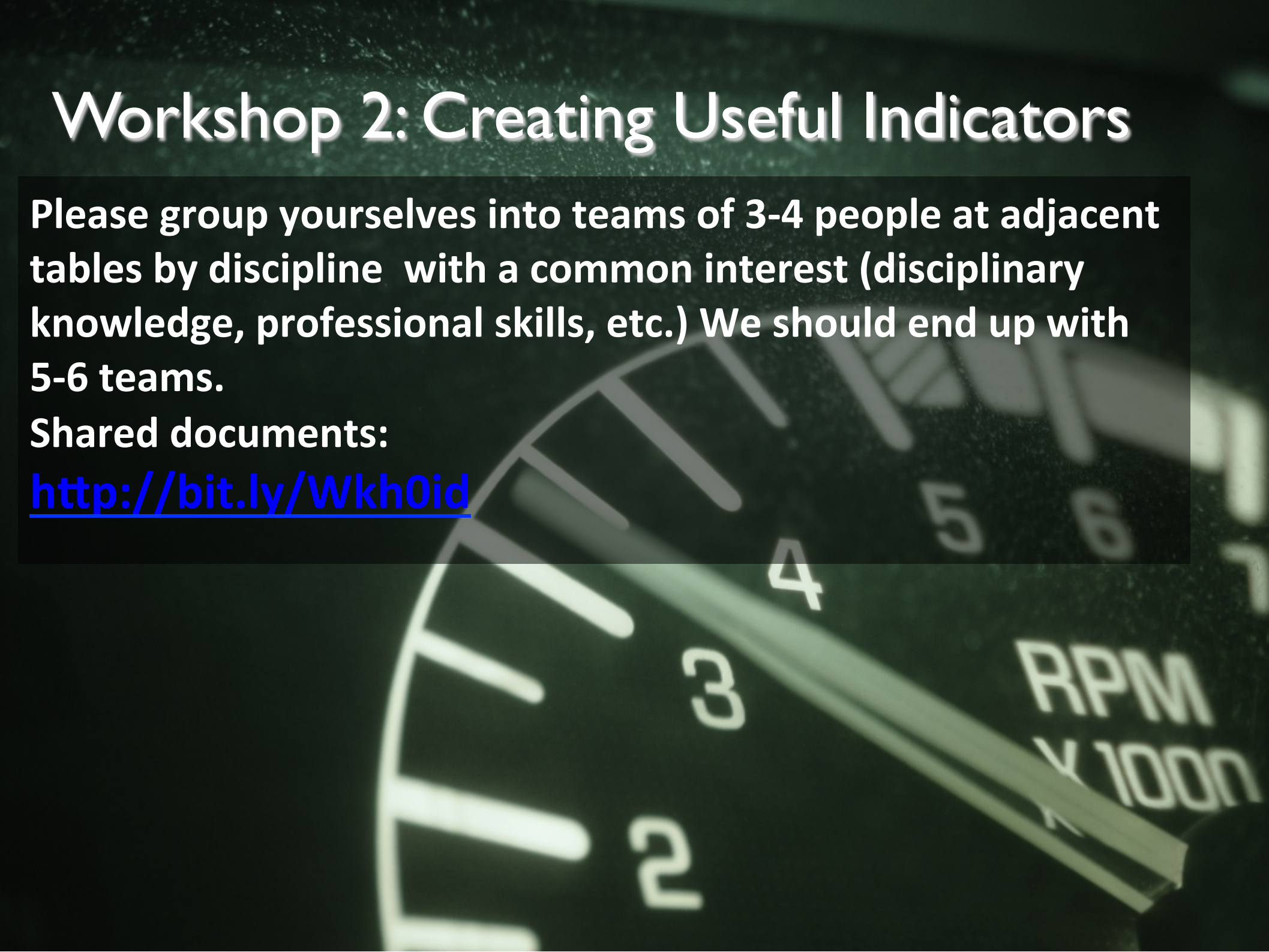
Workshop 2: Creating Useful Indicators

Please group yourselves into teams of 3-4 people at adjacent tables by discipline with a common interest (disciplinary knowledge, professional skills, etc.) We should end up with 5-6 teams.

Shared documents:

http://bit.ly/Wkh0id



Development and Assessment

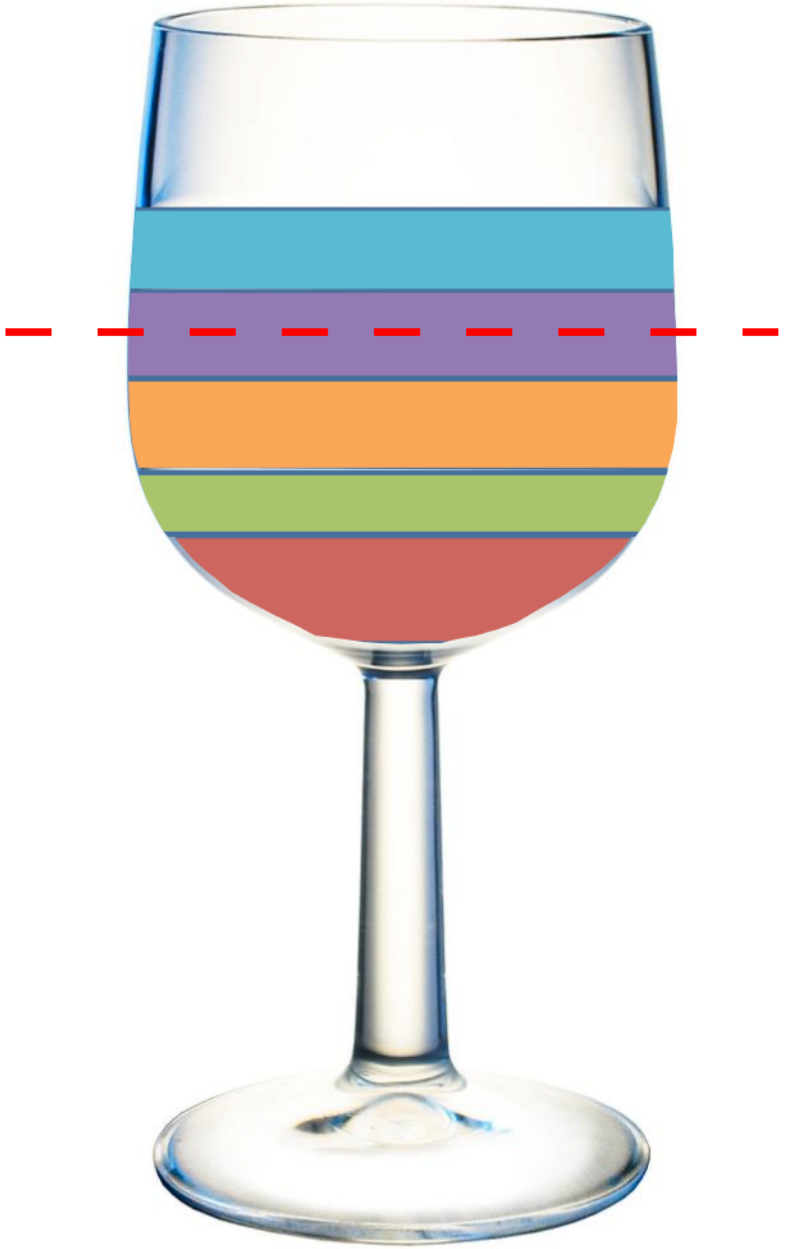
Curricular

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

Your course



Lab Investigation

Problem Solving

Writing

Concept #2

Concept #1

Your program

WHAT is the value of identifying learning outcomes/indicators?

A study synthesizing:

800 meta-analyses

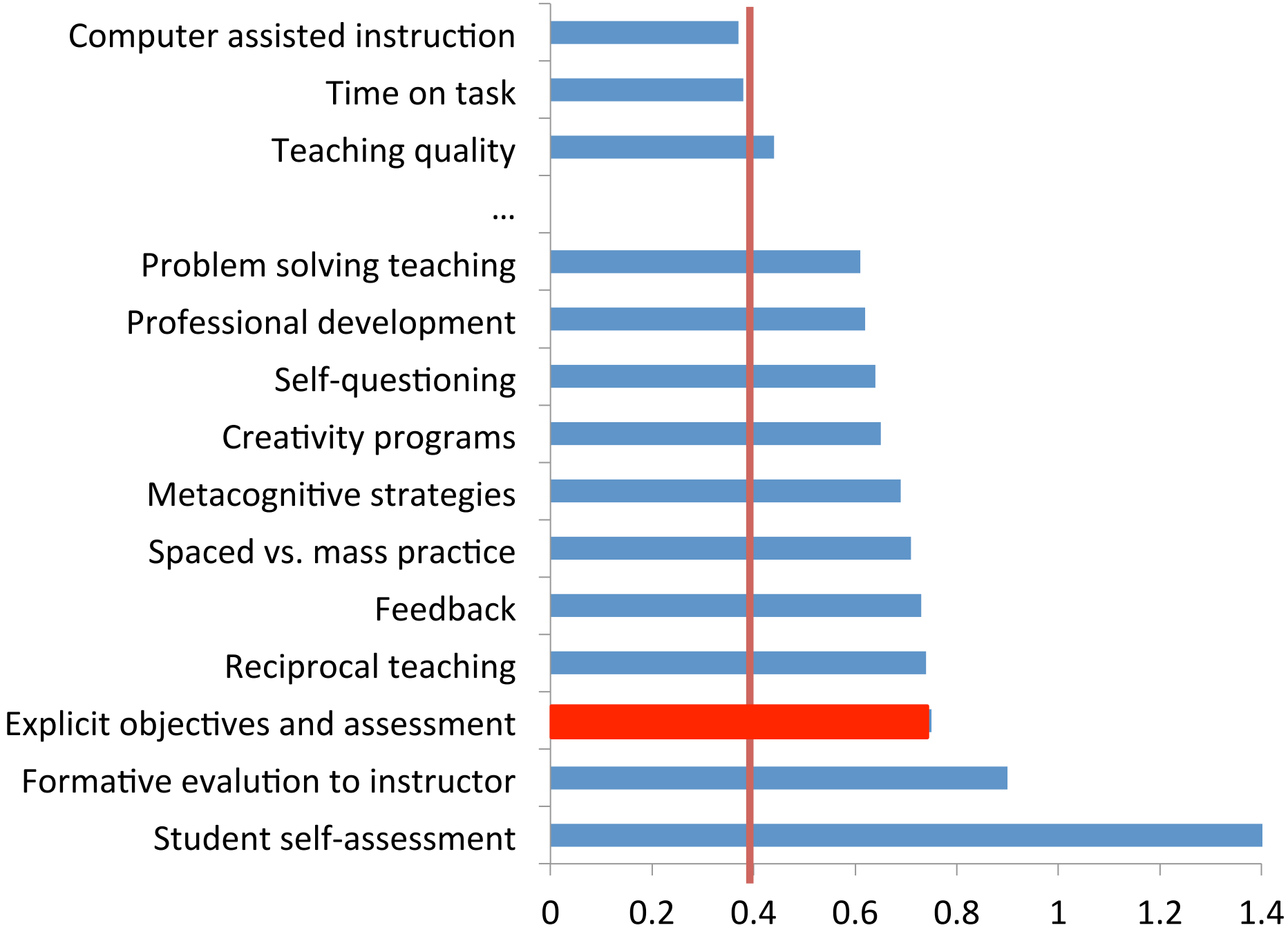
50,000+ studies

200+ million students

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

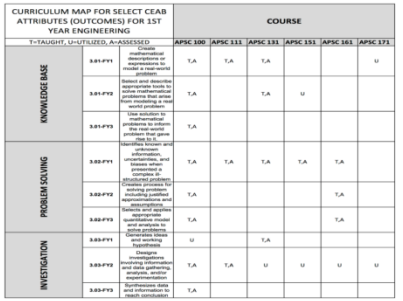
Hattie, J. (2009). The Black Box of Tertiary Assessment: An Impending Revolution. In L. H. Meyer, S. Davidson, H. Anderson, R. Fletcher, P.M. Johnston, & M. Rees (Eds.), Tertiary Assessment & Higher Education Student Outcomes: Policy, Practice & Research (pp.259-275). Wellington, New Zealand: Ako Aotearoa

Effect size (performance gain in σ)



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	Selects & describes 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 biases 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					

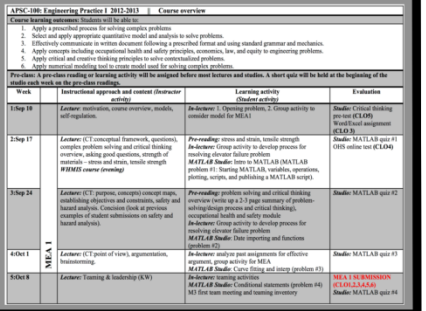
Program

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

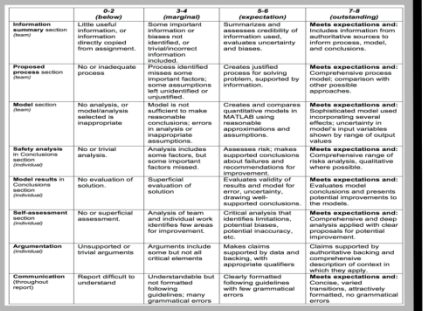
Course learning outcomes: Students will be able to:

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 studies. 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

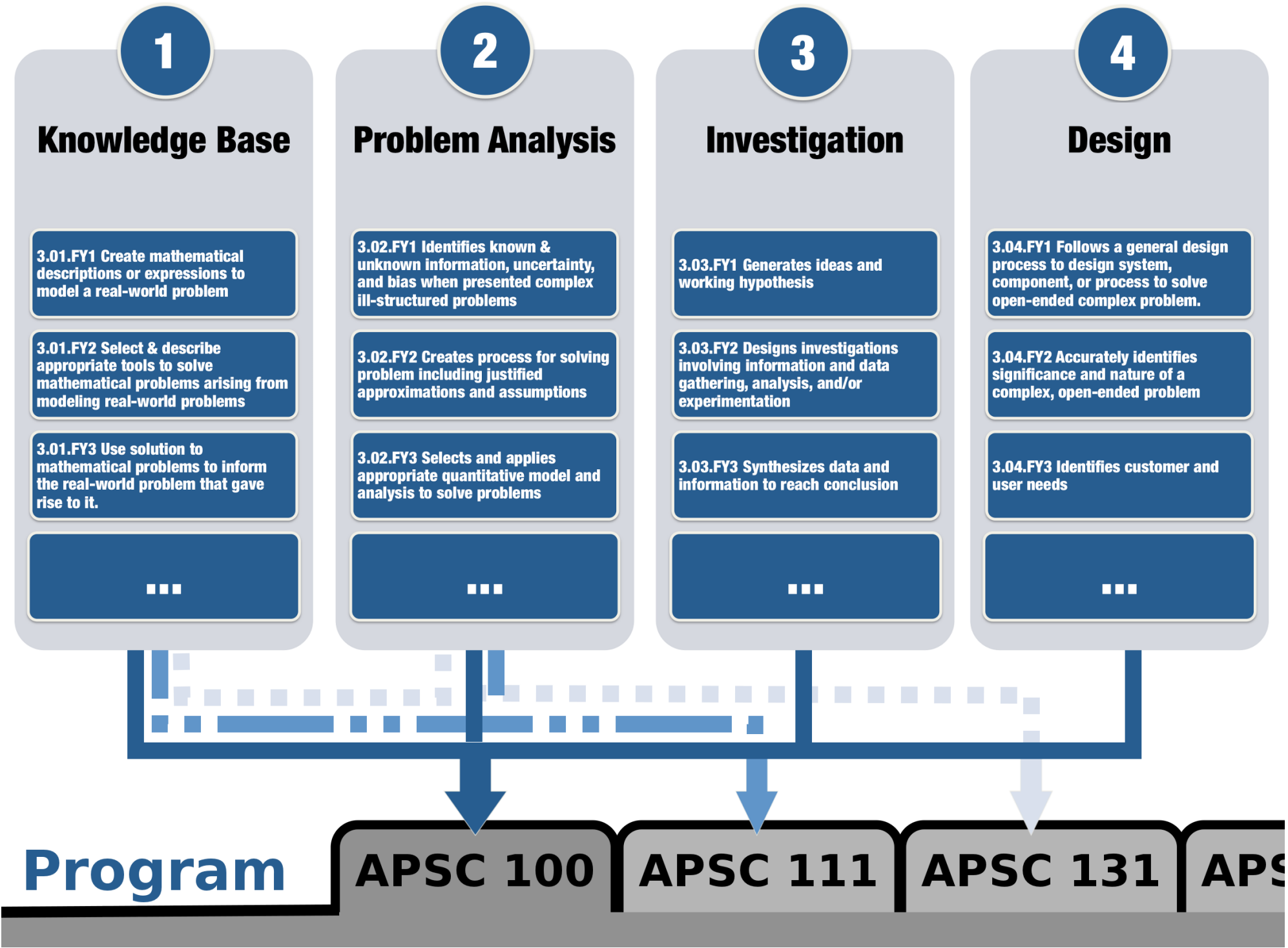
Tool: Rubric

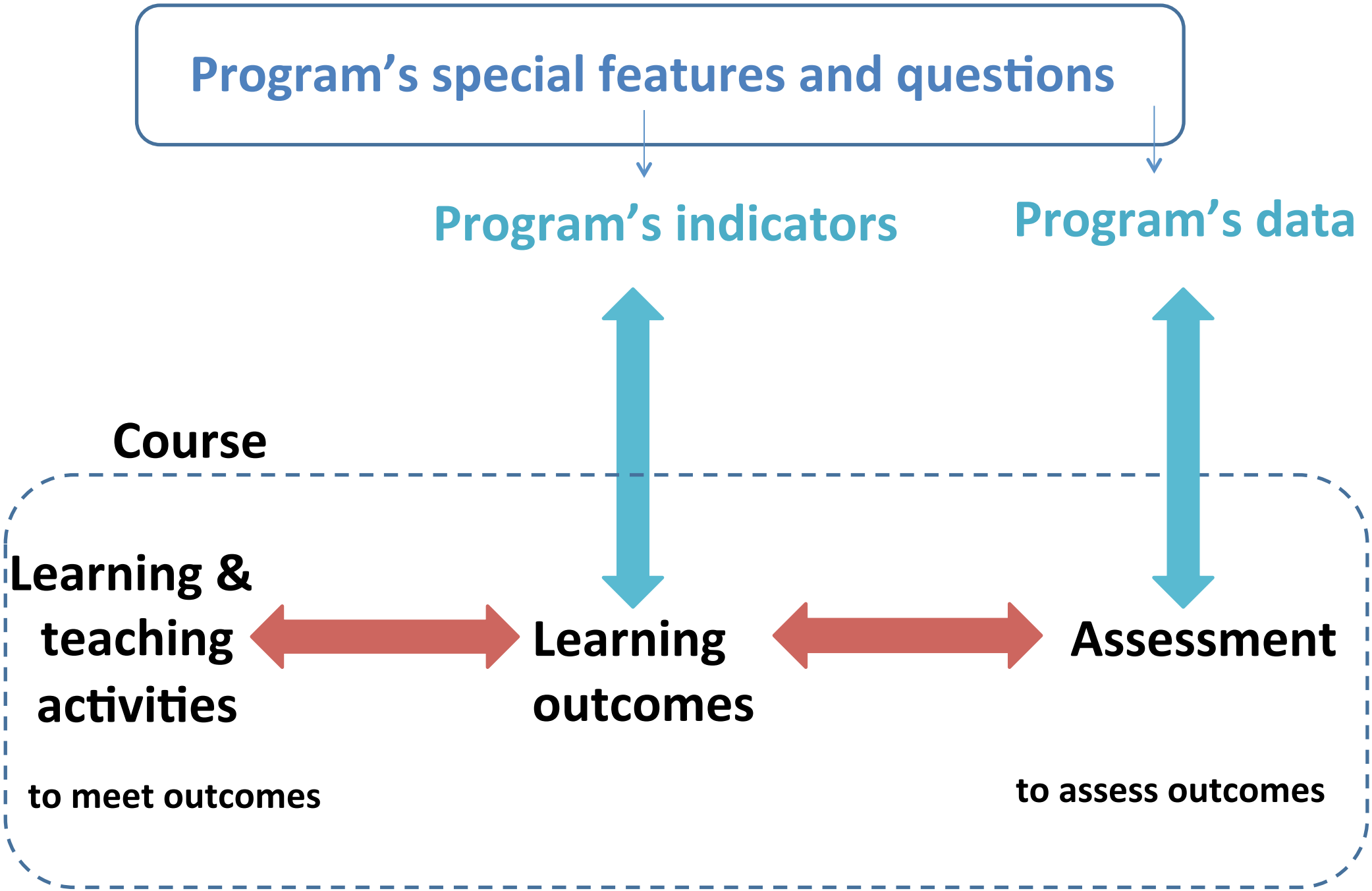


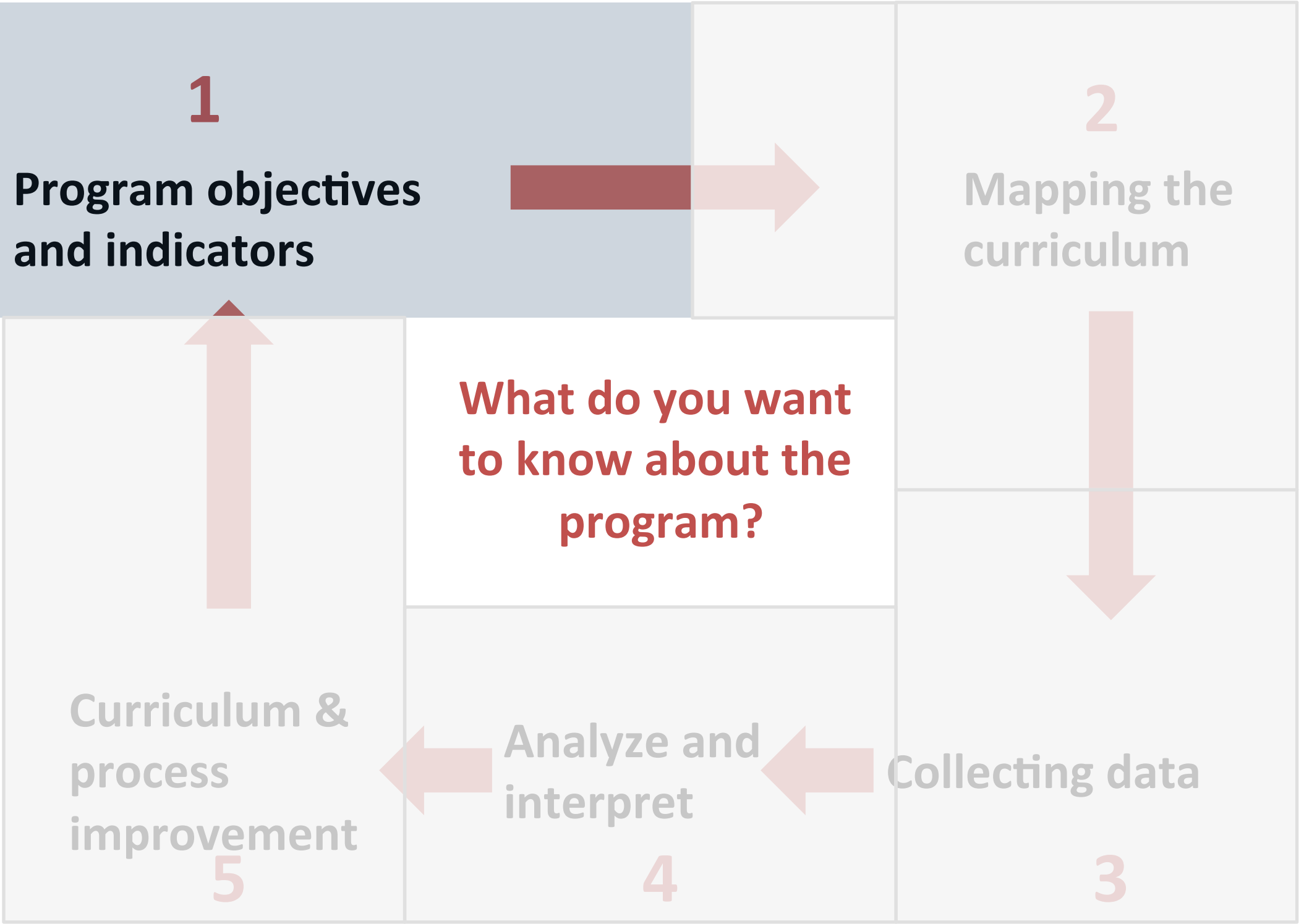
	0–2 *(below)*	3–4 *(marginal)*	5–6 *(expectation)*	7–8 *(outstanding)*
Information summary section *(Team)*	Little useful information, or information directly copied from assignment.	Some important information or biases not identified, or trivial/incorrect information included.	Summarizes and assesses reliability of information used, evaluates uncertainty and biases.	**Meets expectations and:** Includes information from authoritative sources to inform process, model, and conclusions.
Proposed process section *(Team)*	No or inadequate process	Process identified but missing some 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 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:** Effective 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


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

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?

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

At your table, **evaluate these indicators. Could you assess them? Would multiple graders generally expect the same thing?**

"The student understands Newton's laws."

"The student reads scholarly articles in the field."

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

FOLLOW-UP

Indicators should be measureable and meaningful

Indicators should have: content, context, and verb

Indicators should be useful to YOU to help students.

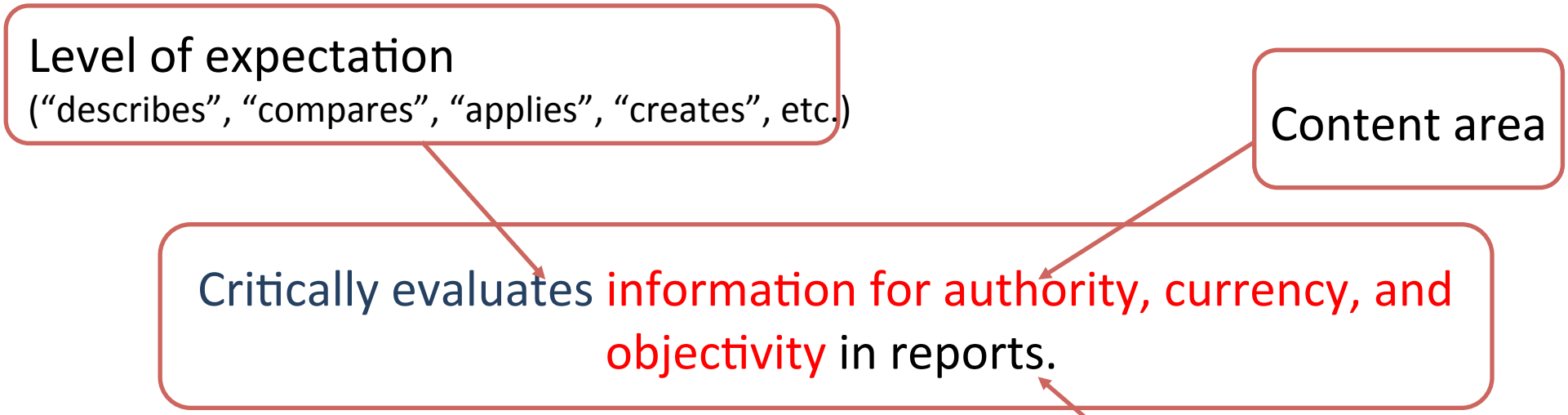
Apply a design process to **solve an open-ended complex problem with guidance by a mentor.**

1.Verb

2. Content

3. Context

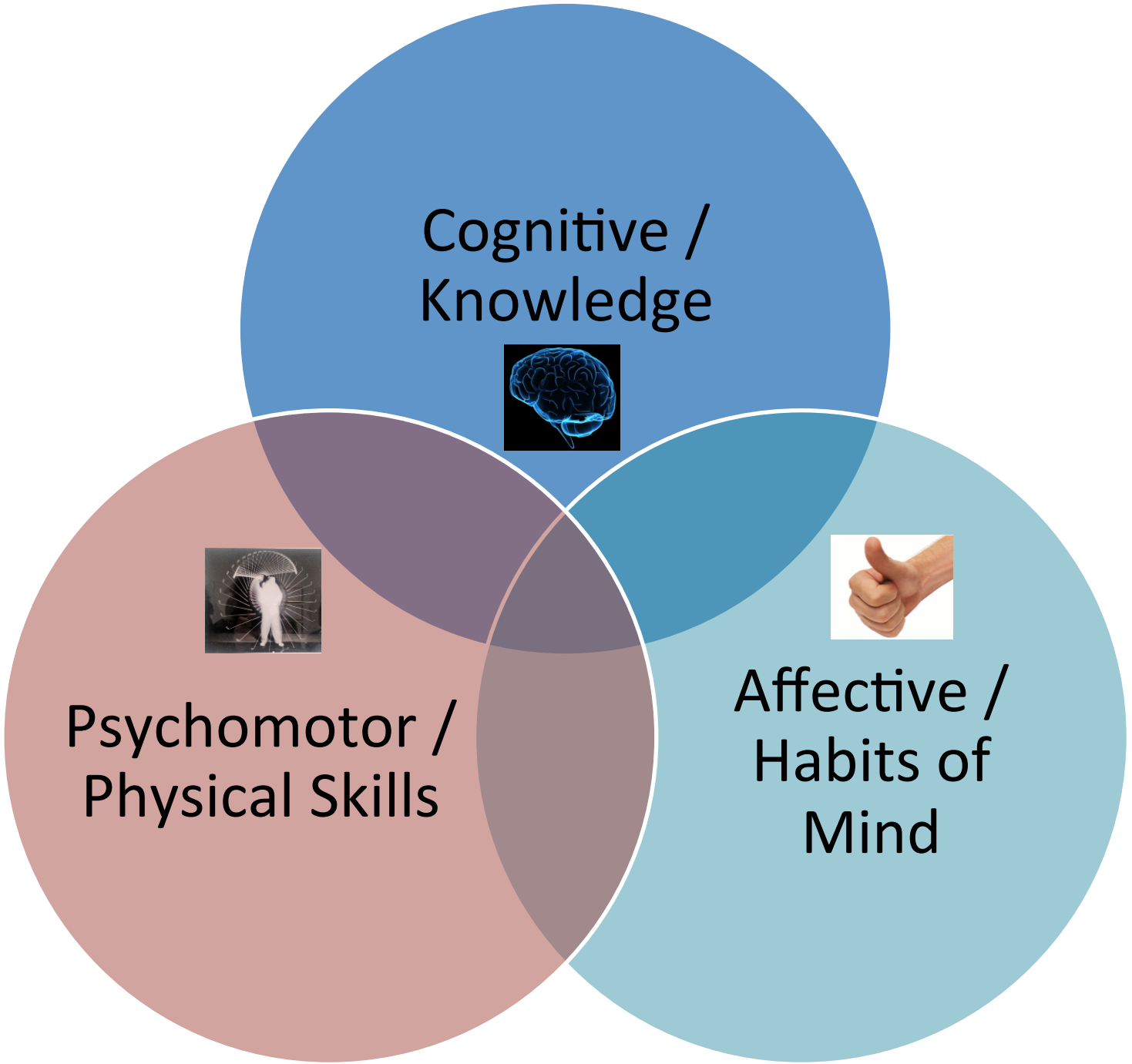
Establishing Indicators



- 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

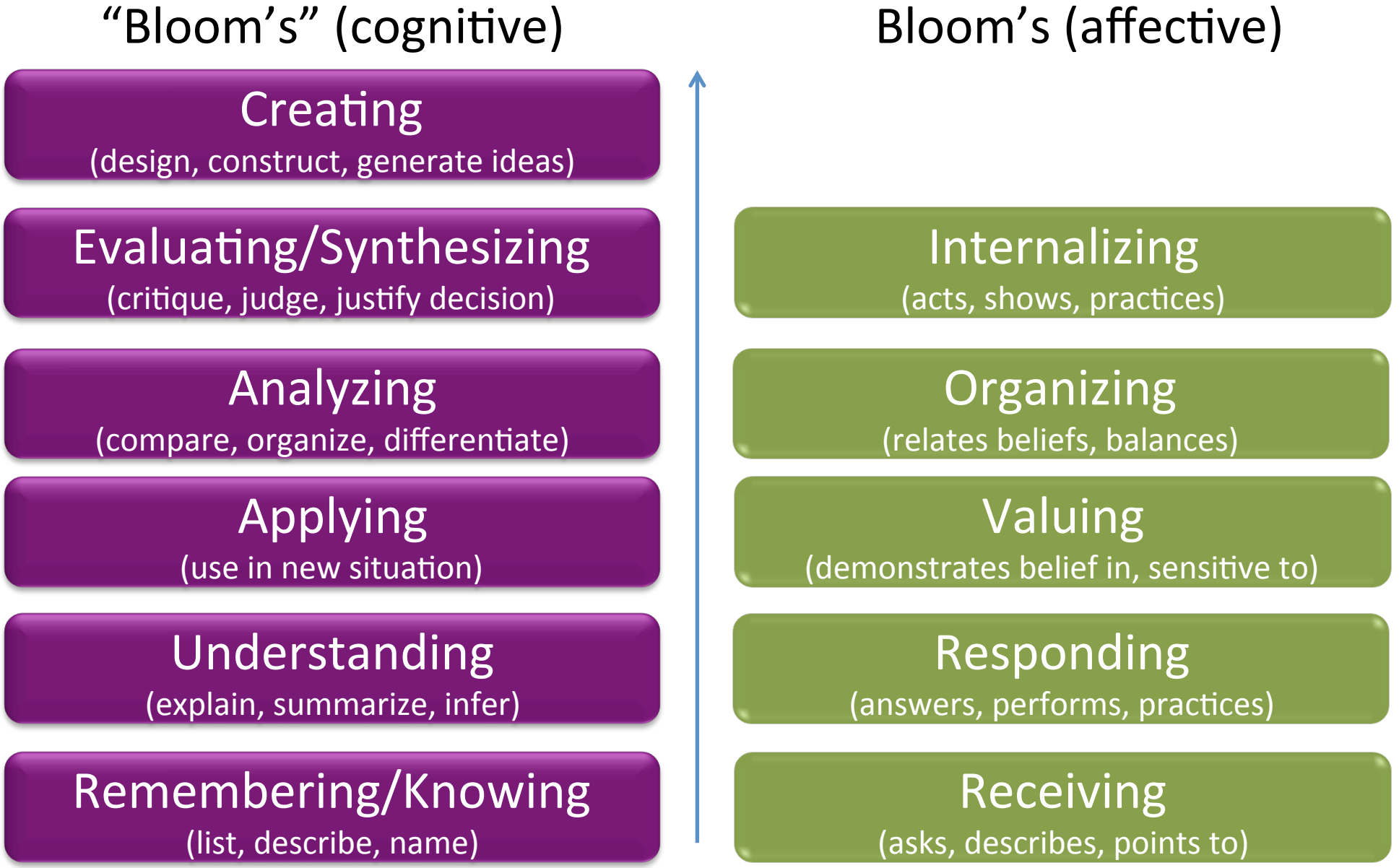
Developing indicators using taxonomies

- 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

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

Your turn

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?

Group working time (1 hr)

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 (1 hr)

Resources:

- Disciplinary expectations (e.g. ACM/IEEE syllabus for software engieering)
- Generic engineering expectations:
  - EC2000 (USA)
  - CDIO
  - HEQCO Physical Sciences Tuning Draft
  - OCAV UDLEs

Table 3.3. Relative performance capabilities of computing graduates by discipline

Area	Performance Capability	CE	CS	IS	IT	SE
Algorithms	Prove theoretical results	3	5	1	0	3
	Develop solutions to programming problems	3	5	1	1	3
	Develop proof-of-concept programs	3	5	3	1	3
	Determine if faster solutions possible	3	5	1	1	3
Application programs	Design a word processor program	3	4	1	0	4
	Use word processor features well	3	3	5	5	3
	Train and support word processor users	2	2	4	5	2
	Design a spreadsheet program (e.g., Excel)	3	4	1	0	4
	Use spreadsheet features well	2	2	5	5	3
	Train and support spreadsheet users	2	2	4	5	2
Computer programming	Do small-scale programming	5	5	3	3	5
	Do large-scale programming	3	4	2	2	5
	Do systems programming	4	4	1	1	4
	Develop new software systems	3	4	3	1	5
	Create safety-critical systems	4	3	0	0	5
	Manage safety-critical projects	3	2	0	0	5
Hardware and devices	Design embedded systems	5	1	0	0	1
	Implement embedded systems	5	2	1	1	3
	Design computer peripherals	5	1	0	0	1
	Design complex sensor systems	5	1	0	0	1
	Design a chip	5	1	0	0	1
	Program a chip	5	1	0	0	1
	Design a computer	5	1	0	0	1
Human-computer interface	Create a software user interface	3	4	4	5	4
	Produce graphics or game software	2	5	0	0	5
	Design a human-friendly device	4	2	0	1	3
Information systems	Define information system requirements	2	2	5	3	4
	Design information systems	2	3	5	3	3
	Implement information systems	3	3	4	3	5
	Train users to use information systems	1	1	4	5	1
	Maintain and modify information systems	3	3	5	4	3
Information management (Database)	Design a database mgt system (e.g., Oracle)	2	5	1	0	4
	Model and design a database	2	2	5	5	2
	Implement information retrieval software	1	5	3	3	4
	Select database products	1	3	5	5	3
	Configure database products	1	2	5	5	2
	Manage databases	1	2	5	5	2
	Train and support database users	2	2	5	5	2
IT resource planning	Develop corporate information plan	0	0	5	3	0
	Develop computer resource plan	2	2	5	5	2
	Schedule/budget resource upgrades	2	2	5	5	2
	Install/upgrade computers	4	3	3	5	3
	Install/upgrade computer software	3	3	3	5	3
Intelligent systems	Design auto-reasoning systems	2	4	0	0	2
	Implement intelligent systems	2	4	0	0	4
Networking and communications	Design network configuration	3	3	3	4	2
	Select network components	2	2	4	5	2
	Install computer network	2	1	3	5	2
	Manage computer networks	3	3	3	5	3
	Implement communication software	5	4	1	1	4
	Manage communication resources	1	0	3	5	0
	Implement mobile computing system	5	3	0	1	3
	Manage mobile computing resources	3	2	2	4	2
Systems Development Through Integration	Manage an organization's web presence	2	2	4	5	2
	Configure & integrate e-commerce software	2	3	4	5	4
	Develop multimedia solutions	2	3	4	5	3
	Configure & integrate e-learning systems	1	2	5	5	3
	Develop business solutions	1	2	5	3	2
	Evaluate new forms of search engine	2	4	4	4	4

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**

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

Pitfalls to avoid:

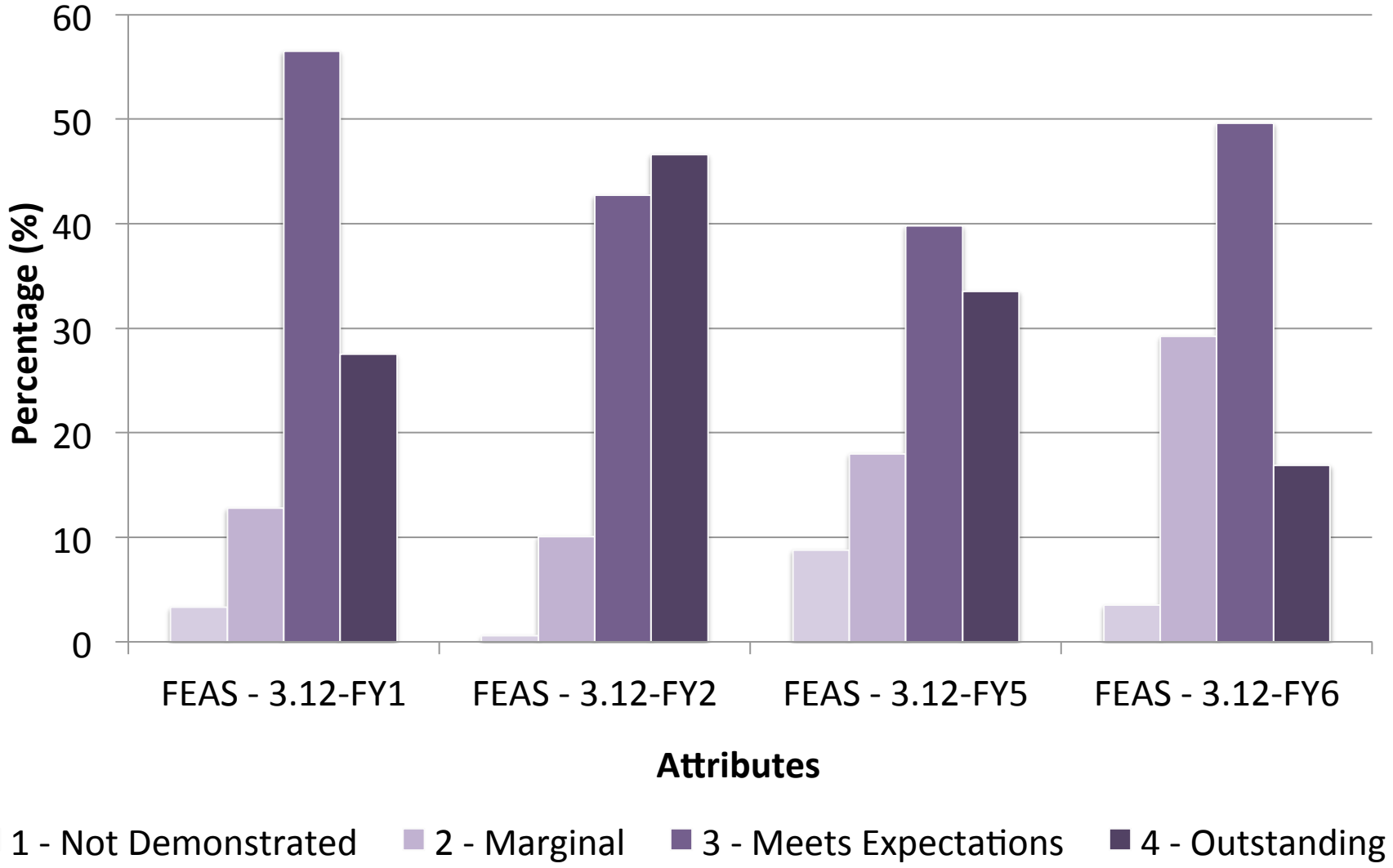
Johnny B. "Good": What is "good" performance?

unmeasurable: Can you observe it?

Out of alignment: Is indicator aligned with attribute?

unreliable: Can multiple graders agree on it?

Histograms for Lifelong learning (Queens)



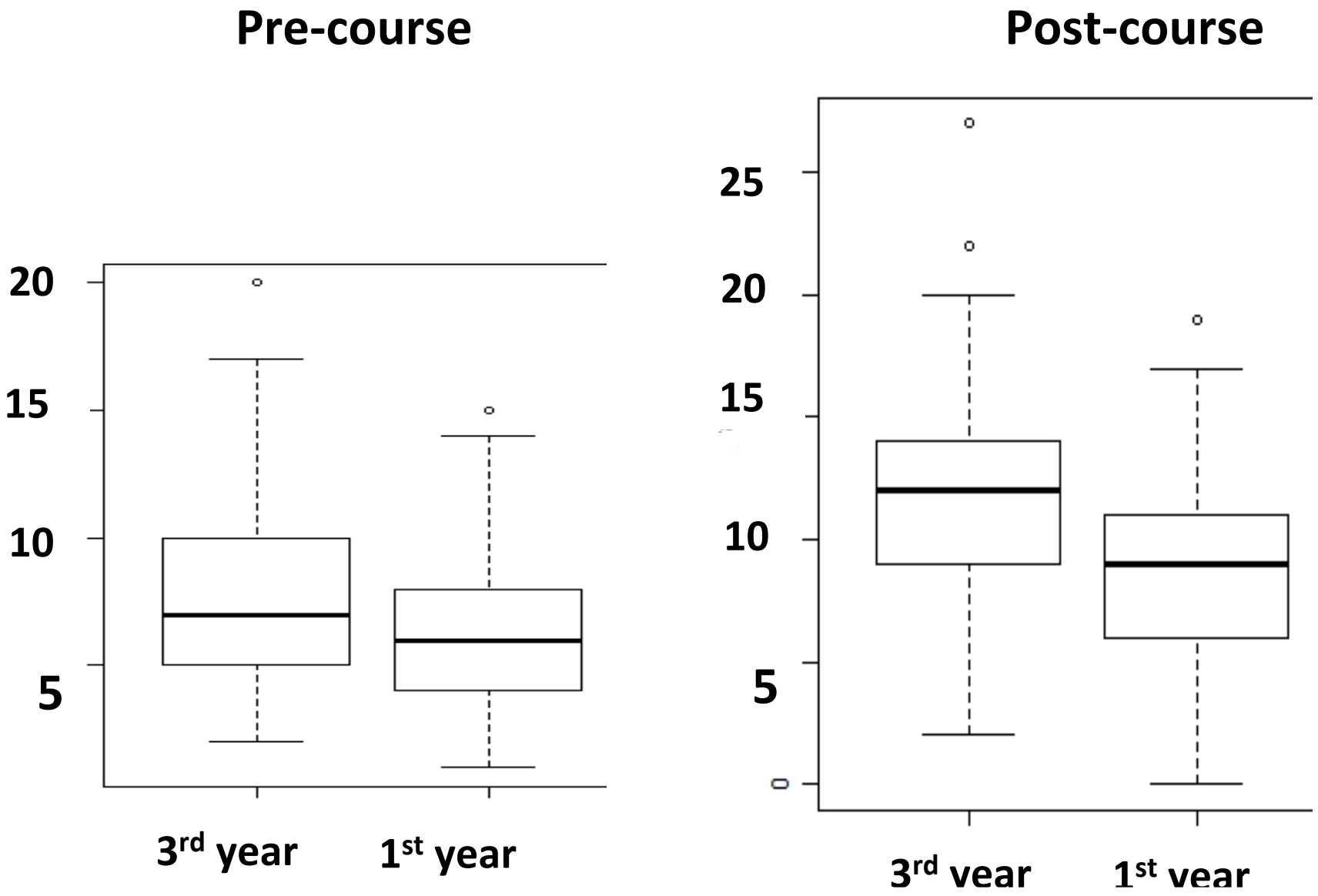
3.12-FY1 Uses information effectively, ethically, and legally to accomplish a specific purpose, including clear attribution of Information sources.

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.

Design process test



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: Program objectives

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

Questions/comments?