Graduate Attributes: The Big Picture

http://bit.ly/EGADCU

Goals of session 1

You should be able to define terms in including graduate attributes, indicators, and assessment measures

You should be able to describe the 5 steps of the EGAD Program improvement process

You should be able to describe simple tools like curriculum maps, rubrics, and course planning tables.

Outcomes-based assessment means…

1. **Developing clear descriptions** of what students should be able to do in a course, program, or institution
2. **Measuring** student performance
3. **Using data** to improve quality of the learning environment

Why learning outcomes?

- Assessing and improving quality of learning
- Curriculum development
- Space planning
- Student services and academic support planning

Responding to needs including…

- Pressure for accountability
- Mobility, credit transfer, “unbundling”
- Multiple modes of delivery

What is the value of identifying learning outcomes/indicators?

A study synthesizing:

800 meta-analyses

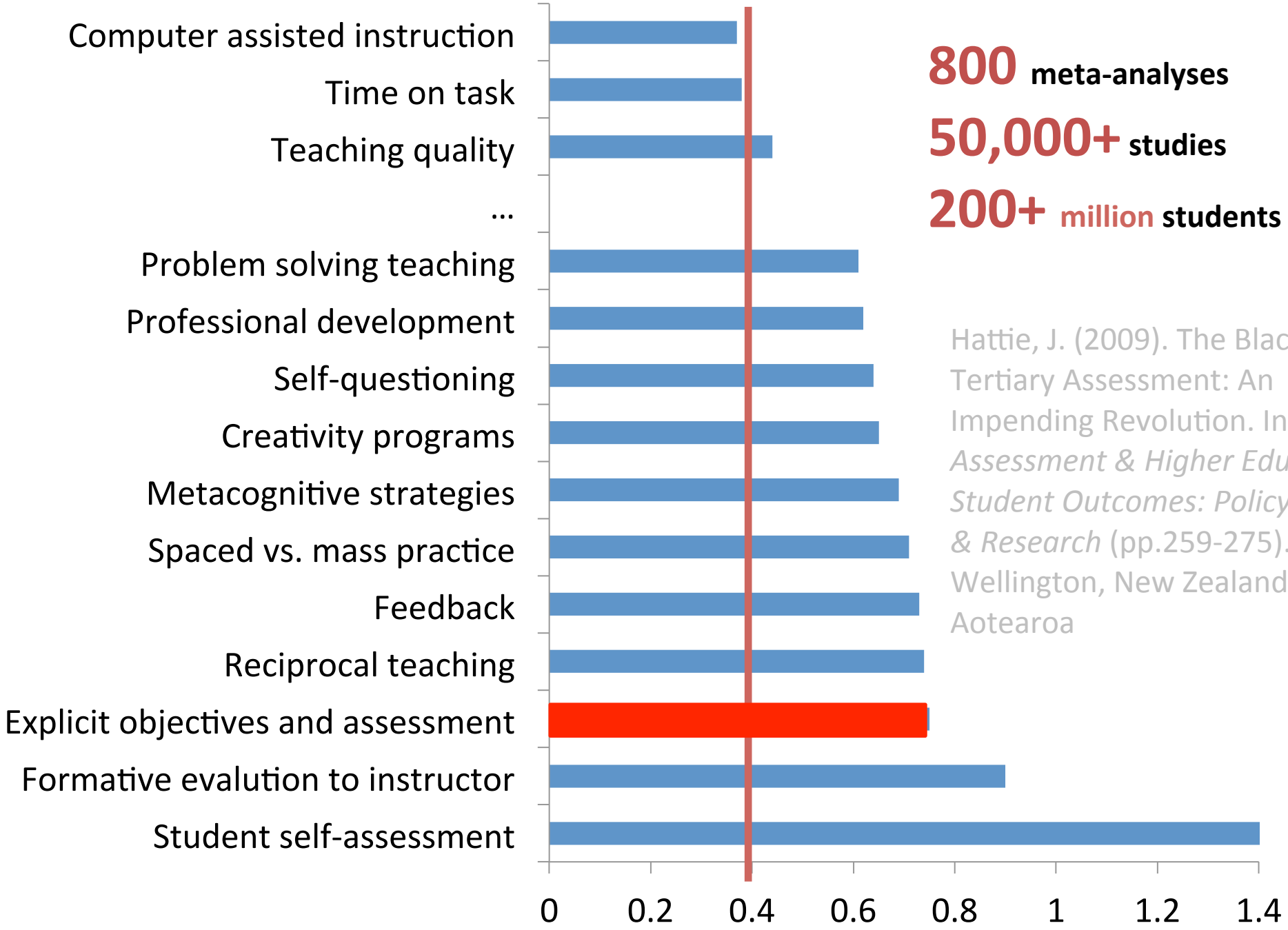
50,000+ studies

200+ 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)



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Requirements from 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

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

Elements of a program improvement process (and required by CEAB)

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 attributes: generic characteristics, expected to be exhibited by graduates

Knowledge base: **"Demonstrated competence in university level …"**

…

Communications: **": An ability to communicate complex engineering…"**

Set by CEAB
N=12

Indicators: descriptors of what students must do to be considered competent in the attribute

"Summarizes and paraphrases written work accurately with citations."

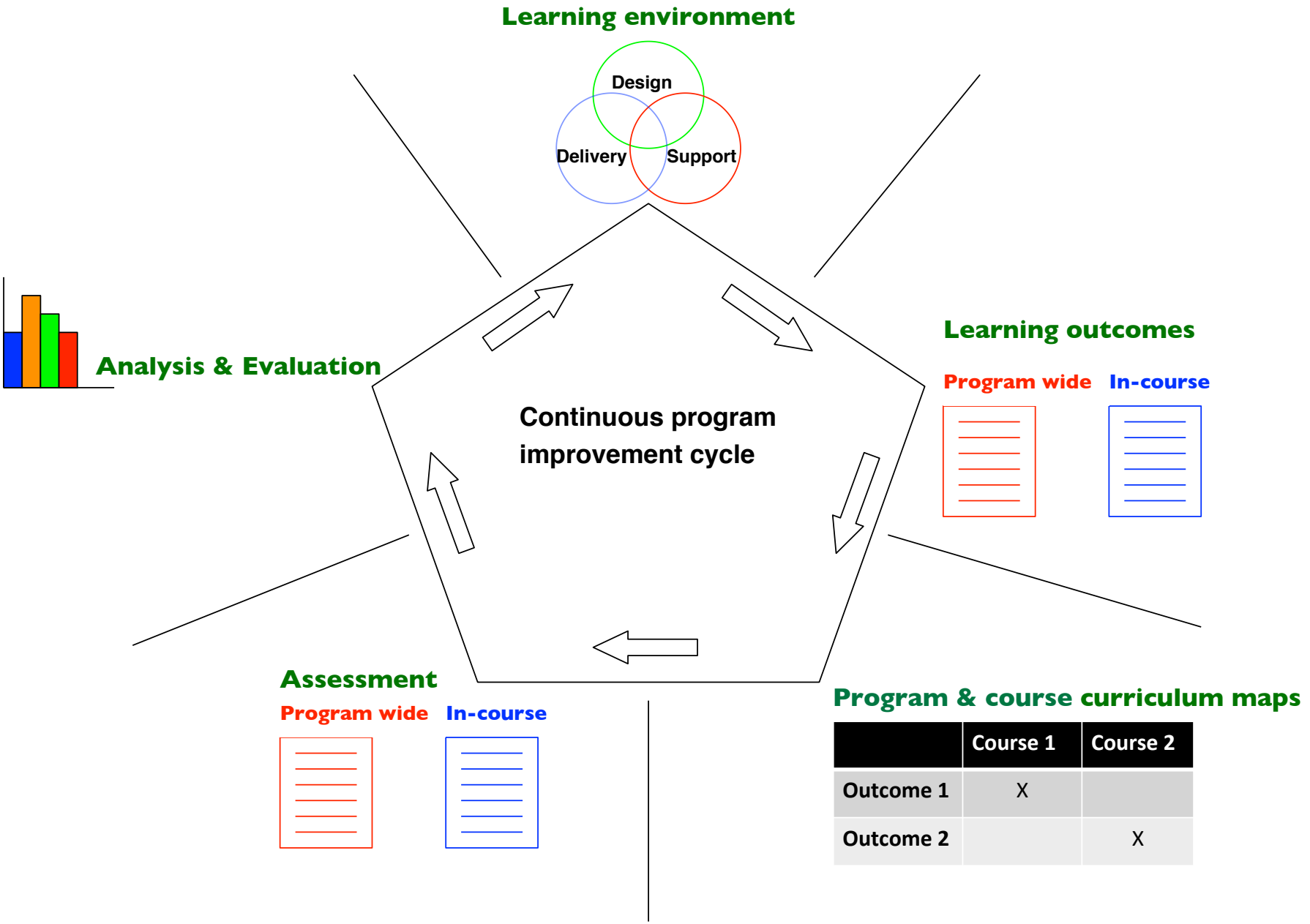
Set by faculty/ program

Course learning outcomes: descriptors what a learner is expected to know, understand and be able to do by the end of a course

Courses

Set by instructor

Program improvement Process



EGAD National Snapshot

Survey Description

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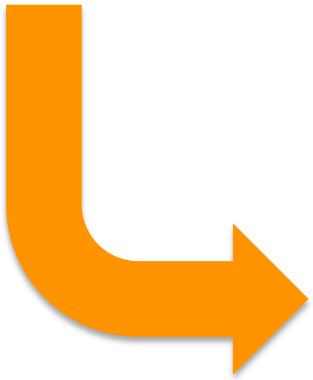
Questions



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Demographic

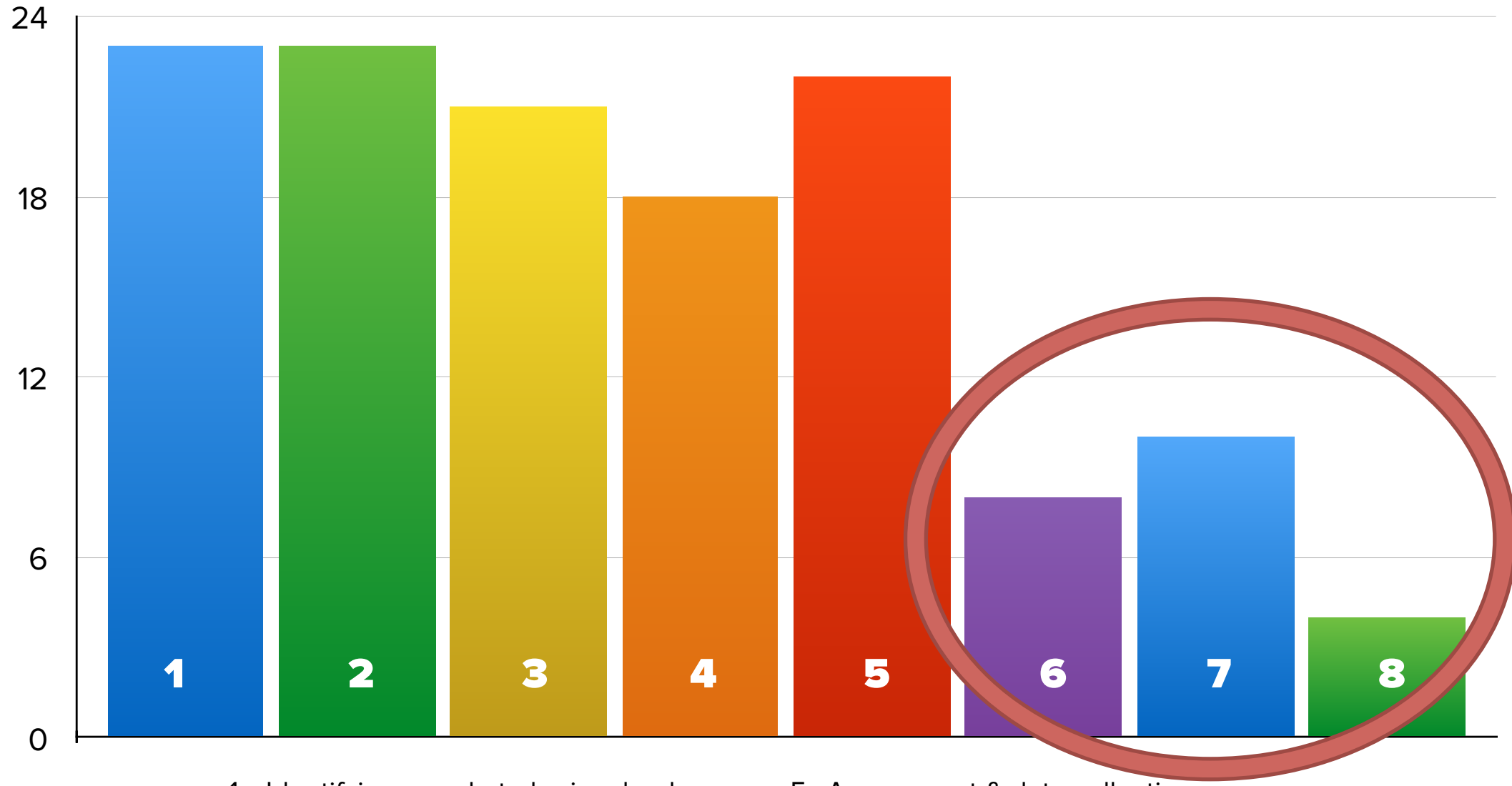
7

Open-response

22

Multiple-choice

Which activities for outcomes-based curriculum improvement have you completed or already have in place?

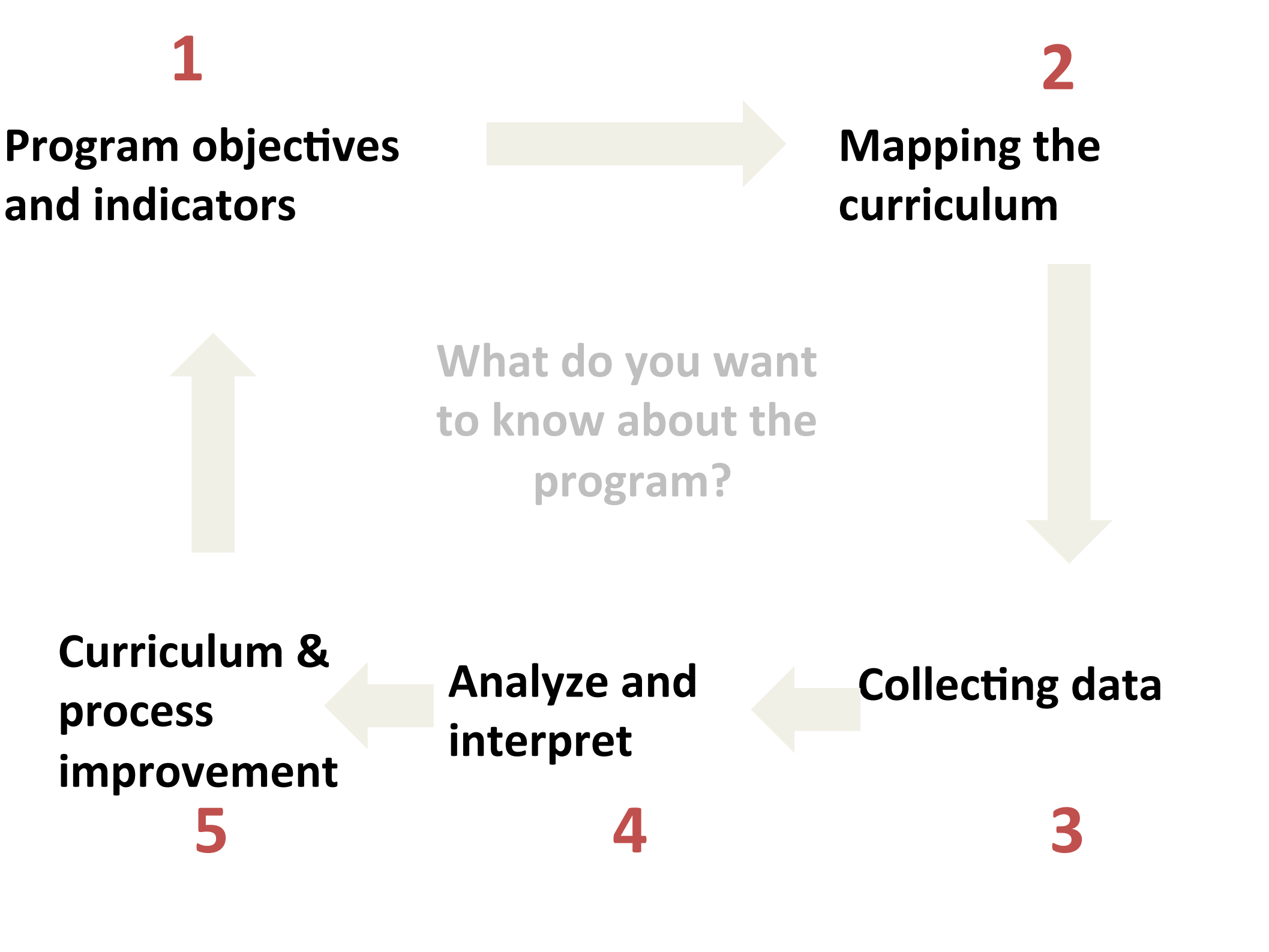


1. Identifying people to be involved
2. Established objectives and indicators
3. Mapped the curriculum
4. Faculty engagement activities
5. Assessment & data collection
6. Analysis & interpretation of data
7. Curriculum & program improvement
8. Closing the loop

With respect to the graduate attribute accreditation process, what are the key issues or questions at your institution?

1. **Faculty** engagement & buy-in
2. Resources, **time** & workload
3. **closing** the loop

PROCESS OVERVIEW


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

EGAD Recommended "Process tools"

Tool for Step 1: Indicator collection

	Year 1	Year 2	Year 3	Year 4
Problem Analysis (APSC-PA-Y-03)				
Design (APSC-DE-Y-01)				
Communication (APSC-CO-Y-03)				
Impact of Engineering (APSC-IM-Y-03)				

Tool for Step 2: Curriculum map

	APSC 100	APSC 111	APSC 131	APSC 151	APSC 161	APSC 171
Problem Analysis (APSC-PA-xx-01)	Develop, Assess	-	Develop, Assess	Develop, Assess	Assess	-
Design (APSC-DE-xx-02)	Develop, Assess	-	-	Assess	-	-
Communication (APSC-CO-xx-02)	Develop, Assess	-	Assess	Develop, Assess	-	-
Impact of Engineering (APSC-IM-xx-03)	Develop, Assess	-	Assess	Assess	-	-

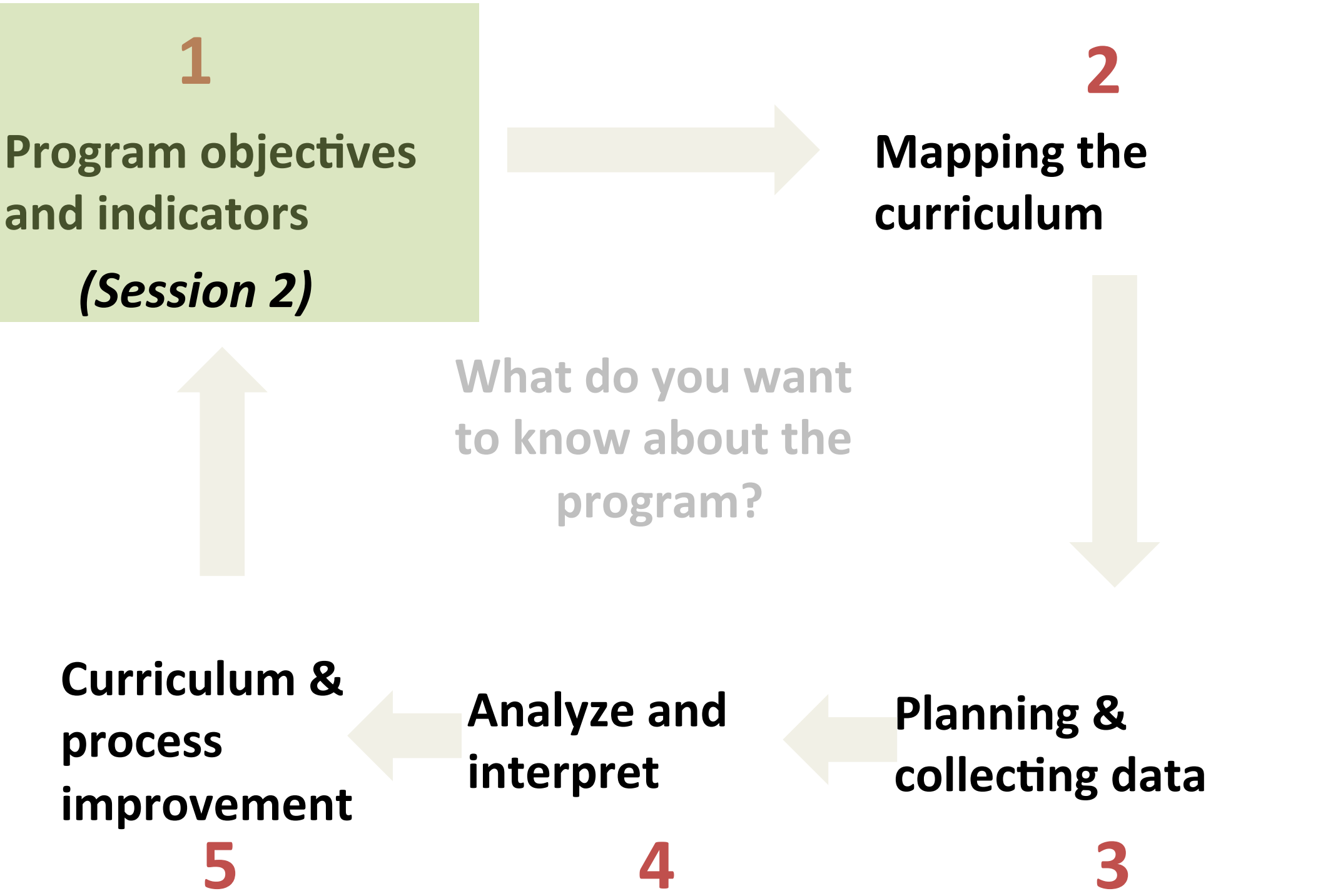
Tool for Step 3: Course planning table

APSC 100 Course Outcomes	
	1. Apply a general process for solving complex problems. (APSC-DE-1-01) 2. Select and apply appropriate quantitative model and analysis to solve problems. 3. Effectively communicate following a prescribed format, using standard grammar and mechanics. (APSC-CO-1-03) 4. Apply concepts including occupational health and safety principles, economics, law, and equity to engineering problems. (APSC-IM-1-03) 5. Apply critical and creative thinking principles to solve contextualized problems. (APSC-PA-1-03) 6. Apply a numerical modelling tool to create a model used to solve complex problems

	Teaching	Activity	Assessment
Week 1			
Week 2			
Week 3			
Week 4			

Tool for Step 3: Rubrics

	Not Demonstrated	Marginal	Developing	Expectation	Outstanding
	0-3	4	5	6	7-8
Problem Definition					
Proposed Process (APSC-DE-1-01)					
Model					
Conclusions					
Argumentation (APSC-PA-1-03)					
Communication (APSC-CO-1-03)					



STEP 1: Objectives and indicators

Indicators: examples

Graduate attribute

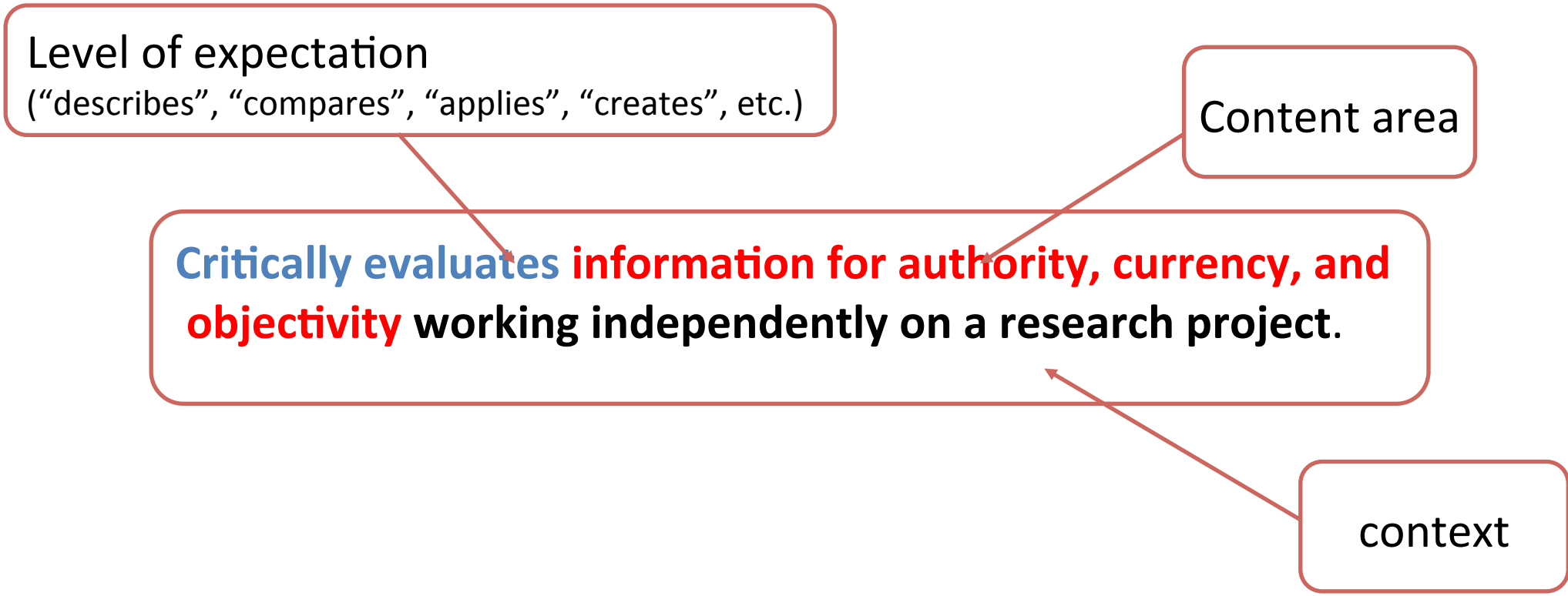
Lifelong learning
An ability to identify and address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge

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

Learning outcome (indicator) elements (from Biggs)



CEAB Reporting Requirements: Indicators

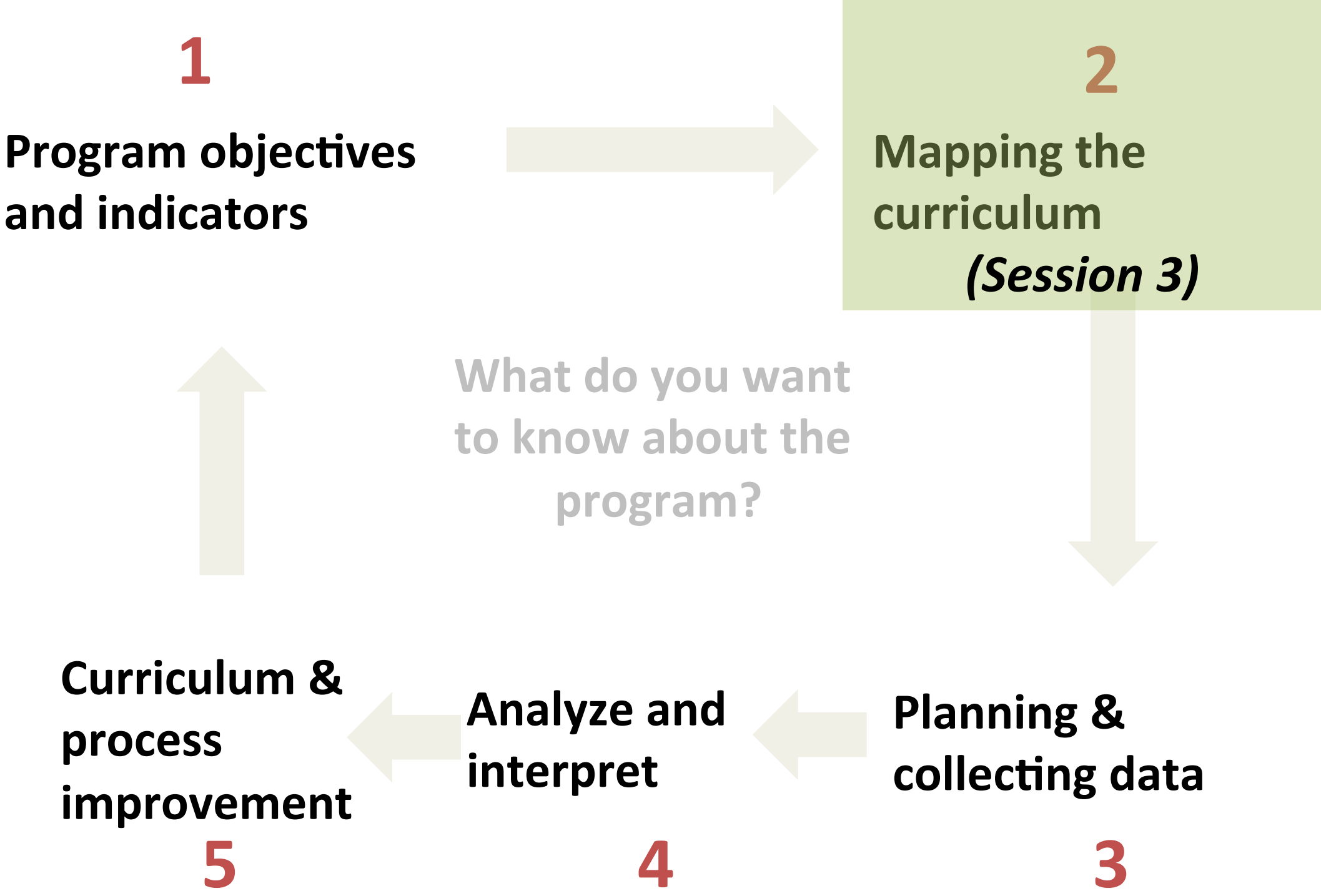
Instructions: List the indicators associated with each attribute together with the learning activities where the indicator has been used to assess performance of students (as highlighted in Table 3.1.1). Rows are provided but there is no expectation that they will all be used for any particular attribute. If more rows are needed, add rows as required.
Please delete the sample entries and highlighting to use this table.

Table 3.1.2: Indicators and Learning Activities Assessed

Graduate Attribute	Indicator	Relative Level		
		Inroductory	Intermediate	Advanced
Knowledge base	Creates mathematical descriptions for model real-world problems	MATH101		
	Selects and describes appropriate tools and methodologies to solve mathematical problems		MATH202	
	Recalls and describes fundamental concepts in chemistry	CHEM101	NSCI204	
	Recalls and describes fundamental concepts in physics	PHYS102	NSCI204	
	Recalls and describes fundamental engineering concepts	ENGR101		
	Comprehends and applies fundamental engineering concepts		ENGR202	
	Comprehends and applies discipline-specific engineering concepts		DSPE202	DSPE401
Problem analysis	Identifies known and unknown information, uncertainties and biases	ENGR103	DSPE201	DSPE302
	Creates process for solving problem including approximations and assumptions	ENGR103	DSPE201	DESX401
	Selects and applies appropriate quantitative model and analysis to solve problem	ENGR103	DSPE302	DESX401
	Evaluates validity of results, risks, errors and uncertainties	ENGR103	DSPE302	DESX401
Investigation	Generates working hypotheses	ENGR202	DSPE202	DSPE302
	Applies and tests working hypotheses	ENGR202	DSPE202	DSPE302
	Designs investigations and/or experiments	DSPE202	DSPE302	DESX401
	Synthesizes data to reach conclusions		DSPE302	DESX401
	Assesses validity of conclusions within limitations of data and methodologies		DSPE302	DESX401

Process Tool: Indicator collection

	Year 1	Year 2	Year 3	Year 4
Problem Analysis (APSC-PA-Y-03)	Applies critical and creative thinking principles to solve contextualized problems.			
Design (APSC-DE-Y-01)	Follows a general design process to design system, component, or process to solve open-ended complex problem.	Employ and apply design processes and tools with emphasis on early stages (problem definition, creative thinking processes for idea generation and decision making) on multi-disciplinary and disciplinary projects.	Applies technical knowledge, models/ simulations, and/or appropriate computer aided design tools with iteration to analyze and construct potential design solutions to complex open-ended problems.	Follows appropriate iterative design process involving knowledge, creativity, justifiable decision making, analysis, and tools.
Communication (APSC-CO-Y-03)	Effectively communicates technical information following a prescribed format and using standard grammar and mechanics.		Demonstrates conciseness, precision, and clarity of language in technical writing.	Demonstrates conciseness, precision, and clarity of language in technical writing.
Impact of Engineering (APSC-IM-Y-03)	Devises solutions for engineering problems that incorporate technical, social, environmental, and legal factors.	Devises solutions for engineering problems that incorporate technical, financial, social, environmental, and legal factors.	In the context of engineering activity evaluates societal, business, and technical norms of other cultures while maintaining ethical, moral position required for engineering practice in Ontario.	



STEP 2: Mapping the curriculum

Curriculum Mapping

Where are attributes/ indicators developed?

Where are attributes/ indicators assessed?

CEAB Reporting requirement

Instructions:	List all learning activities (courses etc) that relate to specific graduate attributes. Highlight those activities where student achievement has been, or is planned to be, assessed. *Please delete the sample entries and highlighting to use this table.*
Table 3.1.1:	Summary Graduate Attribute Curriculum Map

Graduate Attribute	Semester							
	1	2	3	4	5	6	7	8
Knowledge base	CHEM101	PHYS102	MATH201	MATH202	MATH301	DSPE302	DSPE401	DSPE402
	MATH101	MATH102	MATH203	ENGR202	DSPE301	DSPE304	DSPE403	DSPE404
	ENGR101	ENGR102	ENGR201	NSCI202	DSPE303	DSPE306	DSPE405	DSPE406
	ENGR103	CMPT102	NSCI201	NSCI204	DSPE305			
			DSPE201	DSPE202				
			STAT201					
Problem analysis	ENGR103		DSPE201		DSPE303	DSPE302	DESX401	
					DSPE305	DSPE306	DESX403	
Investigation				ENGR202		DSPE302	DESX401	
				DSPE202			DESX403	
Design	DESX101	DESX102			DESX301	DESX302	DESX401	DESX402
					DSPE303	DSPE304	DESX403	DESX404
							DSPE405	DSPE406
Use of engineering tools		ENGR102			DSPE301	CO-OP	DSPE401	
		CMPT102			CO-OP		DESX401	
							DESX403	
Individual and team work	DESX101	DESX102			DESX301	DESX302	DESX401	DESX402
					CO-OP	CO-OP	DESX403	DESX404
Communication skills	ENCS101	ENCS102		ENCS202	DSPE303	DESX302	ENCS401	DESX402
	DESX101	DESX102			CO-OP	CO-OP		DESX404

CEAB: Course learning outcomes

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:	CS_ELECT
Course title:	Complementary Studies Elective
Calendar web link:	
*Notes:	

* Provide explanatory notes on inconsistencies with calendar information (if applicable)

CEAB course type		CEAB curriculum category ntent		Math		Natural science		Complementary studies		Engineering science		Engineering design	
	E	AU percentage:		0%		0%		100%		0%		0%	
Compulsory	Elective	Total:	36					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
							I	I	I	I	I	I

** Enter content code most appropriate for each attribute

Content level codes: blank = not applicable (less than 2 AU); I = introduced (introductory); D = developed (intermediate); A = applied (advanced)

Professor-in-charge : (name, reg-status, PhD, acad. rank)					All other instructor(s): (name, reg-status, PhD, acad. rank)				
Family name	Initial(s)	L. Status	Doctorate	Acad Rank	Family name	Initial(s)	L. Status	Doctorate	Acad Rank
tba		Unknown	Unknown	Unknown					

Course delivery and outcomes:	Total instructional hours per week	Hours per section		Total num. sections		Teaching assistants		Average grade		Failure rate (%)
		Lecture	Lab/tut	Lecture	Lab/tut	Number	Hours	%	Letter	
	3	3.0	0.0	1	0	0	0.0		B	1-2

Major learning outcomes:	Learning outcome indicators
	1
	2
	3
	4
	5
	6

Process Tool: Curriculum map

	APSC 100	APSC 111	APSC 131	APSC 151	APSC 161	APSC 171
Problem Analysis (APSC-PA-xx-01)	Develop, Assess	-	Develop, Assess	Develop, Assess	Assess	-
Design (APSC-DE-xx-02)	Develop, Assess	-	-	Assess	-	-
Communication (APSC-CO-xx-02)	Develop, Assess	-	Assess	Develop, Assess	-	-
Impact of Engineering (APSC-IM-xx-03)	Develop, Assess	-	Assess	Assess	-	-

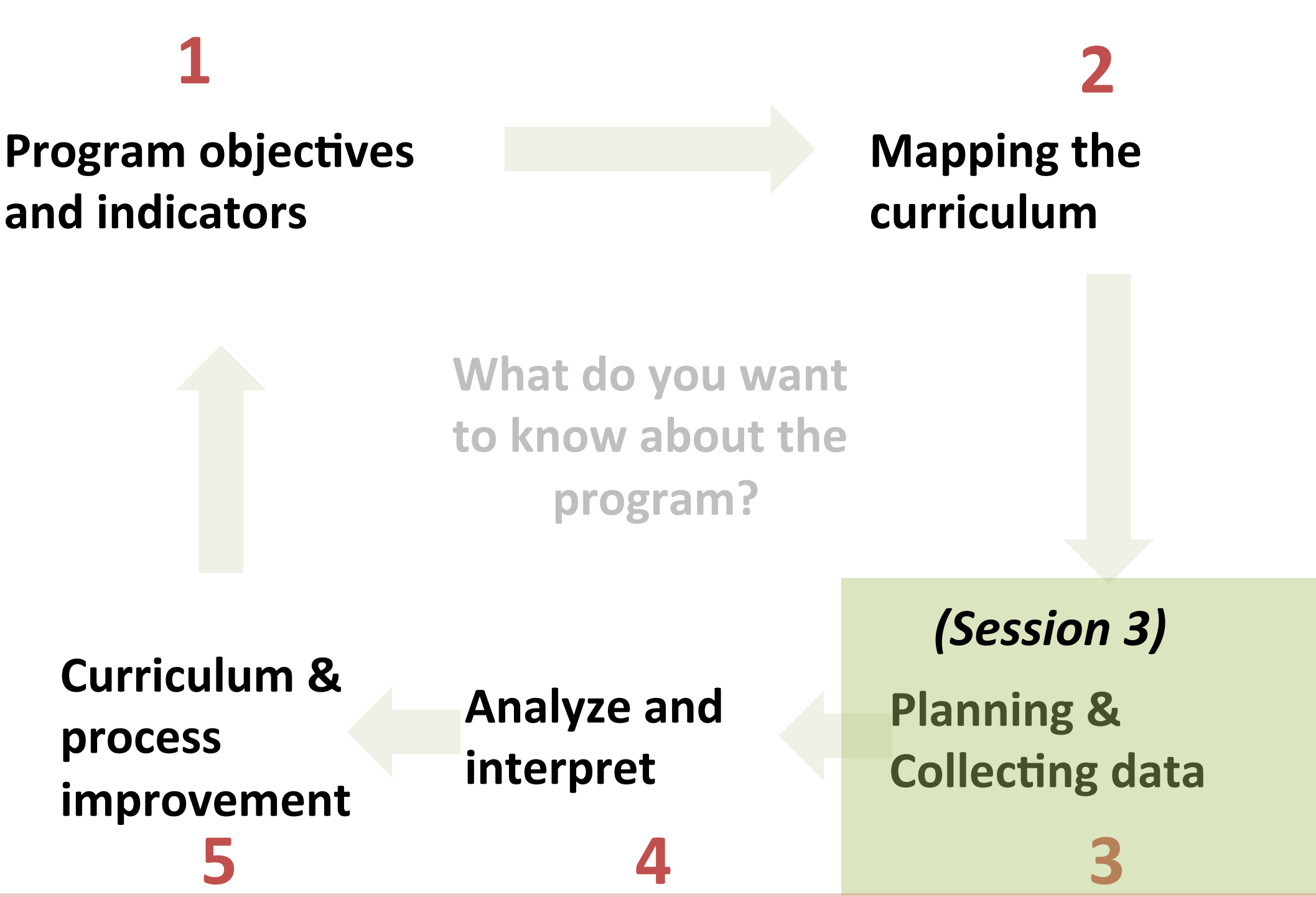
Example: Mapping to Courses (UBC)

Introduce
Emphasize
Utilize

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

Useful pieces of information:

- What methods of instruction do you use in your course? (**What**)
- What methods of assessment are used in your course? (**How**)
- Which program-level learning outcomes are developed in your course? (**What**)
- What level of complexity/depth is expected for each of the learning outcomes? (**Level**)
- Please specify how each of the learning outcomes are taught and assessed in your course. (**How**)



STEP 3: Collecting data

CEAB Reporting Requirement – Assessment tools

Instructions: Provide examples of the assessment tools (rubric or other) used to comparatively evaluate performance for any 12 indicators listed in Table 3.1.2. At least one indicator for each of the 12 attributes must be included. Change column headings as required. Add or delete columns as required. Provide performance descriptors that exactly correspond to those used in assessment. A complete set of all assessment tools should be available to the visiting team at the time of the visit.
Please delete the sample entries and highlighting to use this table. If a program uses a different number of levels of performance than what is in the example, columns may be added or deleted. The example shows four levels of achievement but this can be modified to suit the program.

Table 3.1.3: Examples of Assessment Tools

Graduate Attribute	Performance level	Level 0	Level 1	Level 2	Level 3
	Level descriptor	*Fails to meet expectations*	*Minimally meets expectations*	*Adequately meets expectations*	*Exceeds expectations*
Knowledge base	*Recalls and describes fundamental concepts in chemistry*	*Less than 50% on final examination*	*50% to 60% on final examination*	*60% to 80% on final examination*	*Greater than 80% on final examination*
Problem analysis	*Creates process for solving problem including approximations and assumptions*	*Process unacceptable and treatment of approximations and assumptions inadequate*	*Process acceptable but treatment of approximations and/or assumptions marginal*	*Process and treatment of approximations and assumptions acceptable*	*Process and/or treatment of approximations and assumptions exceptional*
Investigation	*Indicator:*	*Performance descriptor*	*Performance descriptor*	*Performance descriptor*	*Performance descriptor*
Design	*Indicator:*	*Performance descriptor*	*Performance descriptor*	*Performance descriptor*	*Performance descriptor*
Use of engineering tools	*Indicator:*	*Performance descriptor*	*Performance descriptor*	*Performance descriptor*	*Performance descriptor*

Assessment Tools

How to measure learning against specific expectations?

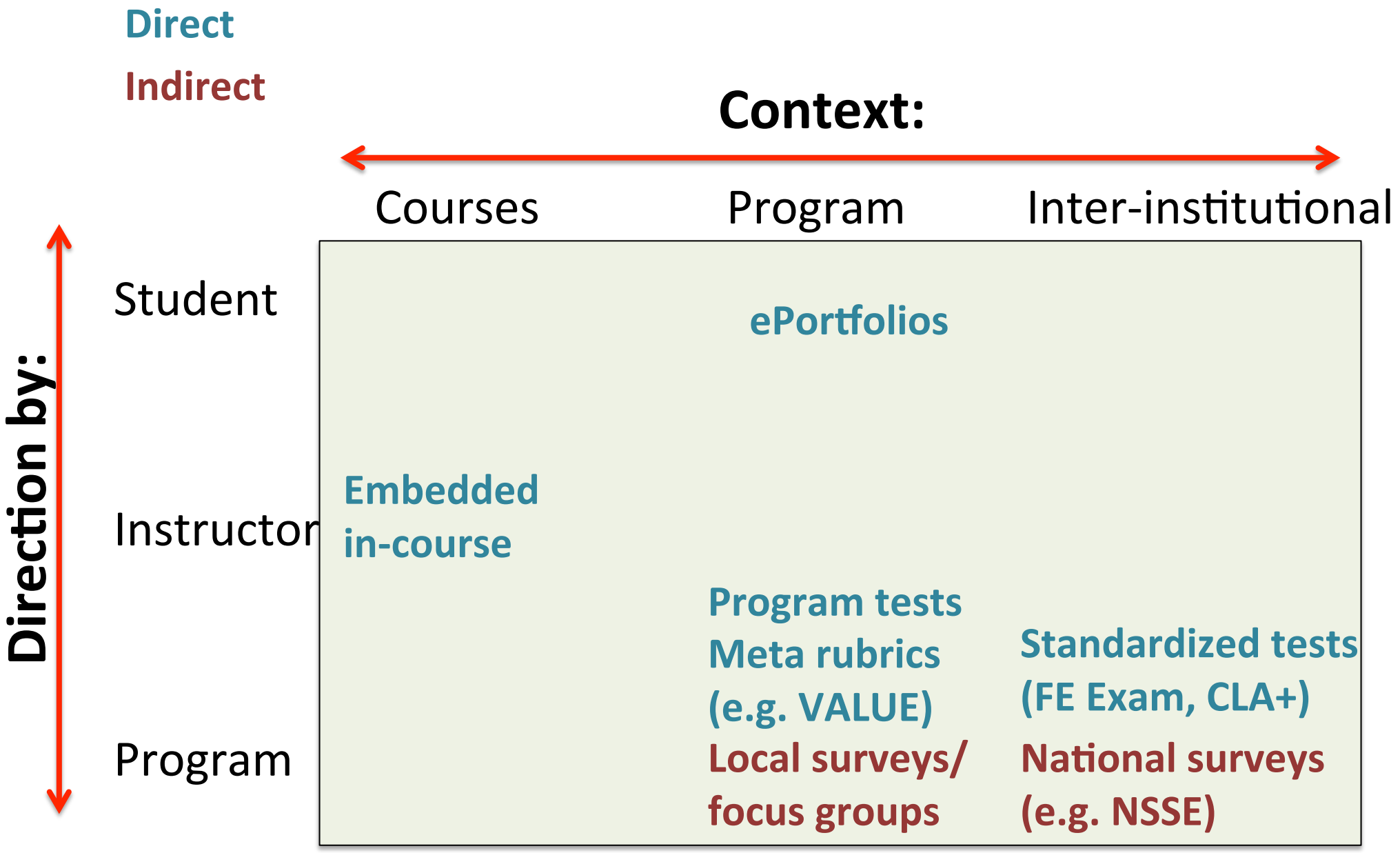
Direct measures – directly observable or measurable assessments of student learning

- 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.

Programmatic assessment approaches

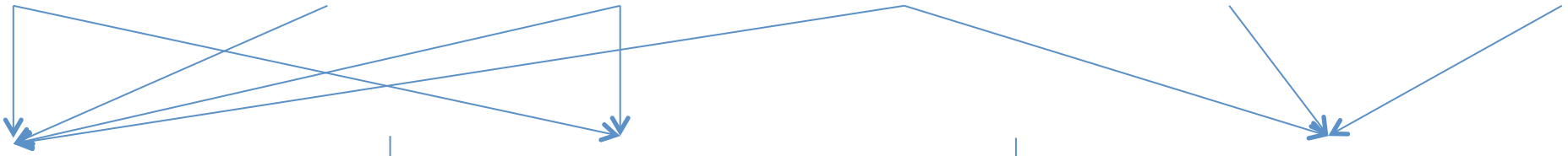


Process tool: Assessment plan

Attribute	Course level assessment	Program level assessment	
		Direct methods	Indirect methods
Problem analysis	Project 1 & 2	Standardized Instrument	Graduating student survey Faculty Survey
Design	Project 1 & 2	Standardized Instrument	Graduating student survey Faculty Survey
Communications	Project 1 & 2	Standardized Instrument Program-wide Rubric	NSEE Graduating student survey Faculty Survey
Lifelong learning	Project 1 & 2		NSEE Graduating student survey Faculty Survey

Queen's delegation plan

Knowledge **Problem anal** **Eng tools** **Design** **Communications** **…**



Individual program

- What are key expectations of your program?
- Mostly focus on **knowledge, engineering tools, and problem analysis**

Multi-department. E.g.:

- Service teaching (e.g. math)
- Engineering science program taking MECH, ECE courses
- Mostly focus on **knowledge and engineering tools**

Faculty-wide

- First year and faculty-wide courses
- Mostly focus on **first year knowledge, design, and on professional skills**
- **Program wide surveys including NSSE, meta-rubric assessment, CLA+**

Process Tool: Course planning table

APSC 100 Course Outcomes	1. Apply a general process for solving complex problems. **(APSC-DE-1-01)** 2. Select and apply appropriate quantitative model and analysis to solve problems. 3. Effectively communicate following a prescribed format, using standard grammar and mechanics. **(APSC-CO-1-03)** 4. Apply concepts including occupational health and safety principles, economics, law, and equity to engineering problems. **(APSC-IM-1-03)** 5. Apply critical and creative thinking principles to solve contextualized problems. **(APSC-PA-1-03)** 6. Apply a numerical modelling tool to create a model used to solve complex problems

	Teaching	Activity	Assessment
Week 1	**Motivation:** course overview and structure	Critical Thinking Pre-test	Word/Excel assignment (CLO 3)
Week 2	**Models:** Mini MEA1 **Goal:** what is a model (drawing, text, equations describing behaviour), and using MATLAB script as part of a model	Intro to MATLAB: Starting MATLAB, variables, operations, plotting, scripts, and publishing a MATLAB script.	Mini MEA1 to be done by end of lecture (CLO 2,5,6)
Week 3	**Argumentation:** analyze past assignments for effective argumentation **Goal:** Create argument related to MEA1. Process for creating reports	Conditional statements	
Week 4	**Complex problem solving:** Complex problem solving process. **Goal:** Identify stakeholders and asking relevant questions for MEA1	Curve fitting and interpolation	MEA 1 Draft Submission (CLO 1,2,3,5,6)

CHEE 321 2012-2013 || Module overview

Course learning outcomes (CLO): Students will be able to:

1. Calculate operating parameters (size, flowrates, conversion, etc…) for isothermal and non-isothermal operation of ideal well-mixed batch and continuous reactors, and for ideal plug-flow reactors
2. Formulate a set of consistent material and energy balance equations to describe operation of batch, semi-continuous and continuous reactor systems with single or multiple reactions
3. Formulate an overall rate expression from a series of elementary mechanistic steps
4. Investigate the choice of reactor type and operating conditions on output such as reactant conversion, selectivity and yield.

(Session 3 Activity)

Students are expected to augment lecture material through reading of associated sections of the textbook, and to practice execution of course principles by completing posted problem sets

Module	Lecture approach and content	Tutorial approach and content	Assessment (CLO, and % of course grade)
Module 1 (Wks 1-2)	**Reactions and the GMBE** • Reaction Rates, Rate Laws and Stoichiometry • The General Mole Balance Equation (GMBE) and Ideal Reactors • Estimating Rates from Experimental Data	Worked examples, based on lecture material A set of practice problems is also posted (unmarked)	Material is included on mid-term (CLO1)
Module 2 (Wks 3-5)	**Isothermal Reactors: Single Reaction in Batch, CSTR, PFR** • Solving Problems using Stoichiometric Tables • Levenspiel Plots (Reactor Sizing) and Multiple Reactors • Reversible Reactions	Worked examples, based on lecture material A set of practice problems is also posted (unmarked)	Material is included on mid-term (CLO1) Design assignment 1 (10%, CLO1, CLO4)
Midterm	**Covers Modules 1 and 2**		***Midterm exam:*** *2-3 questions will target CLO1, worth 20% of course grade*
Module 3 (Wks 6-8)	**NonIsothermal Reactor Design** • Forms of the Energy Balance (EB); Isothermal and Adiabatic • CSTR with the EB; multiple steady-states	Worked examples, based on lecture material A set of practice problems is also posted	Material is included on final (CLO1, CLO2)

Assessment methods

- 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, ...)

Scoring

- Numeric (mark out of 10)
- Rubric (discrete levels with description of performance)
- Complete/not complete

Process Tool: Rubric

	Not Demonstrated	Marginal	Developing	Expectation	Outstanding
	0-3	4	5	6	7-8
Problem Definition	Problem not defined, little useful information, or information directly copied.	Some important information or biases not identified, or trivial/incorrect information included.	Problem definition is clear but missing some elements.	Clearly defines scope of problem, stakeholders, and required goals. Summarizes and assesses credibility of information used.	**Meets expectations and**: Includes information from authoritative sources to inform process, model, and conclusions.
Proposed Process (APSC-DE-1-01)	No or inadequate process described	Process identified misses critical factors; some assumptions left unidentified or unjustified.	Process is clear but missing some elements	Creates justified process for solving problem, including tests/investigation, supported by information.	**Meets expectations and:** Comprehensive process described with multiple possible approaches described and compared.
Model	No analysis, or model/ analysis selected is inappropriate, or can't draw conclusions	Model used has significant errors or uses inappropriate assumptions.	Model has minor errors or unsupported approximations or assumptions	Creates and applies quantitative model using supported analysis, approximations and assumptions.	**Meets expectations and:** Sophisticated model used incorporating several effects; uncertainty in model's input variables shown by range of output values
Conclusions	No evaluation of solution.	Superficial evaluation of solution and superficial recommendations to prevent future failures	Most of the elements under "expectation" met, but not all	Evaluates validity of results and model for, drawing well-supported conclusions about causes of failure and supported recommendations for to prevent future failures.	**Meets expectations and:** Quantifies possible error/ uncertainty in model conclusions and provides multiple thoughtful recommendations prevent future failures.
Argumentation (APSC-PA-1-03)	Unsupported or trivial arguments	Arguments weak overall	Arguments include some but not all critical elements	Makes claims supported by data and backing, with appropriate qualifiers	**Meets expectations and:** Claims supported by authoritative backing and comprehensive description of context in which they apply.
Communication (APSC-CO-1-03)	Report difficult to understand	Understandable but not formatted following guidelines; many grammatical errors	Clearly formatted following guidelines but obviously needs proofreading	Concise and clearly formatted following guidelines with few grammatical errors	**Meets expectations and:**Varied transitions, attractively formatted, no grammatical errors

Outcomes Rubric and Assessment Plan for closed-end problems

	Meaning	Letter Grade	Score /10	General Rubric for Engineering Science Problems (Higher levels include the abilities required in lower levels)
Mastery (5)	**All expectations are met well, some exceeded.**	A	8,9,10	Obtains mathematically correct answer and interprets answer in physical and/or practical context. Presentation clear and concise. Describes all assumptions/approx., and context under which it is true.
High Quality (4)	**All expectations are met well.**	B	7	Justifies simplifications, applies appropriate mathematical approach
Developing (3)	**Many expectations are met. Some aspects need more work.**	C	6	Simplifies equations/models with appropriate assumptions
Marginal (2)	**Most aspects need more work to meet expectations.**	D	5	Recognizes need for appropriate models and related equations, states them in appropriate frame of reference and identifies all boundary/initial conditions
Not Demonstrated (1)	**Evidence is either missing or performance entirely unsatisfactory.**	F	0,1,2,3,4	Makes conceptually incorrect errors

Validated rubric development (University of Toronto)

Design rubrics adapted and compiled from a wide variety of sources (see Reference section

Outcome	Indicator	Fails	Below	Meets	Exce
	The student displays the ability to…				
…frame a problem in design terms	…identify stakeholders	Little consideration of stakeholders.	Some essential stakeholders missing.	All expected stakeholders identified.	Comp list of
	…elicit requirements from stakeholders	Minimal evidence of stakeholder engagement or research. Minimal linkage to engineering requirements.	Some evidence of stakeholder engagement or credible research. Some linkage to engineering requirements.	Evidence of stakeholder engagement and credible research. Clear links to engineering requirements.	Comp stakeh resear source Well d engine
	…extract requirements from conventions, standards, or protocols	Minimal review of conventions, standards, or protocols. Minimal linkage to engineering requirements.	Some review of conventions, standards, or protocols. Some linkage to engineering requirements.	Good review of relevant conventions, standards, or protocols. Clear links to engineering requirements.	Comp releva standa Well d engine
	…extract requirements from similar work, past work, or the State of the Art	Minimal review of state of the art. Minimal linkage to engineering requirements.	Fair review of state of the art. Some linkage to engineering requirements. Essential engineering elements missing (e.g. safety, cost, etc.).	Good review of state of the art. Clear links to engineering requirements. Expected engineering elements included.	Comp state o Well d engine Projec standa when
	…formulate design goals and subgoals	Design goals are not connected in any way to requirements.	Design goals connect in some way to requirements. Subgoals are somewhat	Design goals are mostly connected to requirements. Subgoals are related to	Desig conne Subgo

Example: Rubric for design report (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.

Example: Assessing math knowledge (Queen's)

Calculus course had three learning outcomes that were indicators for Knowledge base in first year:

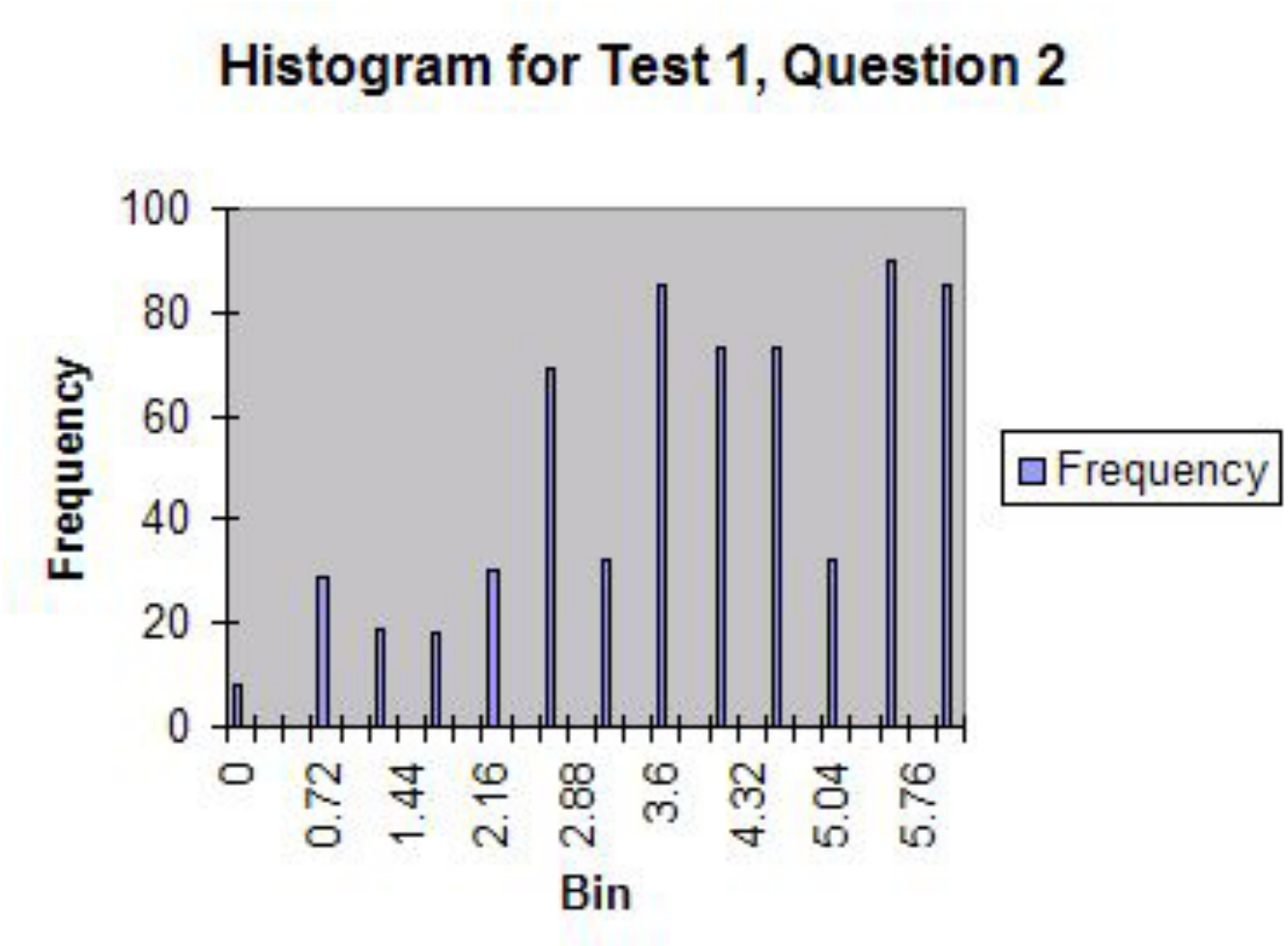
1. Create mathematical descriptions or expressions to model a real-world problem
2. Select and describe appropriate tools to solve mathematical problems that arise from modeling a real-world problem
3. Use solution to mathematical problems to inform the real-world problem that gave rise to it

Instructor assessed those by specific questions on exam

Example (cont'd):

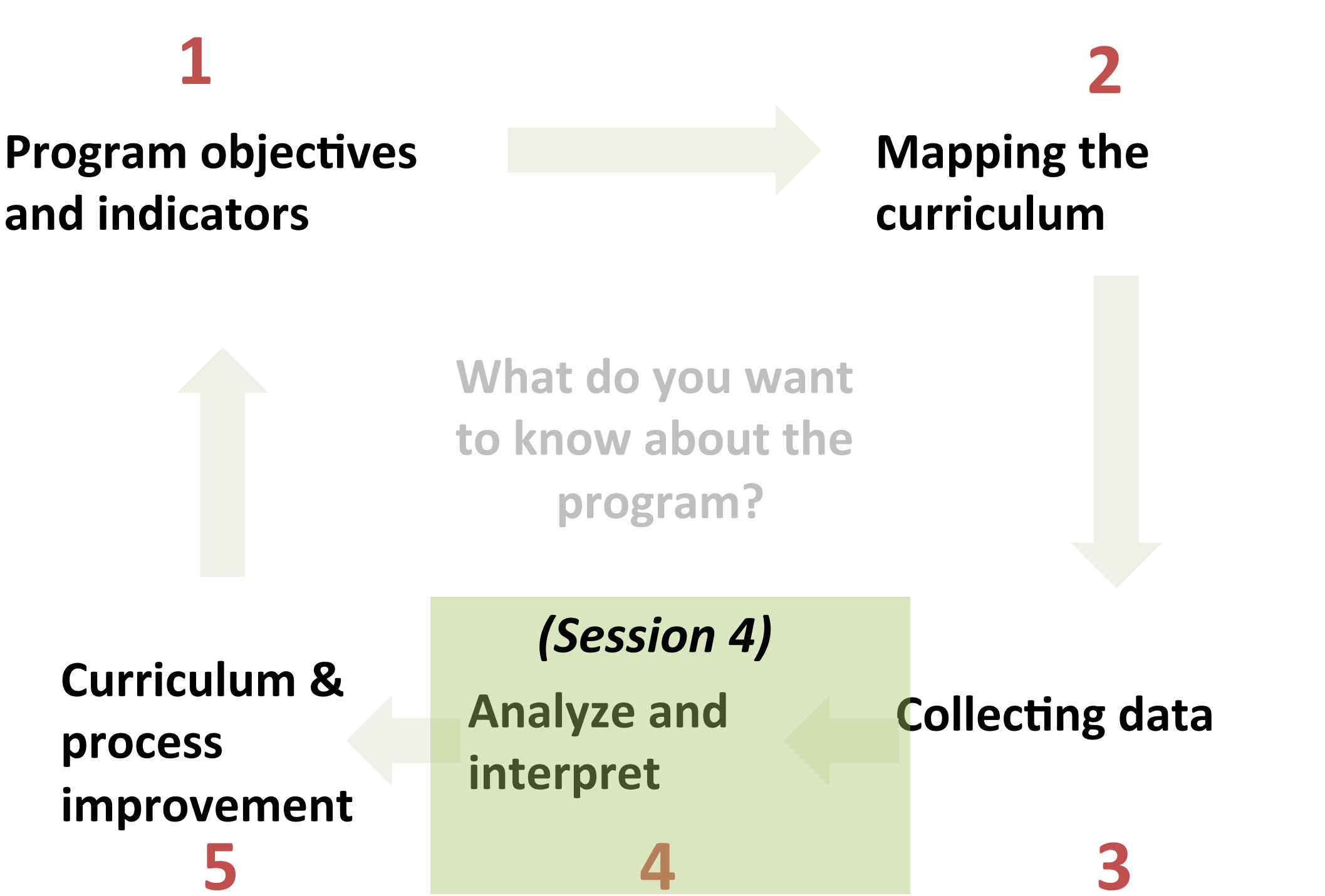
Outcome #1: Create mathematical descriptions or expressions to model a real-world problem

Question Context: calculating intersection of two trajectories



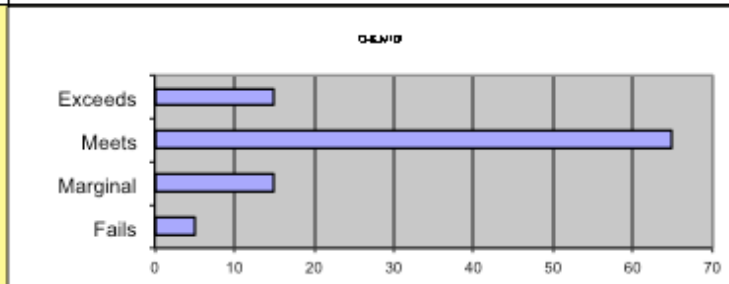
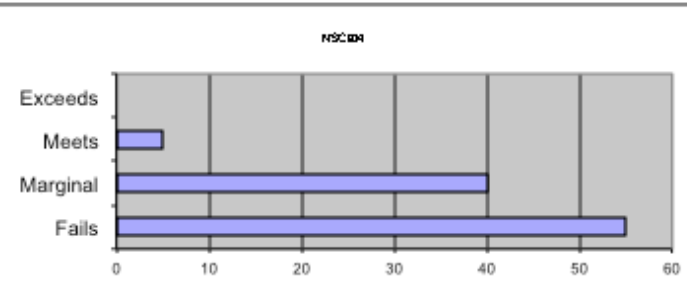
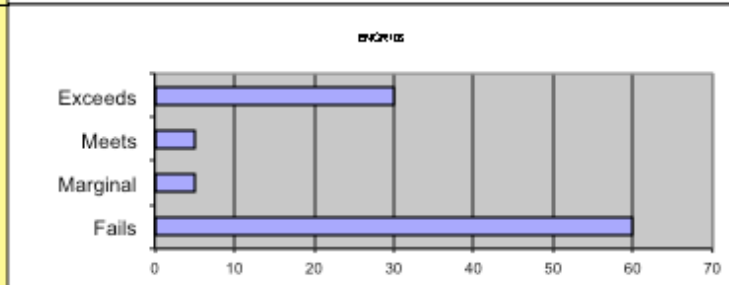
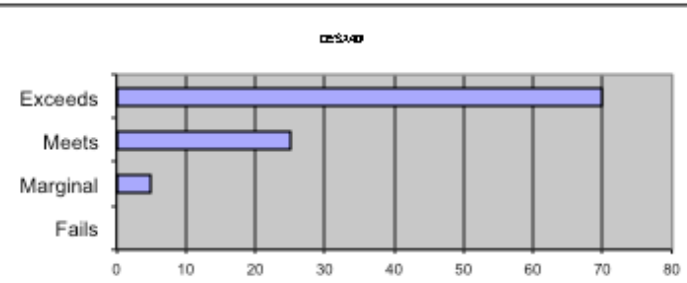
Tracking outcomes scores derived from exams

Student name	Exam mark (/100)	Learning outcome 1 mark from exam question 2 (/6)	Learning outcome 2 mark from exam question 5 (/6)
Bill	70	6	2
Sandra	72	4	6
Ahmed	86	6	6
Yin	68	3	4



STEP 4: Analyze and interpret

CEAB reporting requirement

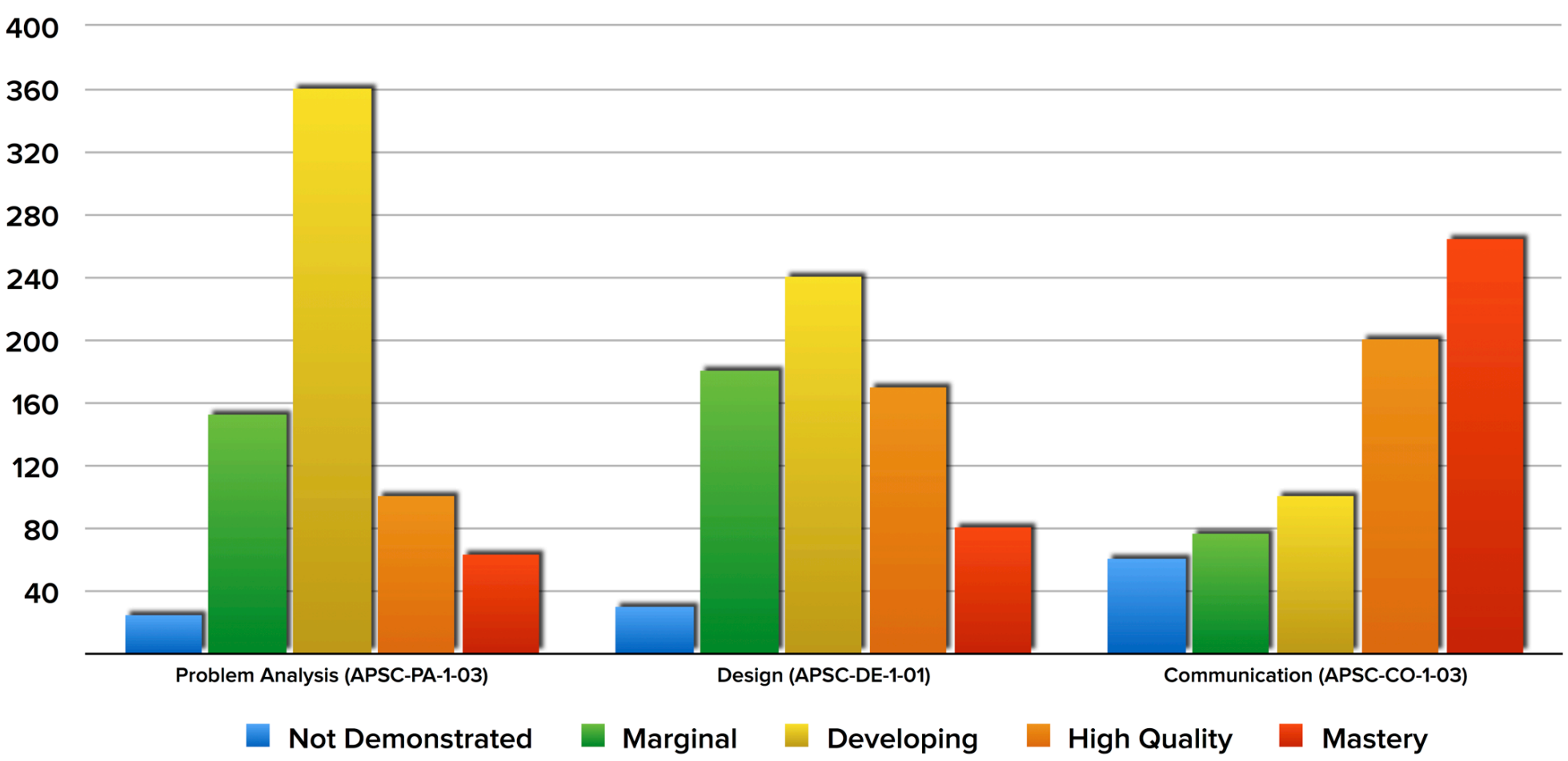
Table 3.1.4:	Examples of Assessment Results		
Graduate Attribute	Indicator	Results (add more columns as required)	
Knowledge base	*Recalls and describes fundamental concepts in chemistry*		
Problem analysis	*Creates process for solving problem including approximations and assumptions*		

Approaches to Analyzing data

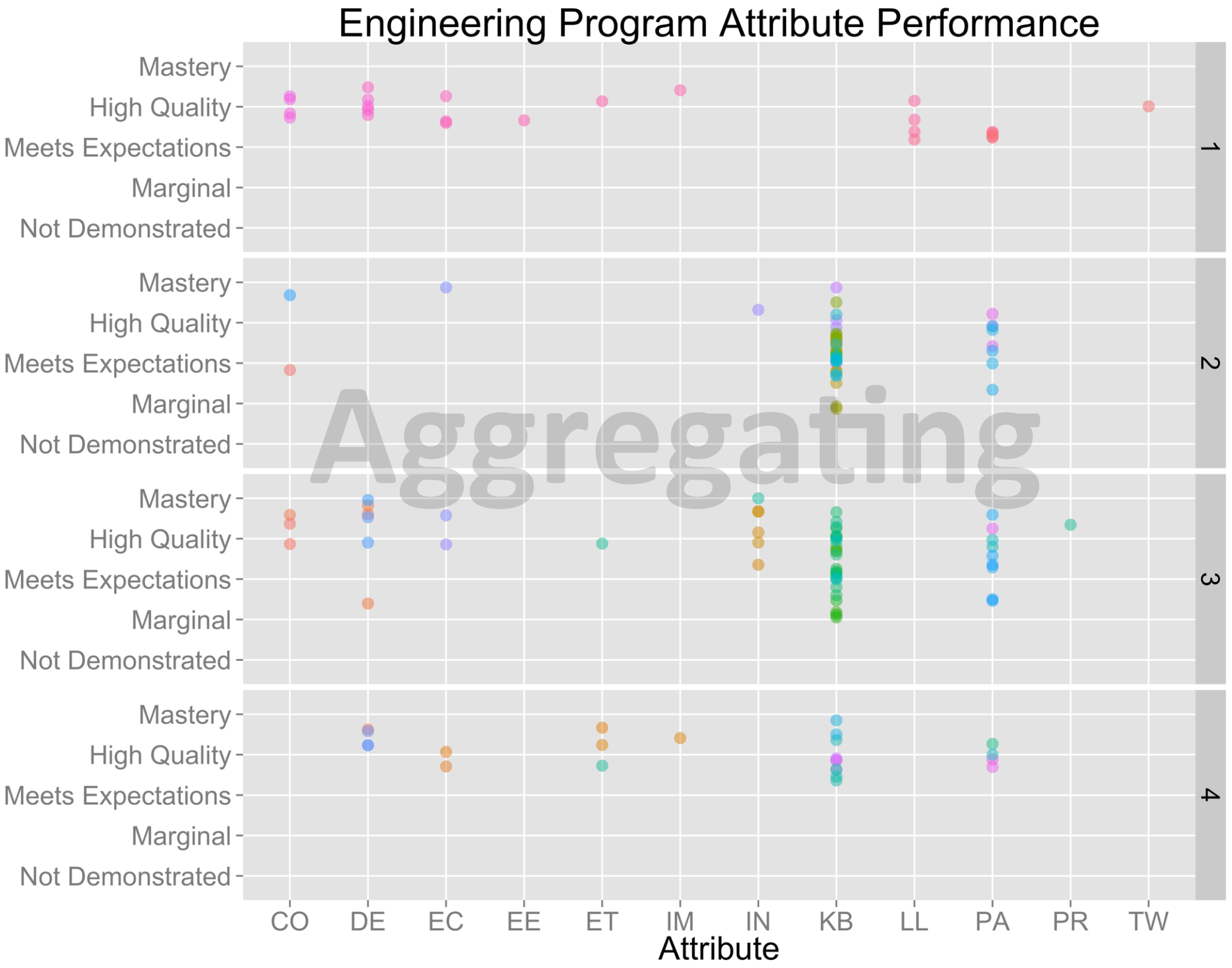
- Look at data by indicator/attribute
- Aggregate indicators and plot
- Cross sectional comparison (e.g. 1st vs 4th year)
- Longitudinal
- Compare between institutions
- Compare special programs within institutions

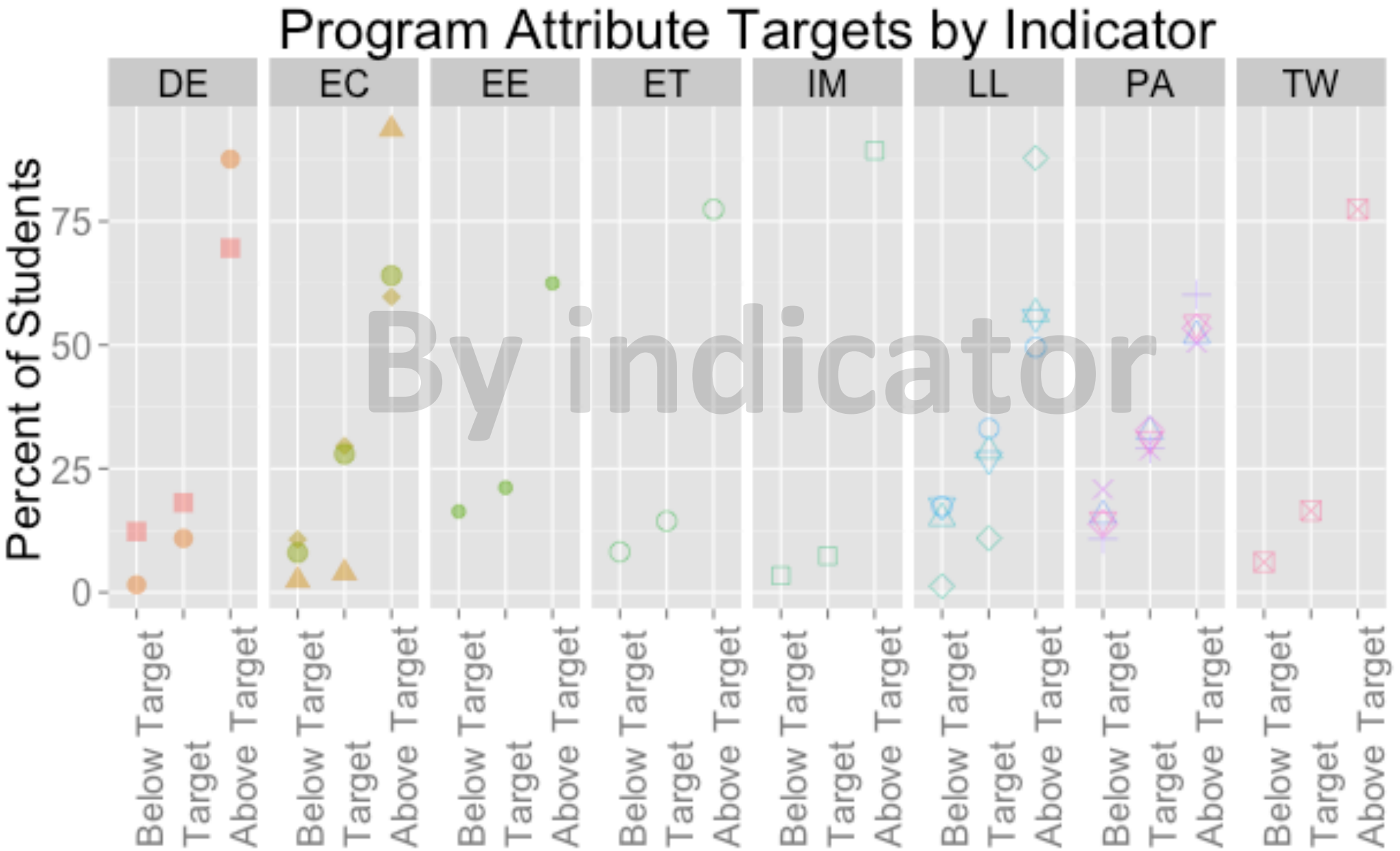
Continuous Improvement Case Study

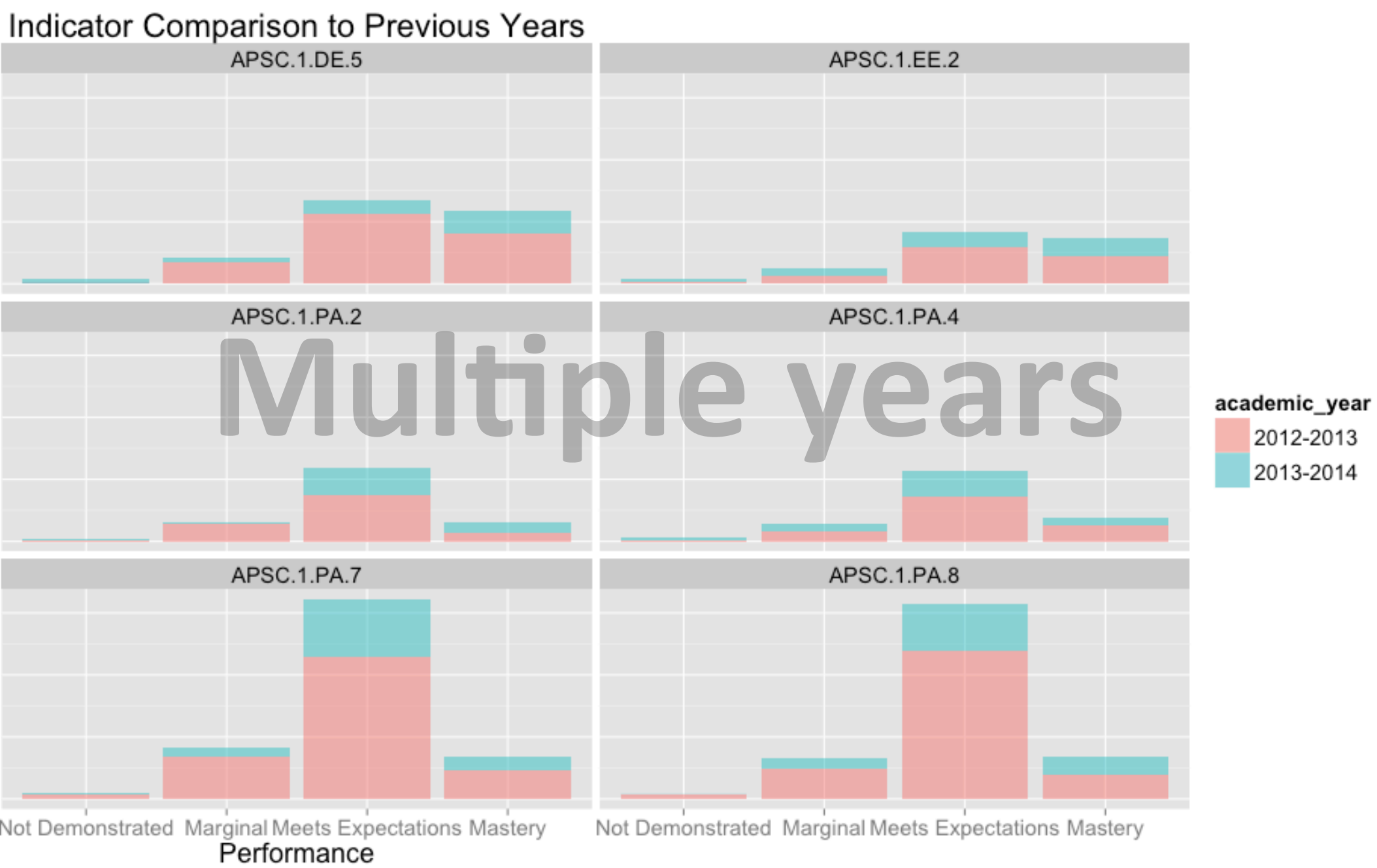
November 11, 2014 ***(Session 4 activity)***



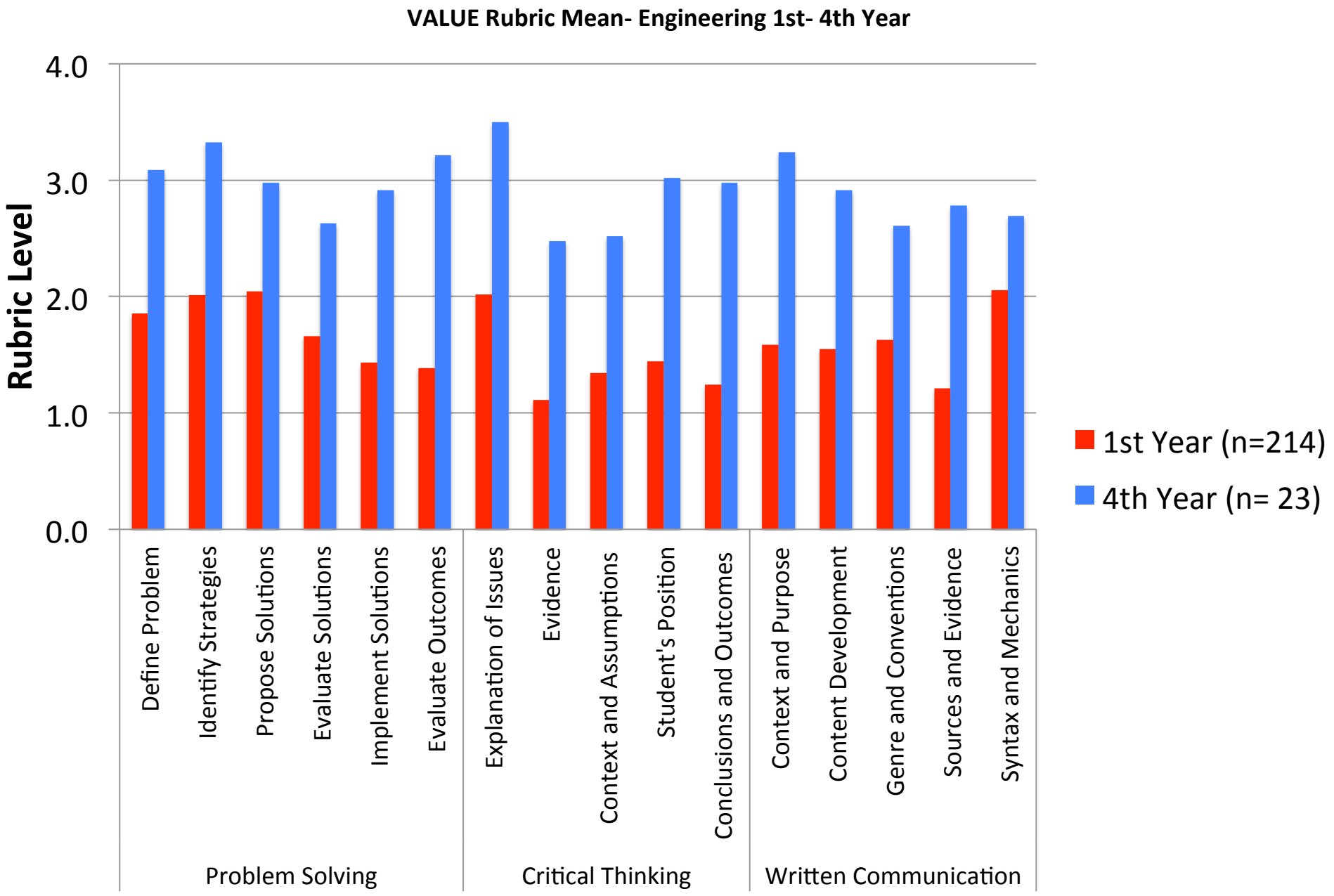
	Not Demonstrated (0-3)	Marginal (4)	Developing (5)	High Quality (6)	Mastery (7-8)
Problem Analysis (APSC-PA-1-03)	Unsupported or trivial arguments	Arguments weak overall	Arguments include some but not all critical elements	Makes claims supported by data and backing, with appropriate qualifiers	**Meets expectations and:** Claims supported…
Design (APSC-DE-1-01)	No or inadequate process described	Process identified, misses critical factors.	Process is clear but missing some elements	Creates justified process for solving problem..	**Meets expectations and:** Comprehensive process…
Communication (APSC-CO-1-03)	Report difficult to understand	Understandable but not formatted…	Clearly formatted following guidelines …	Concise and clearly formatted….	**Meets expectations and:**Varied transitions…


Engineering Program Attribute Performance
Mastery
High Quality
Meets Expectations
Marginal
Not Demonstrated
1
2
3
4
Aggregating
CO
DE
EC
EE
ET
IM
IN
KB
LL
PA
PR
TW
Attribute

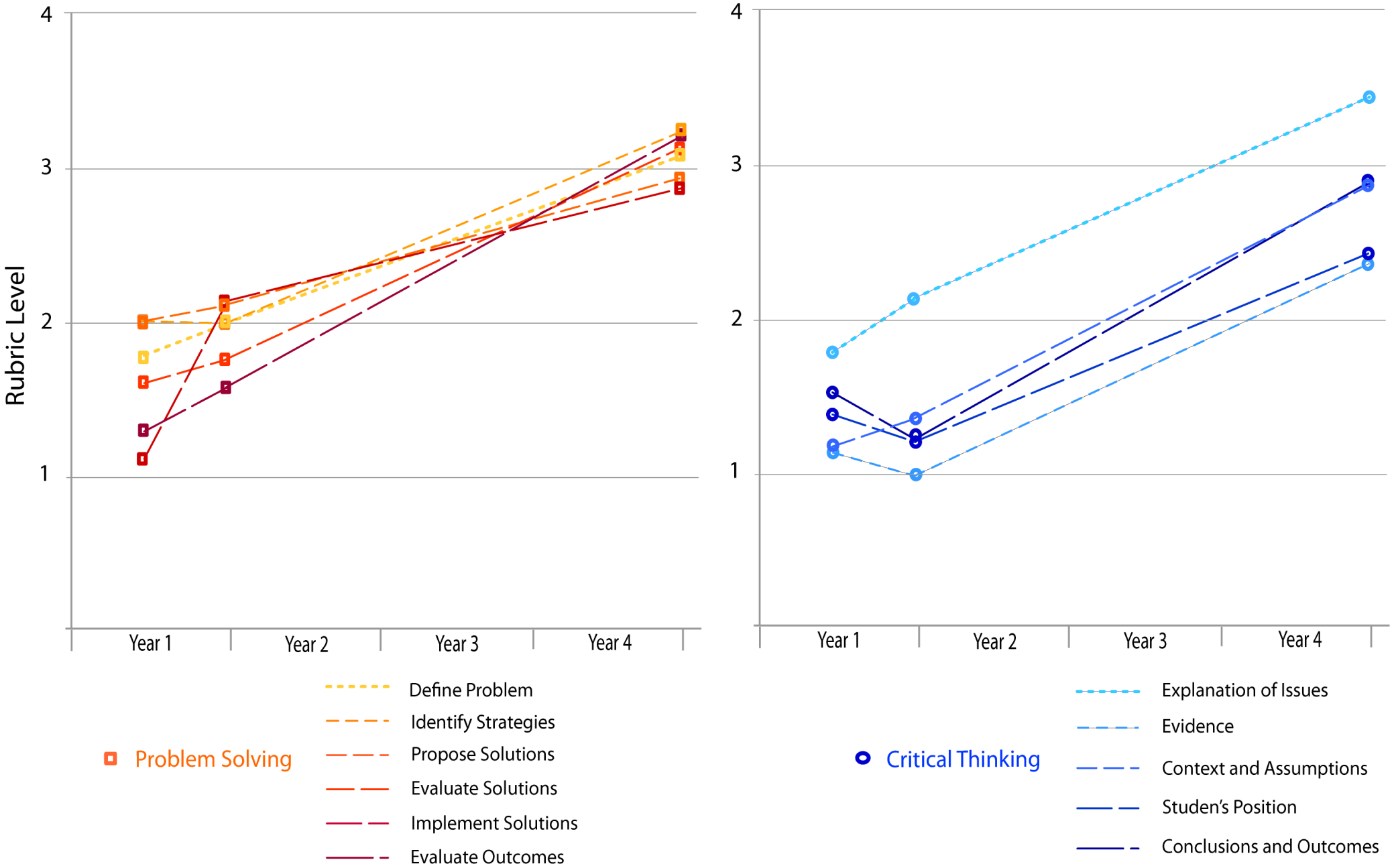

Program Attribute Targets by Indicator
DE
EC
EE
ET
IM
LL
PA
TW
Percent of Students
0
25
50
75
Below Target
Target
Above Target
By indicator


Indicator Comparison to Previous Years
APSC.1.DE.5
APSC.1.EE.2
APSC.1.PA.2
APSC.1.PA.4
APSC.1.PA.7
APSC.1.PA.8
Multiple years
academic_year
2012-2013
2013-2014
Not Demonstrated
Marginal
Meets Expectations
Mastery
Performance

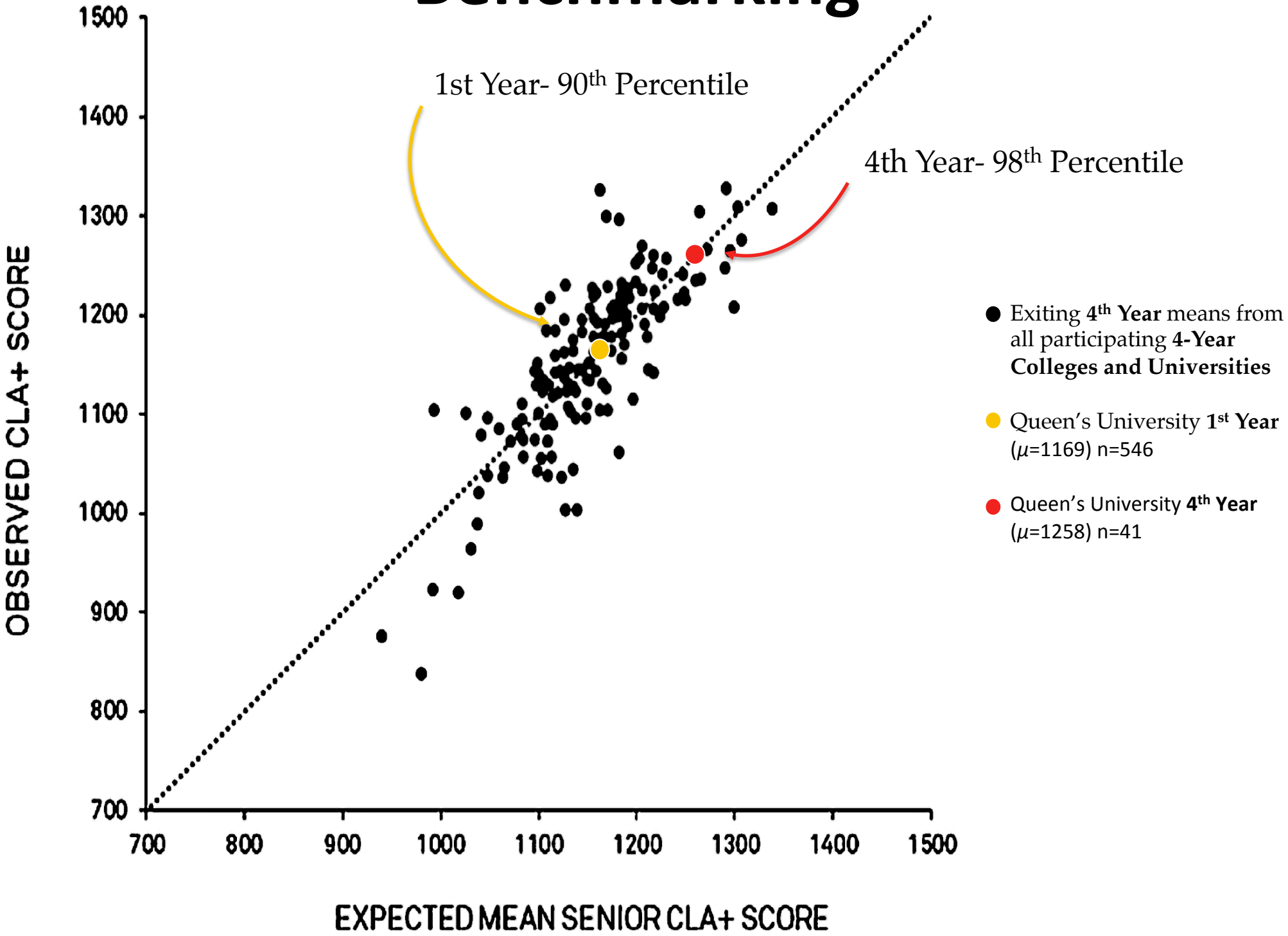
Program-wide rubrics

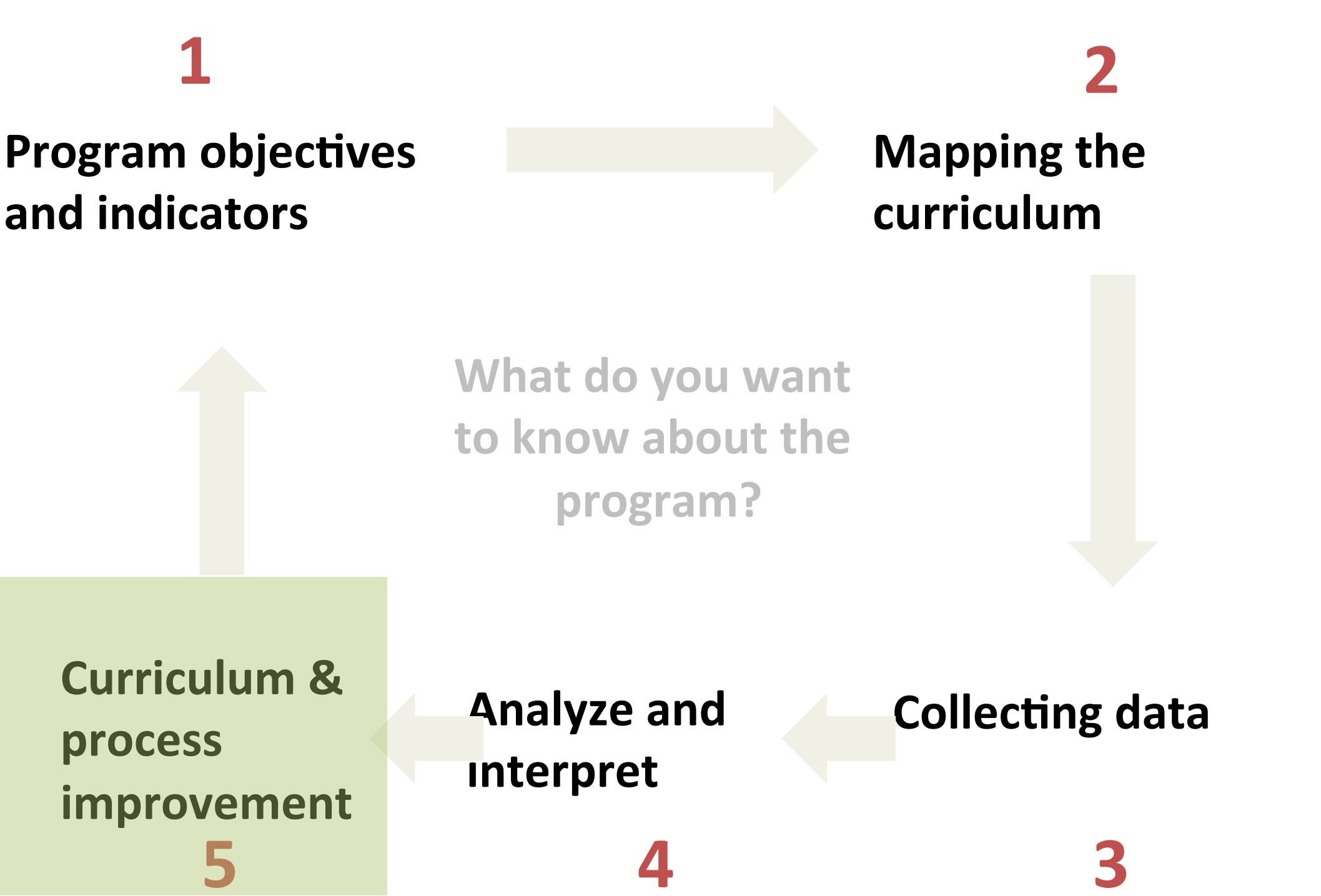


Student development



Benchmarking





STEP 5: Curriculum and process improvement

Program decisions and changes

- CEAB is looking for linkage between the outcomes assessment process and official curriculum oversight (curriculum committee, etc.)
- Critical to have decision making group involved in the outcomes assessment process

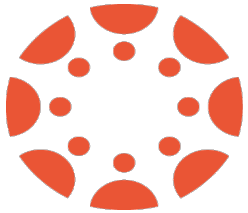
Curriculum changes informed by data

Queen's: In 2011, our data led us to make some changes:

- Need to communicate the process better to students; describe learning objectives in courses.
- **First year**: focus on improving how to make effective arguments, evaluating complex problem solutions against objectives, written communications, and evaluating information
- **Second year:** emphasis on summarizing important information clearly and concisely, effectively participating in informal small group discussions, and on risk assessment and project planning

Software tools to support outcomes assessment

Previous tools review:



		eLumen	Canvas	Moodle	Waypoint Outcomes	Desire2Learn	LiveText
1. LMS, L/CMS or CPI		CPI	LMS	L/CMS	CPI	L/CMS	CPI
2. Integration		Custom	LTI & API	LTI & API	LTI & API	LTI & API	LTI & API
3. Rubric-based assessment							
3a.	Rubric Generation	★★	★★★	★	★★★	★★	★★
3b.	Customizable	★★	★★★	★	★★★	★★	★★
3c	Rubric Repository	★★★	★★★	★	★★★	★★	★★★
4. Learning Outcomes							
4a.	Multi-level capability	★★★	★★	★	★★	★★	★★★
4b.	Multi-level mapping	★★★	★	★	★★	★★	★★
4c.	Multi-instance mapping	★★★	★★★	★★	★★★	★★★	★★★
4d.	Outcomes Repository	★★★	★★★	★★	★★	★★	★★
5. Assessment							
5a.	Direct & Indirect Evidence	★★	★★★	★★	★★★	★★★	★★
5b.	Multiple assessors	★★	★★★	★★	★★★	★★★	★★★
5c.	In-line grading	★	★★★	★	★★★	★★	★★★
5d.	In-line feedback	★	★★★	★	★★★	★★	★★★
6. Analytics							
6a.	Multi-level reporting	★★★	★★	★	★★	★★	★★★
6b.	Tabular reporting	★★★	★	★	★	★★	★★
6c.	Graphical reporting	★	★	★	★	★	★
6d.	On-demand reporting	★★★	★★	★	★★	★★	★★★
6e.	Longitudinal reporting	★★★	★	★	★★	★★	★★★
6f.	Custom group reporting	★★★	★	★	★	★	★
7. Pricing							
7a.	Hosting Model	Self or SaaS	SaaS	Self	SaaS	Self or SaaS	SaaS
7b.	Subscription	Yearly License	Open-source	Open-source	Yearly License	Yearly License	Yearly License
7c.	Cost	FTE Scaled	FTE Scaled ($28)	Free	FTE Scaled ($12-20)	FTE Scaled	$80-98

Engineering Graduate Attribute Development (EGAD) Project

		Chalk & Wire	CoursePeer	Entrada	Atlas Curriculum Mapping	iSeek Supercruncher
1. Classification		AP	LMS/AP	L/CMS	CMT	AS
2. Integration		LTI & API	LTI & API	API	-	API
3. Rubric-based assessment						
3a.	Rubric Generation	★★★	★★★	★	-	-
3b.	Customizable	★★★	★★	★★	-	-
3c	Rubric Repository	★★★	★★★	★★	-	★★
4. Learning Outcomes						
4a.	Multi-level capability	★★★	★★★	★★★	★★★	★★★
4b.	Multi-level mapping	★★★	★★★	★★★	★★★	★★★
4c.	Multi-instance mapping	★★★	★★★	★★★	★★★	★★★
4d.	Outcomes Repository	★★★	★★	★★★	★★★	★★
5. Assessment						
5a.	Direct & Indirect Evidence	★★★	★★★	★★	-	-
5b.	Multiple assessors	★★★	★★★	★★	-	-
5c.	In-line grading	★★★	★★	★	-	-
5d.	In-line feedback	★★★	★★	★	-	-
6. Analytics						
6a.	Multi-level reporting	★★★	★★★	★	★★	★★★
6b.	Tabular reporting	★★★	★★	★	★★	★★
6c.	Graphical reporting	★★★	★★	★	★★	★
6d.	On-demand reporting	★★★	★★★	★	★★	★★★
6e.	Longitudinal reporting	★★★	★★★	★	★★	★★★
6f.	Custom group reporting	★★★	★★	★	★	★★★
7. Pricing						
7a.	Hosting Model	SaaS	SaaS	Self	SaaS	SaaS
7b.	Subscription	Yearly License	Yearly License	Open-source	Yearly License	Yearly License
7c.	Cost	FTE Scaled	FTE Scaled	Free	FTE Scaled	FTE Scaled
8. EGAD 5-Step Alignment		★★★★★	★★★★★	★★★	★★★	★★★★

This year at the Canadian Engineering Education Association conference:

Other activity in Canada

- **UBC**: Indirect qualitative assessment of GA's using student surveys as well.
- **UBC**: assessing outcomes using design dossiers
- **Memorial**: Using a formative approach to assessing GA's throughout course experiences using course-based outcomes & assessments. Also using ePortfolios for assessment and to facilitate student reflection.
- **Toronto**: using communications portfolios for assessment of LLL, Communication & professionalism
- **Calgary**: using exit and alumni surveys for indirect assessment
- **Ryerson**: assessing LLL using work of students in national design competitions

End of the Big Picture