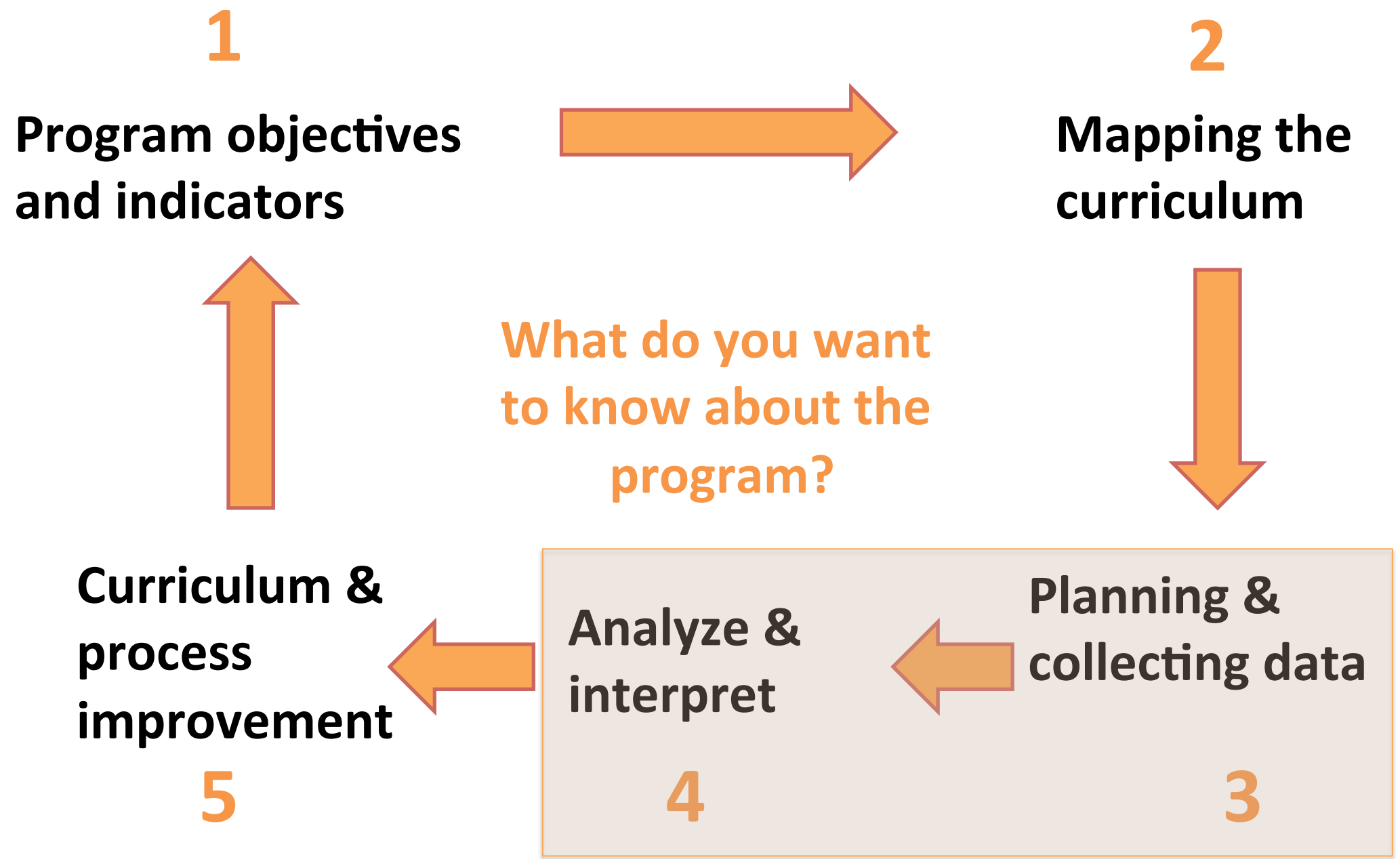
Assessment for Course and Program Improvement

Brian Frank, Queen's University
EGAD Project

EGAD recommended process



Recommended reference:

Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university*. Open university press.

EGAD Recommended "Process tools"

Tool for Step 1: Indicator collection

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

Tool for Step 2: Curriculum map

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

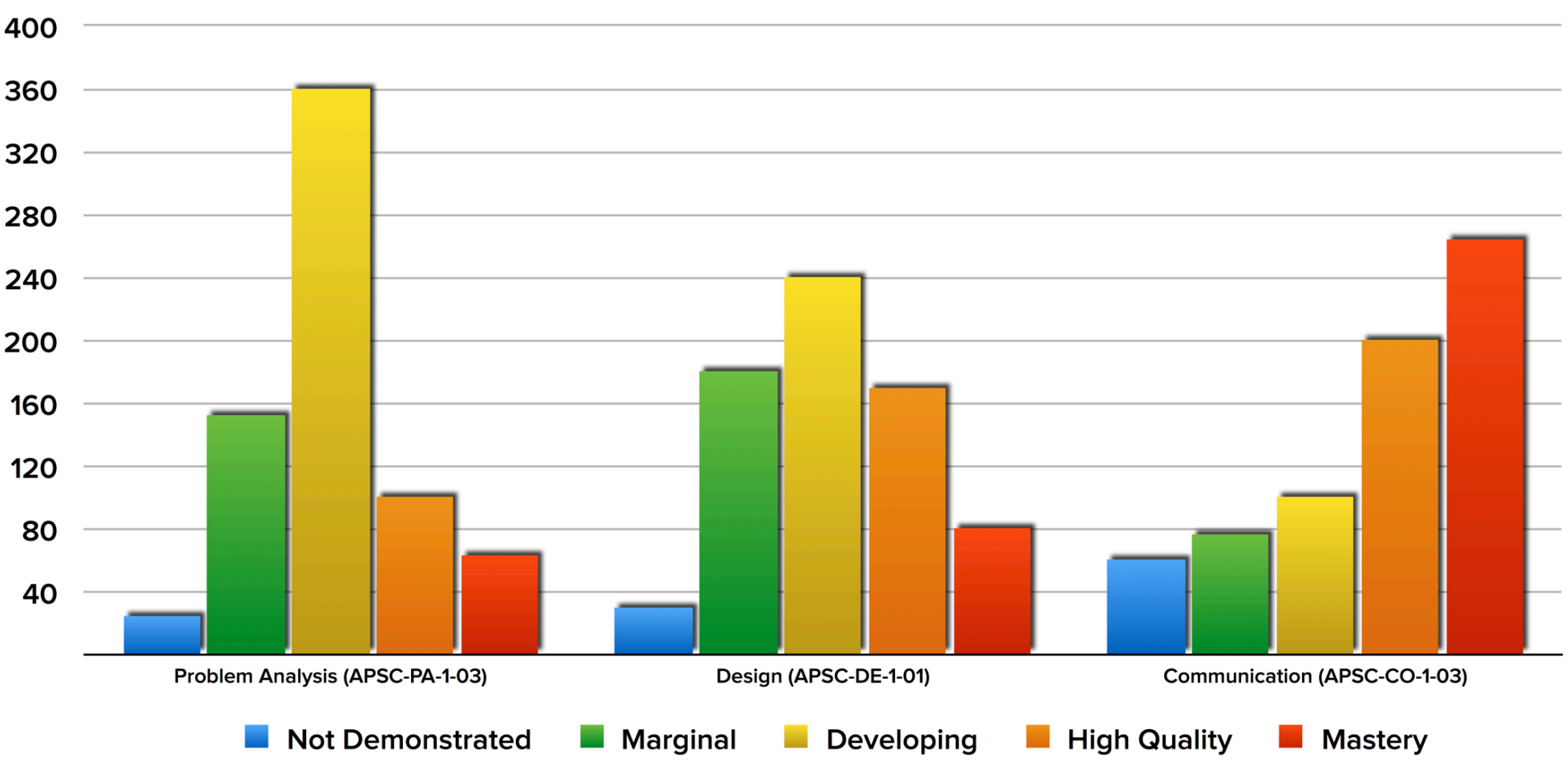
Tool for Step 3: Course planning table

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

	Teaching	Activity	Assessment
Week 1			
Week 2			
Week 3			
Week 4			

Tool for Step 3: Rubrics

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



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

Assessment methods

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

Part 1: Approaches to course assessment and analysis

Small groups:

- Group A: Indicators
- Group B1: Design course assessment
- Group B2: Chemical engineering course assessment
- Group B3: Electrical engineering course assessment
- Group C: Data analysis and curriculum change

Designate a note-taker and person to report back to all participants

Part 1: Group A - Indicators

- “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.”
- “The student effectively leads a team through a semester-long design problem…”
- “Define the concepts of engineering stress and engineering strain.”
- “Follow a provided design process to design system, component, or process to solve an open-ended complex problem as directed by a mentor.”
- “Describes economic feasibility of project using time value of money and defensible financial costs and returns”

Part 1: Group B1 – Design course assessment

Course: Introduction to Design and professionalism

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

1. Apply a prescribed process for solving complex problems *(Indicator: 2.3, 2.4, 2.6 - Problem solving)*
2. Effectively communicate in written document following a prescribed format and using standard English. *(Indicator: 7.1 - Effective writing)*
3. Apply concepts including occupational health and safety principles, economics, law, and equity to engineering problems. *(Indicator 4.3, 10.1, 11.1)*
4. Apply critical and creative thinking principles to solve contextualized problems *(Indicator: 2.7)*
5. Apply numerical modeling tool to create model used for solving complex problems.
6. Critically evaluate information on prescribed criteria *(Indicator: 12.1)*.

Week	Key concepts	Student activity	Assessment
1	Motivation, course overview, models.	Lecture group activity: what is a model?	
2	Complex problem solving process	Accident investigation activity: Part 1	
3	Stakeholders and constraints	Accident investigation activity: Part 2	
4	Argumentation	Practicing oral presentations	
5	Teaming	Teaming and conflict resolution activities	
6	Idea generation	Brainstorming activity	
7	Decision making	Evaluation matrix activity	
8	Safety and hazard analysis	Hazard analysis	
9	Evaluating Information	Team evaluation of information sources	
10	Professionalism and ethics	Ethical dilemma	
11	Engineering Law	Case study: negligence	
12	Economics	Time value of money activity	
13	Design process	Applications of course to client projects	

Part 1: Group B2 – Chemical Engineering

Course: Chemical Reaction Engineering

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

1. Calculate operating parameters (size, flowrates, conversion, etc.) for isothermal and non-isothermal operation of ideal well- mixed batch and continuous reactors, and for ideal plug-flow reactors *(Indicator 1.10, 1.12)*
2. Formulate a set of consistent material and energy balance equations to describe operation of batch, semi-continuous and continuous reactor systems with single or multiple reactions
3. Formulate an overall rate expression from a series of elementary mechanistic steps
4. Investigate the choice of reactor type and operating conditions on output such as reactant conversion, selectivity and yield. *(Indicator 1.11)*
5. Demonstrate ability to take leader role on a team project *(Indicator 6.3)*

Week	Key concepts	Student activity	Assessment
1-2	Reaction rates, stoichiometry	Partly worked examples	
3-5	Isothermal reactors, reversible reactions	Partly worked examples	
6-8	Nonisothermal reactor design	In-class guided design problem	
9-11	Multiple reactions, selectivity and yield	Practicing oral presentations	
12	Reaction networks and pathways		
13	Reactor design challenge	Working time for student teams	

Part 1: Group B3 – Electrical Engineering

Course: Electronics I

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

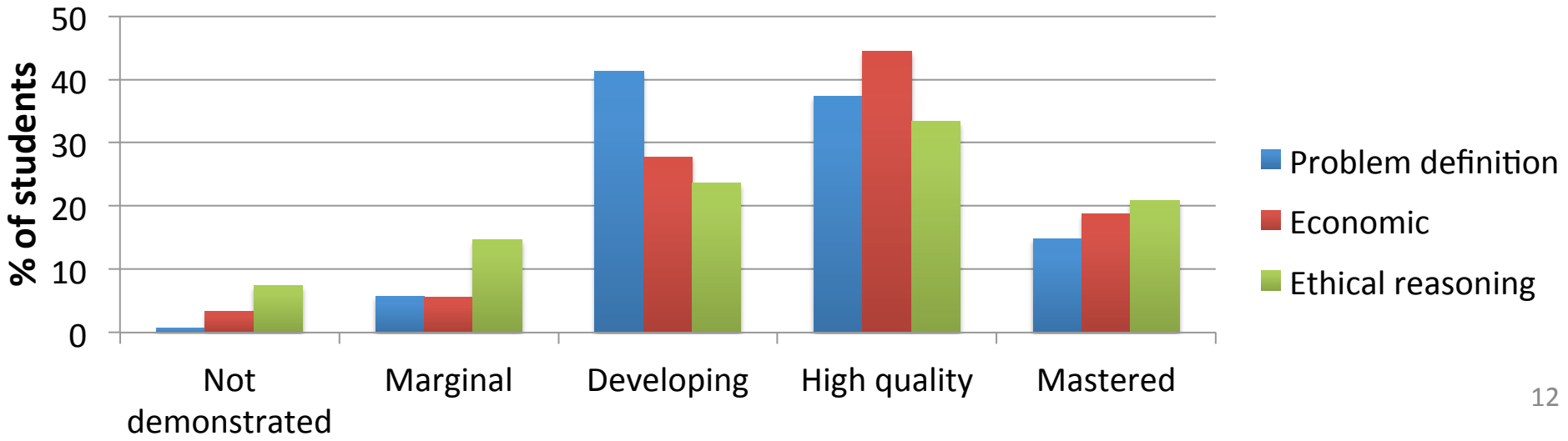
1. Select and use a small signal model to predict behaviour of common nonlinear active devices *(Indicator 1.8)*
2. Calculate current and voltage at nodes of non-linear devices when connected using common bias networks.
3. Calculate component values to implement common amplifier configurations *(Indicator 1.9)*
4. Select and design an electronic circuit (in this course, an amplifier) for a specific real-world application *(Indicator 4.3)*

Week	Key concepts	Student activity	Assessment
1	Motivation, connection to passive electric circuits	Electronics concept inventory pre-test	
2	Two terminal and three terminal active devices (diodes and transistors). Non-linear vs linear.	Team problem solving, followed by computer-based quiz question.	
3	Applications for two terminal devices	Team project planning: Identify requirements of project	
4	Applications and characteristics of amplifiers.	Team problem solving, followed by computer-based quiz question.	
6-7	Operation and behaviour of operational amplifiers. Applications.	Hand-in homework	
8-9	MOSFET amplifiers (CS, CG, CD)	Hand-in homework	
10-11	Bipolar amplifiers (CE, CC, CB)	Hand-in homework	
12	Nonlinear behaviour of transistors		
13	Design considerations, practical limitations of common devices.	Electronics concept inventory post-test	

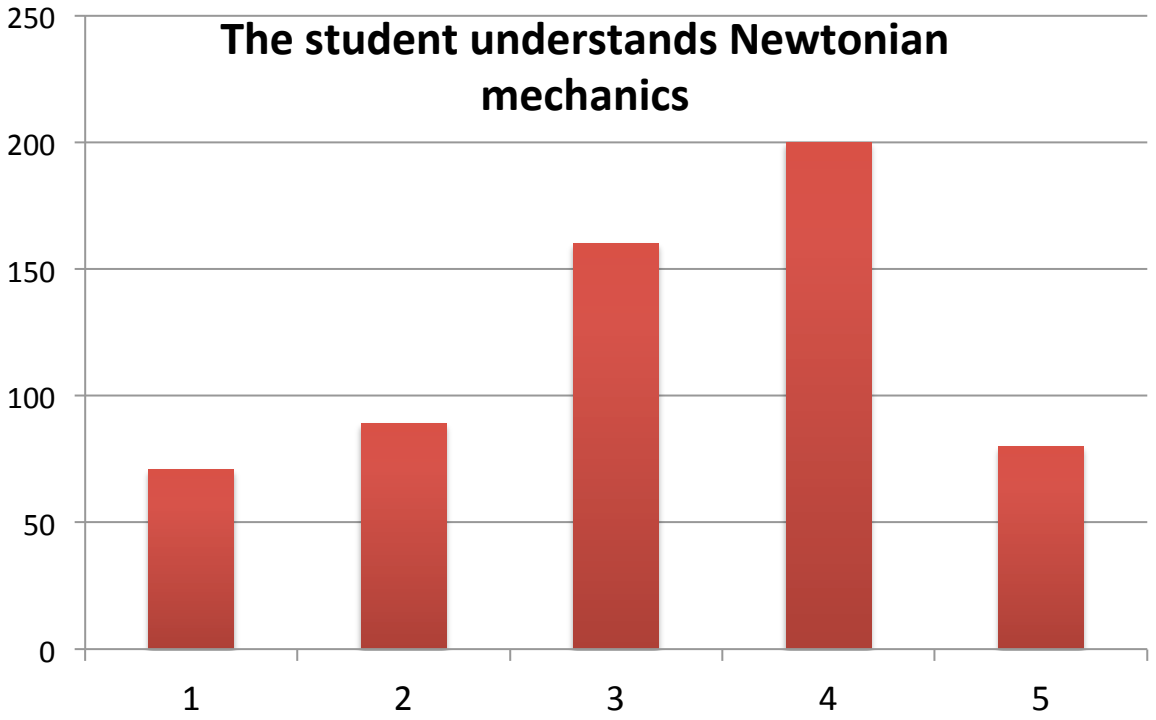
Part 1: Group C – Analysis and curriculum change

First year design course data

Outcome	Task-specific rubric descriptors				
	Not demonstrated	**Marginal**	**Developing**	**High quality**	**Mastered**
Problem definition: Accurately defines a problem, including significance, stakeholders, and client needs.	Problem not sufficiently defined …	Problem definition somewhat unclear, trivial/incorrect information included…	Problem definition is generally clear but minor issues with …	Clearly defines scope of problem, stakeholders, and required goals. Summarizes and assesses credibility of information used.	… and includes information from authoritative sources to inform process, model, and conclusions.
Economic analysis: Describes economic feasibility of project using time value of money and defensible financial costs and returns	No useful economic analysis	Discusses economic principles in a broad or general way without relating to the actual project	Describes economic feasibility …but some unsupported or erroneous analysis	Describes economic feasibility of project using time value of money…	Describes a business plan considering value of money in decision making…
Ethical reasoning: Recognizes and resolves ethical dilemmas based on ethical principles and relevant code of ethics	Does not recognize an ethical dilemma, or …	Identifies approach to resolving an ethical dilemma that is not supported, or misses important stakeholders	Recognizes and resolves ethical dilemmas with limited reference …	Recognizes and resolves ethical dilemmas supported by ethical principles and relevant codes of ethics.	…and analyzes alternatives approaches to resolving a dilemma and how they will impact various stakeholders

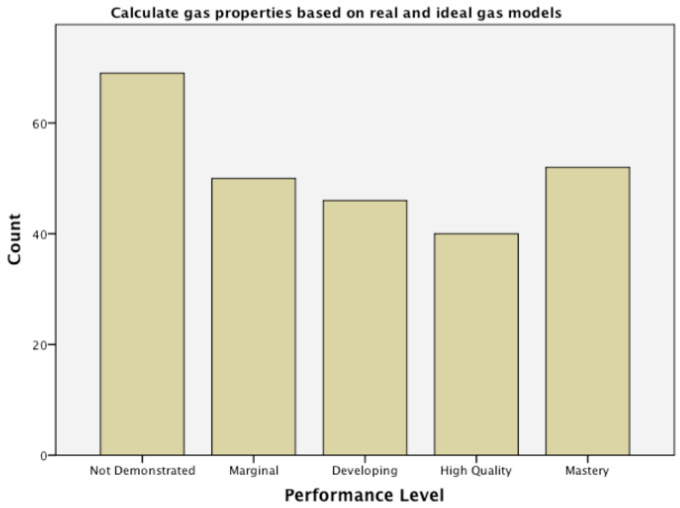


- Course context: First year statics course.
- Enrolment: 600 Students.
- Course Grade Distribution: Exam: 50%, 2 quizzes: 40 %, Assignments: 10%.
- How items were assessed: By TAs on a specific quiz question graded out of 5.

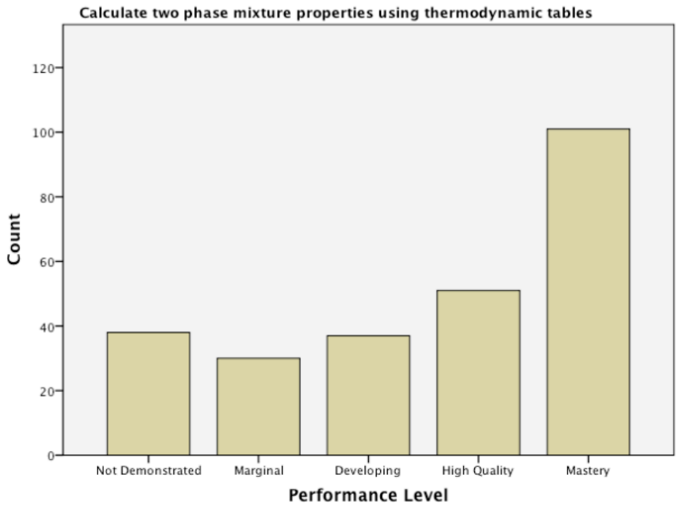


Assessment Data: Thermodynamics Course

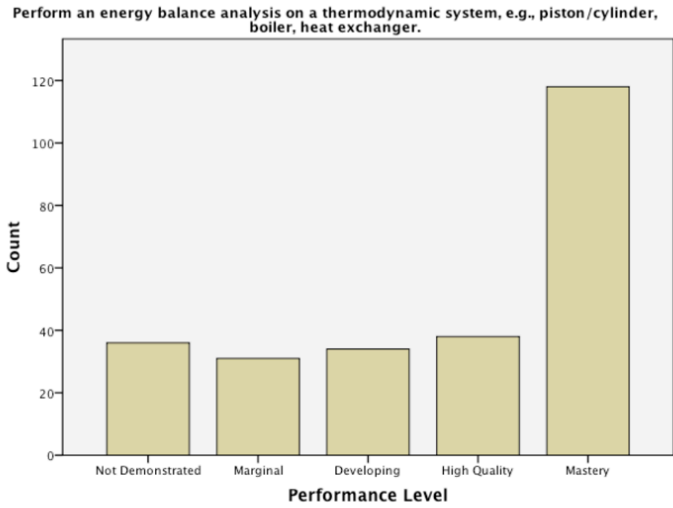
Indicator 1



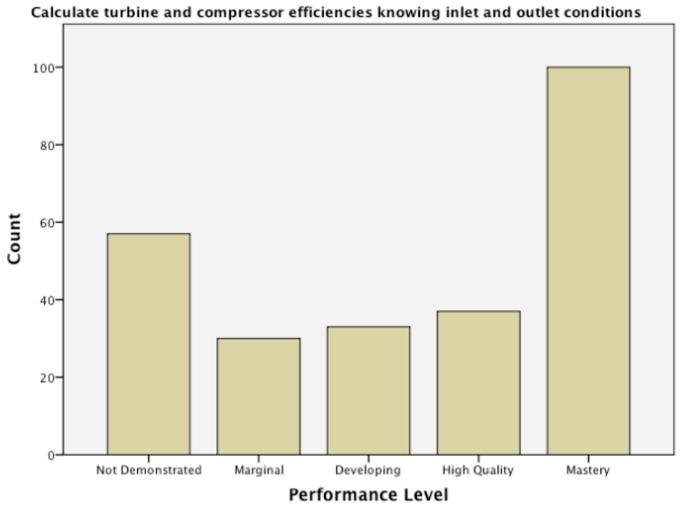
Indicator 2



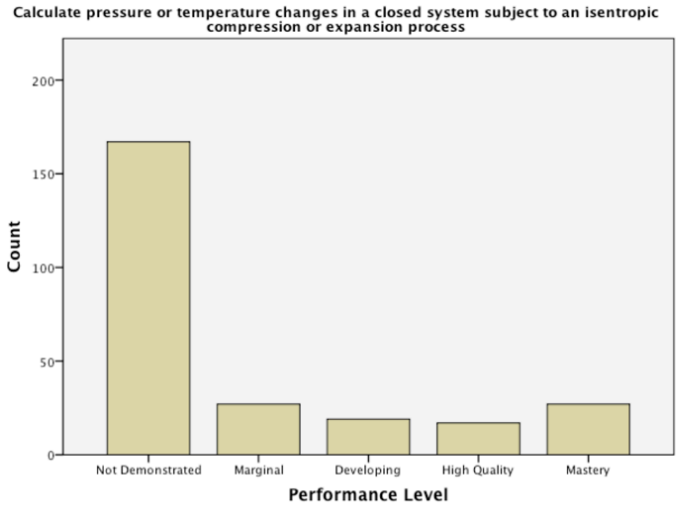
Indicator 3



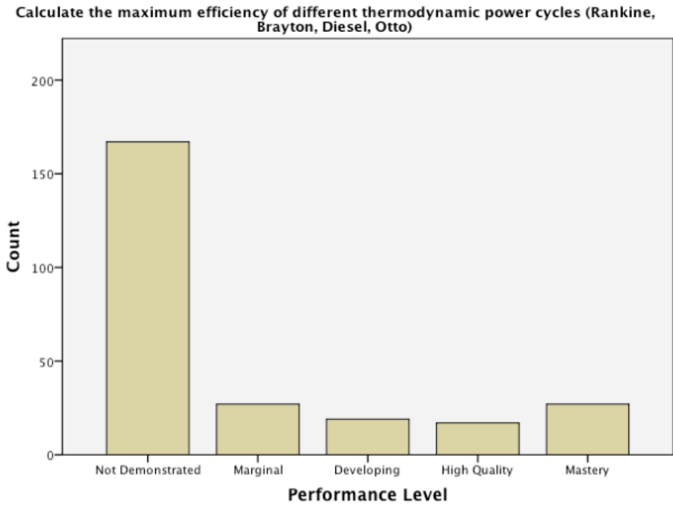
Indicator 4



Indicator 5



Indicator 6



Part 2: Strategy

Each person from the team splits up and moves to a new table.

Scenario: Your group is the graduate attribute planning committee. Currently your group is tasked with identifying an approach to assess how **{???}** are developing over the duration of your program. You need to be able to recommend a process that will generate data that allows your committee to draw meaningful conclusions. Your group has been asked to ensure that your process describes:

- Which kinds of courses to involve
- How assessments will be compared from one year to another
- How you will evaluate the trust-worthiness of the data (are the assessments measuring what you think they are? Would the assessments yield the same results if retested?)

EXAMPLES

Example: First year design course

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

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

First year design course project rubric

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

First year design course data

Outcome	Task-specific rubric descriptors				
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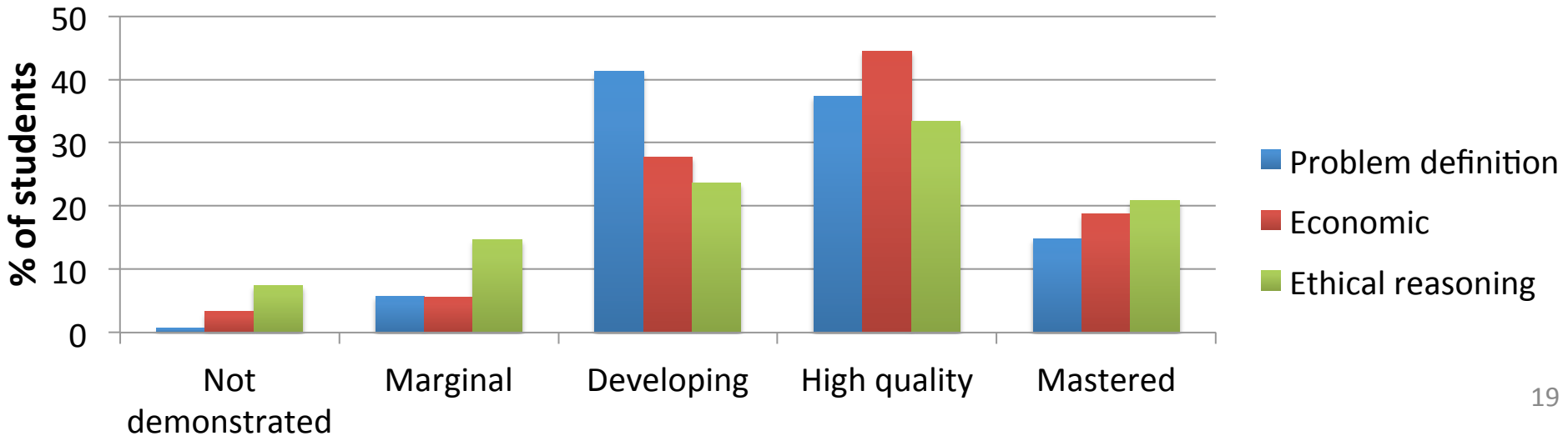
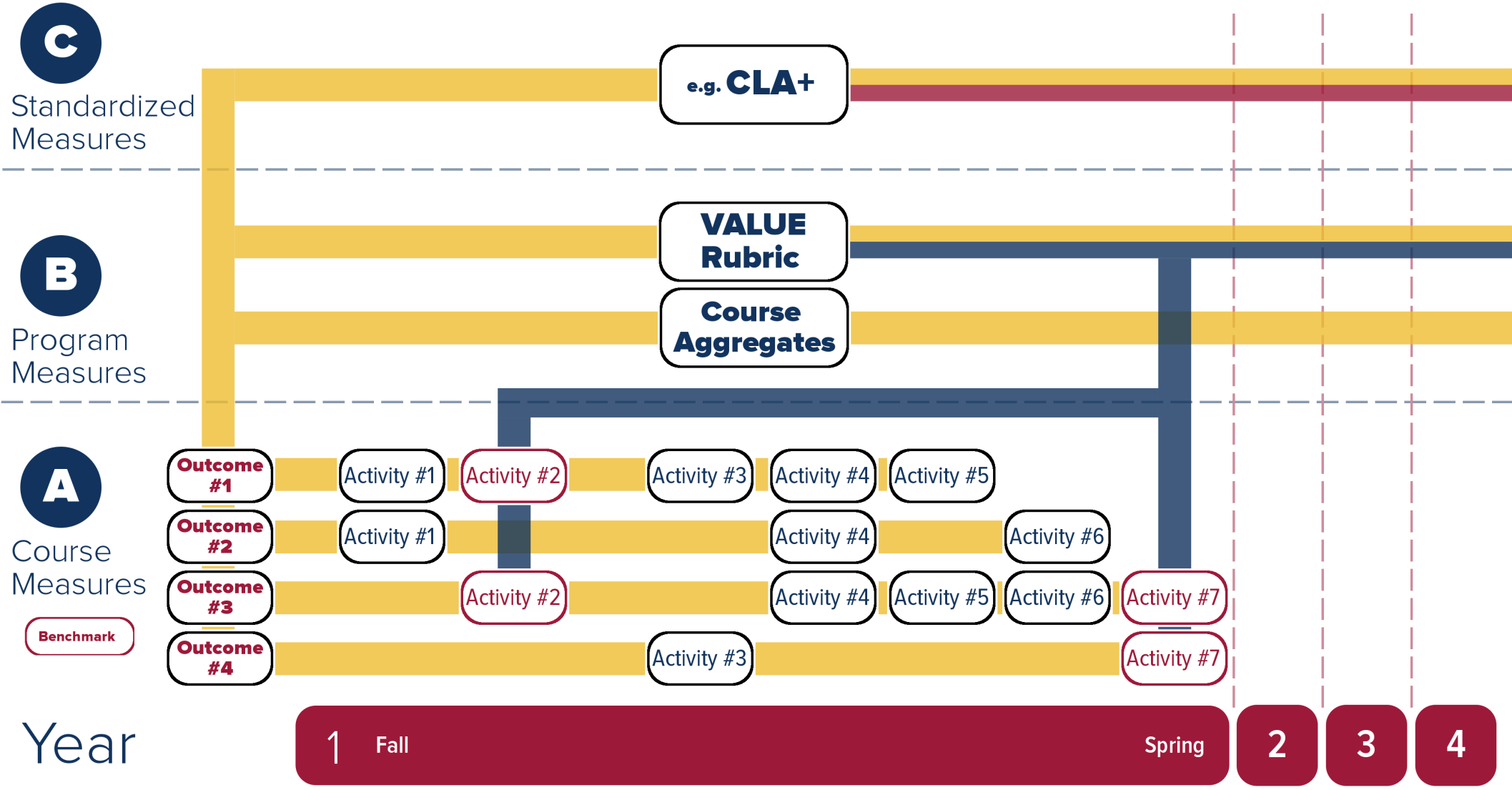


Queen's Example

Longitudinal Outcomes-based Assessment

A sample approach to measuring a specific competency



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