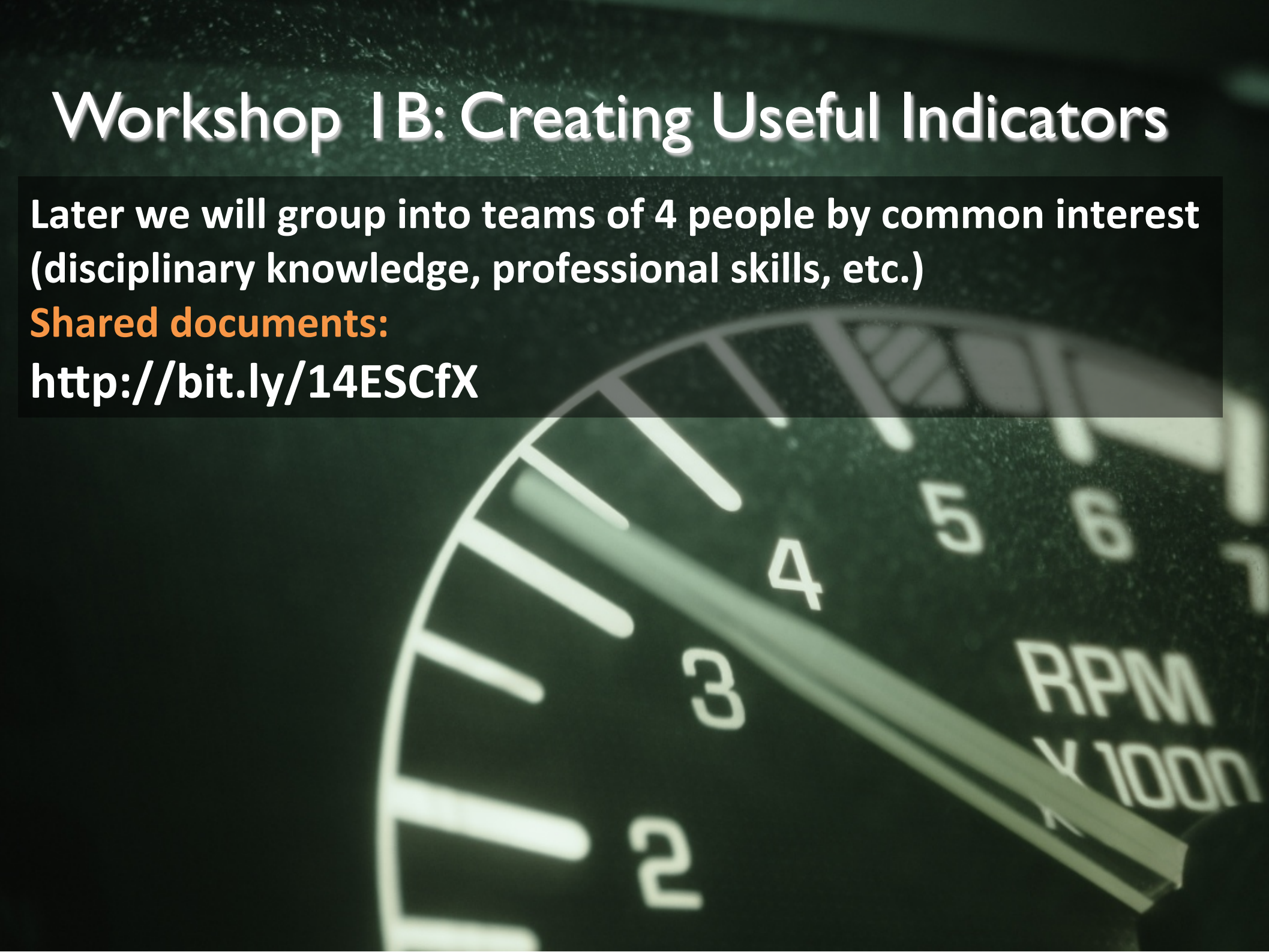
Workshop 1B: Creating Useful Indicators

Later we will group into teams of 4 people by common interest (disciplinary knowledge, professional skills, etc.)

Shared documents:

http://bit.ly/14ESCfX



Engineering Graduate Attribute Development (EGAD) Project

WHO

Engineering educators and educational developers across Canada

MANDATE

Collect and develop resources and training

Run annual national workshops, and customized institutional workshops

EGAD Members: west to east

Peter Ostafichuk (UBC)
Nairman Sepehri (UManitoba)
Peter Wolf (UGuelph)
Susan McCahan (UToronto)
Brian Frank (Queen's)
Jake Kaupp (program manager)
Ali Akgunduz (Concordia)
Anastassis Kozanitis (École Poly.)
Sylvie Dore (ETS)
Chris Watts (Dalhousie)

NAVIGATION

- Home
- Accreditation Related Resources
- Continuous Program Improvement Resources
- EGAD Library

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.

What is an outcome assessment process (as required by CEAB)

A **regular, integrated** process by your program to **gather data** about student abilities to **improve learning**.

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

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

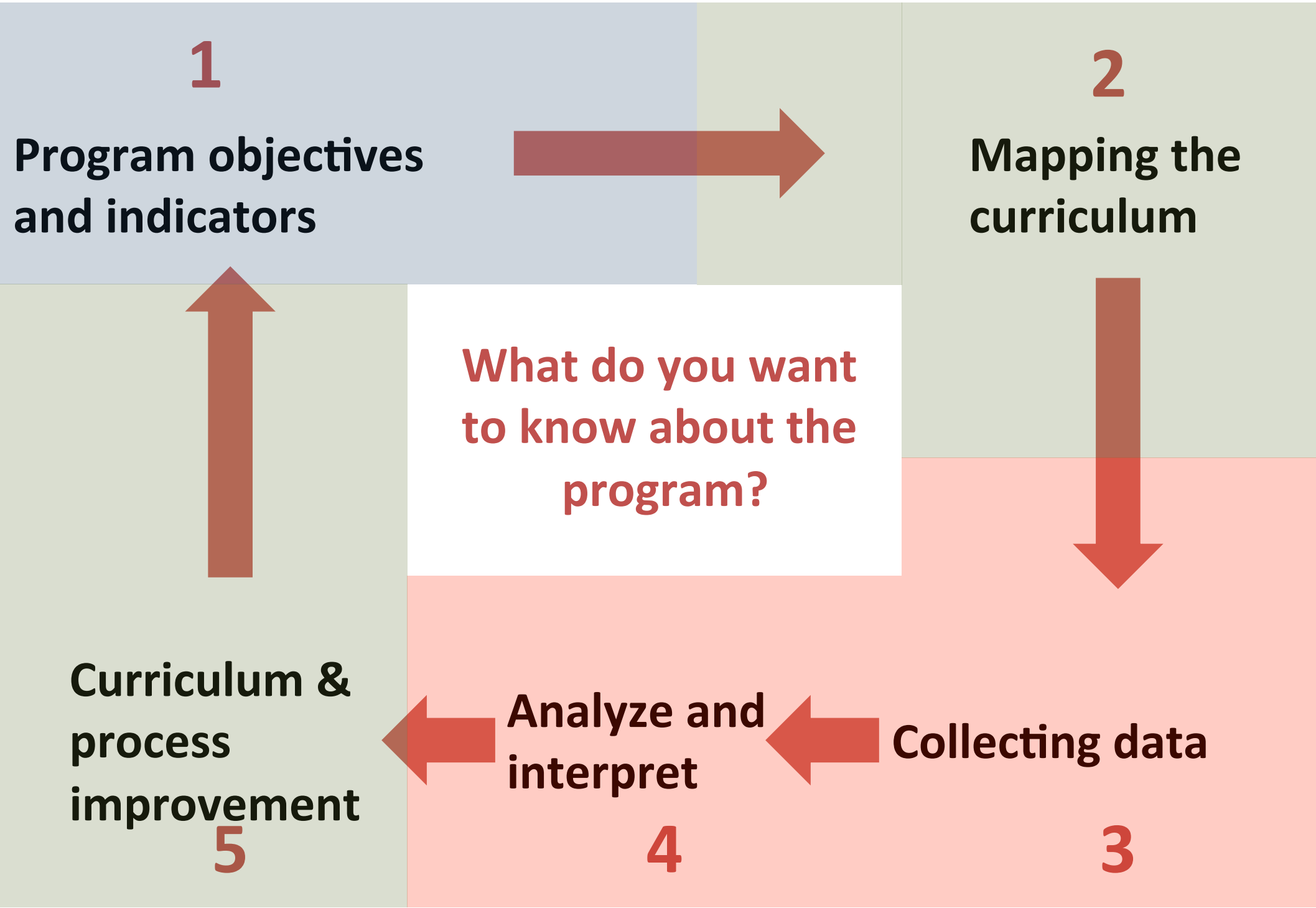
b) A **mapping** of where attributes are developed and assessed within the program

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

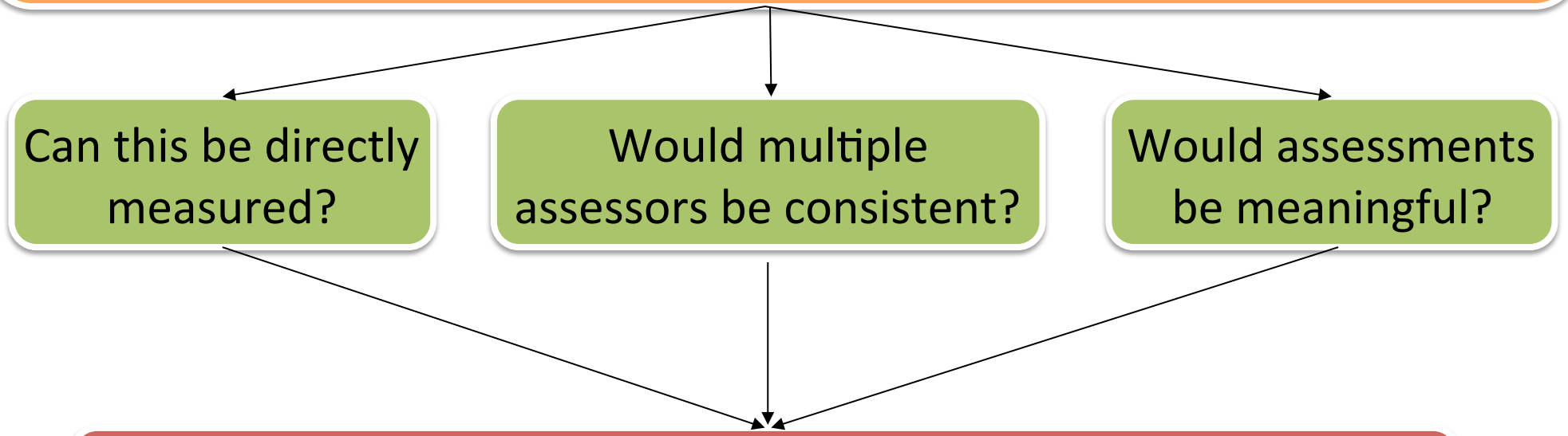
Example process



What are “indicators”?

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

Activity A: Identify goals

- Introduce yourselves
- Share what your institution has done so far on outcomes (graduate attribute) assessment
- What are your goals for this workshop? What would like you learn from facilitators or peers?

Possible directions (sections)

- Coming up with ideas for indicators
- Indicators and the program
- Creating useful indicators
- Taxonomies
- Planning for assessment of indicators

COMING UP WITH IDEAS FOR INDICATORS

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?

Longitudinal development over 4 years?

STEP 0: WHAT DO YOU WANT TO KNOW? (want information, not lots of data!)

1

Program objectives and indicators

Key program objectives

What are your program's goals & objectives?

New certificate/ twinning programs

Enhance recruitment

Improve collaboration with industry

Objectives in strategic plan?

STEP 1: Objectives and indicators

CREATING 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

Activity B: evaluate these indicators.
E.g. Could you assess them? Would multiple graders generally expect the same thing? Could you use data arising from measuring them?

"The student understands Newton's laws."

"The student reads scholarly articles in the field."

"The student defines constraints of design problems presented by a client."

FOLLOW-UP

WHAT ARE CHARACTERISTICS OF GOOD INDICATORS?

Indicators should be measureable and meaningful

Indicators should have: content, context, and verb

Indicators should be useful to YOU to help students.

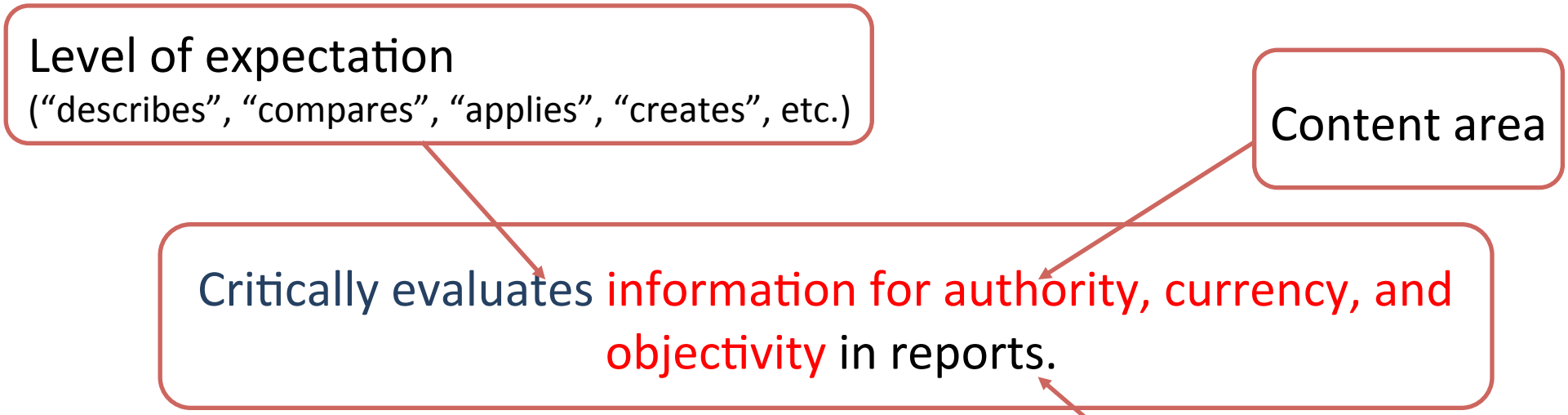
Apply a design process to **solve an open-ended complex problem with guidance by a mentor.**

1.Verb

2. Content

3. Context

Establishing Indicators

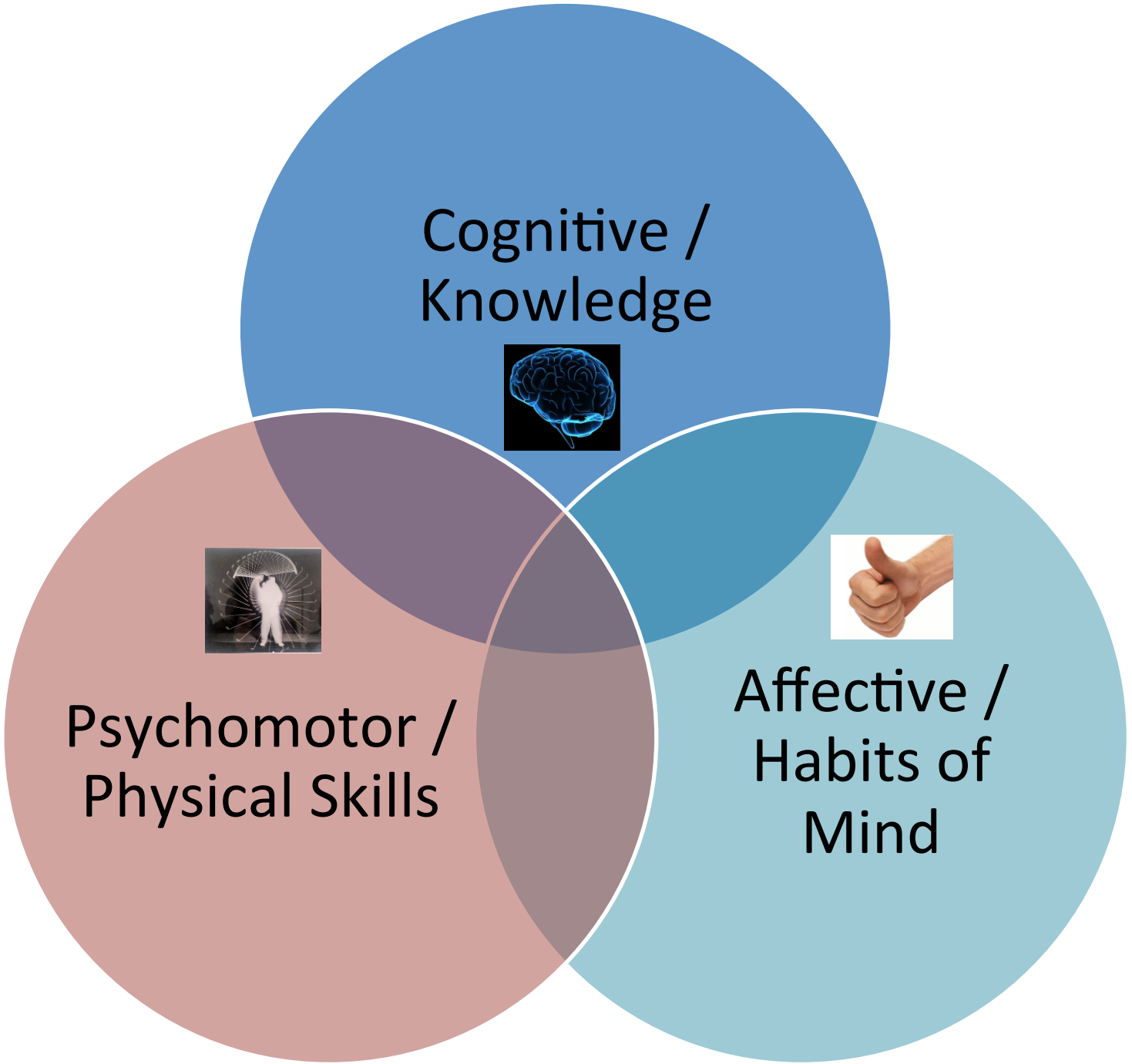


- A well-written indicator includes:
- what students will **do**
- the level of complexity at which they will do it
- the conditions under which the learning will be demonstrated

USING TAXONOMIES TO CREATE INDICATORS

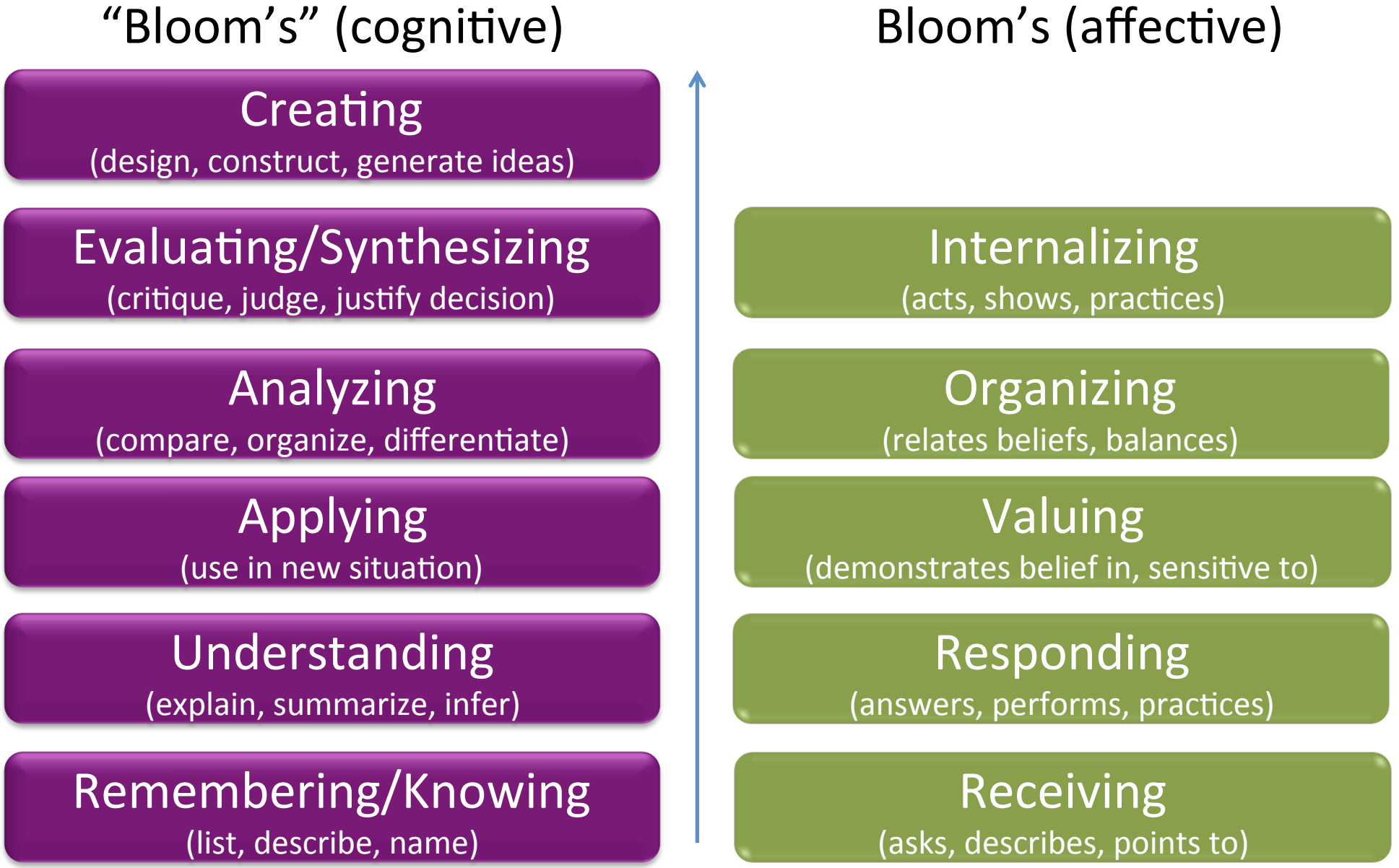
Developing indicators using taxonomies

- 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)



(Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objectives: the classification of educational goals; Handbook I: Cognitive Domain New York, Longmans, Green, 1956.)

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

http://assessment.uconn.edu/docs/LearningTaxonomy_Psychomotor.pdf

Outcomes at Blooms' Levels (Romkey, McCahan):

Knowing: Define the concepts of engineering stress and engineering strain.
Understanding: Explain Hooke's Law in your own words and describe the conditions under which it is applicable.
Applying: Utilize Poisson's Ratio to calculate lateral strain given a longitudinal loading situation.
Analysing: Discuss the specific characteristics of the microstructure that render the stress-strain behaviour of a polymeric material as brittle, plastic, or elastic.
Synthesizing: Investigate recyclability/disposability issues relative to (a) metals, (b) glass, (c) polymers, and (d) composites.
Creating: Argue the economic viability of the "green design" philosophy of product design.

Indicators: verbs, content and context

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

Open to many interpretations…	Open to fewer interpretations…
To KNOW	To WRITE
To UNDERSTAND	To RECITE
To ENJOY	To IDENTIFY
To APPRECIATE	To DIFFERENTIATE
To GRASP THE SIGNIFICANCE OF	To SOLVE
To COMPREHEND	To CONSTRUCT
To BELIEVE	To LIST
	To COMPARE
	To DEMONSTRATE

OCAV UDLEs

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

Indicators can be developed that assess these specifically, preventing you from having to assess separately for quality assurance

Activity C: Develop and share

Phase 1: (5 minutes). At your table:

- Pick an attribute
- Develop (or adapt/select) 2-3 indicators you could assess (5 minutes)

Then **exchange your indicators with another table**.

Phase 2: (5 minutes). Think about how you would use the other table's indicators

- Interpret their indicator
- Determine how you would assess it

Then **exchange thoughts with the other table.**

FOLLOW-UP: DISCUSSION?

Activity D: Development (30 minutes)

Each table should pick an attribute to either:

- Develop indicators specific to the discipline (e.g. for attributes like knowledge, engineering tools, investigation), **OR**
- Develop indicators applicable to multiple disciplines (e.g communications, professionalism, teamwork, etc.)

http://bit.ly/Wkh0id

12 Attributes are: Knowledge base for engineering, Problem analysis, Investigation, Design, Use of engineering tools, Individual and team work, Communication skills, Professionalism, Impact on society and environment, Ethics and equity, Economics and project management, Lifelong learning

Group working time

Resources: **http://bit.ly/14ESCfX**

- EC2000 (USA)
- CDIO
- HEQCO Physical Sciences Tuning Draft
- OCAV UDLEs

Group working time (1 hr)

At each table:

In the context of either your discipline or engineering in general:

- Create/select/adapt some indicators that are measurable, important, and can be assessed *that you think are useful to learn how you can improve your program*
- Sources: existing course learning outcomes, UDLEs, sample materials, your own ideas
- **Handout: verb list and taxonomy**

APPROACHES TO ASSESSING INDICATORS

Development and Assessment of indicators

Curricular

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							

Extra/co-curricular

Internships/co-ops
Portfolios
Design teams
Community involvement
Work experience

Approaches to direct assessment of indicators across program

①Course-specific criterion-referenced scoring using course deliverables

②Stand-alone standardized instruments

③General criterion-referenced scoring using course deliverables

Approaches to direct assessment of indicators across program

①Course specific criterion-referenced scoring using course deliverables

- *Provide clear guidance to students*
- *Useful for course improvement*
- *Limited ability to assess development over multiple years*

②Stand-alone standardized instruments

③General criterion-referenced scoring using course deliverables

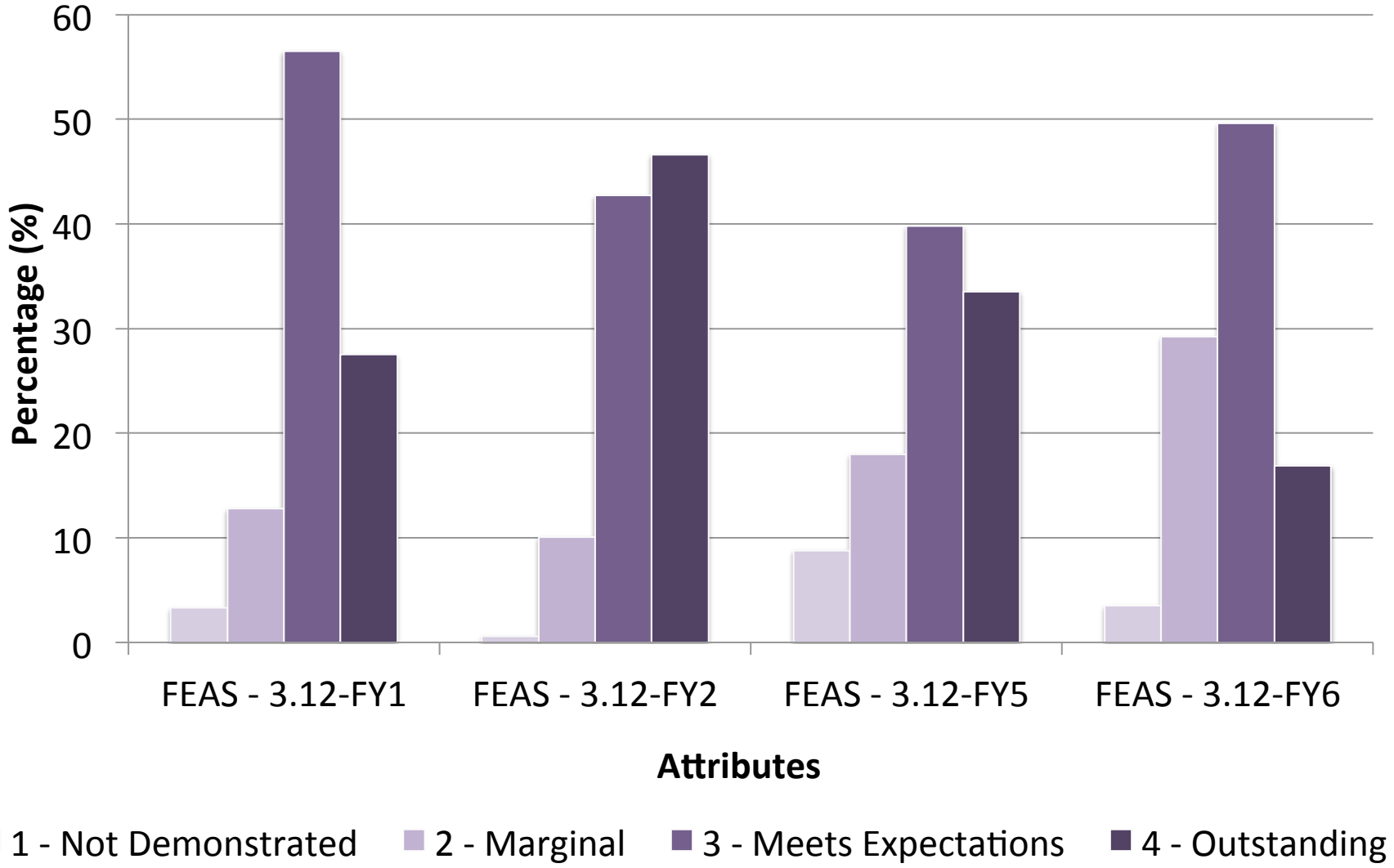
Example: indicators for each year

	Theme	First year	Second year	Third year	Graduating year
Communications	**Process**		Describes typical expectations engineers to communicate effectively.	Generates a traceable and defensible record of a technical project using an appropriate project records system.	Writes and revises documents using appropriate discipline-specific conventions
	Written	Summarizes and paraphrases written work accurately with appropriate citations	Composes documents in styles including progress reports, professional career (cover letters, CV, RFP), design reports	Demonstrates conciseness, precision, and clarity of language in technical writing.	Write concise, coherent and grammatically correct materials that reflect critical analysis and synthesis, appropriate to audience needs.
	Oral	Delivers clear and organized formal presentation following established guidelines	Delivers effective formal oral presentations including appropriate facial gestures, natural body posture and movement	Demonstrates formal oral presentations with appropriate language, style, timing and flow.	Demonstrates confidence in formal and informal oral communications
	Graphical	Creates effective figures, tables, and drawings employing standard conventions to compliment text.		Creates accurate and complete technical graphics.	Uses graphics to explain, interpret, and assess information

E.g. Course specific outcomes assessed using course deliverables

	7-8 outstanding	*5-6 expectation*	*3-4 marginal*	*0-2 below*	*GRADE*
Info. summary	…	Summarizes and assesses credibility...	…	…	/8
Self-reflection	…	Analysis identifies limitations...	…	…	/8
Arguments	…	Claims supported by data…	…	…	/8
Written comm.	…	Clearly formatted with…	…	…	/8

Performance by outcome within a course



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.

Approaches to direct assessment of indicators across program

①Course specific criterion-referenced scoring using course deliverables

②Stand-alone standardized instruments (CLA, etc.)

- *Measure development over multiple years, institutional comparison. Validity & reliability data.*
- *Can be expensive, measure limited set of skills*
- *Low completion rates, poor motivation particularly fourth year students, so results suspect*

③General criterion-referenced scoring using course deliverables

Approaches to direct assessment of indicators across program

①Course specific criterion-referenced scoring using course deliverables

②Stand-alone standardized instruments

③General criterion-referenced scoring using course deliverables

- *Can assess development over multiple years*
- *No additional student work, so no problem with motivation, completion rates*
- *Encourages alignment between program course outcomes and course delivery*
- *Requires some additional grading time*
- *Limited availability of validated rubrics*

Valid Assessment of Learning in Undergraduate Education (VALUE) Rubrics

- Meta-rubrics that synthesize the common criteria and performance levels gleaned from numerous individual campus rubrics for 14 Essential Learning Outcomes
- Can be used to mimic approach taken by some critical thinking tests that allow programs to provide their own "artifact" that is scored against a common set of criteria

CRITICAL THINKING VALUE RUBRIC

for more information, please contact value@aacu.org

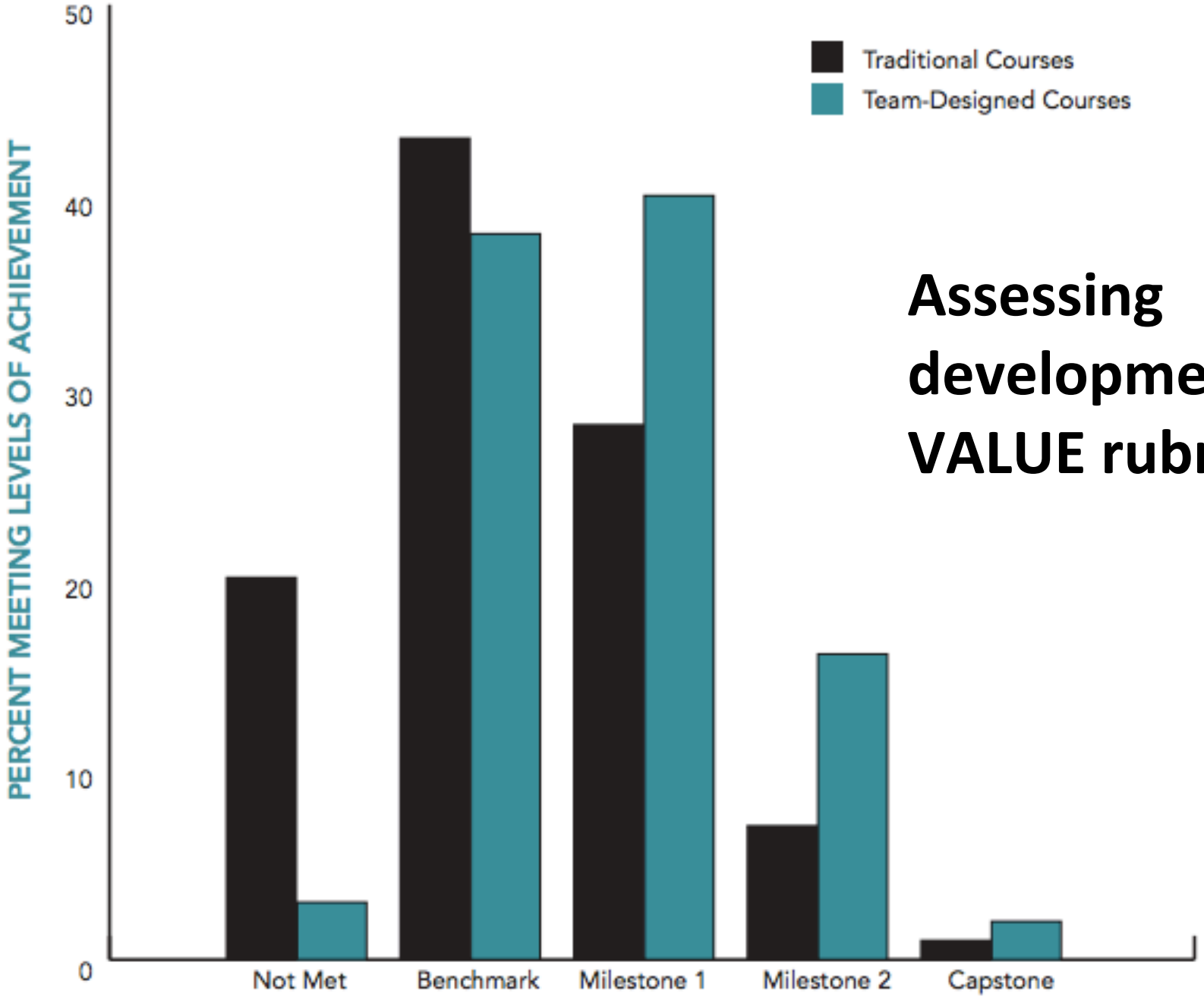
Definition

Critical thinking is a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion.

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone	**Milestones**		**Benchmark**
	4	3	2	1
Explanation of issues	Issue/problem to be considered critically is stated clearly and described comprehensively,…	Issue/problem to be considered critically is stated, described, and clarified so that understanding…	Issue/problem to be considered critically is stated but description leaves some terms undefined,…	Issue/problem to be considered critically is stated without clarification or description.
Evidence	…	…	…	…
Influence of context and assumptions	…	…	…	…
Student's position (perspective, thesis/hypothesis)				
Conclusions and related outcomes				

Rhodes, Terrel, ed. 2010. Assessing Outcomes and Improving Achievement: Tips and Tools for Using Rubrics. Washington, DC: Association of American Colleges and Universities.



Assessing development using VALUE rubrics

FIGURE 2B. CRITICAL THINKING: EVALUATION OF SOURCES AND EVIDENCE

A. Greenhoot, D. Benstein, Using VALUE Rubrics to Evaluate Collaborative Course Design, *Peer Review*, vol. 13 no. 4, AAC&U

Outcomes assessment plan over three years

Outcome	1. Course specific scoring	2. Standard tool (limited cohort)	3. General scoring (VALUE)	4. Think aloud
Critical thinking	If available	CLA or CAT	Critical thinking	Local
Problem solving	If available	CLA or CAT	Problem solving	Local
Written comm.	If available	CLA or CAT	Written comm	
Lifelong learning	If available	LASSI, MLSQ	Info lit/ lifelong learn	SRLIS

INDICATORS AND THE PROGRAM

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

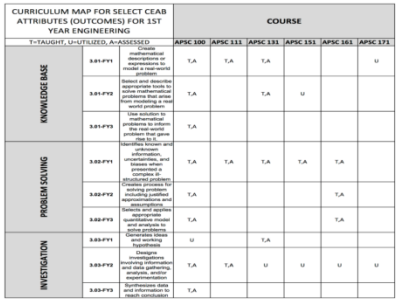
Learning outcomes: descriptors what a learner is expected to know, understand and be able to do by the end of a course

Courses

Set by instructor

Attributes 5-12

Tool: Curriculum Map



CURRICULUM MAP FOR SELECT CEAB ATTRIBUTES (OUTCOMES) FOR 1ST YEAR ENGINEERING			COURSE					
T=TAUGHT, U=UTILIZED, A=ASSESSED			APSC 100	APSC 111	APSC 131	APSC 151	APSC 161	APSC 171
KNOWLEDGE BASE	3.01-FY1	Create mathematical descriptions or expressions to model a real-world problem.	T,A	T,A	T,A			U
	3.01-FY2	Select & describe appropriate tools to solve mathematical problems arising from modeling a real-world problem	T,A		T,A	U		
	3.01-FY3	Use solution to mathematical problems to inform the real-world problem that gave rise to it.	T,A					
PROBLEM SOLVING	3.02-FY1	Identifies known and unknown information, uncertainties, and bias when presented a complex ill-structured problem	T,A	T,A	T,A	T,A	T,A	
	3.02-FY2	Creates process for solving problem including justified approximations and assumptions	T,A				T,A	
	3.02-FY3	Selects and applies appropriate quantitative model and analysis to solve problems	T,A				T,A	
INVESTIGATION	3.03-FY1	Generates ideas and working hypothesis	U		T,A			
	3.03-FY2	Designs investigations involving information and data gathering, analysis, and/or experimentation	T,A	T,A	U	U	U	U
	3.03-FY3	Synthesizes data and information to reach conclusion	T,A					

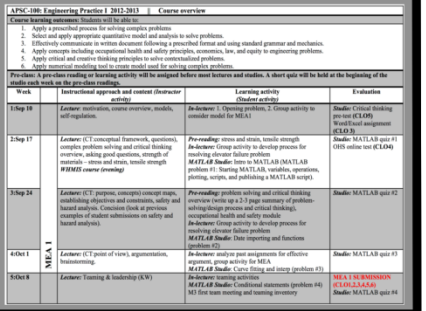
Program

APSC 100 | APSC 111 | APSC 131 | APSC 171 | ...

Course

Course Learning Outcomes ⇔ **Assessment** ⇔ Instructional Approach

Tool: Planning Table



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

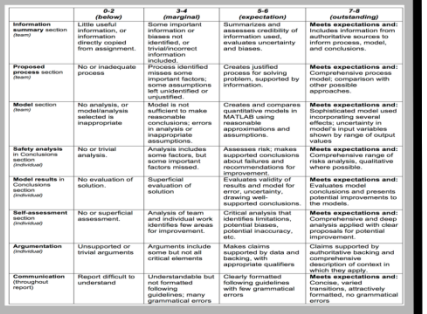
Course learning outcomes: Students will be able to:

1. Apply a prescribed process for solving complex problems
2. Select and apply appropriate quantitative model and analysis to solve problems.
3. Effectively communicate in written document following a prescribed format and using standard grammar and mechanics.
4. Apply concepts including occupational health and safety principles, economics, law, and equity to engineering problems.
5. Apply critical and creative thinking principles to solve contextualized problems.
6. Apply numerical modeling tool to create model used for solving complex problems.

Pre-class: A pre-class reading or learning activity will be assigned before most lectures and studios. A short quiz will be held at the beginning of the studio each week on the pre-class readings.

Week		Instructional approach and content *(Instructor activity)*	Learning activity *(Student activity)*	Evaluation
1/Sep 10		***Lecture:*** motivation, course overview, models, self-regulation.	***In-lecture:*** 1. Opening problem, 2. Group activity to consider model for MEA1	***Studio:*** Critical thinking pre-test **(CLO5)** Word/Excel assignment **(CLO 3)**
2/Sep 17		***Lecture:*** (CT conceptual framework, questions), complex problem solving and critical thinking overview, asking good questions, strength of materials – stress and strain, tensile strength ***WHMIS course (evening)***	***Pre-reading:*** stress and strain, tensile strength ***In-lecture:*** Group activity to develop process for resolving elevator failure problem ***MATLAB Studio:*** Intro to MATLAB (MATLAB problem #1: Starting MATLAB, variables, operations, plotting, scripts, and publishing a MATLAB script).	***Studio:*** MATLAB quiz #1 (HS online test **(CLO4)**
3/Sep 24		***Lecture:*** (CT: purpose, concepts) concept maps, establishing objectives and constraints, safety and hazard analysis. Concision (look at previous examples of student submissions on safety and hazard analysis).	***Pre-reading:*** problem solving and critical thinking overview (write up a 2-3 page summary of problem-solving/design process and critical thinking), occupational health and safety module ***In-lecture:*** Group activity to develop process for resolving elevator failure problem ***MATLAB Studio:*** Date importing and functions (problem #2)	***Studio:*** MATLAB quiz #2
4/Oct 1	MEA 1	***Lecture:*** (CT point of view), argumentation, brainstorming.	***In-lecture:*** analyze past assignments for effective argument, group activity for MEA ***MATLAB Studio:*** Curve fitting and interp (problem #3)	***Studio:*** MATLAB quiz #3
5/Oct 8		***Lecture:*** Teaming & leadership (KW)	***In-lecture:*** teaming activities ***MATLAB Studio:*** Conditional statements (problem #4) M3 first team meeting and teaming inventory	MEA 1 SUBMISSION **(CLO1,2,3,4,5,6)** ***Studio:*** MATLAB quiz #4

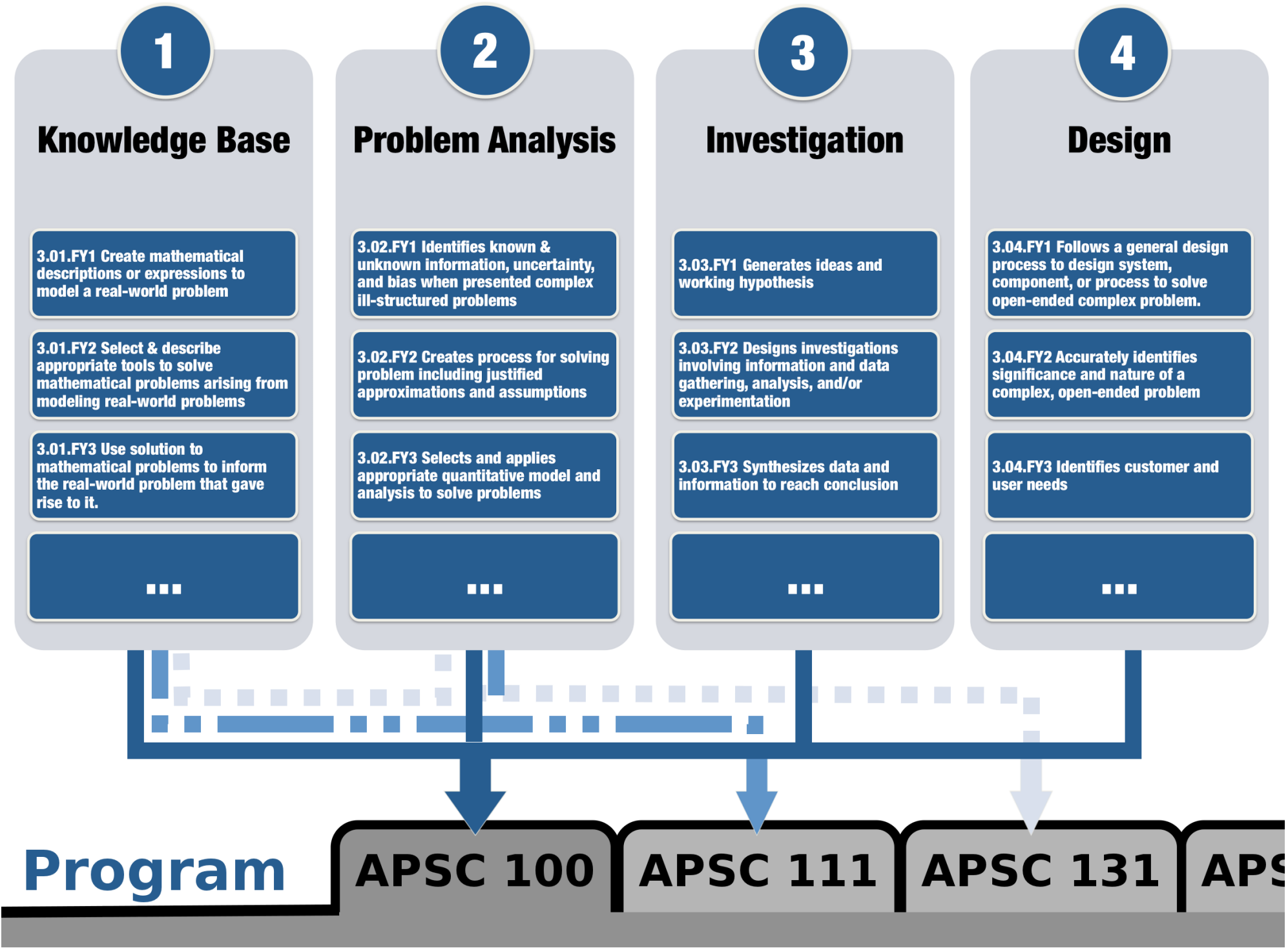
Tool: Rubric

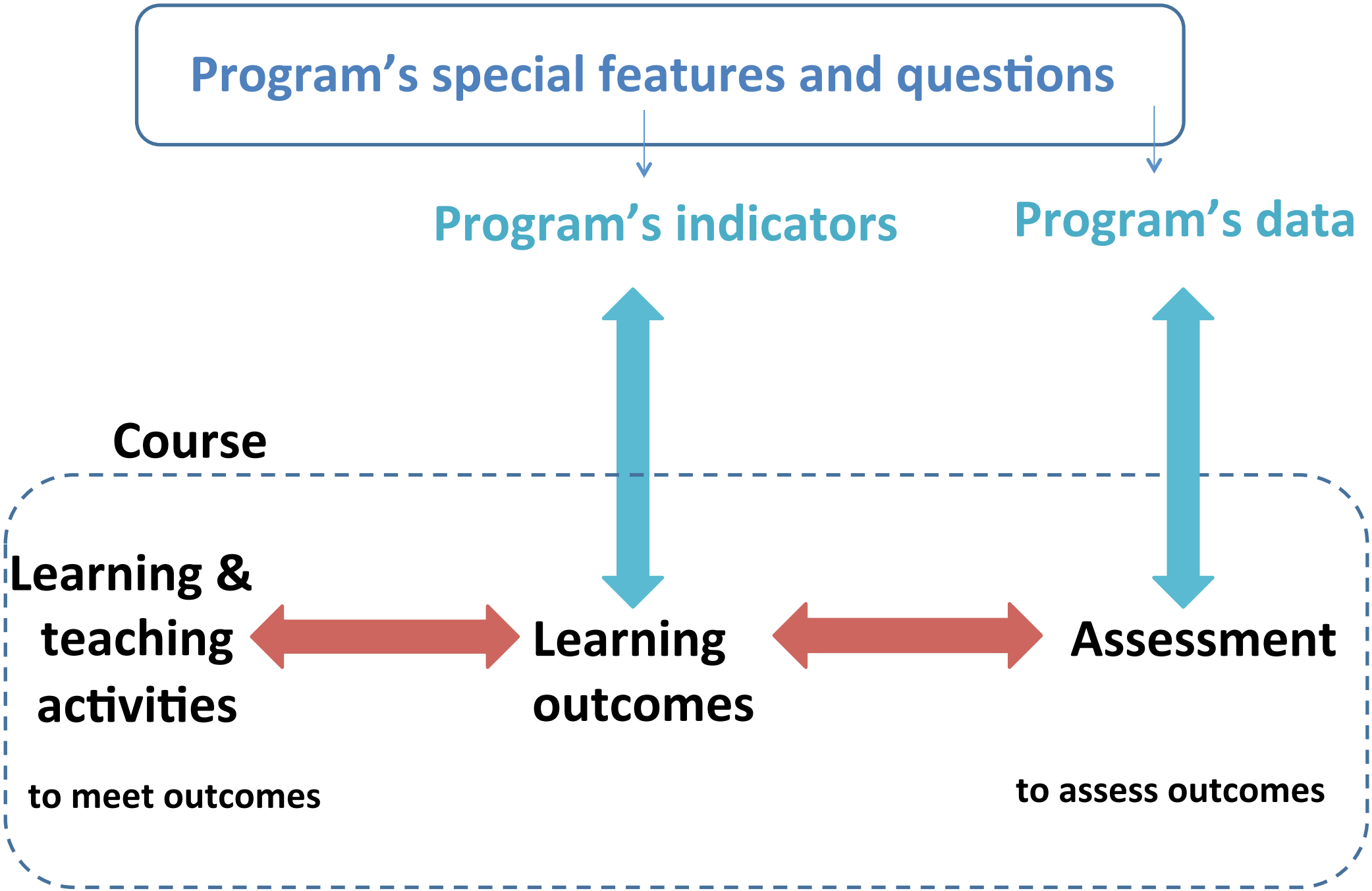


	0–2 *(below)*	3–4 *(marginal)*	5–6 *(expectation)*	7–8 *(outstanding)*
Information summary section *(Team)*	Little useful information, or information directly copied from assignment.	Some important information or biases not identified, or trivial/incorrect information included.	Summarizes and assesses reliability of information used, evaluates uncertainty and biases.	**Meets expectations and:** Insightful synthesis from authoritative sources to inform process, model, and conclusions.
Proposed process section *(Team)*	No or inadequate process	Process identified but missing important factors, some assumptions left unidentified or unjustified.	Creates justified process for solving problem, supported by information.	**Meets expectations and:** Comprehensive process model, comparison with other possible approaches.
Model section *(Team)*	No analysis, or model/analysis selected is inappropriate	Model is not sufficient to make reasonable conclusions; errors and/or inappropriate assumptions.	Creates and compares quantitative models in MATLAB using reasonable approximations and assumptions.	**Meets expectations and:** Sophisticated model used incorporating several effects; uncertainty in model's input variables shown by range of output values
Safety analysis in Conclusions section *(Individual)*	No or trivial analysis.	Analysis includes some factors, but some important factors missed.	Assesses risk; makes supported conclusions about failures and recommendations for improvement.	**Meets expectations and:** Comprehensive range of risks analysis, qualitative where possible.
Model results in Conclusions section *(Individual)*	No evaluation of solution.	Superficial evaluation of solution	Evaluates validity of model, error in model for error, uncertainty, drawing well-supported conclusions.	**Meets expectations and:** Evaluates model comprehensively and presents potential improvements to the models.
Self-assessment section *(Individual)*	No or superficial assessment.	Analysis of team and individual work identifies few areas for improvement.	Critical analysis that identifies limitations, potential biases, potential inaccuracy, etc.	**Meets expectations and:** Comprehensive and deep analysis applied with clear proposals for potential improvement.
Argumentation *(Individual)*	Unsupported or trivial arguments	Arguments include some but not all critical elements	Makes claims supported by data and backing, with appropriate qualifiers	Claims supported by authoritative backing and comprehensive description of context in which they apply.
Communication *(throughout report)*	Report difficult to understand	Understandable but not formatted following guidelines; many grammatical errors	Clearly formatted following guidelines with few grammatical errors	**Meets expectations and:** Flowing transitions, attractively formatted, no grammatical errors

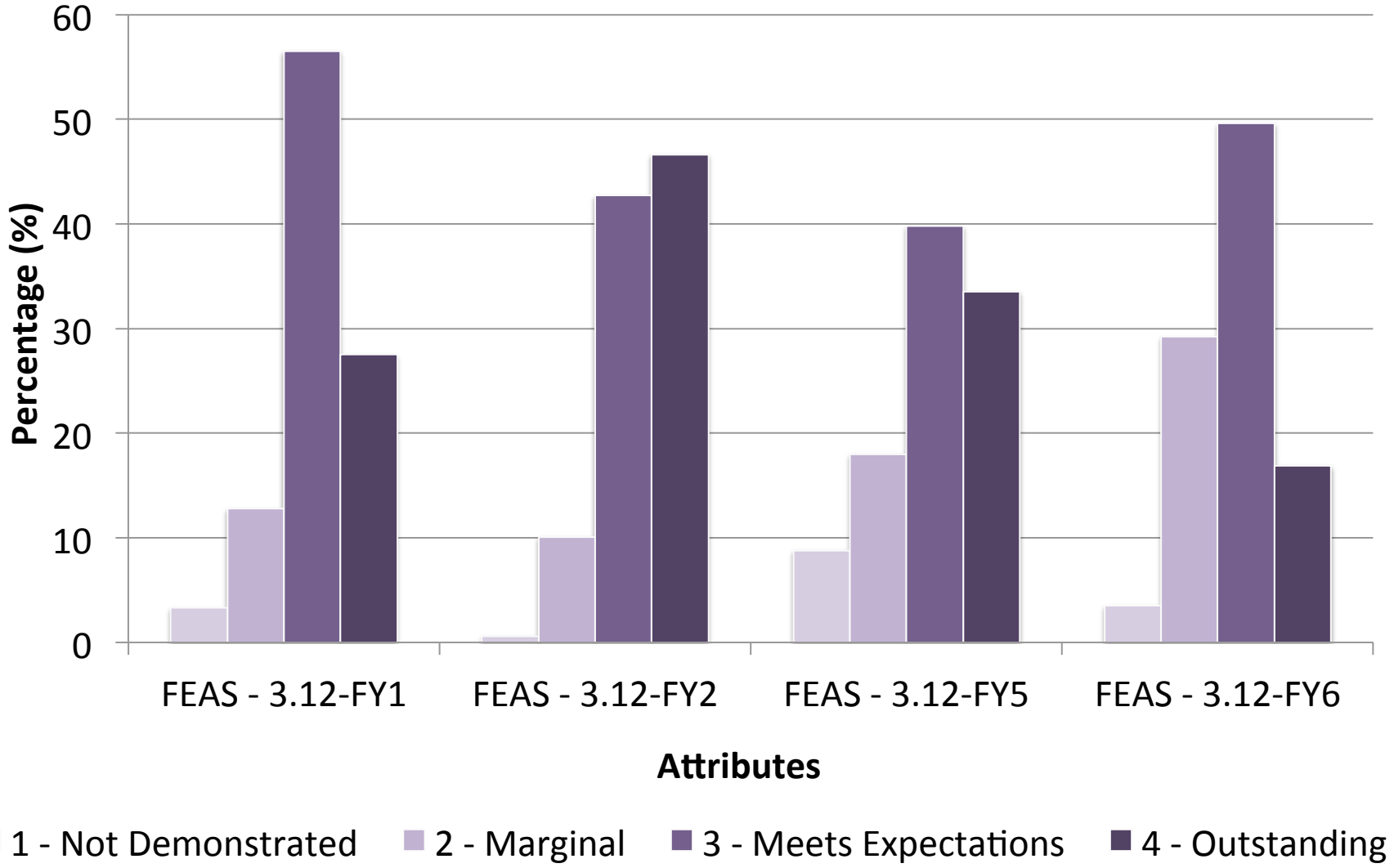
Deliverable

Team Report | Tutorial Quiz | Teaming Evaluation


1
Knowledge Base
3.01.FY1 Create mathematical descriptions or expressions to model a real-world problem
3.01.FY2 Select & describe appropriate tools to solve mathematical problems arising from modeling real-world problems
3.01.FY3 Use solution to mathematical problems to inform the real-world problem that gave rise to it.
...
2
Problem Analysis
3.02.FY1 Identifies known & unknown information, uncertainty, and bias when presented complex ill-structured problems
3.02.FY2 Creates process for solving problem including justified approximations and assumptions
3.02.FY3 Selects and applies appropriate quantitative model and analysis to solve problems
...
3
Investigation
3.03.FY1 Generates ideas and working hypothesis
3.03.FY2 Designs investigations involving information and data gathering, analysis, and/or experimentation
3.03.FY3 Synthesizes data and information to reach conclusion
...
4
Design
3.04.FY1 Follows a general design process to design system, component, or process to solve open-ended complex problem.
3.04.FY2 Accurately identifies significance and nature of a complex, open-ended problem
3.04.FY3 Identifies customer and user needs
...
Program
APSC 100
APSC 111
APSC 131
APS


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

E.g. Histograms for Lifelong learning indicators



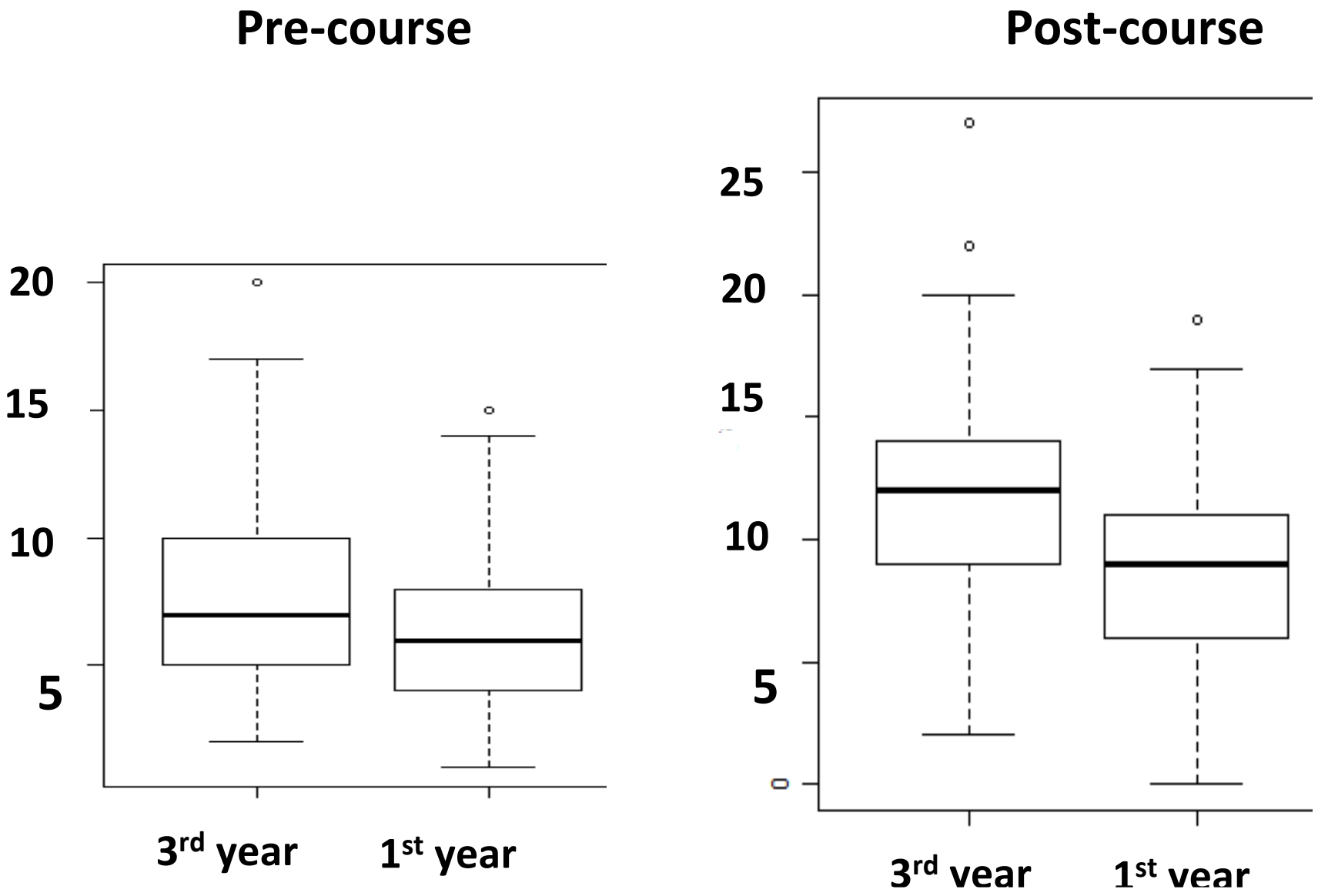
3.12-FY1 Uses information effectively, ethically, and legally to accomplish a specific purpose, including clear attribution of Information sources.

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.

Design process test



EXAMPLES OF INDICATORS

Examples of disciplinary indicators

***Electronics**:*

- Select and use a small signal model to predict behaviour of common nonlinear active devices
- Calculate current and voltage at nodes of non-linear devices when connected using common bias networks.
- Calculate component values to implement common amplifier configurations

Electromagnetics:

- **…**

Engineering tools

- Use an oscilloscope to identify key characteristics of analog and digital signals
- Use software tools to do schematic capture, layout, simulation, and yield analysis of analog and digital electronic circuits

…

Design

- In a team, evaluate possible topologies and simulate, layout, fabricate, and test a mixed-signal electronic circuit for a specific real-world application.

Example: Queen's leveled indicators

	Theme	First year	Second year	Third year	Graduating year
Communications	**Process**		Describes typical expectations engineers to communicate effectively.	Generates a traceable and defensible record of a technical project using an appropriate project records system.	Writes and revises documents using appropriate discipline-specific conventions
	Written	Summarizes and paraphrases written work accurately with appropriate citations	Composes documents in styles including progress reports, professional career (cover letters, CV, RFP), design reports	Demonstrates conciseness, precision, and clarity of language in technical writing.	Write concise, coherent and grammatically correct materials that reflect critical analysis and synthesis, appropriate to audience needs.
	Oral	Delivers clear and organized formal presentation following established guidelines	Delivers effective formal oral presentations including appropriate facial gestures, natural body posture and movement	Demonstrates formal oral presentations with appropriate language, style, timing and flow.	Demonstrates confidence in formal and informal oral communications
	Graphical	Creates effective figures, tables, and drawings employing standard conventions to compliment text.		Creates accurate and complete technical graphics.	Uses graphics to explain, interpret, and assess information

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

Resources for indicators (learning outcomes, criteria,…)

- CDIO
- UDLEs (Ontario)
- American Schools (e.g. EC2000)
- Other national accreditation bodies
- Tuning outcomes (US, Ontario, Europe)
- AAC&U VALUE rubrics
- Other Canadian engineering schools (EGAD site)

Pitfalls to avoid:

Johnny B. "Good": What is "good" performance? Use clear language.

unmeasurable: Can you observe it?

Out of alignment: Is indicator aligned with attribute?

reliable: Can multiple graders agree on it?

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

Summary: Indicators

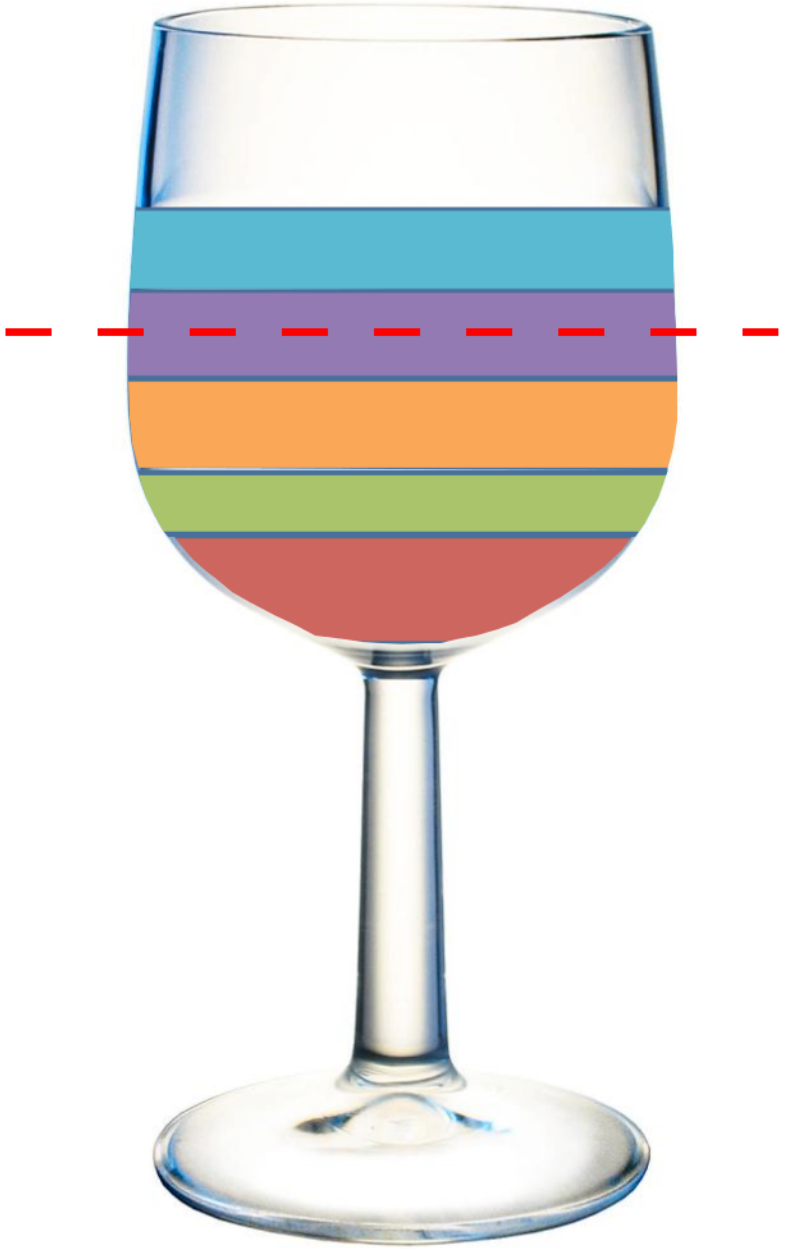
- Ask: What do you want to learn by this process?
- What are your program strengths and objectives?
- Create measurable and meaningful indicators
  - Collaboration among programs may be efficient
  - Having a "working" workshop with some educational developers (e.g. your CTL) can be very helpful to ensure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

Questions/comments?

END OF WORKSHOP 1B

OTHER SLIDES

Your course



Lab Investigation

Problem Solving

Writing

Concept #2

Concept #1

The program

Your program

Identify:

1. **What things should a student be able to do when they finish the program?**
2. **For each of those things:**
   a. **Where do we develop that?**
   b. **Where do we assess that?**
3. **Assess and evaluate**
4. **Improve the program**

Do not have to assess in every course, but need to know how courses contribute to developing expectations.

What is the value of identifying learning outcomes/indicators?

A study synthesizing:

800 meta-analyses

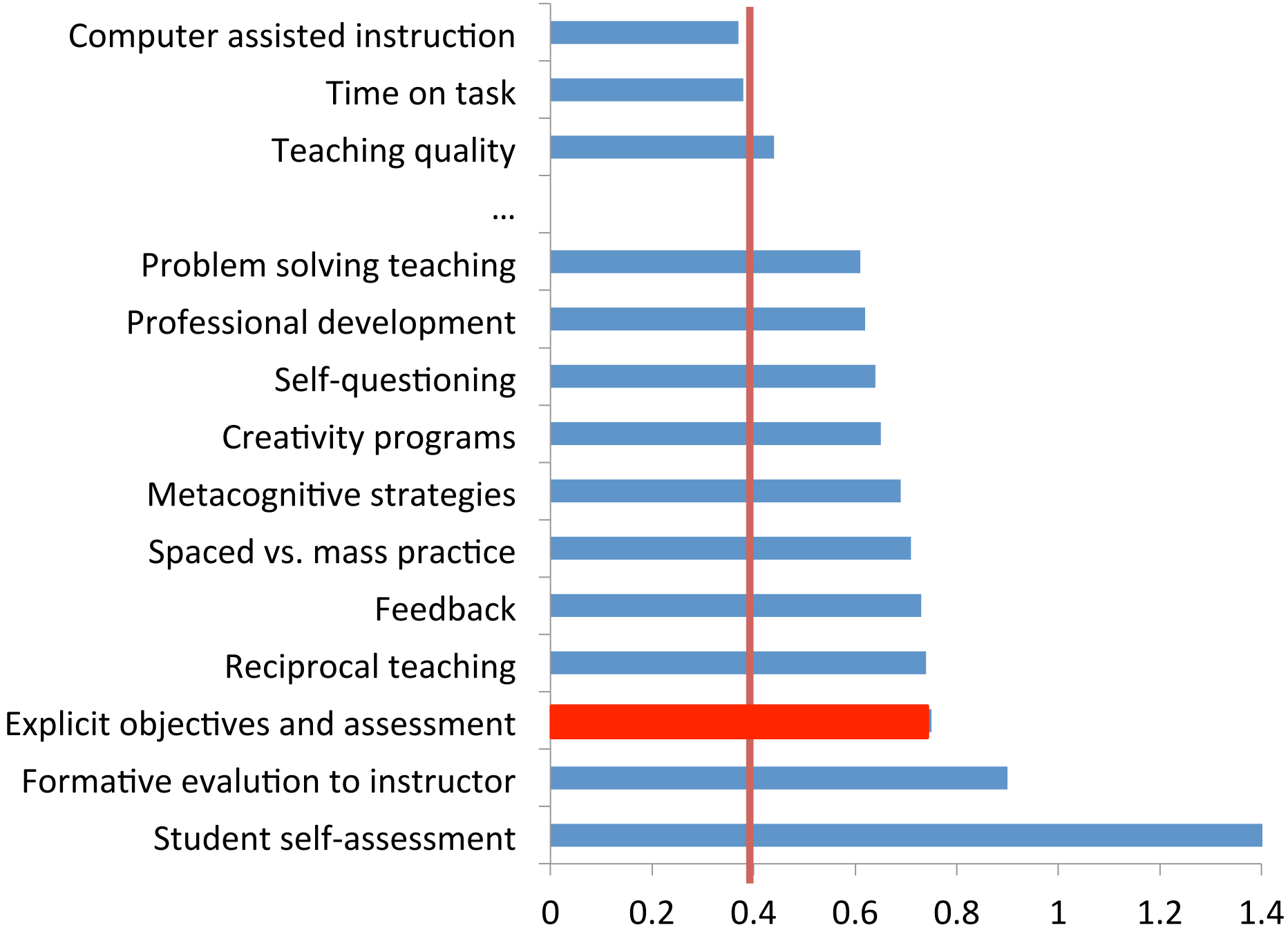
50,000+ studies

200+ million students

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

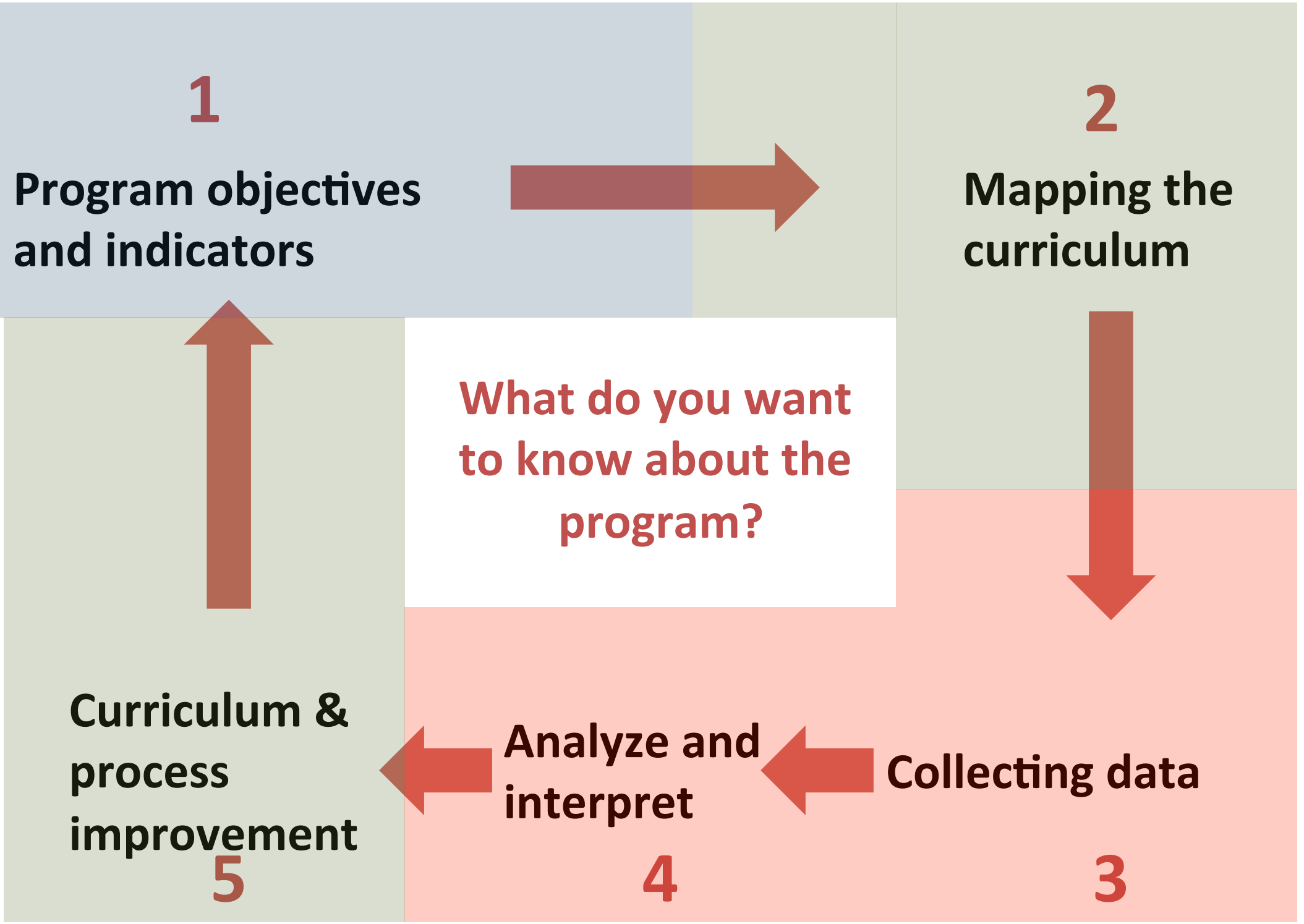
Hattie, J. (2009). The Black Box of Tertiary Assessment: An Impending Revolution. In L. H. Meyer, S. Davidson, H. Anderson, R. Fletcher, P.M. Johnston, & M. Rees (Eds.), Tertiary Assessment & Higher Education Student Outcomes: Policy, Practice & Research (pp.259-275). Wellington, New Zealand: Ako Aotearoa

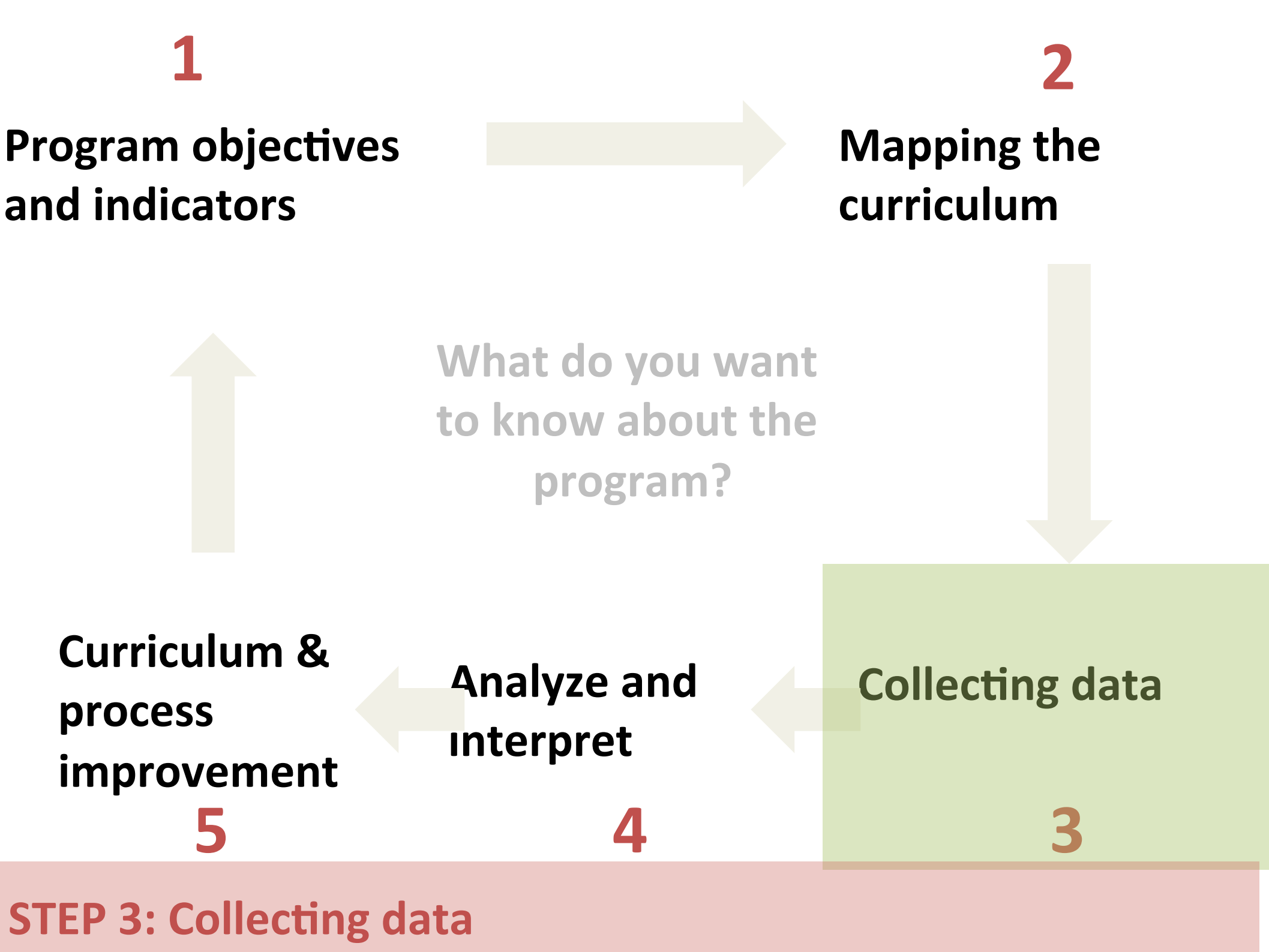
Effect size (performance gain in σ)



WORKSHOP 3B:
PLANNING AT THE COURSE LEVEL

http://bit.ly/Wkh0id

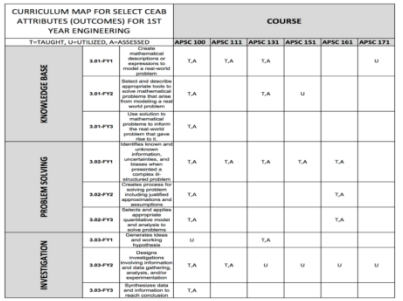

1
Program objectives and indicators
2
Mapping the curriculum
What do you want to know about the program?
3
Collecting data
4
Analyze and interpret
5
Curriculum & process improvement



STEP 3: Collecting data

Attributes 5-12

Tool: Curriculum Map



CURRICULUM MAP FOR SELECT CEAB ATTRIBUTES (OUTCOMES) FOR 1ST YEAR ENGINEERING			COURSE					
T=TAUGHT, U=UTILIZED, A=ASSESSED			APSC 100	APSC 111	APSC 131	APSC 151	APSC 161	APSC 171
KNOWLEDGE BASE	3.01-FY1	Create mathematical descriptions or expressions to model a real-world problem.	T,A	T,A	T,A			U
	3.01-FY2	Select & describe appropriate tools to solve mathematical problems arising from modeling a real-world problem	T,A		T,A	U		
	3.01-FY3	Use solution to mathematical problems to inform the real-world problem that gave rise to it.	T,A					
PROBLEM SOLVING	3.02-FY1	Identifies known and unknown information, uncertainties, and bias when presented a complex ill-structured problem	T,A	T,A	T,A	T,A	T,A	
	3.02-FY2	Creates process for solving problem including justified approximations and assumptions	T,A				T,A	
	3.02-FY3	Selects and applies appropriate quantitative model and analysis to solve problems	T,A				T,A	
INVESTIGATION	3.03-FY1	Generates ideas and working hypothesis	U		T,A			
	3.03-FY2	Designs investigations involving information and data gathering, analysis, and/or experimentation	T,A	T,A	U	U	U	U
	3.03-FY3	Synthesizes data and information to reach conclusion	T,A					

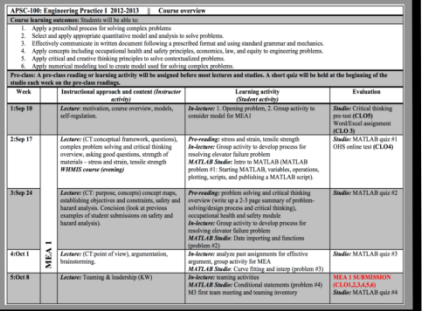
Program

APSC 100 | APSC 111 | APSC 131 | APSC 171 | ...

Course

Course Learning Outcomes ⇔ Assessment ⇔ Instructional Approach

Tool: Planning Table



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

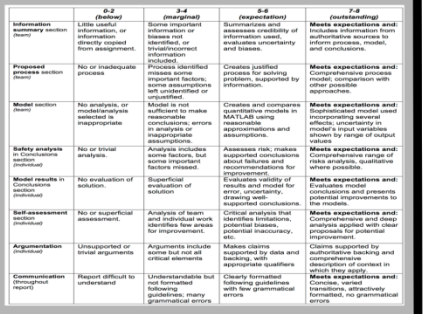
Course learning outcomes: Students will be able to:

1. Apply a prescribed process for solving complex problems
2. Select and apply appropriate quantitative model and analysis to solve problems.
3. Effectively communicate in written document following a prescribed format and using standard grammar and mechanics.
4. Apply concepts including occupational health and safety principles, economics, law, and equity to engineering problems.
5. Apply critical and creative thinking principles to solve contextualized problems.
6. Apply numerical modeling tool to create model used for solving complex problems.

Pre-class: A pre-class reading or learning activity will be assigned before most lectures and studios. A short quiz will be held at the beginning of the studio each week on the pre-class readings.

Week		Instructional approach and content *(Instructor activity)*	Learning activity *(Student activity)*	Evaluation
1/Sep 10		***Lecture:*** motivation, course overview, models, self-regulation.	***In-lecture:*** 1. Opening problem, 2. Group activity to consider model for MEA1	***Studio:*** Critical thinking pre-test **(CLO5)** Word/Excel assignment **(CLO 3)**
2/Sep 17		***Lecture:*** (CT conceptual framework, questions), complex problem solving and critical thinking overview, asking good questions, strength of materials – stress and strain, tensile strength ***WHMIS course (evening)***	***Pre-reading:*** stress and strain, tensile strength ***In-lecture:*** Group activity to develop process for resolving elevator failure problem ***MATLAB Studio:*** Intro to MATLAB (MATLAB problem #1: Starting MATLAB, variables, operations, plotting, scripts, and publishing a MATLAB script).	***Studio:*** MATLAB quiz #1 (IHS online test **(CLO4)**
3/Sep 24		***Lecture:*** (CT: purpose, concepts) concept maps, establishing objectives and constraints, safety and hazard analysis. Concision (look at previous examples of student submissions on safety and hazard analysis).	***Pre-reading:*** problem solving and critical thinking overview (write up a 2-3 page summary of problem-solving/design process and critical thinking), occupational health and safety module ***In-lecture:*** Group activity to develop process for resolving elevator failure problem ***MATLAB Studio:*** Date importing and functions (problem #2).	***Studio:*** MATLAB quiz #2
4/Oct 1	MEA 1	***Lecture:*** (CT point of view), argumentation, brainstorming.	***In-lecture:*** analyze past assignments for effective argument, group activity for MEA ***MATLAB Studio:*** Curve fitting and interp (problem #3)	***Studio:*** MATLAB quiz #3
5/Oct 8		***Lecture:*** Teaming & leadership (KW)	***In-lecture:*** teaming activities ***MATLAB Studio:*** Conditional statements (problem #4) M3 first team meeting and teaming inventory	MEA 1 SUBMISSION **(CLO1,2,3,4,5,6)** ***Studio:*** MATLAB quiz #4

Tool: Rubric



	0–2 *(below)*	3–4 *(marginal)*	5–6 *(expectation)*	7–8 *(outstanding)*
Information summary section *(Team)*	Little useful information, or information directly copied from assignment.	Some important information or biases not identified, or trivial/incorrect information included.	Summarizes and assesses reliability of information used, evaluates uncertainty and biases.	**Meets expectations and:** Insightful synthesis from authoritative sources to inform process, model, and conclusions.
Proposed process section *(Team)*	No or inadequate process	Process identified but missing important factors; some assumptions left unidentified or unjustified.	Creates justified process for solving problem, supported by information.	**Meets expectations and:** Comprehensive process model, comparison with other possible approaches.
Model section *(Team)*	No analysis, or model/analysis selected is inappropriate	Model is not sufficient to make reasonable conclusions; errors and/or inappropriate assumptions.	Creates and compares quantitative models in MATLAB using reasonable approximations and assumptions.	**Meets expectations and:** Sophisticated model used incorporating several effects; uncertainty in results / input variables shown by range of output values
Safety analysis in Conclusions section *(Individual)*	No or trivial analysis.	Analysis includes some factors, but some important factors missed.	Assesses risk; makes supported conclusions about failures and recommendations for improvement.	**Meets expectations and:** Comprehensive range of risks analysis, qualitative where possible.
Model results in Conclusions section *(Individual)*	No evaluation of solution.	Superficial evaluation of solution	Evaluates validity of results from model for error, uncertainty, drawing well-supported conclusions.	**Meets expectations and:** Evaluates model limitations and presents potential improvements to the models.
Self-assessment section *(Individual)*	No or superficial assessment.	Analysis of team and individual work identifies few areas for improvement.	Critical analysis that identifies limitations, potential biases, potential inaccuracy, etc.	**Meets expectations and:** Comprehensive and deep analysis applied with clear proposals for potential improvement.
Argumentation *(Individual)*	Unsupported or trivial arguments	Arguments include some but not all critical elements	Makes claims supported by data and backing, with appropriate qualifiers	Claims supported by authoritative backing and comprehensive description of context in which they apply.
Communication *(throughout report)*	Report difficult to understand	Understandable but not formatted following guidelines; many grammatical errors	Clearly formatted following guidelines with few grammatical errors	**Meets expectations and:** Smooth transitions, attractively formatted, no grammatical errors

Deliverable

Team Report | Tutorial Quiz | Teaming Evaluation

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	…	…	…	…

C-100: Engineering Practice I || 2012-2013
se learning outcomes
. Applies prescribed process for solving complex problems (3.02-FY1)
. Selects and applies appropriate quantitative model and analysis to solve problems (3.0
. Evaluates validity of results and model to describe limitations and quantify error (3.02
. Composes structured document following prescribed format using standard grammar a
. Analyzes quantitative data to reach supported conclusion with explicit uncertainty (3.0
. Describe occupational health and safety principles (3.04-FY1)
. Apply critical thinking principles to contextual scenarios (3.02-FY4)
. Apply numerical modeling tool to create model used for solving complex problem. (3.0
. Construct arguments with claim, data, backing, and qualifier (3.02-FY5)

	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)

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

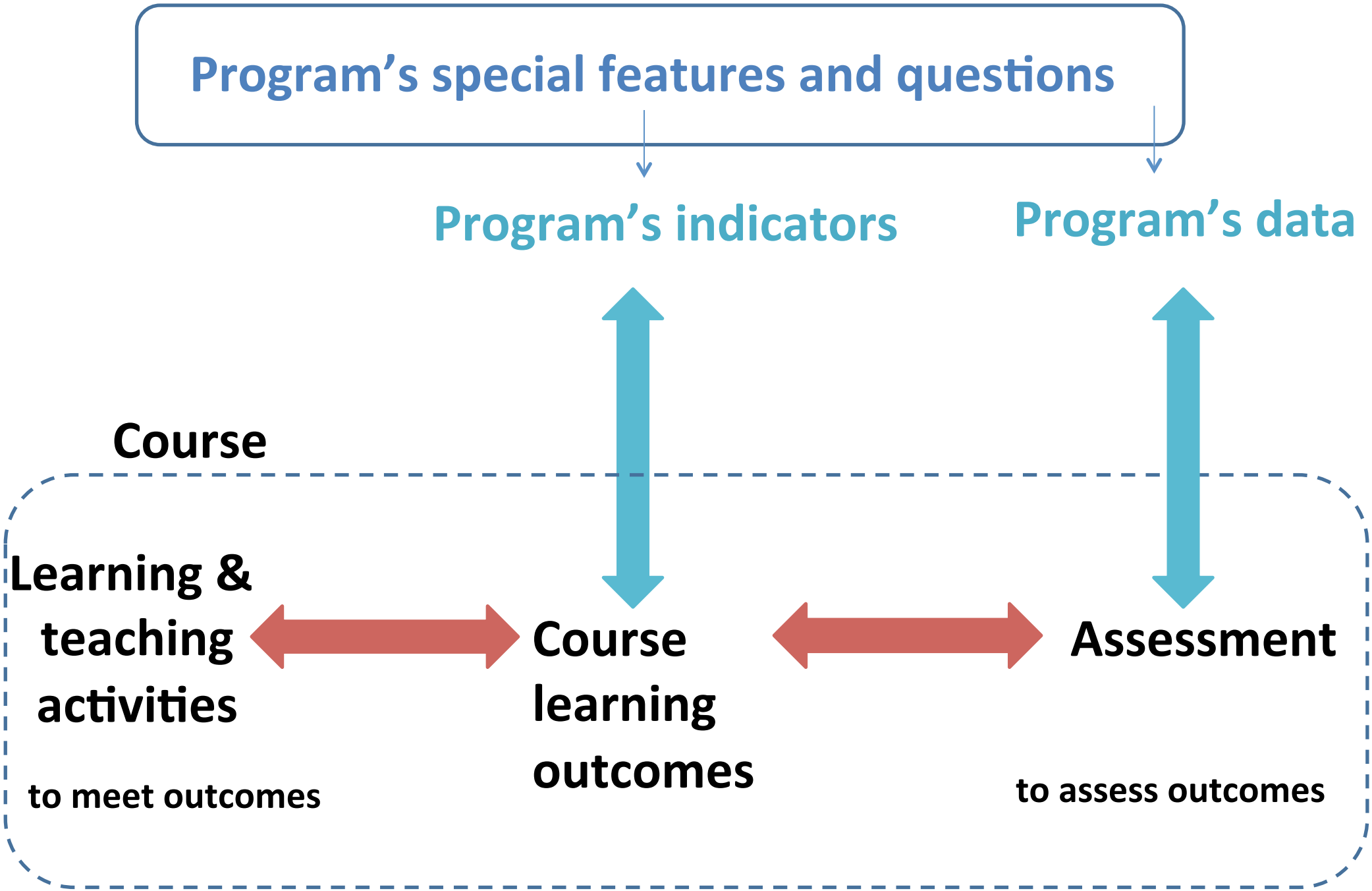
Course grades usually aggregate assessment of multiple objectives, and are *indirect* evidence for *some* expectations

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)?


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

At the 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 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.

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, ...)

Course planning table: link outcomes to assessment tools

ELEC-252 2013-2014 || Weekly overview

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

1. *Select and use a small signal model to predict behaviour of common nonlinear active devices
2. Calculate current and voltage at nodes of non-linear devices when connected using common bias networks using large signal model
3. *Calculate component values to implement common amplifier configurations
4. In a small team, select and design an appropriate amplifier topology for a real-world application

Pre-class: A pre-class reading or learning activity will be assigned before most lectures and studios. A short quiz will be held at the beginning of the tutorial each week on the pre-class readings.

Week	Lecture approach and content	Tutorial approach and content	Assessment (CLO, and % of course grade)
1:Sep 9	Motivation for the course, course overview, academic integrity expectations, group-based clicker problems.	Electronics concept inventory pre-test (same test to be given at end of course)	***Electronics concept inventory pre-test*** targeting CLO 1,2,3 (worth 1% of course grade)
2:Sep 16	Two terminal and three terminal active devices (diodes and transistors). Non-linear vs linear devices, applications. Group and individual clicker questions.	Team problem solving, followed by computer-based quiz question.	***In-tutorial computer-based quiz*** *targeting CLO 1 (worth 4% of course grade)*
3:Sep 23	***Lecture:*** Applications and characteristics of amplifiers.	Team project planning: Identify requirements of project, power requirements, frequency range	
4: Sep 30	***Lecture: ...***	Team problem solving, followed by computer-based quiz question.	***In-tutorial computer-based quiz*** *targeting CLO 1 (worth 4% of course grade)*
6: Oct 14	***Lecture:***	...	***Midterm exam:*** *2 questions will target CLO1 (worth 20% of course grade)*
...	...	...	...
12:	...	...	***Final team project:*** *targets CLO4 (worth 10% of course grade)*
EXAM			***Final exam:*** *Two questions will target each CLO (worth 50% of course grade)*

Example: Evaluating knowledge

- 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.

SCORING/EVALUATING

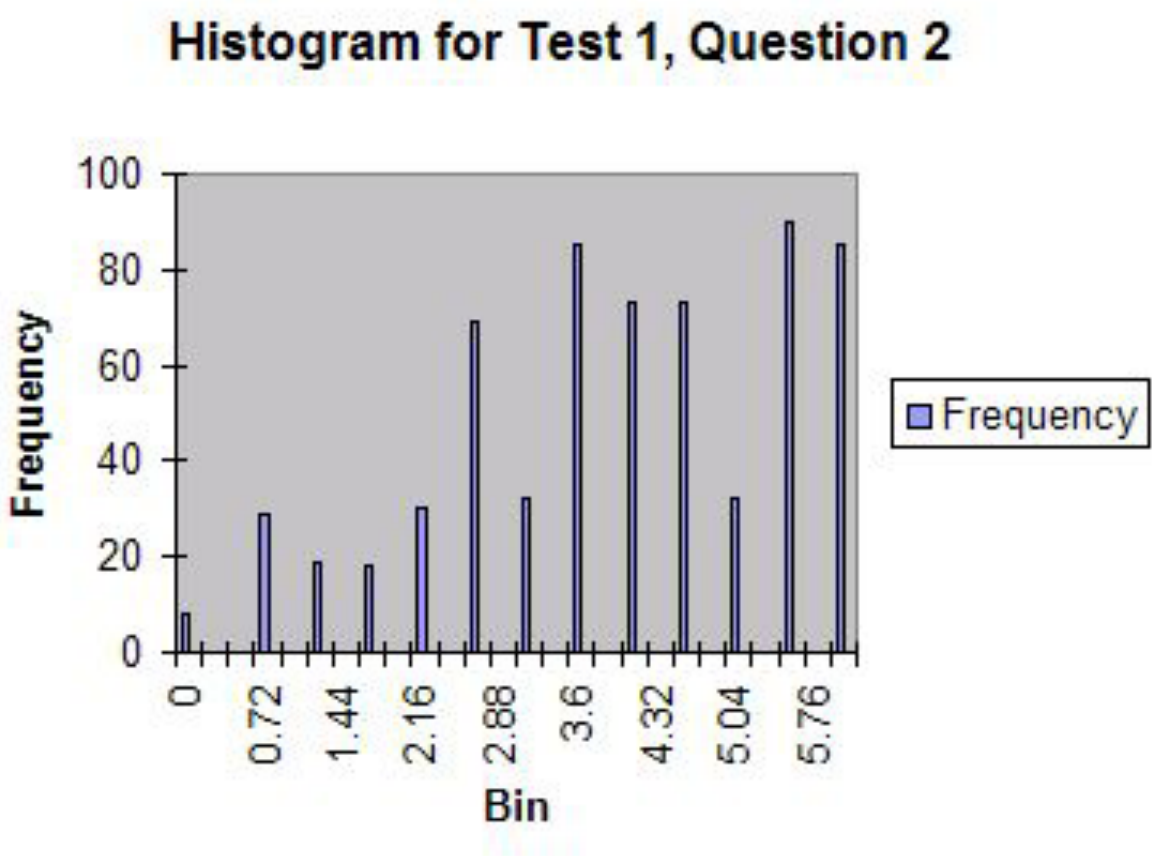
Example: Evaluating knowledge

- 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)

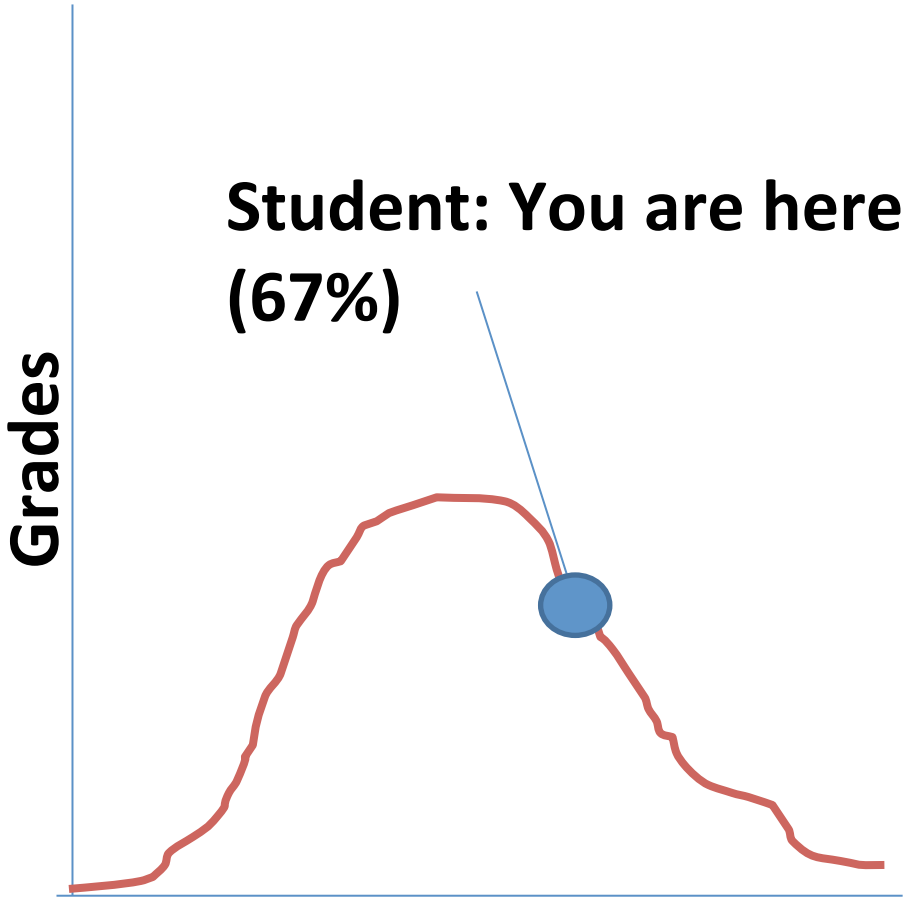
Context: calculating Intersection of two trajectories



When assessing non-quantitative student work

- Need to ensure that instructor, students, curriculum committee, and program visitors clearly know how items are scored for data gathering
- Often we use norm-referenced grading – certain percentage get an ‘A’, ‘B’, etc. Or grades are bell curved to achieve some desired distribution

Norm referenced evaluation



Used for large scale evaluation to compare students against each other

Criterion referenced evaluation

Student has marginally met expectations because submitted work mentions social, environmental, and legal factors in design process but no clear evidence of that these factors Impacted on decision making.

Used to evaluate students against stated criteria

	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**

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.

Group working time (20 min)

Take an activity from the course you worked on, and start developing a way of evaluating it (e.g. a rubric)

A rubric template is in the Workshop 3B Google Drive directory.

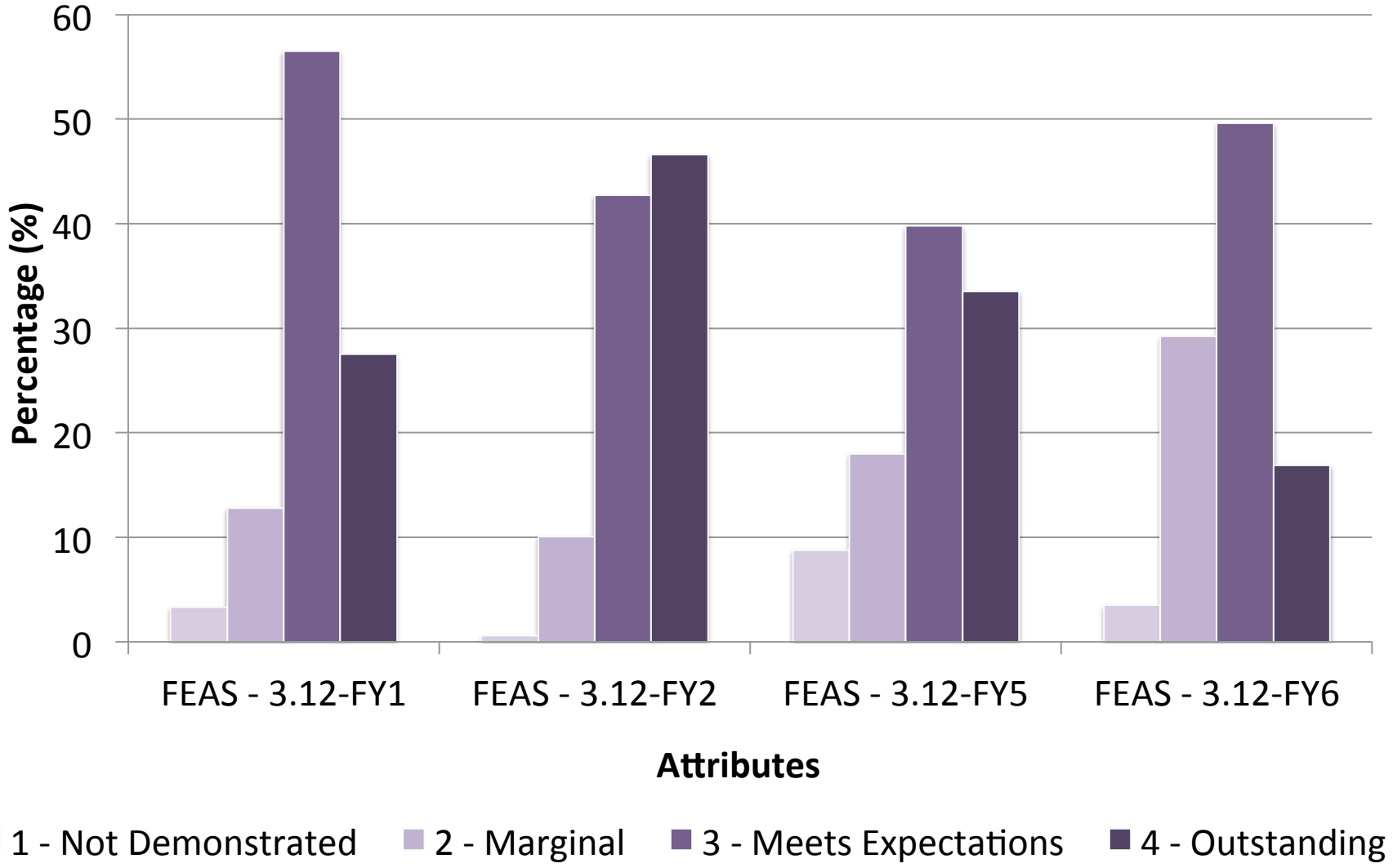
Avoid duplication in grading if possible

- 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)

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

Histograms for Lifelong learning (Queens)



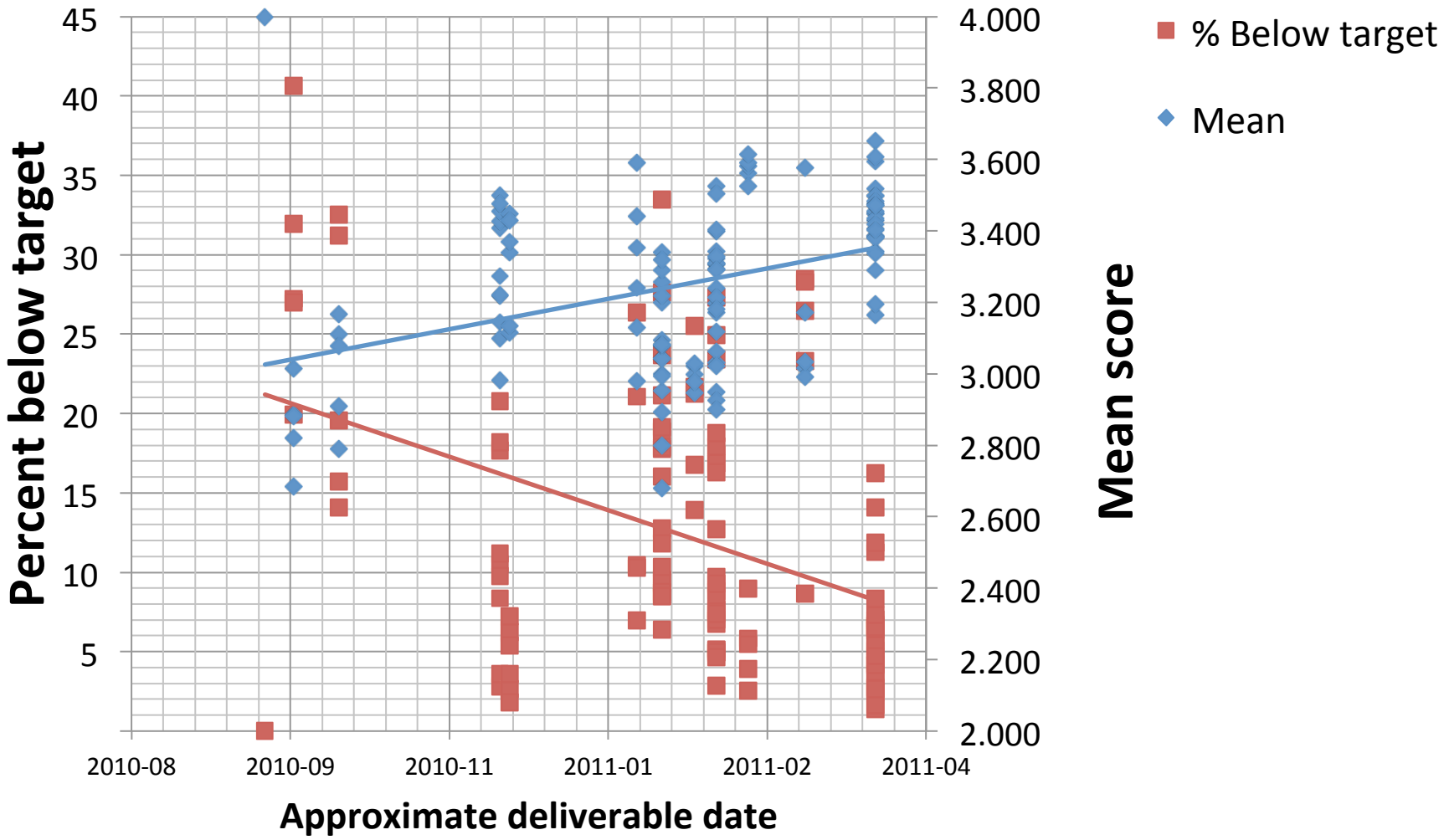
3.12-FY1 Uses information effectively, ethically, and legally to accomplish a specific purpose, including clear attribution of Information sources.

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

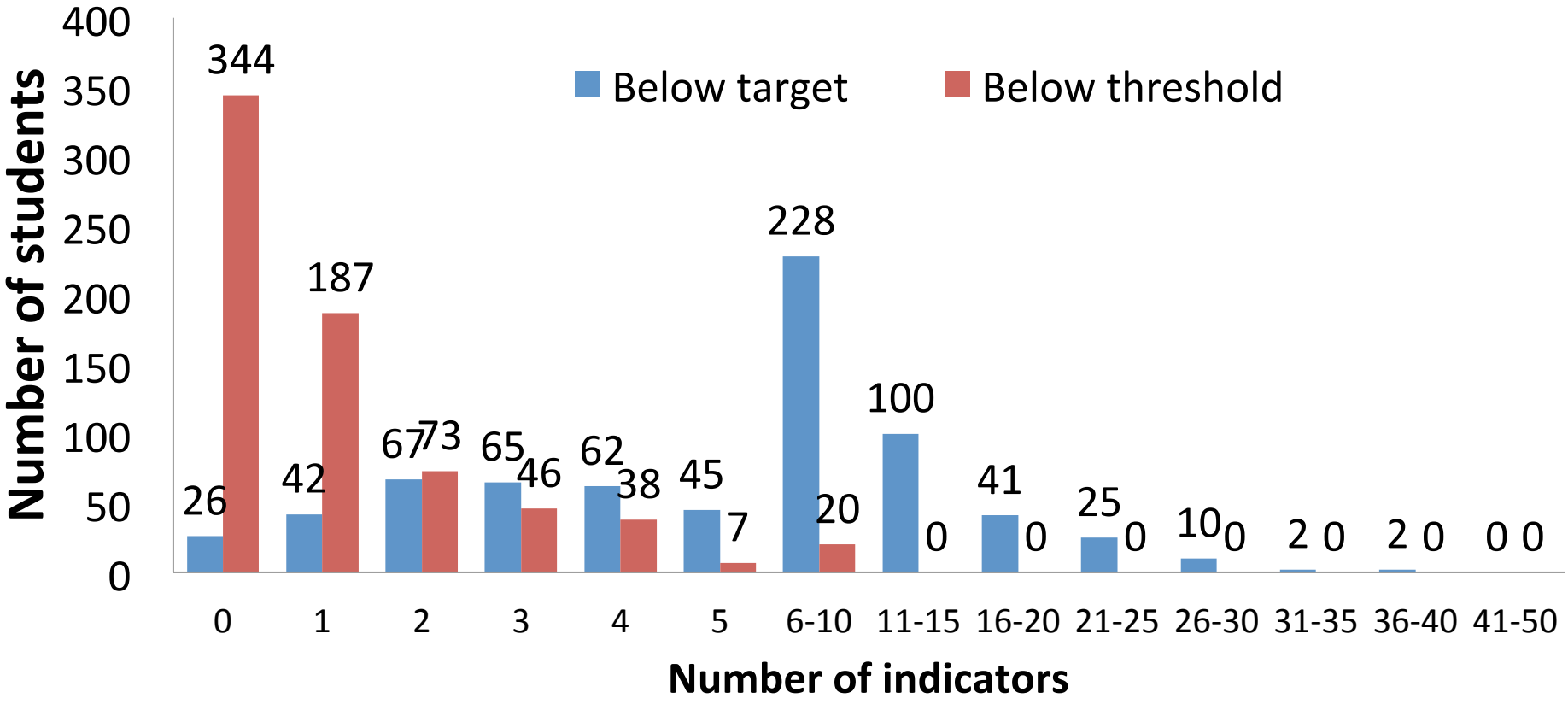
3.12-FY5 Identifies appropriate technical literature and other information sources to meet a need

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)

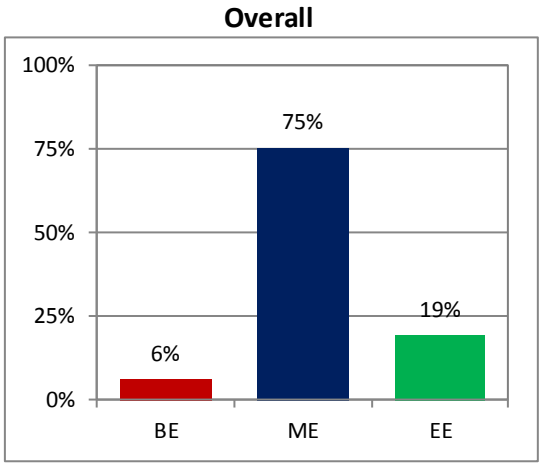


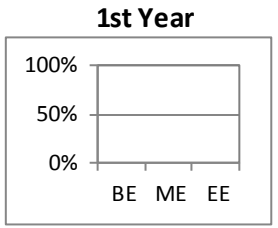
Histograms / Summary for Design (UBC)

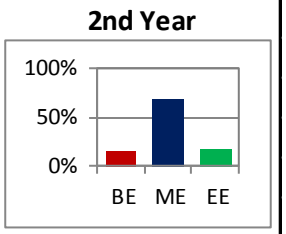
Attribute 4: Design

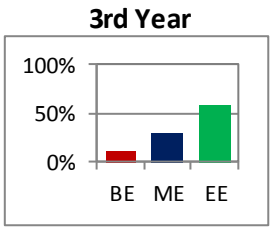
An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.

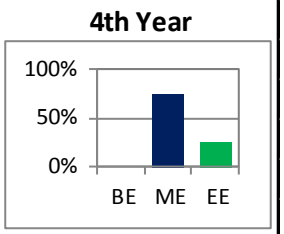
Below Expectations: 6%
Meets Expectations: 75%
Exceeds Expectations: 19%











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

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.