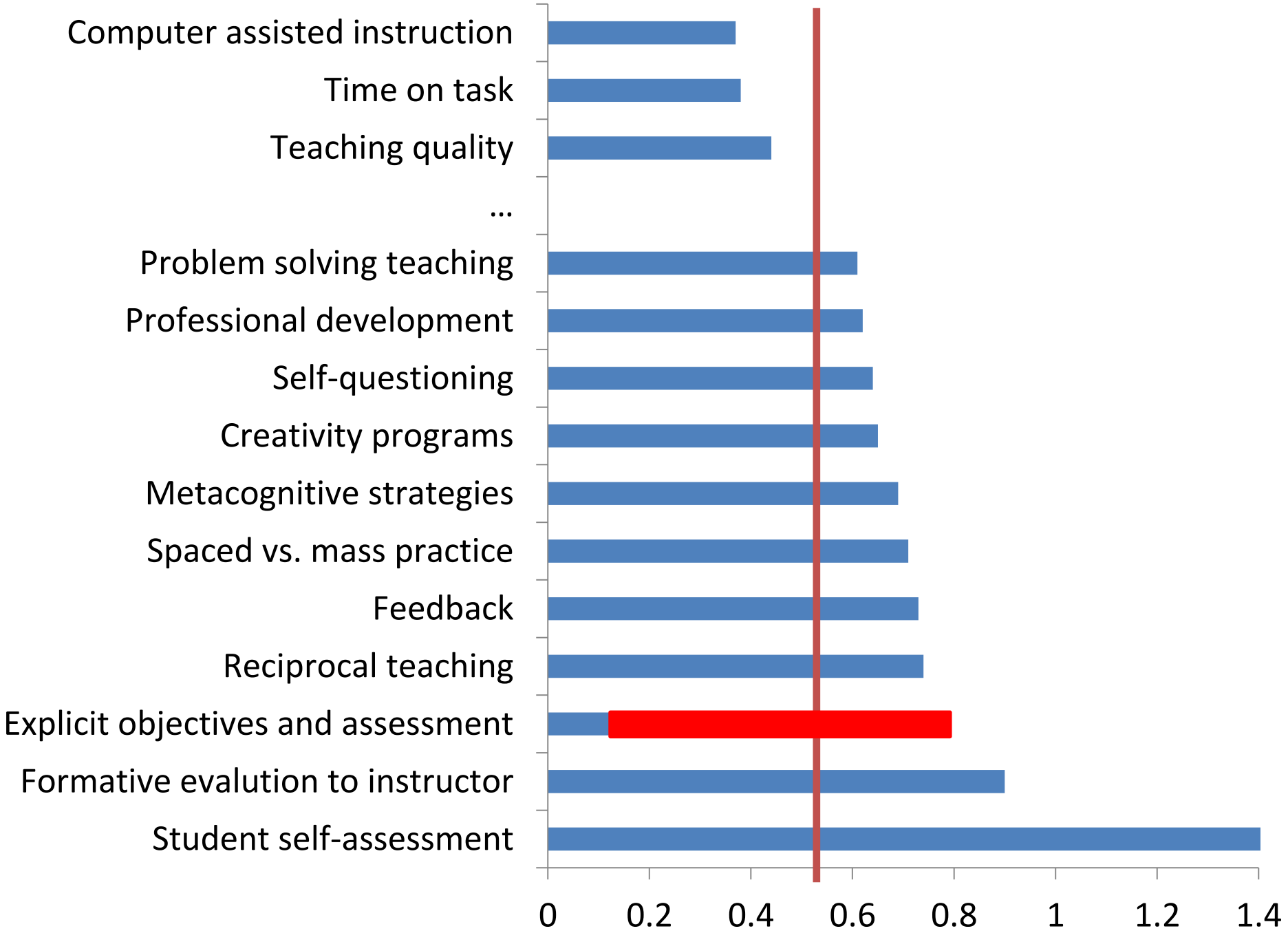
50,000+ studies

250+ million students

found that explicit outcomes and assessment has one of the largest effects on learning…

Hattie, J. (2009). The Black Box of Tertiary Assessment: An Impending Revolution. In L. H. Meyer, S. Davidson, H. Anderson, R. Fletcher, P.M. Johnston, & M. Rees (Eds.), Tertiary Assessment & Higher Education Student Outcomes: Policy, Practice & Research (pp.259-275). Wellington, New Zealand: Ako Aotearoa

Effect size (performance gain in σ)



International agreement for outcomes assessment

- Accreditation bodies in countries who are signatories to the Washington Accord use outcomes-based assessment
- Washington Accord allows substantial equivalency of graduates from Australia, Canada, Hong Kong, Republic of Ireland, New Zealand, South Africa, United Kingdom, and United States, Japan, Singapore, Korea, and Chinese Taipei

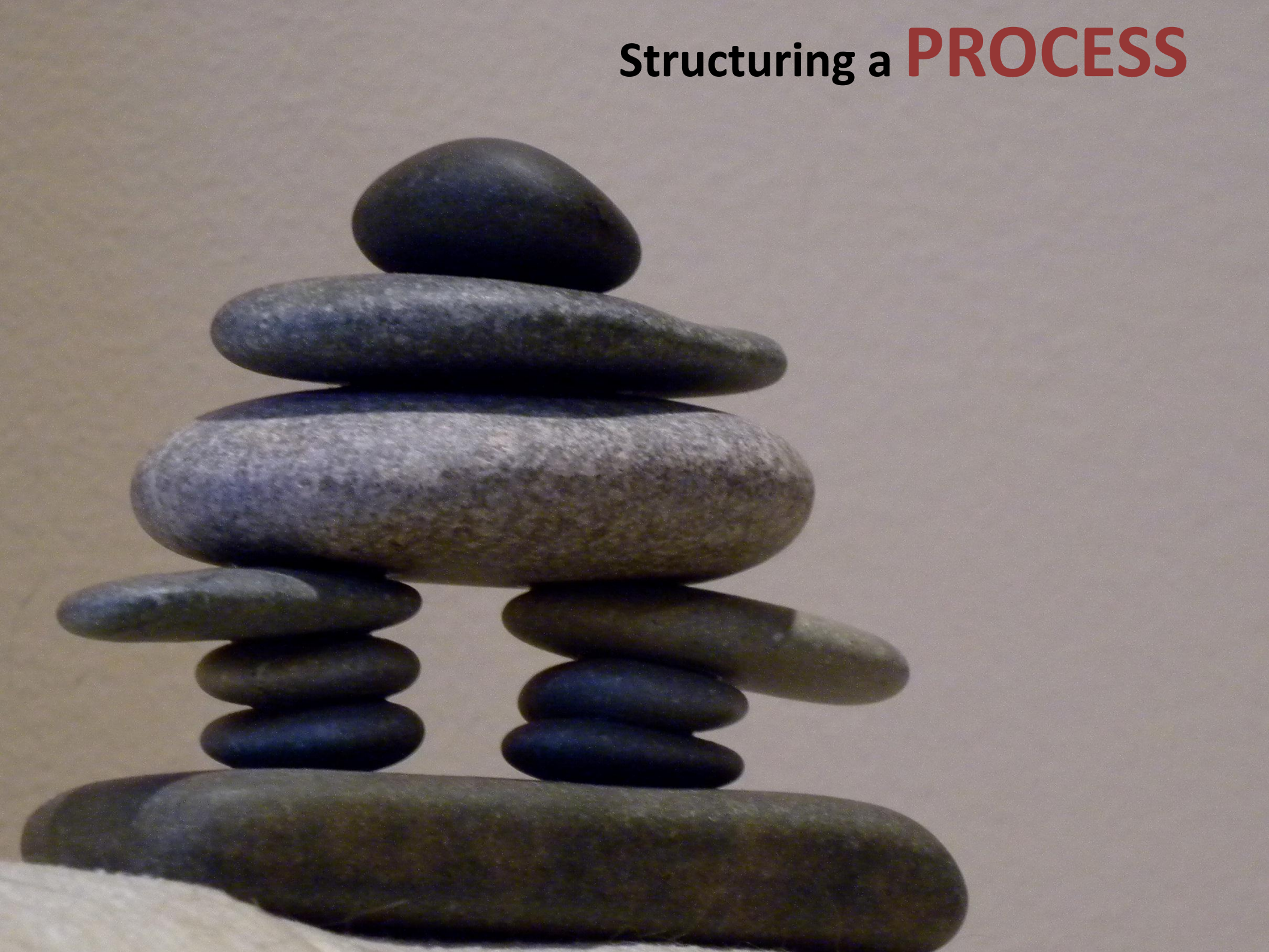
Provincially: Undergraduate Degree Level Expectations

All undergraduate programs in Ontario required to demonstrate students have:

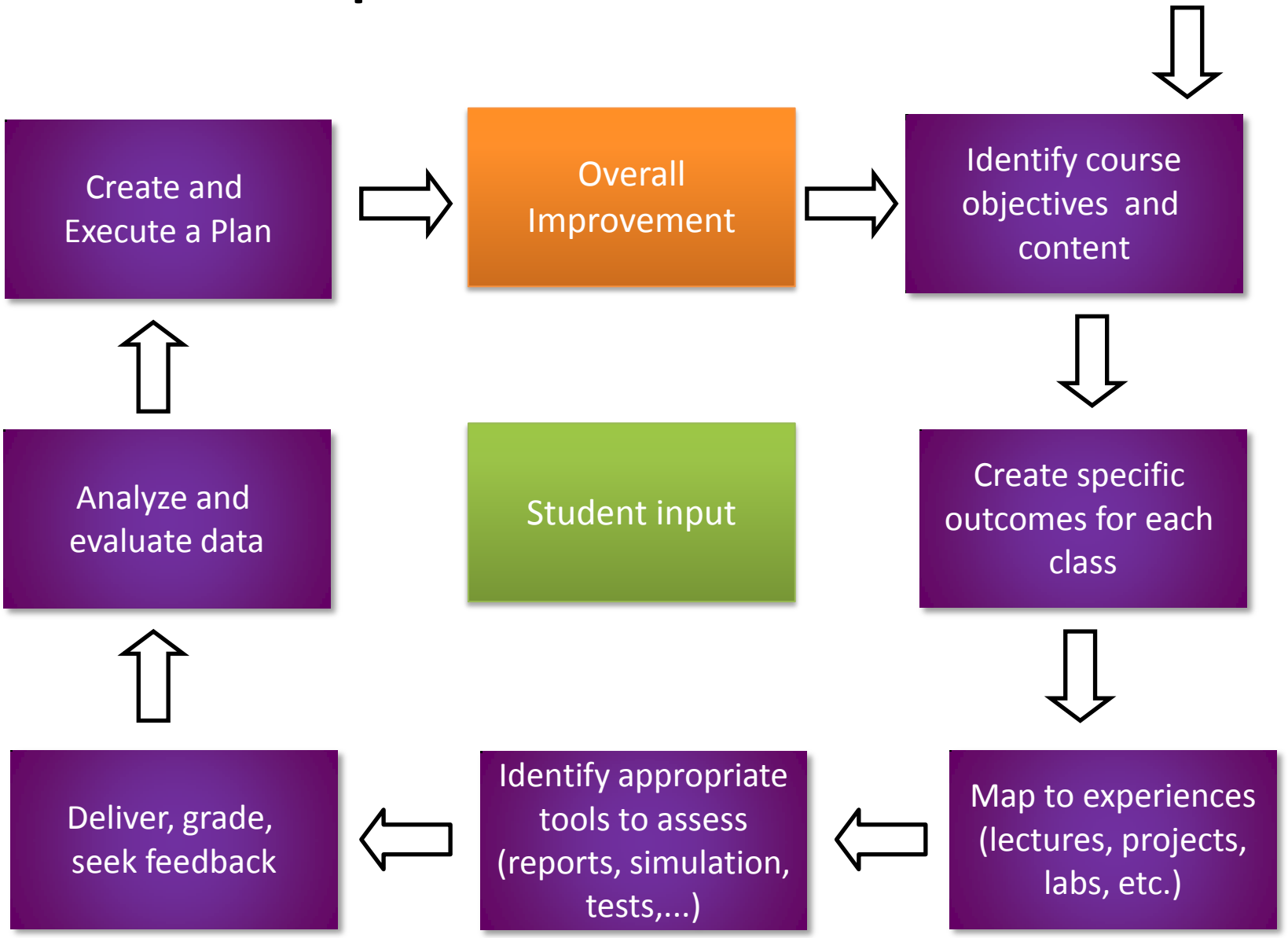
- Depth and Breadth of Knowledge
- Knowledge of Methodologies
- Application of Knowledge
- Communication Skills
- Awareness of Limits of Knowledge
- Autonomy and Professional Capacity

These can be mapped to CEAB expectations, and a single process used to assess both.

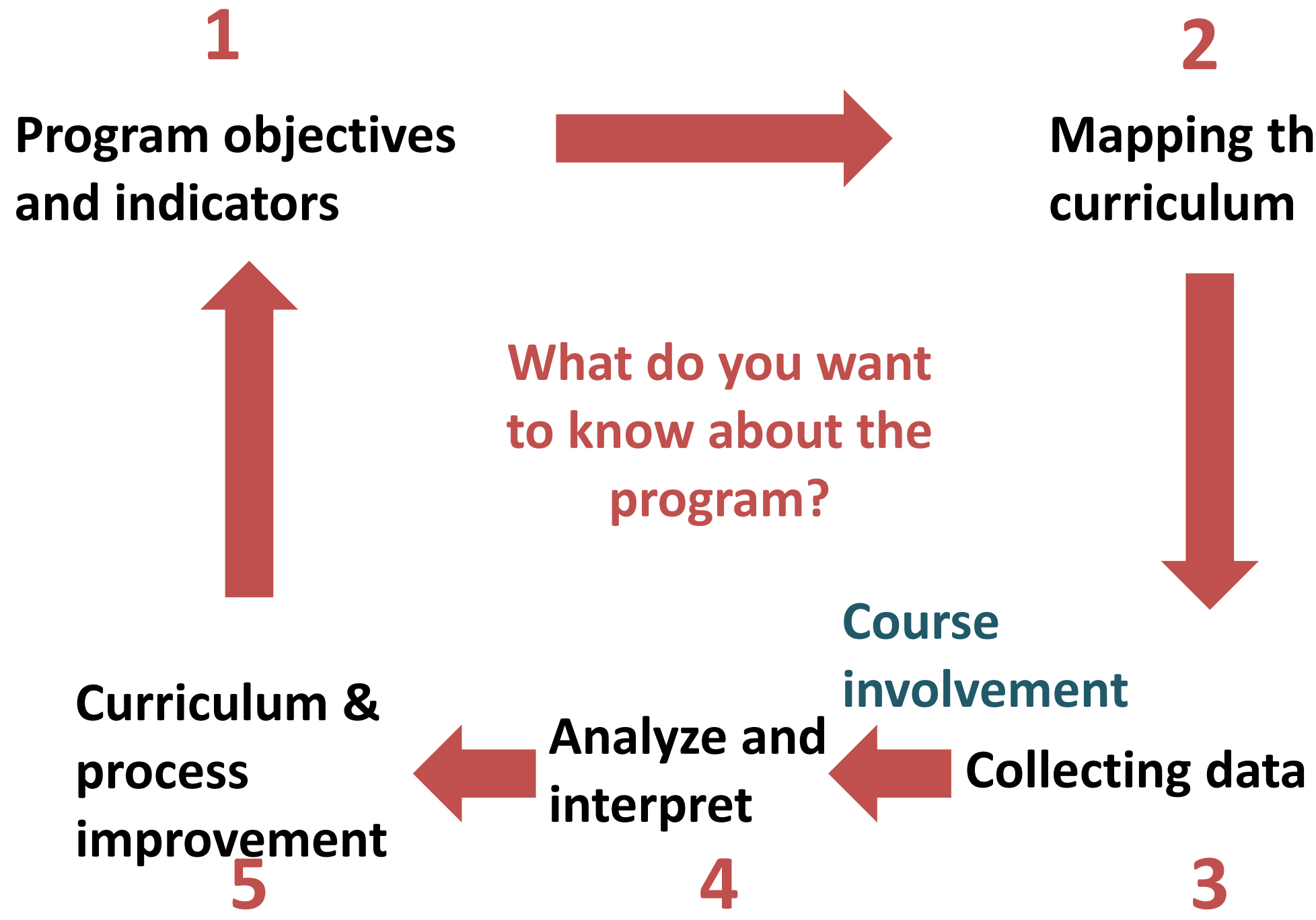
Structuring a PROCESS



Idealistic course development/ improvement process



Program improvement process



Impact of internship?

Differences between program options?

Impact of particular stream of courses?

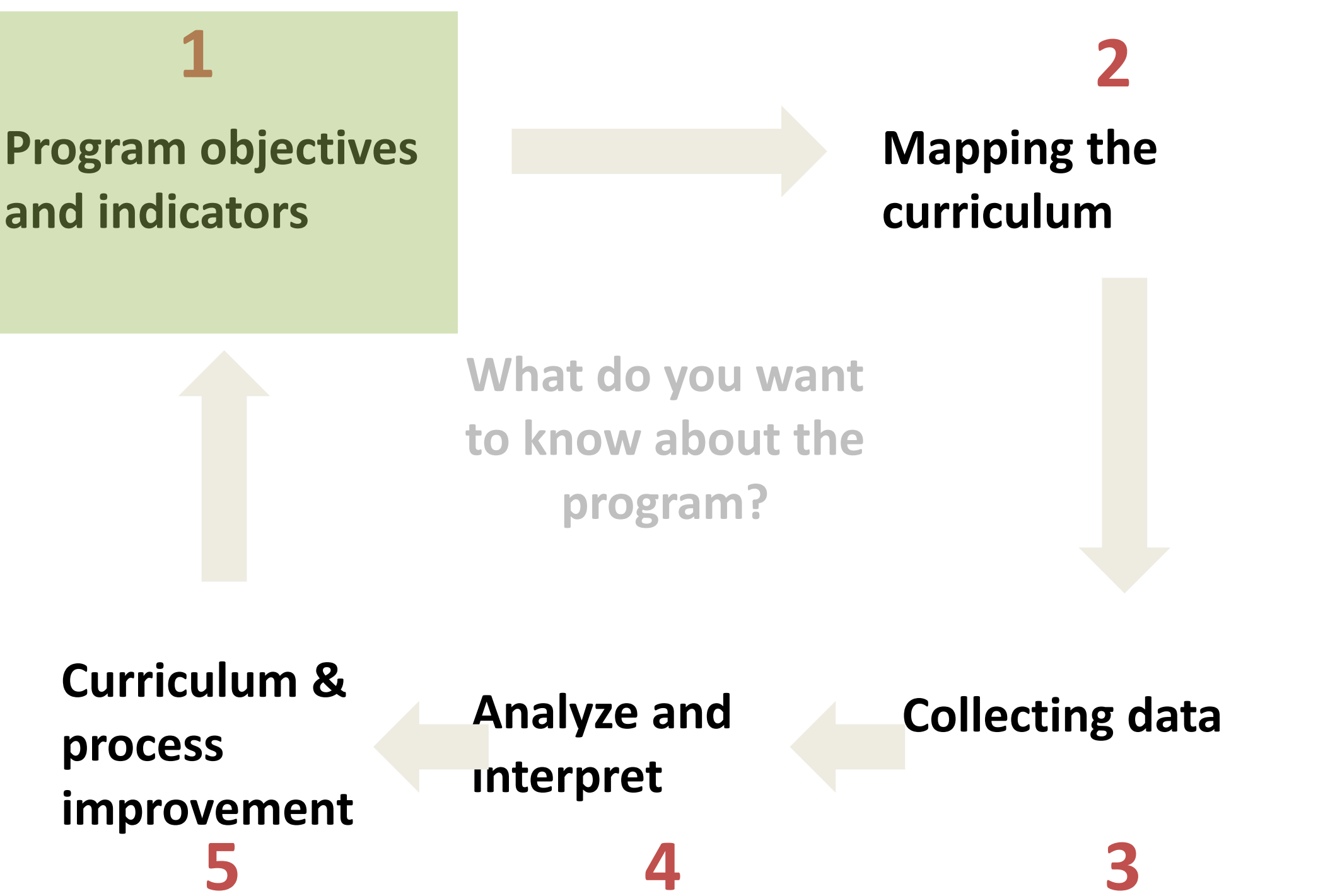
Special students (transfer/twinning)?

What do you want to know about the program?

Particular skill set desired by large employers?

Longitudinal development over 4 years?

STEP 0: WHAT DO YOU WANT TO KNOW?



STEP 1: Objectives and indicators

1

Program objectives and indicators

Key program objectives

What are your program's goals & objectives?

New certificate/twinning programs

Enhance recruitment

Particular skill set desired by large employers

Improve collaboration with industry

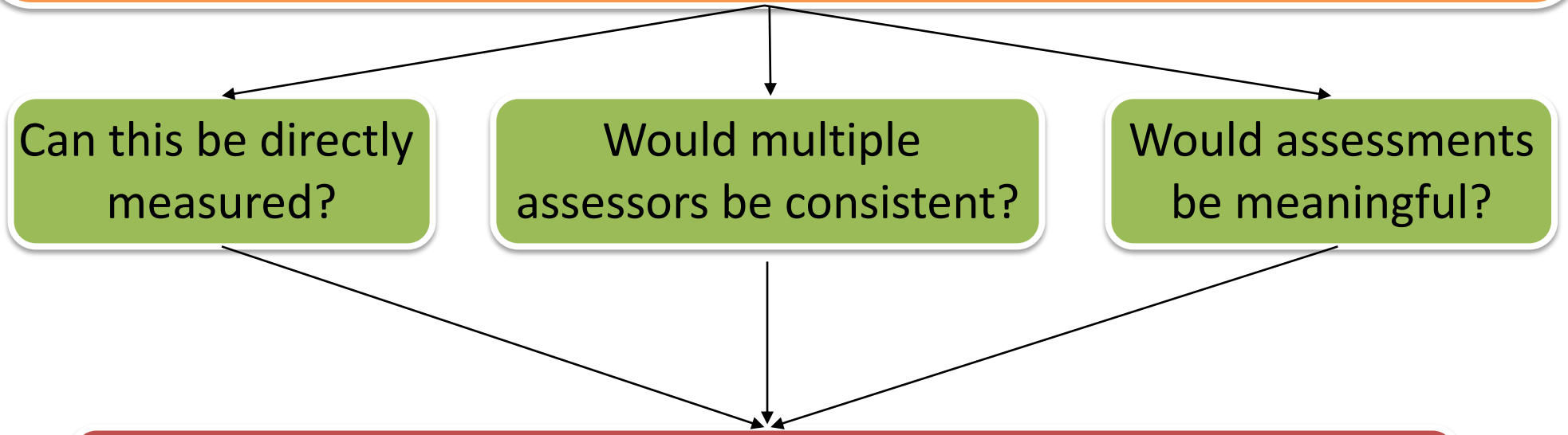
Objectives in strategic plan?

Once we have a vision…
What specifically are we looking for?

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

Assess lifelong learning

Lifelong learning
An ability to identify and address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge



Probably not, so more specific measurable *indicators* are needed.
This allows ***the program*** to decide what is important

Indicators: examples

Graduate attribute

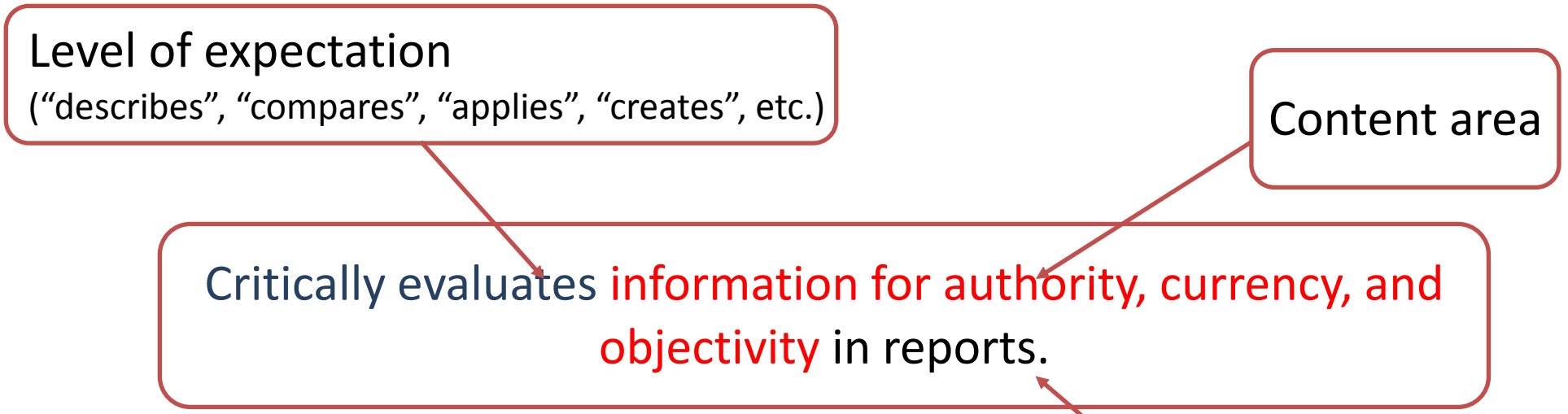
Lifelong learning
An ability to identify and address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge

The student:

Indicators

- Critically evaluates information for authority, currency, and objectivity when referencing literature.
- Identifies gaps in knowledge and develops a plan to address
- Describes opportunities for future professional development.
- Uses information ethically and legally to accomplish a specific purpose

Establishing Indicators

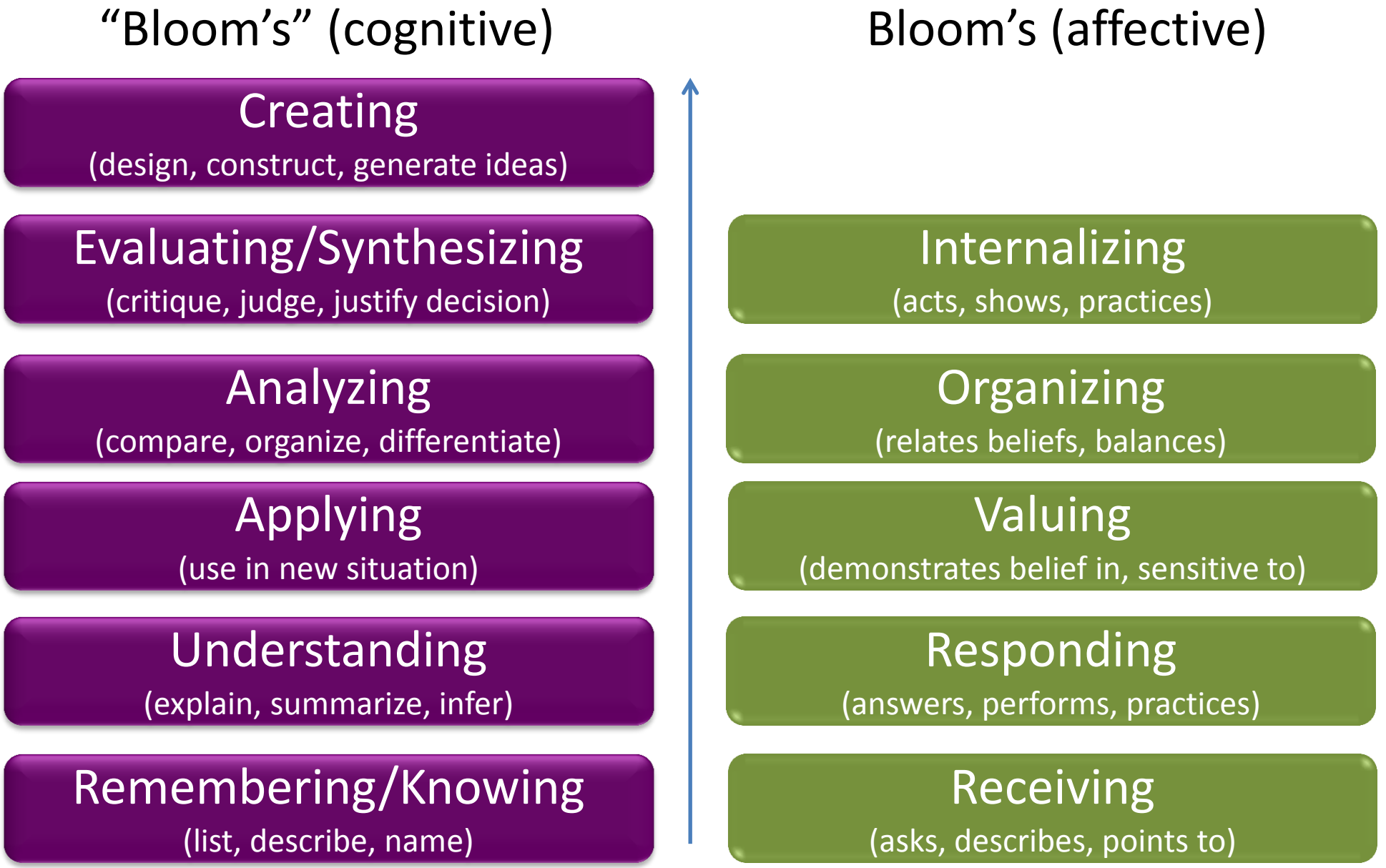


- A well-written indicator includes:
- what students will **do**
- the level of complexity at which they will do it
- the conditions under which the learning will be demonstrated

Developing indicators using taxonomies

- Taxonomy: a classification of learning objectives (e.g. Bloom's, Fink's, etc.)
- Used to categorize the type and depth of learning
- Helpful for writing effective indicators and assignments
- One approach is to think of student abilities as including cognitive (thinking), psychomotor (doing), and affective (attitudes)

Taxonomy



Anderson, L. W. and David R. Krathwohl, D. R., et al (Eds..) (2001) A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives

Taxonomy

Psychomotor ("skills")

- Origination
  (create new motion as needed)
- Adaptation of responses
- Complex response
- Mimic simple actions

Example: Adapted from Queens, 2010

#	Attribute	Primary Year	Shortname	Description
2	Problem analysis	First	Identify problem	**Identifies** known and unknown information, uncertainties, and biases when presented a complex ill-structured problem
		Graduating		**Identifies** problem, known and unknown information, uncertainties, and biases
		First	Create process	**Creates** process for solving problem including justified approximations and assumptions
		Graduating		
		First	Select model	**Selects and applies** appropriate quantitative model and analysis to solve problems
		Graduating		**Selects and applies** appropriate model and analysis to solve problems
		First	Evalute solution	**Evaluates** validity of results and model for error, uncertainty
		Graduating		
3	Investigation	First	Generates ideas	**Generates** ideas and working hypothesis
		First	Designs investigation	**Designs** investigations involving information and data gathering, analysis, and/or experimentation
		First	Synthesizes data	**Synthesizes** data and information to reach conclusion
		First	Appraise conclusions	**Appraises** the validity of conclusion relative to the degrees of error and limitations of theory and measurement
4	Design	First	Uses process	**Adapts** general design process to design system, component, or process to solve open-ended complex problem.
		First	Identify design problem	Accurately **identifies** significance and nature of a complex, open-ended problem
		Graduating	Identify design problem	**Identifies** problem and constraints including health and safety risks, applicable standards, economic, environmental, cultural and societal considerations
		…	…	…

E.g. leveled indicators by changing verbs and context (Queen's)

1. Follow a provided design process to design system, component, or process to solve an open-ended complex problem as directed by a mentor.
2. Employ and apply design processes and tools with emphasis on problem definition, idea generation and decision making in a structured environment to solve a multidisciplinary open-ended complex problem.
3. Applies specified disciplinary technical knowledge, models/simulations, and computer aided design tools and design tools in a structured environment to solve complex open-ended problems
4. Selects, applies, and adapts disciplinary technical knowledge and skills and design concepts to solve a complex client-driven open-ended problems

Example: From UofT

3.1.3 Investigation

1. Ability to define the problem

- **State** the problem, its scope and importance
- **Describe** the previous work
- **State** the objective of the work

2. Ability to devise and execute a plan to solve the problem

- **Select** a set of tests to be conducted
- **Select, plan and apply** the methods for collecting the results
- **Identify** limitations of the methods used and their impact on the results.

3. Ability to use critical analysis to reach valid conclusions supported by the results of the plan

- **Analyze** the results
- **Formulate** the conclusions
- **Validate** conclusions by induction or deduction
- **Compare** conclusions with previous work
- **Characterize** the limitations and implications of the conclusions

3.1.7 Communication

1. Ability to identify and credibly communicate engineering knowledge

- **Situate**, in document or presentation, the solution or design in the world of existing engineering, taking into account social, environmental, economic and ethical consequences
- **Recognize** a credible argument (reading)
- **Construct** a credible argument in written or spoken form – to persuasively present evidence in support of a claim
- **Organize** written or spoken material– to structure overall elements so that their relationship to a main point and to one another is clear
- **Create** "flow" in document or presentation – flow is a logical progression of ideas, sentence to sentence and paragraph to paragraph

2. Ability to incorporate visual elements in communication

- **Incorporate** visual material that enhances communication without detracting from it
- **Incorporate** various media appropriately
- **Incorporate** principles of visual design appropriately

3. Ability to develop communication through an iterative process

- **Use** iteration to clarify and amplify understanding of issues being communicated
- **Use** reflection to determine and guide self-development

Implications

- Attributes are specified by CEAB but *indicators* are defined by programs
- Leads to divergence in indicators between programs (i.e. no single list, though programs are sharing their indicators on the EGAD website)
- Opportunity for programs to customize and differentiate

Sample indicators

- EGAD website has sample draft indicators from some programs, and links to other examples under “Additional Resources” page

Sample Indicators

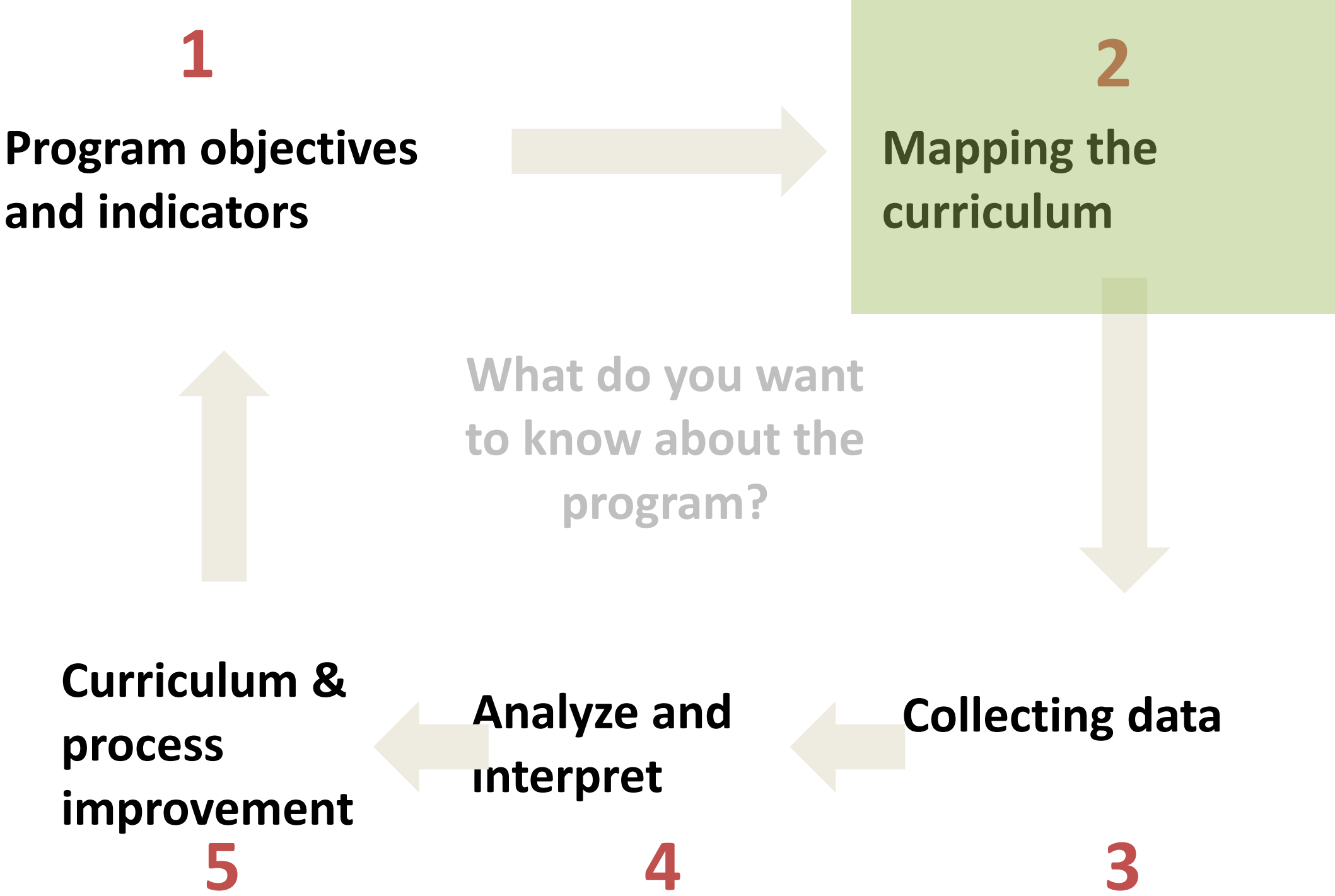
University	Date	Document Title
Concordia	2012	• Sample Indicators
Queen's	2011	• Sample Leveled Indicators
Toronto	2011	• Attribute Tables as of November

http://egad.engineering.queensu.ca

Summary: Program objectives

- Ask: What do you want to learn by this process?
- What are your program strengths and objectives?
- Create measurable and meaningful indicators
  - Collaboration among programs may be efficient
  - Having a “working” workshop with some educational developers (e.g. your CTL) can be very helpful to ensure indicators are measurable

Questions/comments?



STEP 2: Mapping the curriculum

Program mapping

Where are attributes/ indicators developed?

Where are attributes/ indicators assessed?

- This is important to ensure
  1. The program deliberately develops the attributes
  2. The program assesses attributes in appropriate times/courses
  3. Targeted program improvements can be made

Assessment schedule and mapping

- Not required to assess every student
  - Graduate Attributes is not a “minimum path” assessment
  - Not required to track individual students
  - Can use sampling to gather representative data
- Not required to develop or assess in every course
- Not required to develop or assess in every year

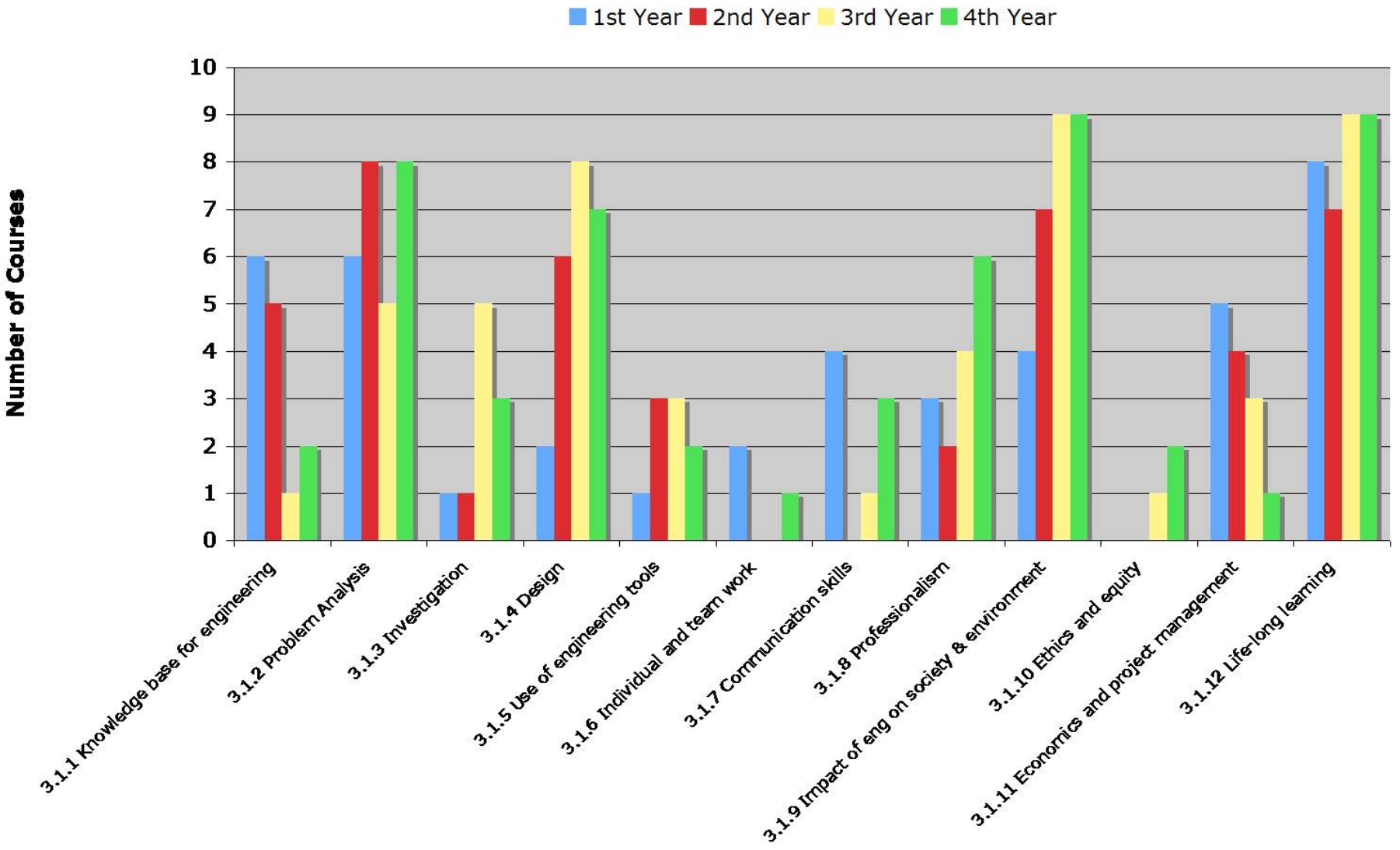
Where can we assess students?

- Important to identify where students:
  - develop attributes
  - are assessed for purpose of program improvement
- Usually a program would:
  - Conduct surveys or formal mapping exercises to determine where attributes are being developed
  - Identify/select courses used to assess attributes

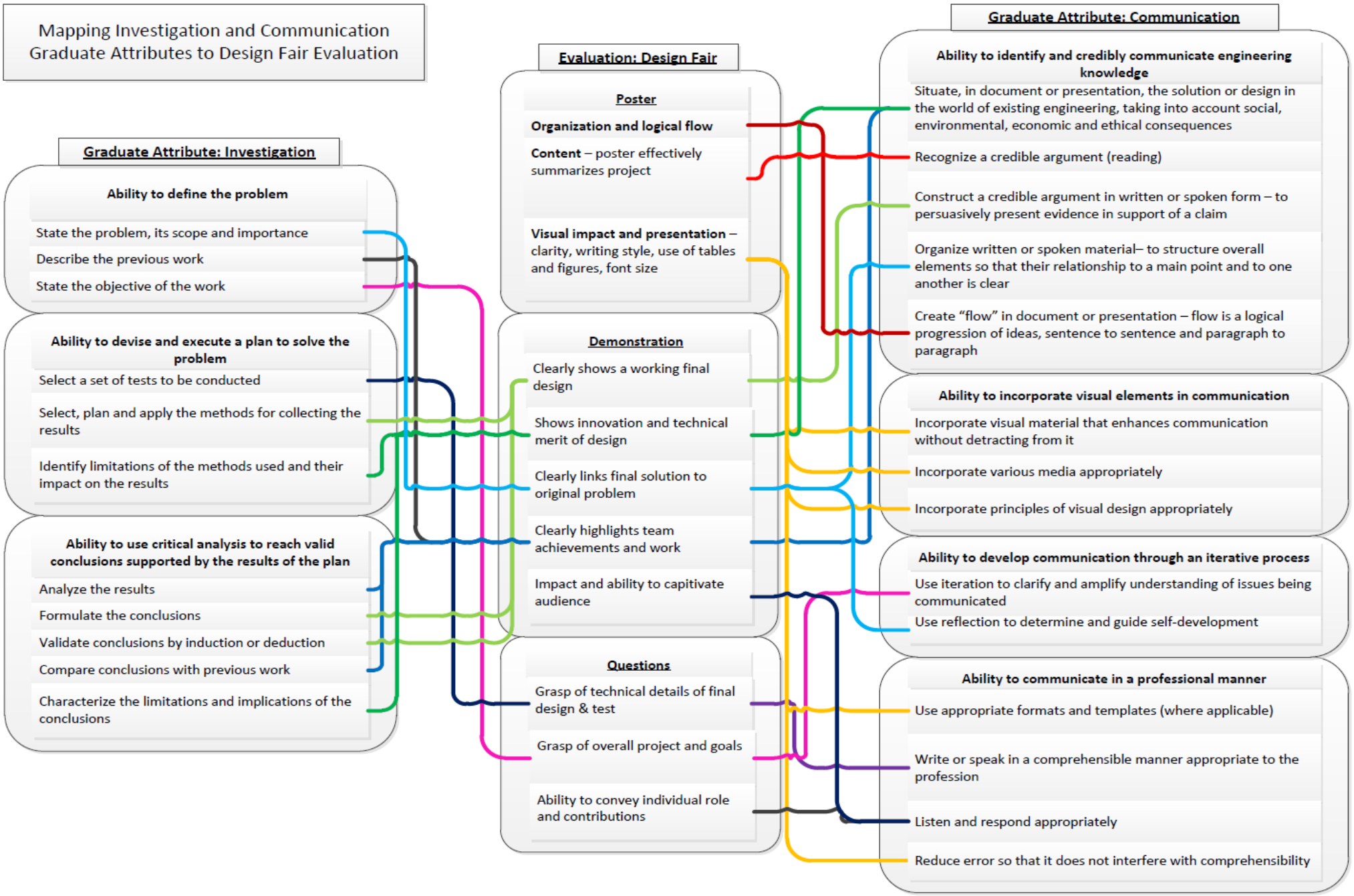
Curriculum Mapping

- Mapping software
  - Kuali (open source, http://www.kuali.org/)
  - U Guelph developing Currickit (http://currickit.wikispaces.com/)
- Surveys
  - CDIO: Introduced, Developed, or Utilized (ITU)
  - Custom survey (e.g. UBC Grad Attribute survey, http://tinyurl.com/EGADSurvey)
- Informal discussions

Example: ITU Analysis (UofC)



Example: Mapping to Assessments (UofT)

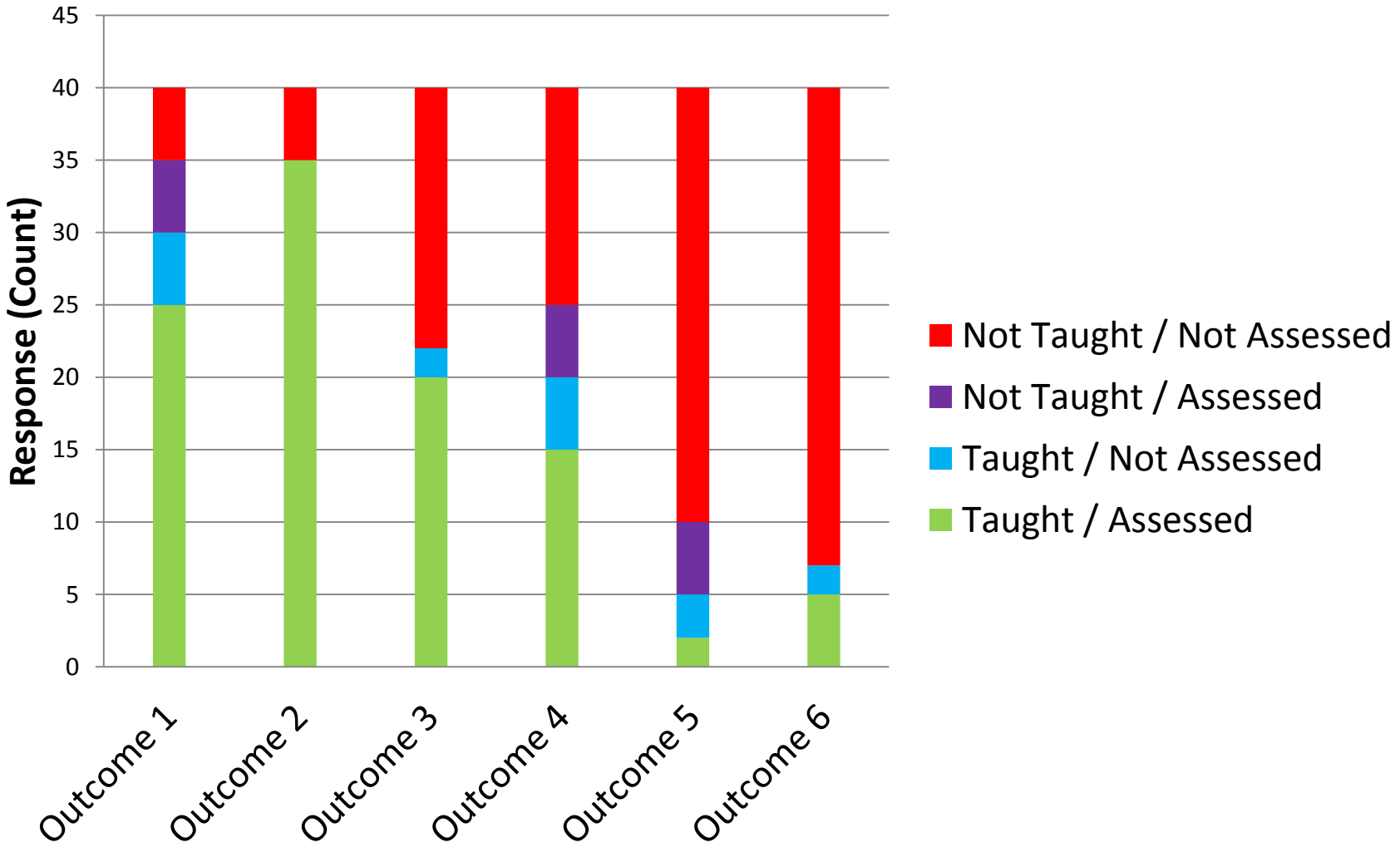


Example: Mapping to Courses (UBC)

Course	Number	1 Knowledge Base	2 Problem Analysis	3 Investigation	4 Design	5 Engineering Tools	6 Individual / Team Work	7 Communication	8 Professionalism	9 Impact of Engineering	10 Ethics / Equity	11 Econ. / Project Management	12 Life-long Learning
APSC	150	I	I		I	I	I		I	U	I		I
MATH	100	E	U	I				U		I			I
MATH	101	E	U	I				U		I			I
MATH	152	E	I	E		E							I
PHYS	153	E	E	E	I	I	E	U	U	U	U	I	U
PHYS	170	E	E	U	I	U	I	I					
APSC	201	U	E	U	U	U	E	E	E		E	I	U
MATH	253	E	E	I	E		I	U		I	U		U
MATH	256	E	E	U	I	I							
MECH	220	E	I	U	U	E	U	I	I	I	I		I
MECH	221	E	E	E	I	E	U	U	I	I	I		I
MECH	222	E	E	E	U	E	U	U	I	I	I	I	I
MECH	223	E	E	E	E	E	E	U	U	E	I	E	I

Assessment Mapping to Courses (UBC)

Course		1 Knowledge Base										
Course	Number	Emphasis	Exams	Quizzes	Assignments	In-class	Reports	Project / lab	Presentations	No Assesmt	Other	Other description
MATH	100	E	X	X	X							
MATH	101	E	X	X	X							
APSC	150	I										
MATH	152	E	X	X	X		X	X				
PHYS	153	E	X	X	X	X	X					
PHYS	170	E	X	X	X	X						
APSC	201	U										
MECH	220	E	X	X	X			X				
MECH	221	E	X	X	X		X	X			X	Question / Answer sessions
MECH	222	E	X	X	X	X	X	X				
MECH	223	E	X	X	X	X	X	X	X		X	Prototype Demonstration
MATH	253	E	X	X	X	X						
MATH	256	E	X		X							


Response (Count)
45
40
35
30
25
20
15
10
5
0
Outcome 1
Outcome 2
Outcome 3
Outcome 4
Outcome 5
Outcome 6
Not Taught / Not Assessed
Not Taught / Assessed
Taught / Not Assessed
Taught / Assessed

What does this mean at a course level? E.g. in a syllabus:

APSC-100 (Engineering practice)

This course will help you develop the following attributes:

{design, problem analysis, lifelong learning,…}

By the end of this course students will be able to:

1. Follow a provided design process to design system, component, or process to solve an open-ended complex problem as directed by a mentor. *{design}*
2. Critically evaluate information for authority, currency, and objectivity. *{lifelong learning}*
3. Lays out project plan with clear scope, milestones and delegation appropriate to project stage {*project management*}

Some of the learning outcomes could be a more specific form of the program-wide indicators.

Assessment schedule

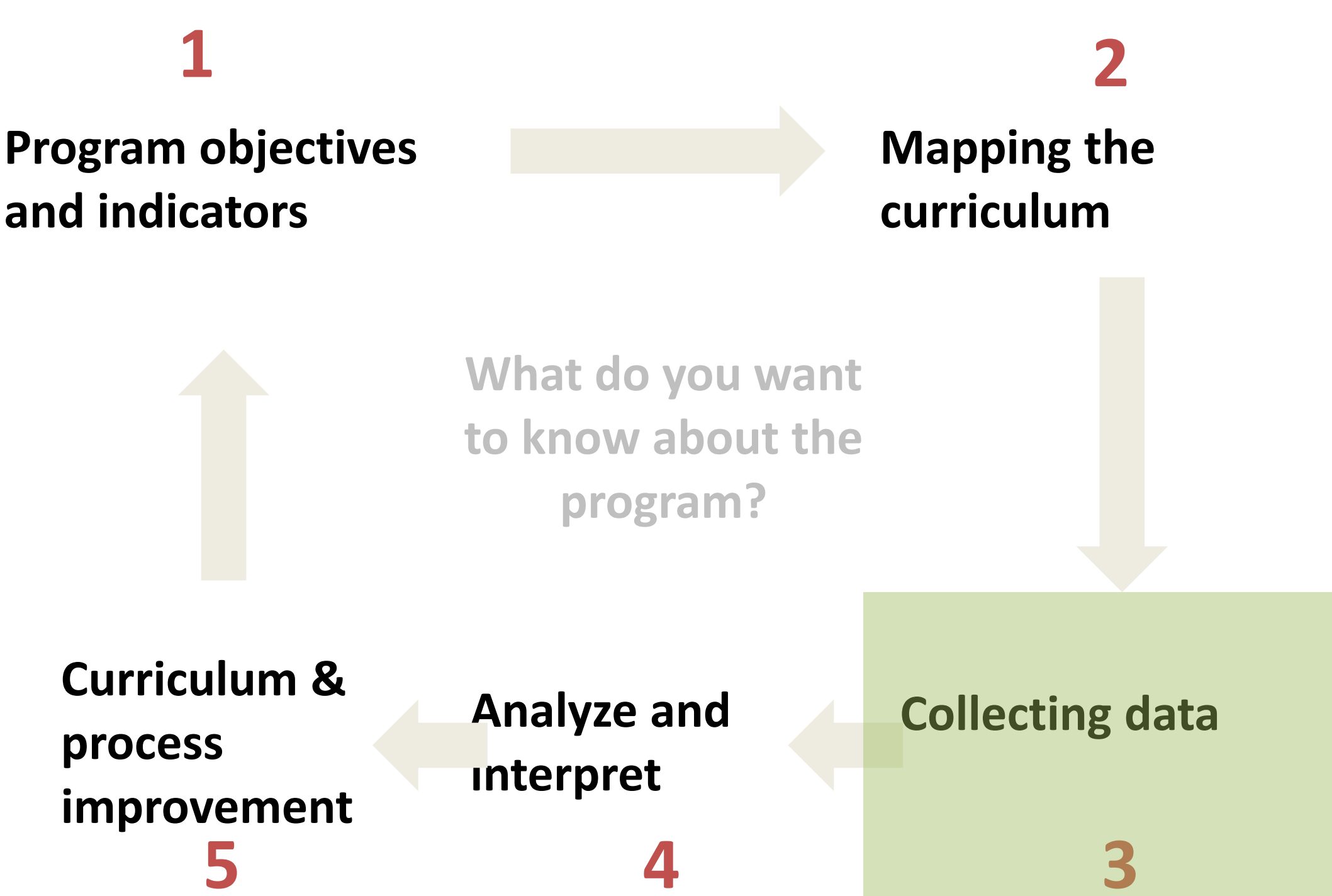
- Some programs are using a rolling 3 year cycle, e.g. divide 12 attributes into 3 groups (A, B, C)
  - Year 1: Gather data on group A
  - Year 2: Gather data on group B, analyze data and develop improvement for group A
  - Year 3: Gather data on group C, analyze data and develop improvement for group B, implement changes from group A

  etc.
- Another approach: follow cohorts through program

Summary: Program Mapping

- Determine where in the program students develop and are assessed on attributes
- Curriculum mapping tables allow planning
- Create a schedule for assessment

Questions/comments?



STEP 3: Collecting data

Assessment Tools

How to measure learning against specific expectations?

- **Direct measures** – directly observable or measurable assessments of student learning
  - E.g. Student exams, reports, oral examinations, portfolios, concept inventories etc.
- **Indirect measures** – opinion or self-reports of student learning or educational experiences
  - E.g. grades, surveys, focus group data, graduation rates, reputation, etc.

Why not use grades to assess outcomes?

Student transcript

Electric Circuits I	78
Electromagnetics I	56
Signals and Systems I	82
Electronics I	71
Electrical Engineering Laboratory	86
Engineering Communications	76
Engineering Economics	88
...	
Electrical Design Capstone	86

How well does the program prepare students to solve open-ended problems?

Are students prepared to continue learning independently after graduation?

Do students consider the social and environmental implications of their work?

What can students do with knowledge (plug-and-chug vs. evaluate)?

Course grades usually aggregate assessment of multiple objectives, and are *indirect* evidence for *some* expectations

Selecting Assessments

- Looking for assessments that are:
  - **Valid**: they measure what they are supposed to measure
  - **Reliable**: the results are consistent; the measurements are the same when repeated with the same subjects under the same conditions
- Capitalize on what you are already doing
- Look for “leading Indicators”
- One approach for dealing with qualitative assessments (not the only!) is with **Rubrics**

Assessment Tools

- Local written exam (e.g. question on final)
- Standardized written exam (e.g. Force concept inventory)
- Performance appraisal (e.g. Lab skill assessment)
- Simulation (e.g. Emergency simulation)
- Behavioural observation (e.g. Team functioning)
- Portfolios (student maintained material)
- External examiner (e.g. Reviewer on design projects)
- Oral exam (e.g. Design projects presentation)
- Oral interviews
- Surveys and questionnaires
- Focus group
- Archival records (registrar's data, records, ...)

Avoid duplication in grading if possible

- Why grade students for their course grades separately from assessment for program improvement?
- E.g. use embedded questions
  - Set tests, exams, quizzes, etc. such that specific questions are linked to specific indicators
  - Record marks separately by question, or on a rubric dimension (discussed later)

Example: Knowledge assessment

- Physics course instructors administering the Force Concept Inventory (FCI) before and after course in mechanics to assess conceptual understanding
- Allows for benchmarking, which is difficult to do for most other indicators.

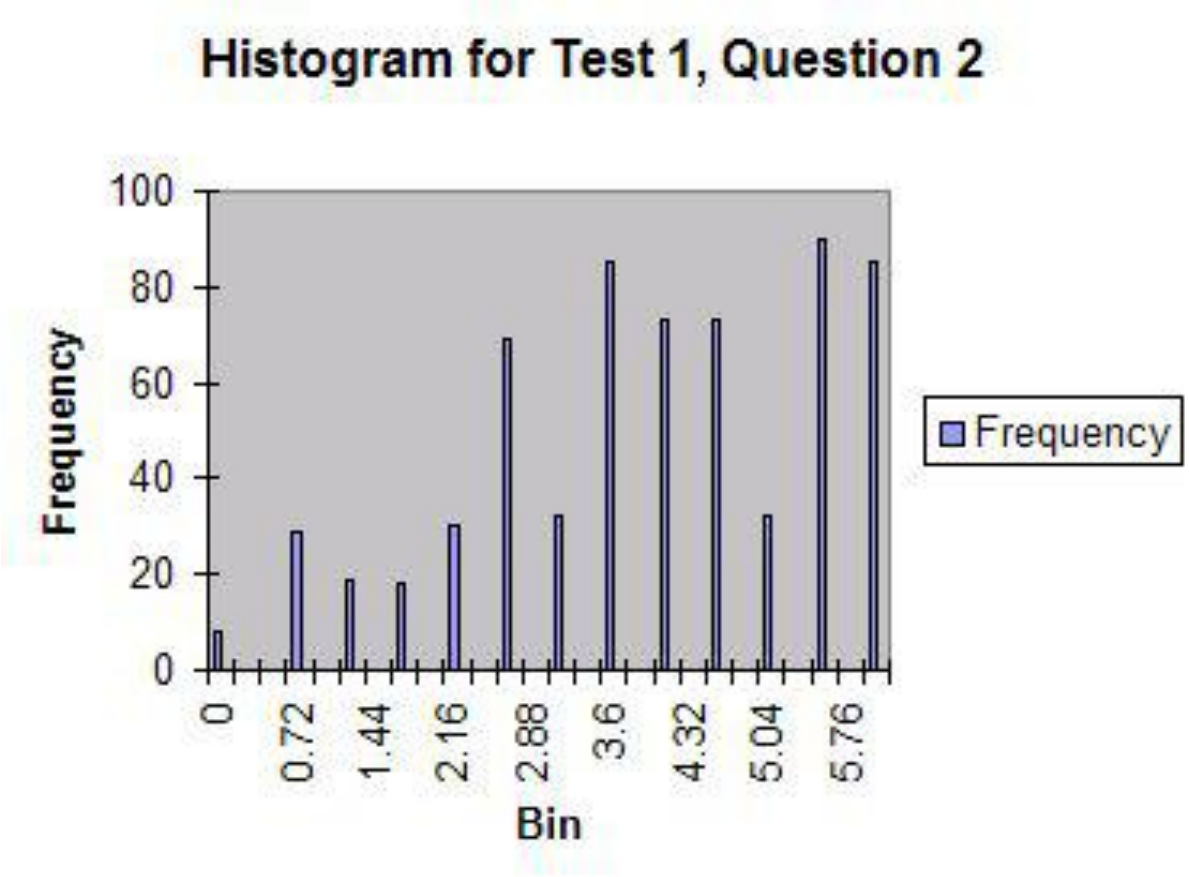
Example: Knowledge assessment

- Calculus instructor asked questions on exam that specifically targeted 3 indicators for "Knowledge":
  1. "Create mathematical descriptions or expressions to model a real-world problem"
  2. "Select and describe appropriate tools to solve mathematical problems that arise from modeling a real-world problem"
  3. "Use solution to mathematical problems to inform the real-world problem that gave rise to it"

Example (cont'd):

- The student can create and/or select mathematical descriptions or expressions for simple real-world problems involving rates of change and processes of accumulation (overlaps problem analysis)

Context: calculating Intersection of two trajectories



Rubrics

Dimensions (Indicator)	**Scale (Level of Mastery)**			
	Not demonstrated	Marginal	Meets expectations	Exceeds expectations
Indicator 1	Descriptor 1a	Descriptor 1b	Descriptor 1c	Descriptor 1d
Indicator 2	Descriptor 2a	Descriptor 2b	Descriptor 2c	Descriptor 2d
Indicator 3	Descriptor 3a	Descriptor 3b	Descriptor 3c	Descriptor 3d

Reduces variations between grades (increase reliability)
Describes clear expectations for both instructor and students (increase validity)

	1 *(not demonstrated)*	*2* *(marginal)*	*3* *(meets expectations)*	*4* *(outstanding)*	*Mark*
Gathers information from appropriate sources *3.04-FY4: Gathers info*	No significant information used, not cited; blatant plagiarism.	Insufficient usage; improper citations.	Gathers and uses information from appropriate sources, including applicable standards, patents, regulations as appropriate, with proper citations	Uses information from multiple authoritative, objective, reliable sources; cited and formatted properly	*/4*
Plans and manages time and money *3.11-FY1: Manage time and money*	No useful timeline or budget described; poorly managed project; safety issues	Poor timeline or budget; infrequent meetings; minor safety problems	Plans and efficiently manages time and money; team effectively used meetings; safety considerations are clear	Efficient, excellent project plan presented; detailed budget; potential risks foreseen and mitigated	*/4*
Describes design process *3.04-FY1: Uses process*	No discussion of design process.	Generic design process described.	Describes design process used to design system, component, or process to solve open-ended complex problem.	Comprehensive design process described, with appropriate iterations and revisions based on project progress	*/4*
Incorporates social, environmental, and financial factors *3.09-FY4: Sustainability in decisions*	No consideration of these factors.	Factors mentioned but no clear evidence of impact on decision making.	Incorporated appropriate social, environmental, and financial factors in decision making	Well-reasoned analysis of these factors, with risks mitigated where possible	*/4*
Demonstrates appropriate effort in implementation	Insufficient output	Sufficient implementation but some opportunities not taken, or feedback at proposal not incorporated in implementation	Appropriate effort, analysis, and/or construction demonstrated to implement product, process, or system	Outstanding implementation	*/4*
Compares design solution against objectives *3.04-FY7: Compares solution*	No evaluation of design solution	Some factors missed in evaluating design solution	Compares the design solution against the project objectives and functional specifications, providing qualitative evaluation where appropriate	Comprehensive evaluation of design solution, with well-defended recommendations for future work or implementation	*/4*
Creates report following requirements	Poorly constructed report	Some organization problems, minor formatting problems, redundancy, spelling grammar/errors	Report achieves goal using formal tone, properly formatted, concisely written, appropriate use of figures, few spelling/grammar errors	Professional tone, convincing argument, authoritative, skillful transitions	*/4*
				Overall Grade:	*/28*

Sample Rubric (Queens)

threshold

target

Mapping Indicators to Existing Evaluation (UofT)

1. Ability to define the problem

- State the problem, its scope and importance
- Describe the previous work
- State the objective of the work

FINAL THESIS REPORT RUBRIC – I – ESC499

Supervisor: _____ Grade: _____ /100

Component	Poor	Avg.	Good	Excep-tional	Requirement	Comments *(Use back if necessary)*
Introduction	☐	☐	☐	☐	Establishes context necessary to facilitate thorough understanding of thesis work in a concise manner	
	☐	☐	☐	☐	Establishes a clear research gap/design problem, makes a convincing case for the significance of proposed research work	
	☐	☐	☐	☐	Identifies goal for thesis work that explicitly addresses this gap/problem; provides clear purpose statement	
Literature Review / Background	☐	☐	☐	☐	Explains theoretical concepts important to understanding of thesis work	
	☐	☐	☐	☐	Identifies, summarizes, and synthesizes relevant research in constructing an understanding of current state of field	
	☐	☐	☐	☐	Enables deeper understanding of research question/design problem through analysis of research in the field, indicating a path for moving research forward	
Methods and Findings	☐	☐	☐	☐	Describes methods or design in sufficient detail to enable understanding of work done	
	☐	☐	☐	☐	Provides justification for methods chosen or design decisions made	
	☐	☐	☐	☐	Results displayed clearly in organized manner, using appropriate figures or graphics; key results highlighted	
Discussion and Conclusions	☐	☐	☐	☐	Engages with and explains results intelligently	
	☐	☐	☐	☐	Identifies key claims to be drawn from results of research or design evaluation, qualifies them appropriately	
	☐	☐	☐	☐	Outlines significance of research done, identifies potential future work that arises from thesis work	
Overall Document Design:	☐	☐	☐	☐	Abstract concisely summarizes purpose, methods, key results of research, and presents conclusions clearly	
	☐	☐	☐	☐	Document length, formatting, structure meets stated requirements, and specific demands of thesis topic	
	☐	☐	☐	☐	Organized well, with content in discrete and appropriate positions in paper, structure clearly laid out, transitions that create flow in document	
	☐	☐	☐	☐	Demonstrates coherent prose that concisely and clearly communicates complex topics in well designed paragraphs	
	☐	☐	☐	☐	Demonstrates grammatical correctness and clarity in sentence design	
	☐	☐	☐	☐	Provides clear attribution of ideas throughout paper using a known referencing standard; uses references effectively to help establish context, back claims, or justify decisions	
Project Experience	☐	☐	☐	☐	Work has contributed to scholarship in field / made a measurable impact	
	☐	☐	☐	☐	Demonstrated initiative and ownership of work throughout thesis project	
	☐	☐	☐	☐	Demonstrated an ability to work independently and manage their work plan, meeting all critical deadlines	
	☐	☐	☐	☐	Quality of effort and thesis work indicative of potential for future research success	

1. Ability to identify and credibly communicate engineering knowledge

- Situate, in document or presentation, the solution or design in the world of existing engineering, taking into account social, environmental, economic and ethical consequences
- Recognize a credible argument (reading)
- Construct a credible argument in written or spoken form – to persuasively present evidence in support of a claim
- Organize written or spoken material– to structure overall elements so that their relationship to a main point and to one another is clear
- Create "flow" in document or presentation – flow is a logical progression of ideas, sentence to sentence and paragraph to paragraph

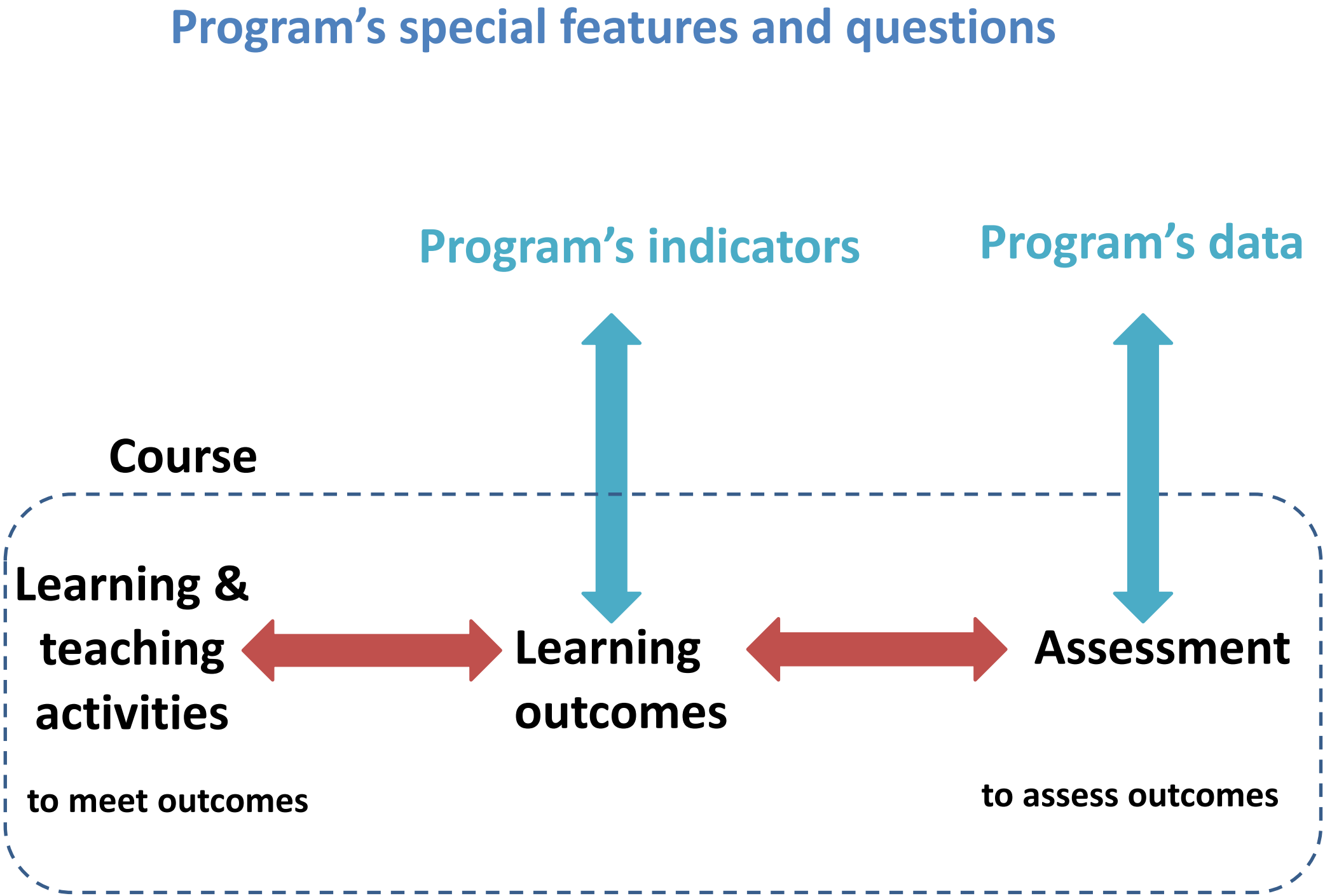
Old Evaluation Form (UBC)

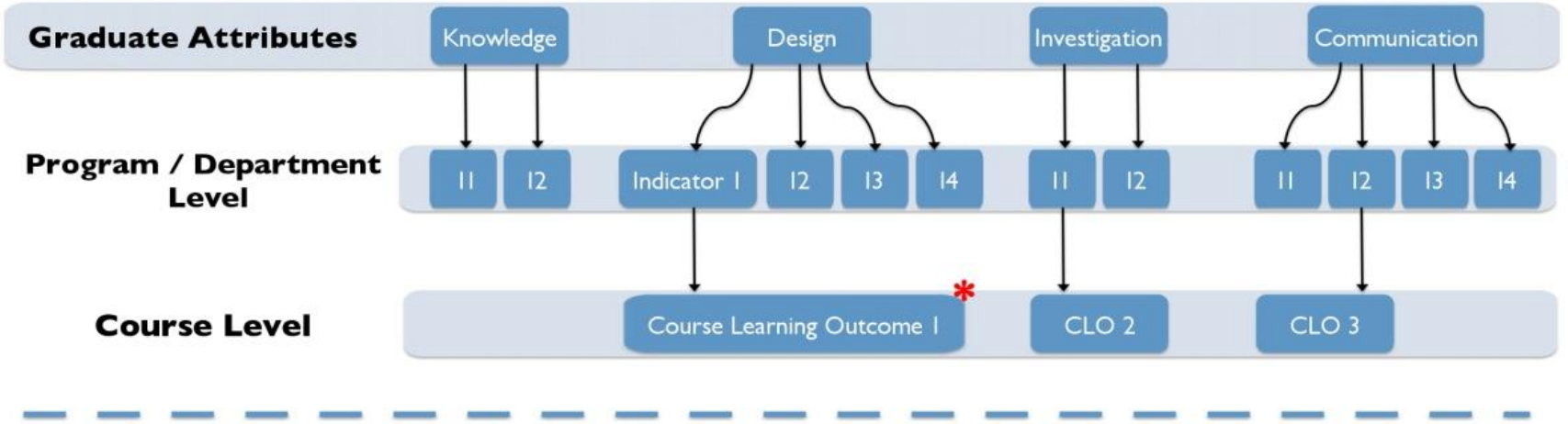
	0	1	2	3	4	5
Is the parameter/factor being studied important to the overall project success? The team should be able to describe why they are conducting the prototype test and what they hope to find with it. They should be able to explain why this particular prototype test is preferred over a calculation or simulation.						
Has an appropriate prototyping method been selected? Given what the teams want to find, have they selected a good approach? (Does it have sufficient accuracy? Is it reasonably insensitive to other parameters? Is there an obvious better/simpler/more accurate way to run the test?)						
What is the quality of the prototype, the test execution, and the results? Did the team do a good job in building their prototype, running their tests, and analyzing/interpreting the data?						
Are the findings being used appropriately? How does the team plan to incorporate the results of the prototype test to their design? Do they understand the limitations of the data they have collected?						
Totals						

Evaluation Reformatted as Rubric (UBC)

Criterion	Level of Mastery			
	Unacceptable **0**	**Below Expectations** **1**	**Meets Expectations** **2**	**Exceeds Expectations** **3**
2.1 Problem Identification	Team is NOT able to identify the parameter they are using the prototype to study.	Parameter studied is NOT directly relevant to project success.	Parameter studied is appropriate for project, AND the team is able to provide *some* justification why.	Parameter studied is appropriate for project, AND the team is able to provide *strong* justification why.
3.2 Investigation Design	Team has NOT built a prototype.	Prototyping method is NOT appropriate for the parameter being studied (i.e. will not yield desired data).	Prototyping method is *at least somewhat* appropriate for the parameter being studied; a simpler approach MAY exist	Prototyping method is appropriate for the parameter being studied, AND the team is able to *clearly* justify why the physical prototype used is superior to other physical or virtual prototypes.
3.3 Data Collection	No data collected; prototype does NOT work	The prototype works BUT data collection / analysis techniques are inappropriate.	Data collection and analysis are done appropriately AND data quality is *fair*.	Data collection and analysis are done appropriately AND data is of *high* quality.
3.4 Data Synthesis	No conclusions are drawn, OR inappropriate conclusions are drawn.	Appropriate conclusions are drawn from the data, BUT the team is NOT able to explain the how the data affects the project.	Appropriate conclusions are drawn from the data, AND the team is able to provide *some* explanation of how the data affects the project. Some implications are overlooked.	Appropriate conclusions are drawn from the data, AND the team is able to provide *strong and complete* explanation of how the data affects the project.
3.5 Analysis of Results	The team does NOT consider limitations or errors in the tests, or validity of the conclusions.	The team considers errors, limitations, and validity in the tests, BUT does NOT quantify errors or take appropriate action.	The team quantifies errors, and considers limitations and validity, AND takes action, BUT action is *limited* or somewhat inappropriate.	The team quantifies errors, and considers limitations and validity, AND is able to *justify* and take appropriate action.

PLANNING AT THE COURSE LEVEL


Program's special features and questions
Program's indicators
Program's data
Course
Learning & teaching activities
Learning outcomes
Assessment
to meet outcomes
to assess outcomes



Course Assessment Matrix

Deliverable	Assessment tool	Week	(F)ormative, (S)ummative, (I)ndicator	Program-wide indicators			
				Indicator 1	Indicator 2	Indicator 3	Indicator 4
Learning Outcome #1	Assignment #1	2	F,I				
Learning Outcome #2	Assignment #2	3	F,I				

Assignment #1 Rubric

	Not Demonstrated (0-3)	Marginal (4-5)	Meets Expectations (6)	Exceeds Expectations (7-8)	Grade
* Course Learning Outcome 1	Concise description using appropriate content, verb selection and context of the outcome that is not demonstrated	Concise description using appropriate content, verb selection and context of the outcome that is considered marginal	Concise description using appropriate content, verb selection and context of the outcome that meets expectations	Concise description using appropriate content, verb selection and context of the outcome that exceeds expectations	/8
Other Learning Outcome	Concise description using appropriate content, verb selection and context of the outcome that is	Concise description using appropriate content, verb selection and context of the outcome that is	Concise description using appropriate content, verb selection and context of the outcome that	Concise description using appropriate content, verb selection and context of the outcome that	/8

APSC-100: Engineering Practice I || 2012-2013

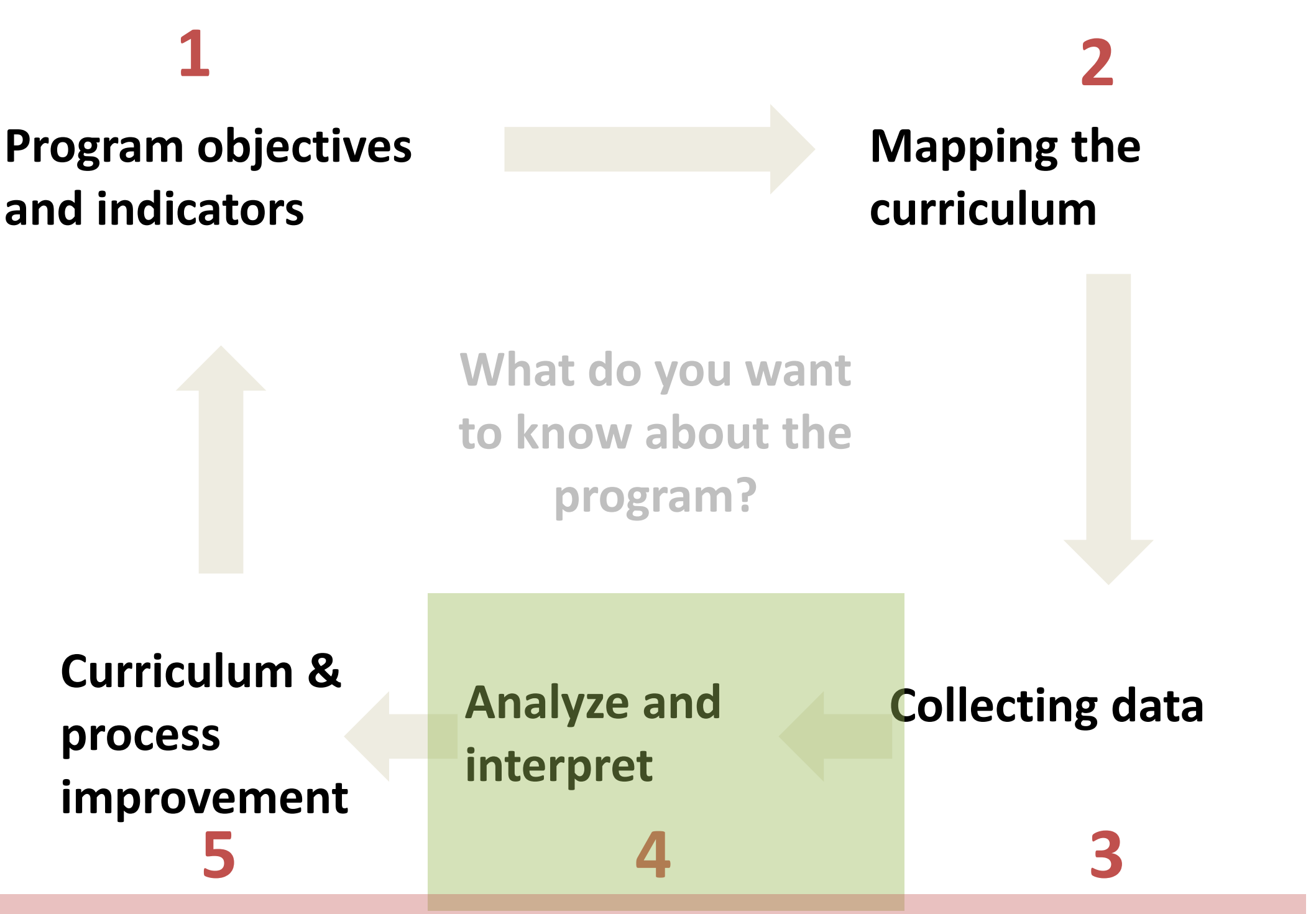
Course learning outcomes

1. Applies prescribed process for solving complex problems (3.02-FY1)
2. Selects and applies appropriate quantitative model and analysis to solve problems (3.02-FY2)
3. Evaluates validity of results and model to describe limitations and quantify error (3.02-FY3)
4. Composes structured document following prescribed format using standard grammar and mechanics (3.07-FY1)
5. Analyzes quantitative data to reach supported conclusion with explicit uncertainty (3.03-FY1)
6. Describe occupational health and safety principles (3.04-FY1)
7. Apply critical thinking principles to contextual scenarios (3.02-FY4)
8. Apply numerical modeling tool to create model used for solving complex problem. (3.05-FY1)
9. Construct arguments with claim, data, backing, and qualifier (3.02-FY5)

Week	Learning objectives	Instructional approach and content	Learning activity	Evaluation
1	4,5	***Lecture***: motivation, course overview, models.	***Lecture:*** Group activity to consider model for elevator failure problem	***Studio:*** CLA/Cornell Critical thinking pretest **(CLO7)** Word/Excel assignment **(CLO 4,5)**
2	1,2,3,8	***Pre-studio:*** MATLAB online module 1 ***Lecture:*** complex problem solving, risk, hazard analysis ***WHMIS course (evening)***	***Lecture:*** Group activity to develop process for resolving elevator failure problem ***Pre-studio:*** MATLAB online readiness quiz (no grades) ***MATLAB Studio***: intro to MATLAB (MATLAB in-class problem #1) OHS online safety module	MATLAB quiz #1 OHS online test **(CLO6)**
3	8,9	***Pre-studio:*** MATLAB online module 2 ***Lecture:*** argumentation, brainstorming, MEA1 expectations	***Lecture:*** analyze past assignments for effective argument ***MATLAB Studio***: Importing data (in-class problem #2)	MATLAB quiz #2
4	1,8	***Pre-studio:*** MATLAB online module 3 ***Lecture:*** concept maps, enthalpy	***Lecture:*** Group activity to develop process for enthalpy wheel problem ***MATLAB Studio***: Curve fitting and interp (in-class problem #3)	MATLAB quiz #3 Assignment 1 **(CLO1,2,3,4,7,8,9)**
5	8	***Pre-studio:*** MATLAB online module 4 ***Lecture:*** Teaming & leadership	***MATLAB Studio:*** Conditional statements (in-class problem #4) Teaming inventory	MATLAB quiz #4
6	…	…	…	…

Summary: Assessments

- Determine how indicators will be assessed (reports, presentations, observation, etc.)
- Direct assessment and indirect assessment can be useful
- Rubrics can help to increase reliability and validity
- Another approach: embedded questions
  - Set tests, exams, quizzes, etc. such that specific questions are linked to specific indicators
  - Record marks separately by question



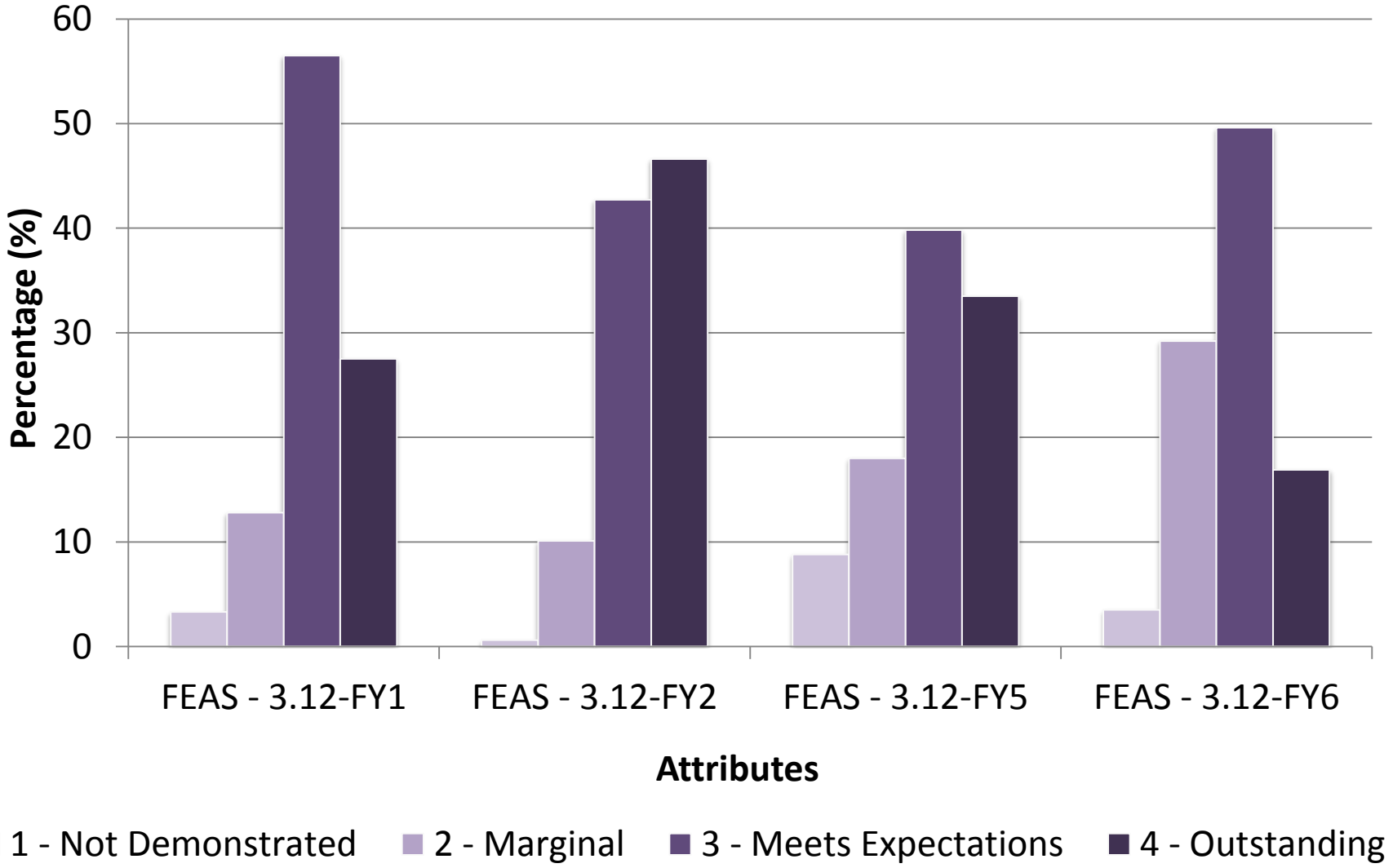
STEP 4: Analyze and interpret

Now that we have data… analyze and evaluate

- Remember: the driving question is “what do we want to know to improve our program?”, not “what does CEAB want us to do?”
- Not a “checklist” or “hoop jumping” exercise
- Organize data in a meaningful way that allows you to identify strengths, trouble spots, trends,…
- Look for how many students are meeting program expectations
- Look for validity and reliability in your assessments

- Some examples…

Histograms for Lifelong learning (Queens)



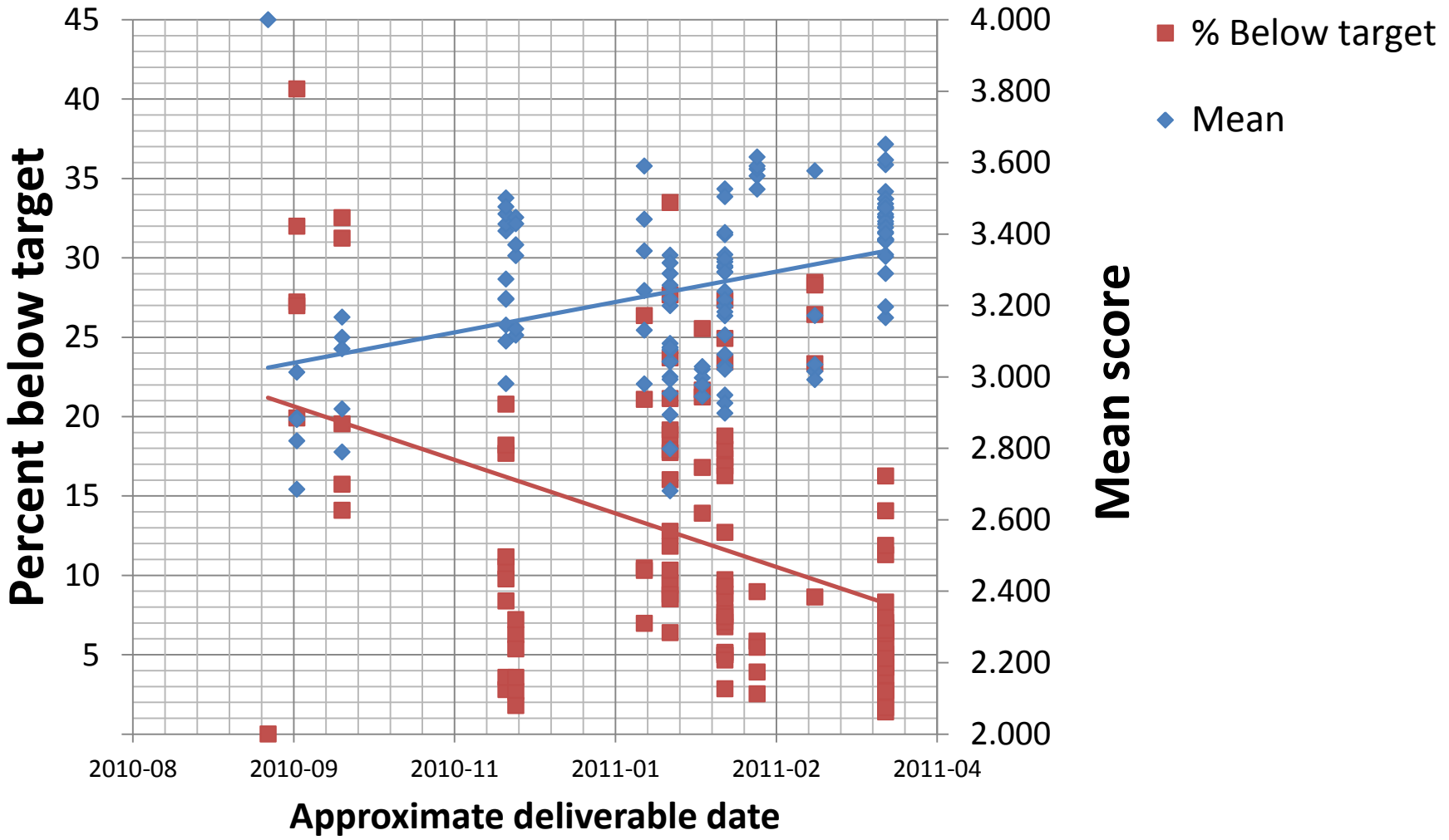
3.12-FY1 Uses information effectively, ethically, and legally to accomplish a specific purpose, including clear attribution of Information sources.

3.12-FY2 Identifies a specific learning need or knowledge gap.

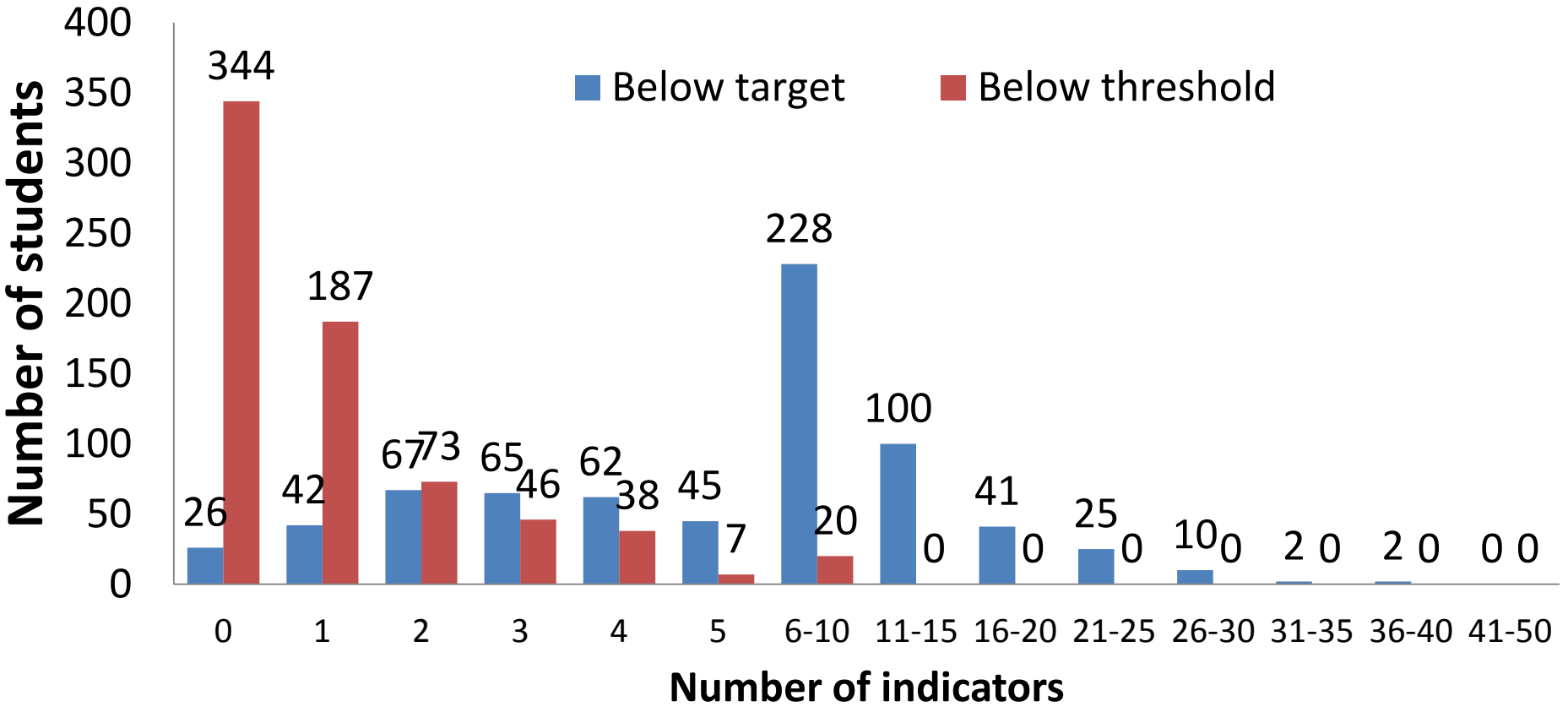
3.12-FY5 Identifies appropriate technical literature and other information sources to meet a need

3.12-FY6 Critically evaluates the procured information for authority, currency, and objectivity.

Could look for trends over a semester (Queen's)…

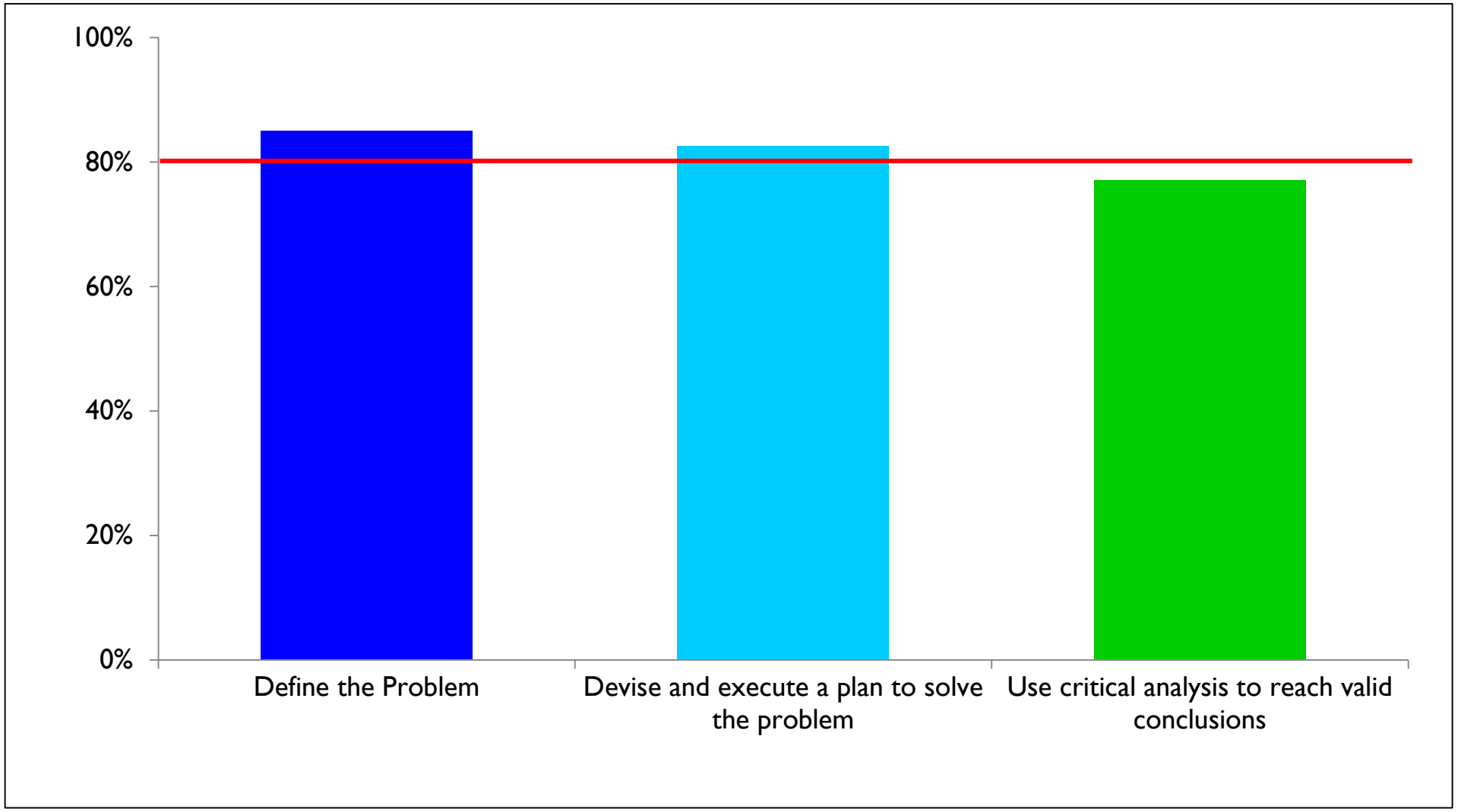


Could look at performance by student (Queen's)



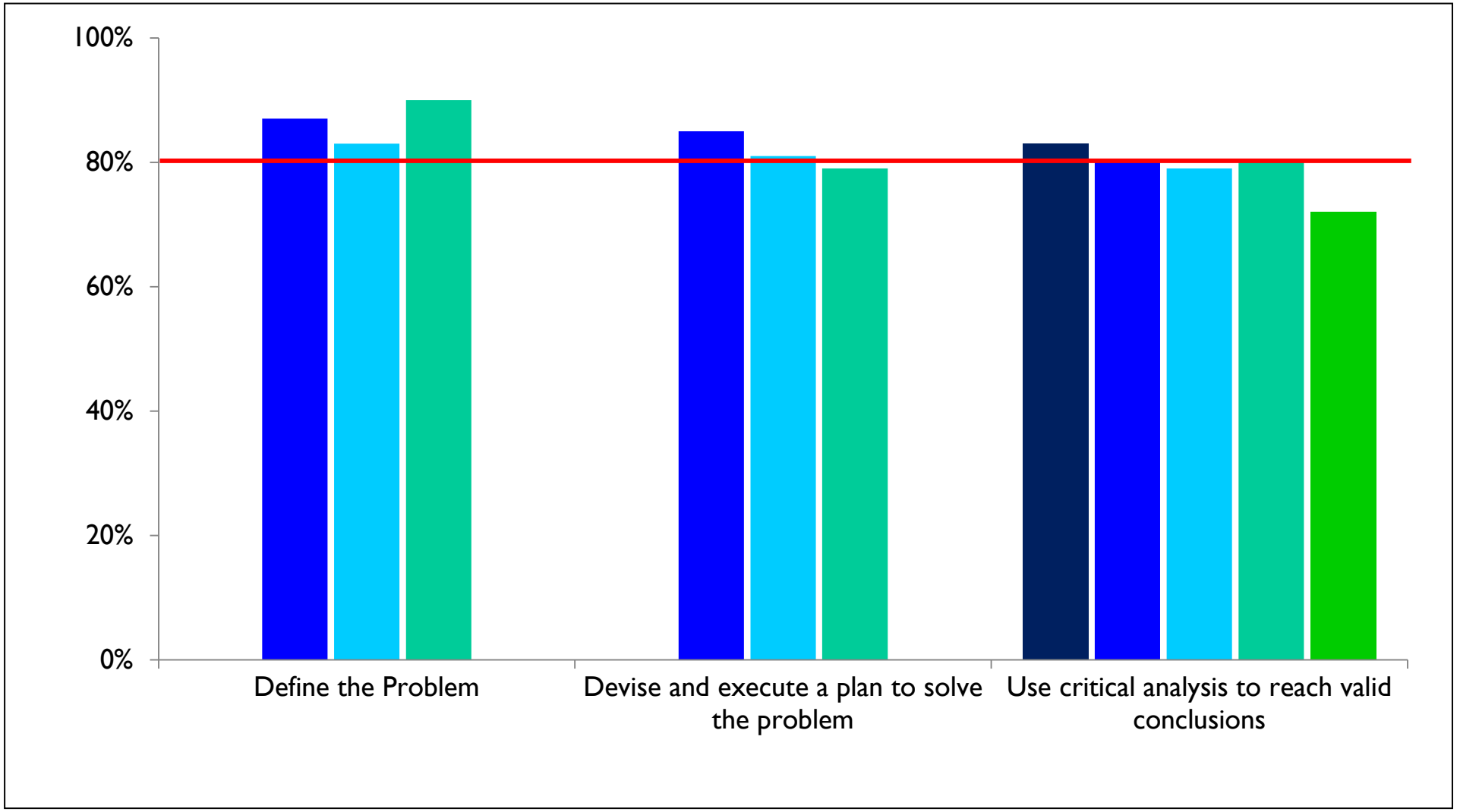
Histogram for Communication (UofT)

Percentage of students who meet or exceed performance expectations in indicators



Histogram for Communication (UofT)

Percentage of students who meet or exceed performance expectations in indicators

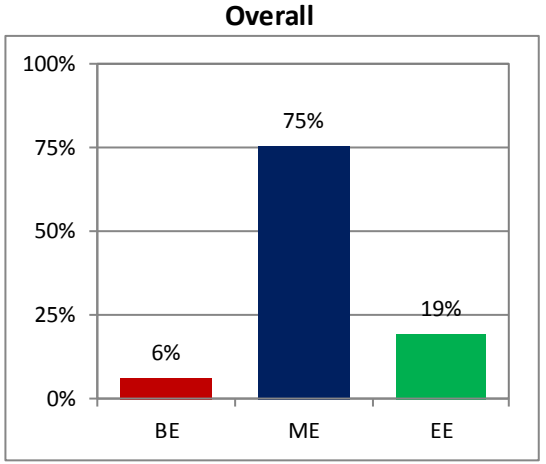


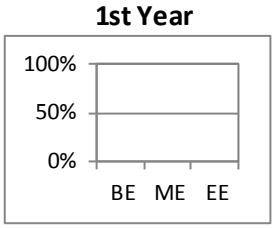
Histograms / Summary for Design (UBC)

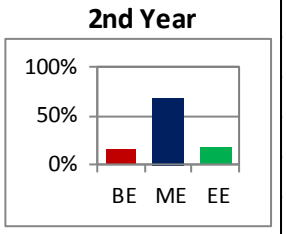
Attribute 4: Design

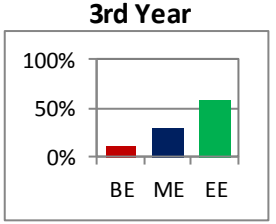
An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.

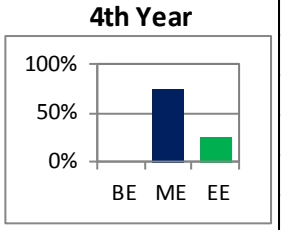
Below Expectations: 6%
Meets Expectations: 75%
Exceeds Expectations: 19%











Indicator Summary	Courses and elements assessed
4.4 Solution Generation Produce a variety of potential design solutions suited to meet functional specifications	MECH 223 Formal report 1 & 2 MECH 223 Oral presentation 1 & 2 MECH 45X Concept selection report
4.5 Solution Evaluation Perform systematic evaluations of the degree to which several design concept options meet project criteria	MECH 223 Formal report 1 & 2 MECH 223 Oral presentation 1 & 2 MECH 45X Concept selection report
4.6 Detailed Design Apply appropriate engineering knowledge, judgement, and tools, in creating and analyzing design solutions criteria	MECH 223 Formal report 1 & 2 MECH 325 Assignments 1-5 MECH 45X Preliminary design report

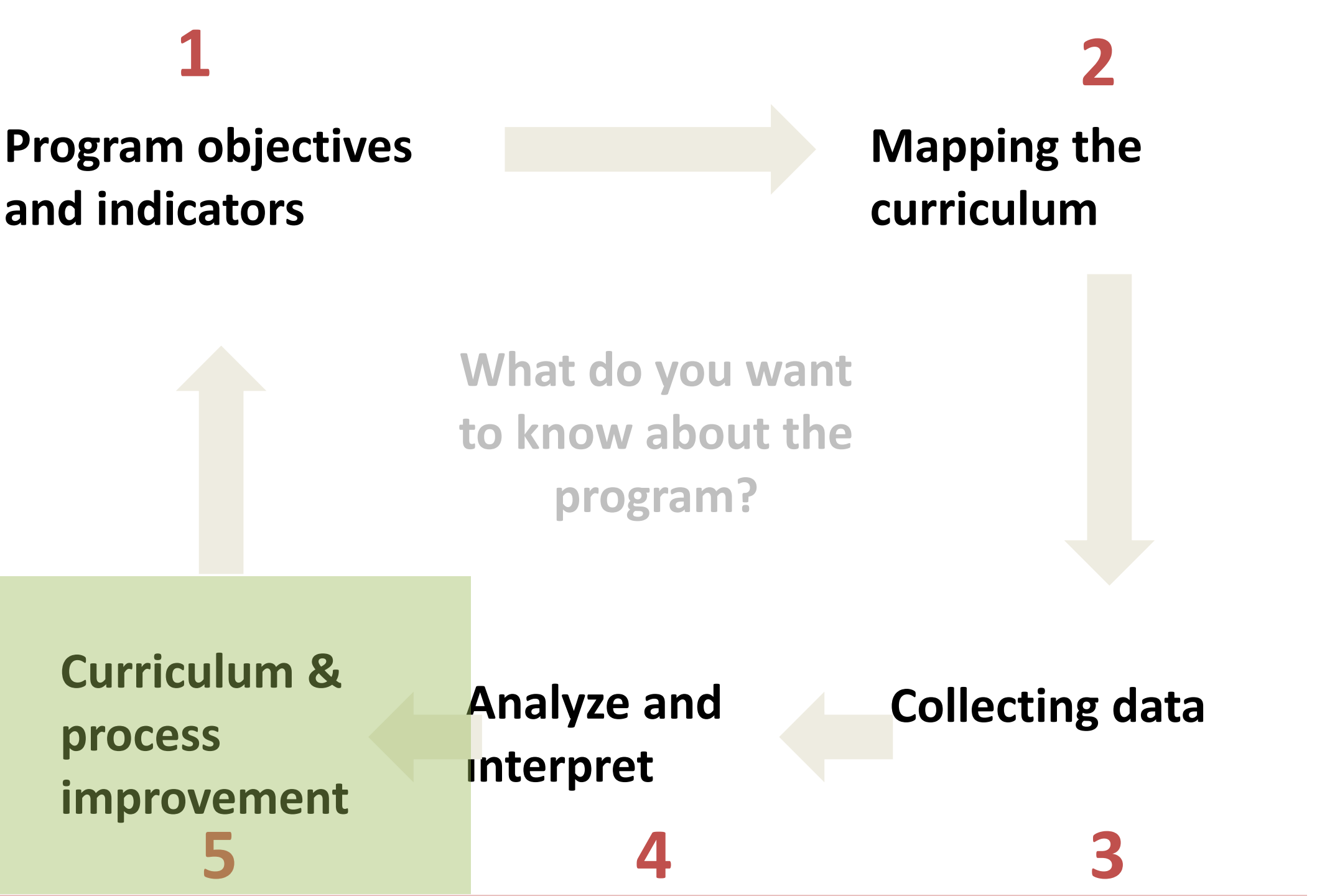
Other possible analysis

- Triangulation – is there correlation between data in different courses/times
- Changes in individual student performance over time (e.g. longitudinal)
- Changes in performance in a particular course over time

Summary: Analysis and interpretation

- Use measured data to evaluate how well students are meeting expectations
- Consider how valid and reliable data is
- What areas need to be strengthened?

Questions/comments?



STEP 5: Curriculum and process improvement

Who is involved in process?

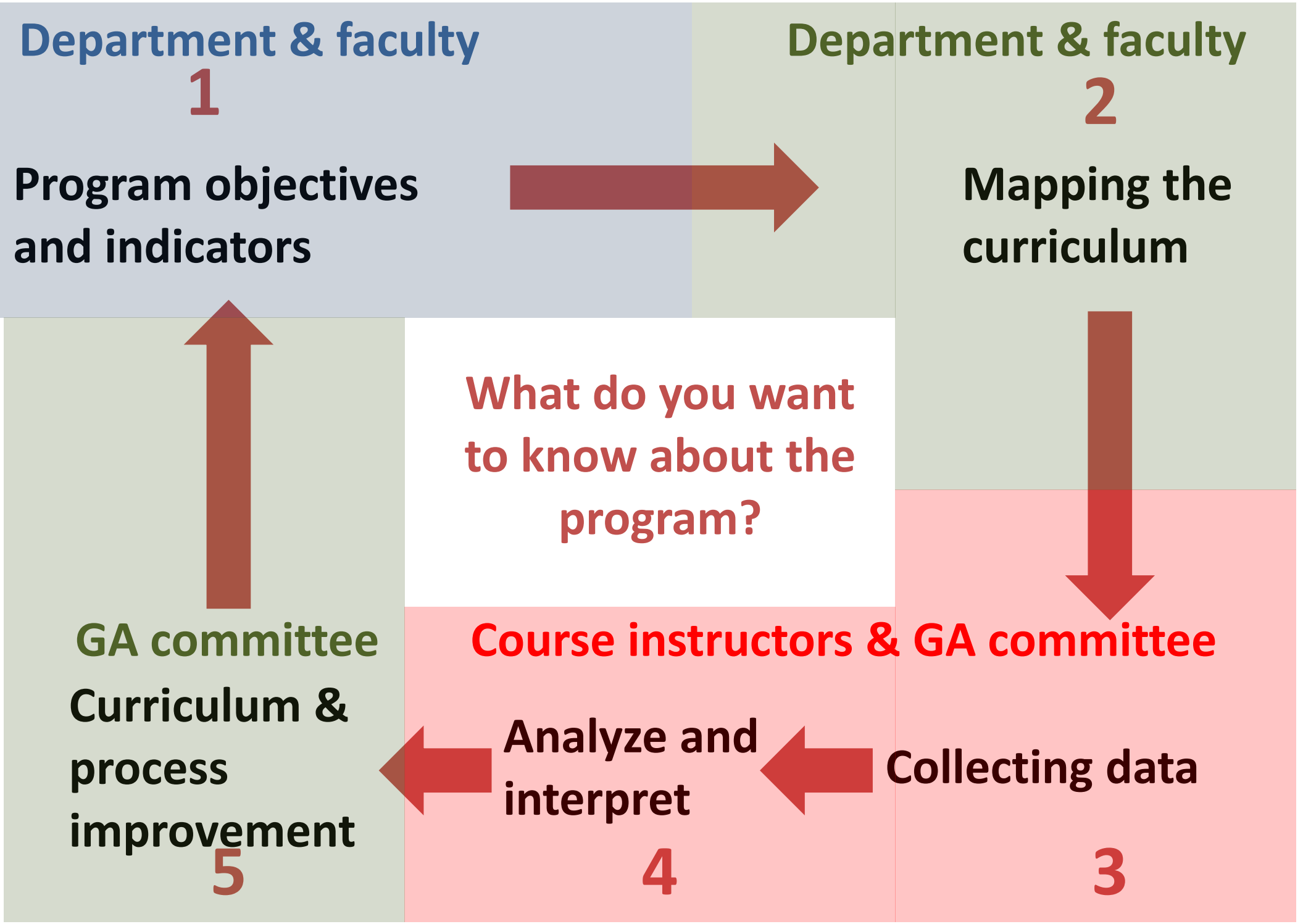
- Who coordinates? Someone in Dean's office? Coordination with programs?
- What bodies have primary responsibility for creating indicators, curriculum mapping, data gathering/collating, analysis, and curriculum changes?
- Who keeps process moving along – reminding instructors, collating data, etc.?
- Are changes needed in faculty regulations/policies/workload expectations?
- Which stakeholders need to be involved? Administration, faculty, students, staff, alumni, …?

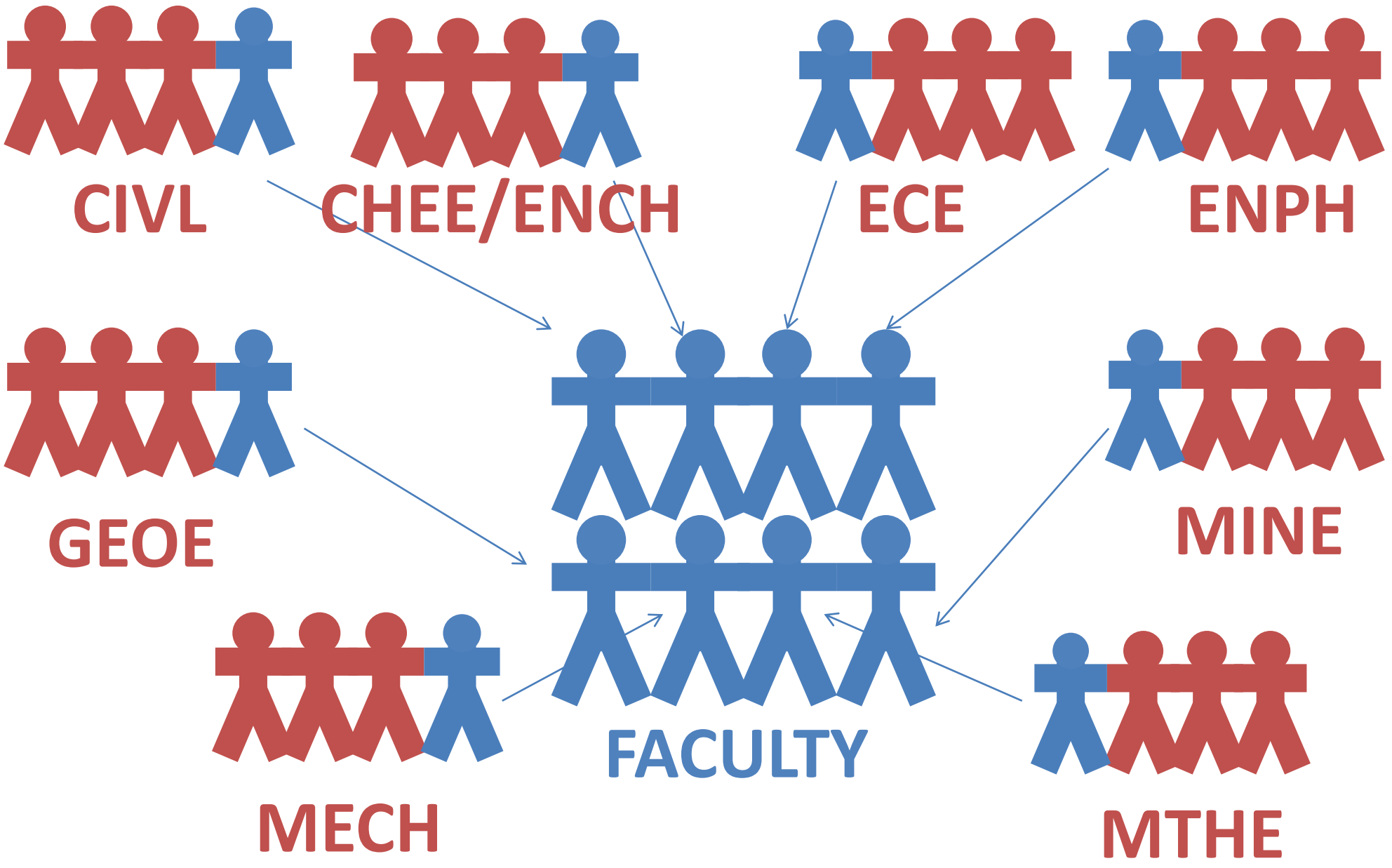
E.g. Queen's changes informed by data

Based on evaluation of the data, the following changes are planned:

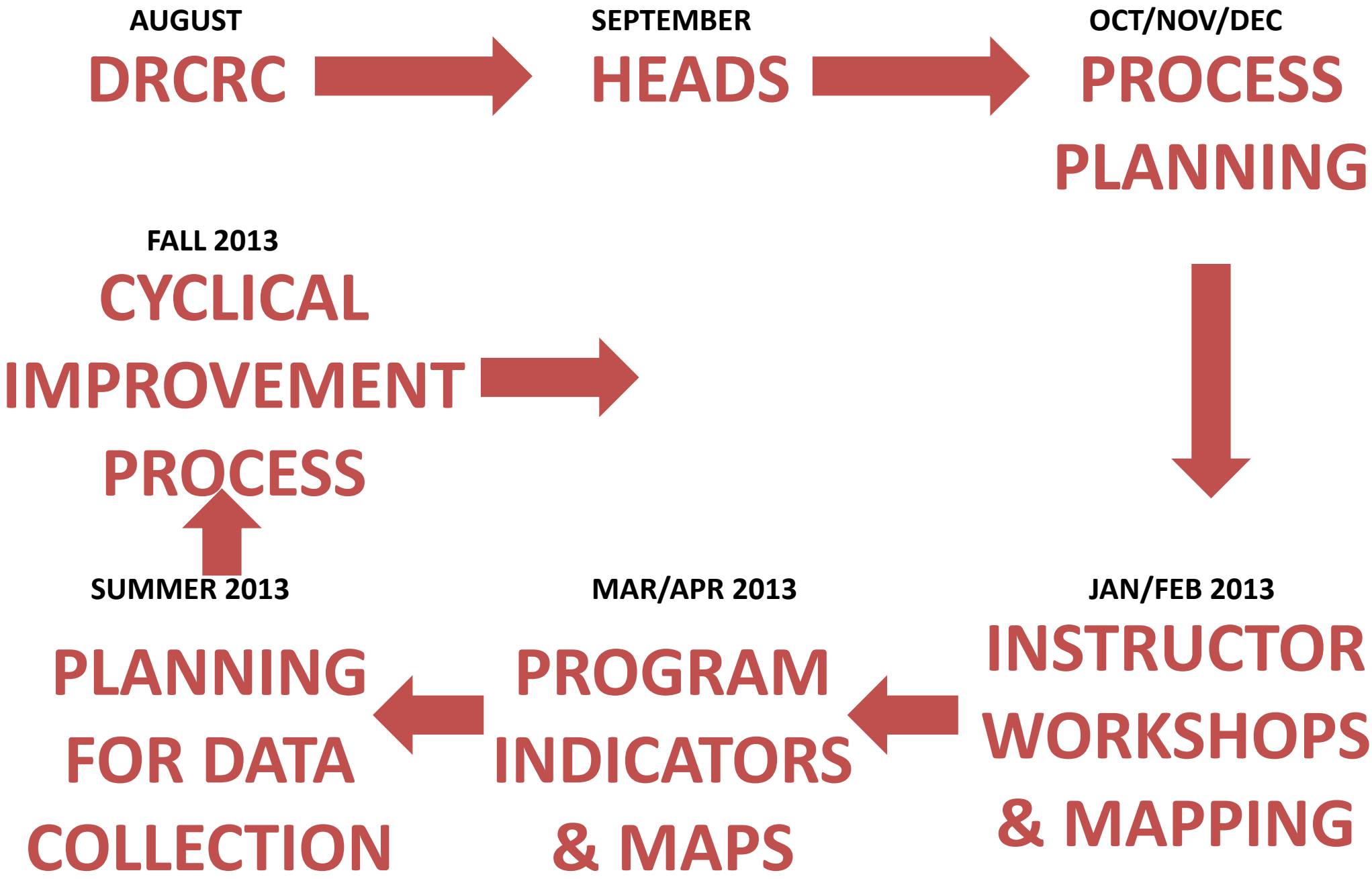
- The existence and importance of attributes for engineering practice will be communicated and used more extensively, and linked to learning objectives in courses.
- At the first year level, the program is being revised in the areas including making effective arguments, evaluating complex problem solutions against objectives, written communications, and evaluating information.
- At the second year level, more emphasis will be placed on summarizing important information clearly and concisely, effectively participating in informal small group discussions, and on risk assessment and project planning.
- A 4-year sequence of courses in engineering design and practice is being developed to develop and assess attributes in broad integrative experiences, like team projects, that emulate professional practice.

EXAMPLE: QUEEN'S PROPOSED PROCESS


Department & faculty
1
Program objectives and indicators
Department & faculty
2
Mapping the curriculum
What do you want to know about the program?
Course instructors & GA committee
Collecting data
3
Analyze and interpret
4
GA committee
Curriculum & process improvement
5


CIVL
CHEE/ENCH
ECE
ENPH
GEOE
MINE
FACULTY
MECH
MTHE

Proposed approach to start



OTHER SUPPORT

Slides and online resources are posted on the EGAD website http://egad.engineering.queensu.ca

Online materials

NAVIGATION

- Home
- Accreditation Related Resources
- Continuous Program Improvement Resources
- Our Mandate

Engineering Graduate Attribute Development (EGAD) Project

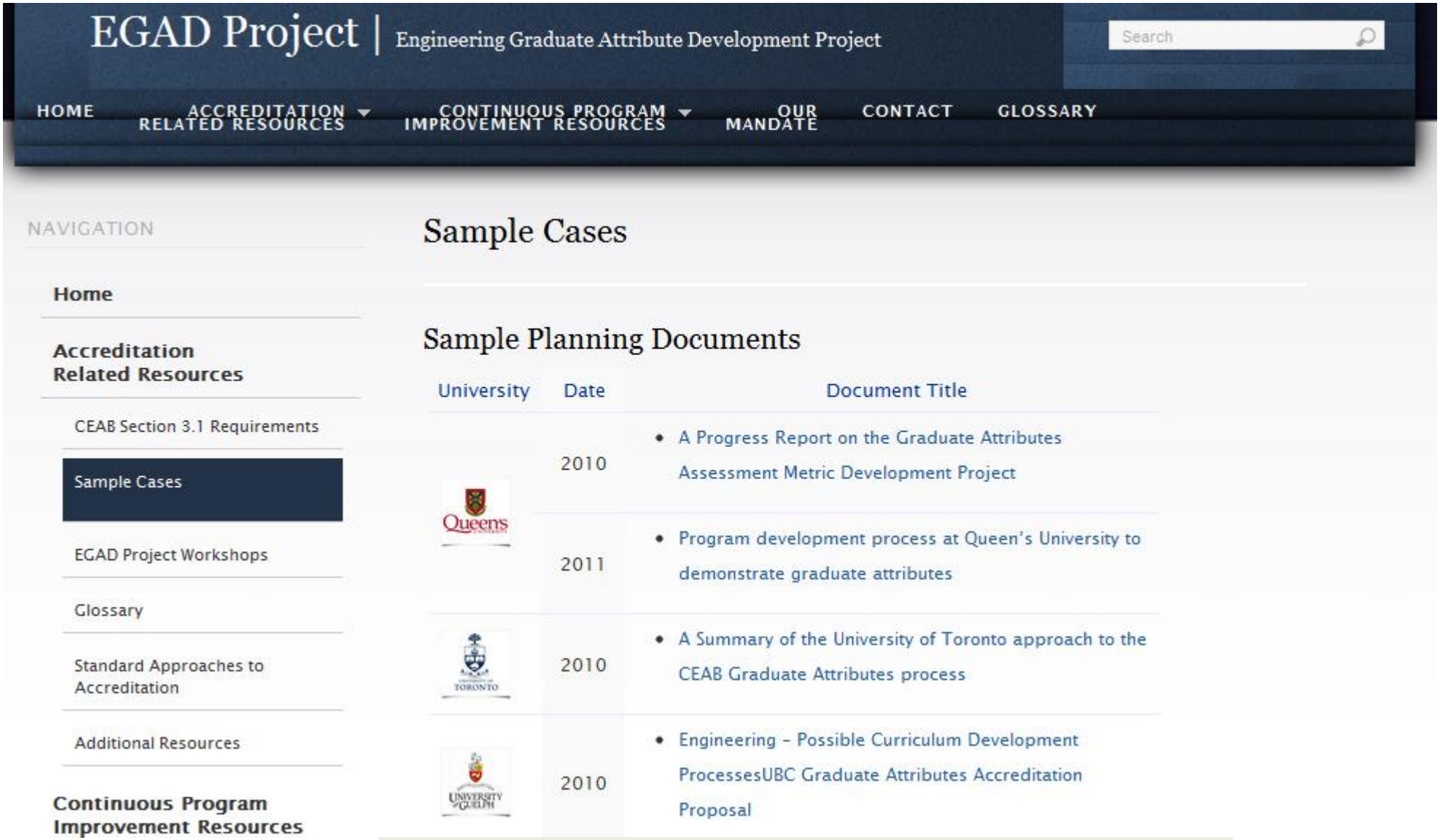
Welcome

As Canadian faculties and schools of engineering make the transition to outcome-based programming, assessment, and accreditation, The Engineering Graduate Attribute* Development (EGAD) Project has been formed in order to assist our engineering colleagues in this endeavour. It is a collaborative effort that is co-sponsored by the National Council of Deans of Engineering and Applied Science (NCDEAS), and Engineers Canada.The EGAD Project findings are offered to

sts of resources,

http://egad.engineering.queensu.ca

Online materials: samples



http://egad.engineering.queensu.ca

Online materials: Questionnaires

Sample Section 3.1 Responses

University	Date	Program	Notes
Queen's	2011	Mechanical	• A snapshot of a program's progress to meeting CEAB's graduate attribute requirements in 2011. • Not all attributes assessed, but the foundation of the process is outlined. • First year of egineering program is common, and coordinated by the faculty office. Faculty wide courses are denoted APSC.
Queen's	2011	Geological	• A snapshot of a program's progress to meeting CEAB's graduate attribute requirements in 2011. • Not all attributes assessed, but the foundation of the process is outlined. • First year of egineering program is common, and coordinated by the faculty office. Faculty wide courses are denoted APSC.
University of Calgary	2012	Mechanical	• Directly addressing CEAB requirement 3.1.1 to 3.1.12. • Three exhibits included: Curriculum Map, Survey Results and Completed Capstone Design Reflective Memo.

Sample Indicators

http://egad.engineering.queensu.ca

Online materials: training

HOME | ACCREDITATION RELATED RESOURCES | CONTINUOUS PROGRAM IMPROVEMENT RESOURCES | OUR MANDATE | CONTACT | GLOSSARY

NAVIGATION

- Home
- Accreditation Related Resources
- Continuous Program Improvement Resources
  - Key Principles
  - A 5 Step Guide To Curriculum Development
  - EGAD Project Workshops
  - Additional Resources
- Our Mandate
- Contact
- Glossary

A 5 Step Guide To Curriculum Development

Welcome

The EGAD* Project group has designed a 5 step guide which parallels the stages and steps involved when undertaking a systematic program review – particularly useful, we think, for faculty members, curriculum teams and others preparing for accreditation visits from the CEAB*.

Each step consists of a learning module containing information relevant to some aspect of outcomes-based* program review. The intention isn't to influence your institution's approach to program review but rather to highlight some of the key elements of a comprehensive review, highlighting the approaches and tools being used successfully by some of the schools across the country. And, using the CEAB accreditation questionnaire as a guide, we've also been very careful to use CEAB-compatible language and share processes that align well with what CEAB site teams are likely to be looking for.

Each learning module represents one phase of a 5-step data-informed approach to curriculum or program evaluation:

1 Program Evaluation: Getting Started

http://egad.engineering.queensu.ca

Program visitors will be looking for evidence of progress towards:

- Timing of data collection and analysis is clear, and continuous (cyclic).
- Analysis is high quality and addresses the data
- Improvement plan aligns with the analysis and data
- Improvement plan is implemented

General advice

- Capitalize on what you're already doing: innovators, first adopters, experimenters
- Start from the question “what do we want to know to improve our program”, rather than “what does CEAB want us to do” – think of this as self-directed learning!
- Don't generate reams of data that you don't know what to do with: create *information*, not *data*
- Dean/chair support can help encourage large scale curriculum development

Questions and discussion?