Aggregating quantitative data to draw meaningful conclusions

EGAD Workshop June 2019

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with Brian Frank, Nerissa Mulligan and Jake Kaupp

Session focus

Comparing approaches to aggregating data, going

From: Task-level scores assigned to **individual students** (which most of us are doing)

→

To: Demonstrating that a **student cohort** possesses a graduate attribute

3.1.5 Assessment results: At least one set of assessment results must be obtained for all twelve attributes over a cycle of six years or less. The **results should provide clear evidence that graduates of a program possess the above list of attributes.**

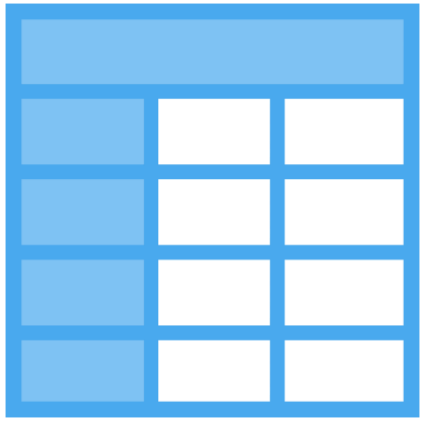
3.2.1 Improvement process: There must be processes in place that demonstrate that program outcomes are being assessed in the context of the graduate attributes, and that the **results are validated, analyzed** and applied to the further development of the program.

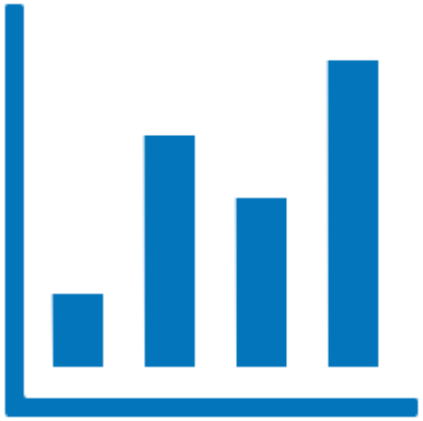
When you **aggregate data**, you replace **groups of observations** with **summary statistics** based on those observations.

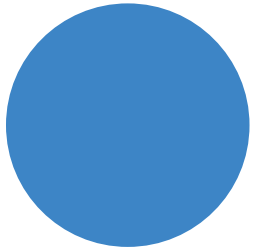
Aggregation level

Low

High



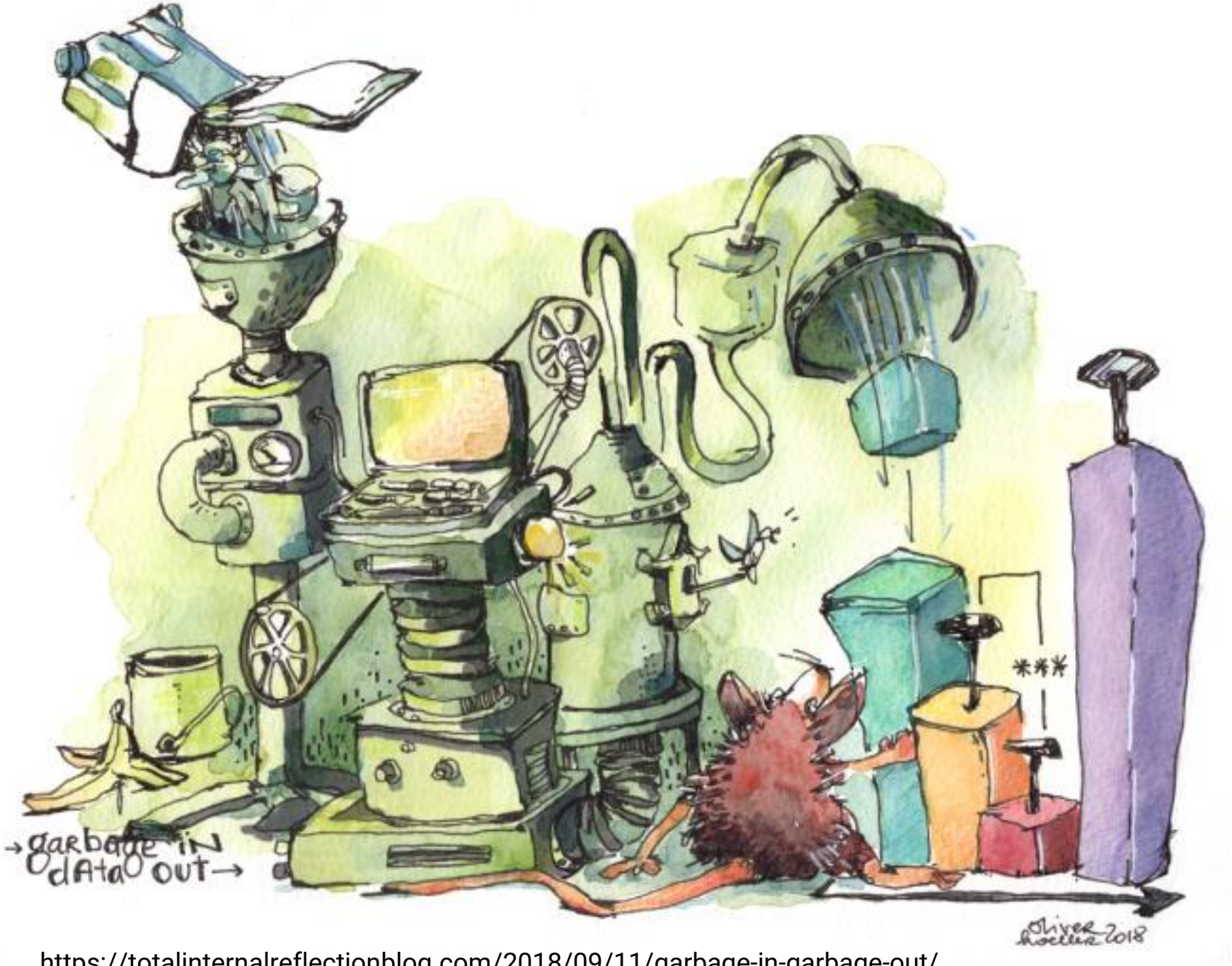




High

Low

Amount of data conveyed



"It is not possible to carry out meaningful statistical analysis of data that is fundamentally inaccurate."

https://totalinternalreflectionblog.com/2018/09/11/garbage-in-garbage-out/

We need ***reliable data*** if we are to draw ***valid conclusions***.

Task 1: In your groups, discuss what does it mean to say data is “reliable.”

Task 1 discussion: To draw **valid** conclusions we need **reliable** data.

Reliability of data relies on *consistency*, which can be measured as:

- Consistency over time
  - i.e. test-retest reliability
- Consistency between graders
  - i.e. inter-rater reliability
- Internal consistency
  - i.e. inter-item reliability

Validity of conclusions depends on:

- Measuring the right things (e.g. indicators)
- Using appropriate approaches to measure
- Agreement with conclusions drawn from other approaches (students, employers, alumni,…)

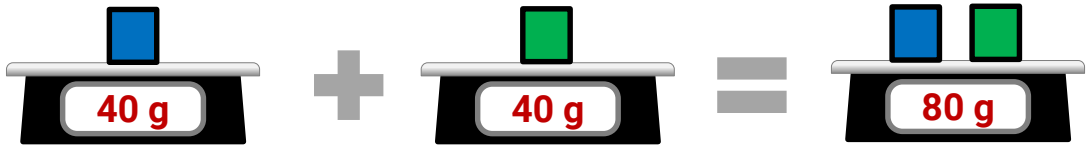
OTHER WORKSHOPS

- Reliability

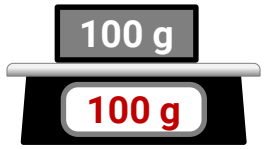
An analogy to test understanding…

Inter-rater reliability:

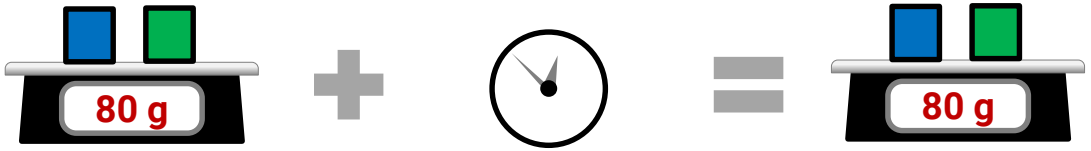
Inter-item reliability:



Validity:

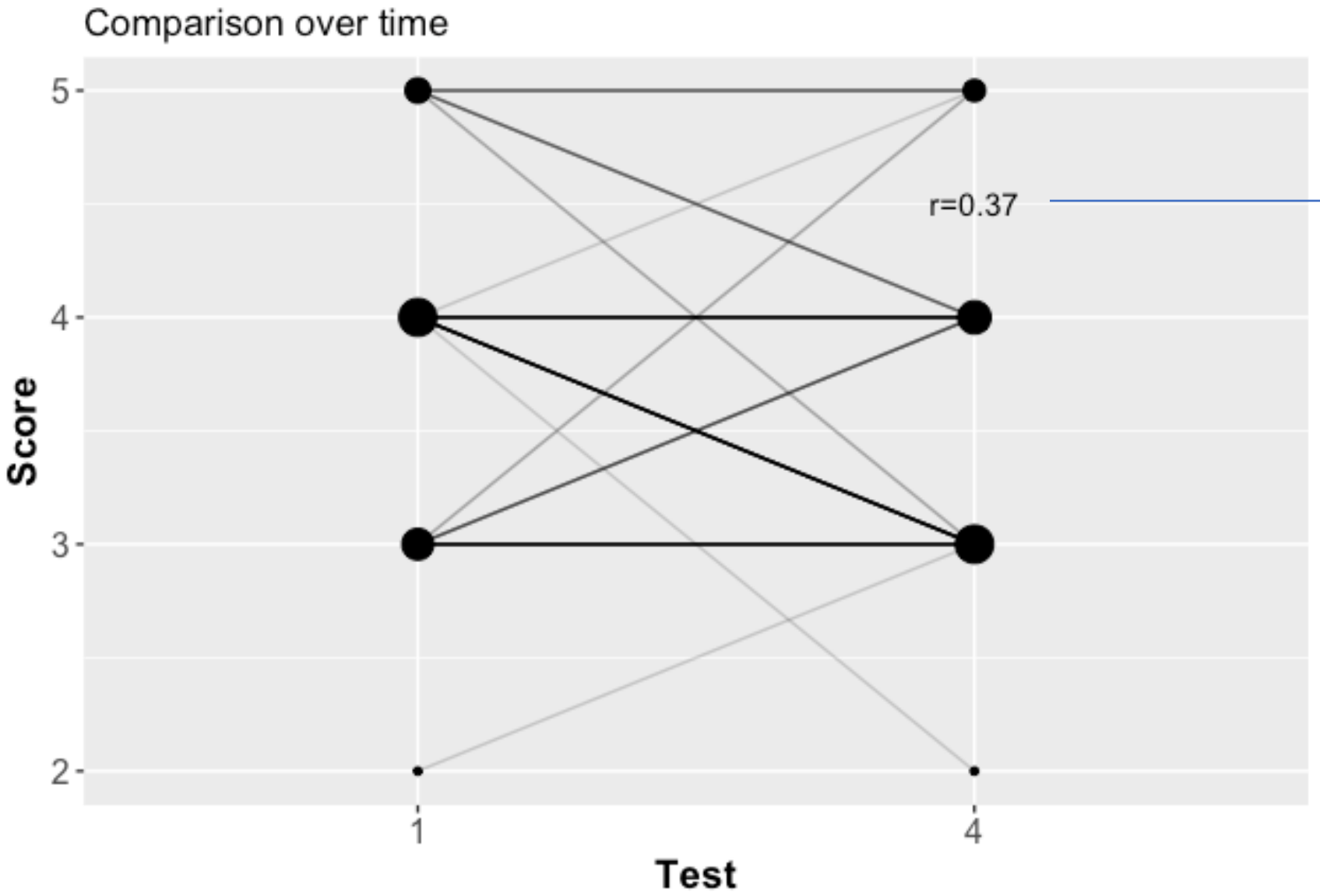


Test-retest reliability:



Inter-item reliability:

Characterizing reliability could involve comparing over time (e.g. multiple tests):



Correlation coefficient suggests poor consistency

Characterizing reliability could involve comparing grader agreement:

Task 2: In your group, identify what you are doing, or could do, in your GA process to make your data consistent, considering three possible risks:

1. Consistency over time (test-retest reliability)
2. Consistency between graders (inter-rater reliability)
3. Internal consistency (inter-item reliability)

Task 2 discussion: what you are doing, or could do, in your GA process to make your data consistent, considering three possible risks:

1. Consistency over time (test-retest reliability)
2. Consistency between graders (inter-rater reliability)
3. Internal consistency (inter-item reliability)

`group_by(Student ID, Course, Attribute, Indicator)`

Student ID	Program	Year of Study	Course	Attribute	Indicator	Assessment	Score
A	ENGR	1	ENGR 101	KB	ENGR-KB-1	Midterm	3
A	ENGR	1	ENGR 101	KB	ENGR-KB-1	Final	5
B	ENGR	1	ENGR 101	KB	ENGR-KB-1	Midterm	4
B	ENGR	1	ENGR 101	KB	ENGR-KB-1	Final	4
C	ENGR	1	ENGR 101	KB	ENGR-KB-1	Midterm	4
C	ENGR	1	ENGR 101	KB	ENGR-KB-1	Final	1

Raw Data

`summarize(Score = mean(Score)`

Student ID	Course	Attribute	Indicator	Score
A	ENGR 101	KB	ENGR-KB-1	4
B	ENGR 101	KB	ENGR-KB-1	4
C	ENGR 101	KB	ENGR-KB-1	2.5

Distribution

`group_by(Course, Attribute, Indicator)`

Student ID	Course	Attribute	Indicator	Score
A	ENGR 101	KB	ENGR-KB-1	4
B	ENGR 101	KB	ENGR-KB-1	4
C	ENGR 101	KB	ENGR-KB-1	2.5

`summarize(Score = mean(Score)`

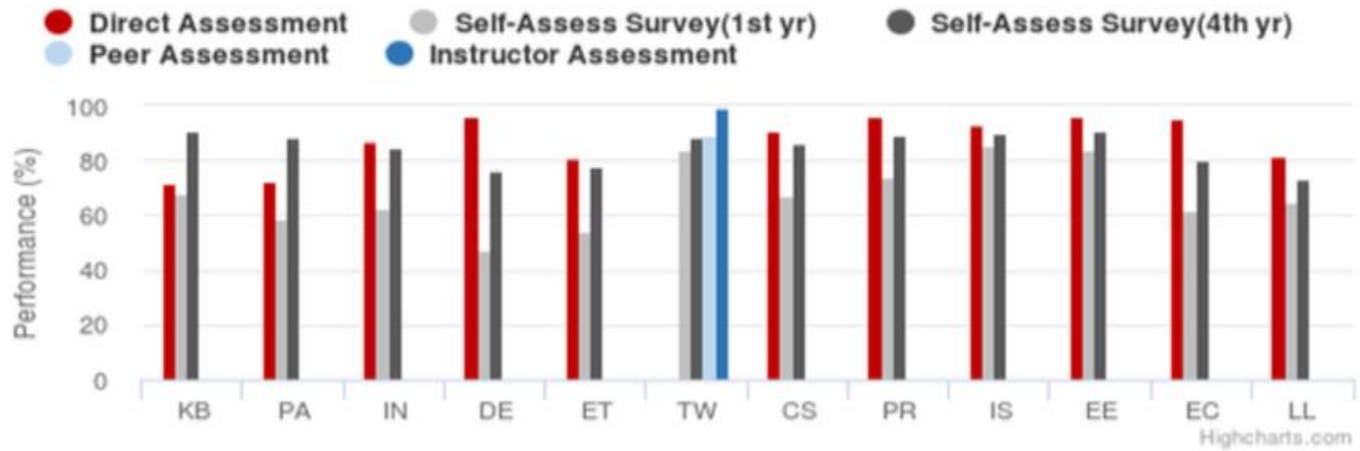
Course	Attribute	Indicator	Score
ENGR 101	KB	ENGR-KB-1	3.5

Aggregate

Framework for comparing aggregation approaches

Factor	Possible options
Aggregation target	• single value (e.g. Design = 3.6/5) • distribution of performance, (e.g. histogram of student performance) • qualitative description (textual based analysis of results)
Aggregation level	• up to attribute (e.g. “Design”) • up to indicator within each attribute (e.g. “Problem definition”) • up to course-level learning outcome / sub-indicator (e.g. aspect of “problem definition”)
Differentiation factors	• Year of Program (Year 1 to 4) • IDA level (Introduce, Developed, Applied) • Program option (e.g. biomechanics vs. materials) • Summative vs. Formative • Assessment type (e.g. final report, exam, lab simulation, portfolio) • Student groups (first in family, racialized, Indigenous)
Reliability measure	• Correlation between tasks (e.g. correlation between three measures of “problem definition”) • Correlation between years (e.g. correlation between scores in 2016, 2017, and 2018) • Correlation between multiple ways of measuring an indicator

Examples

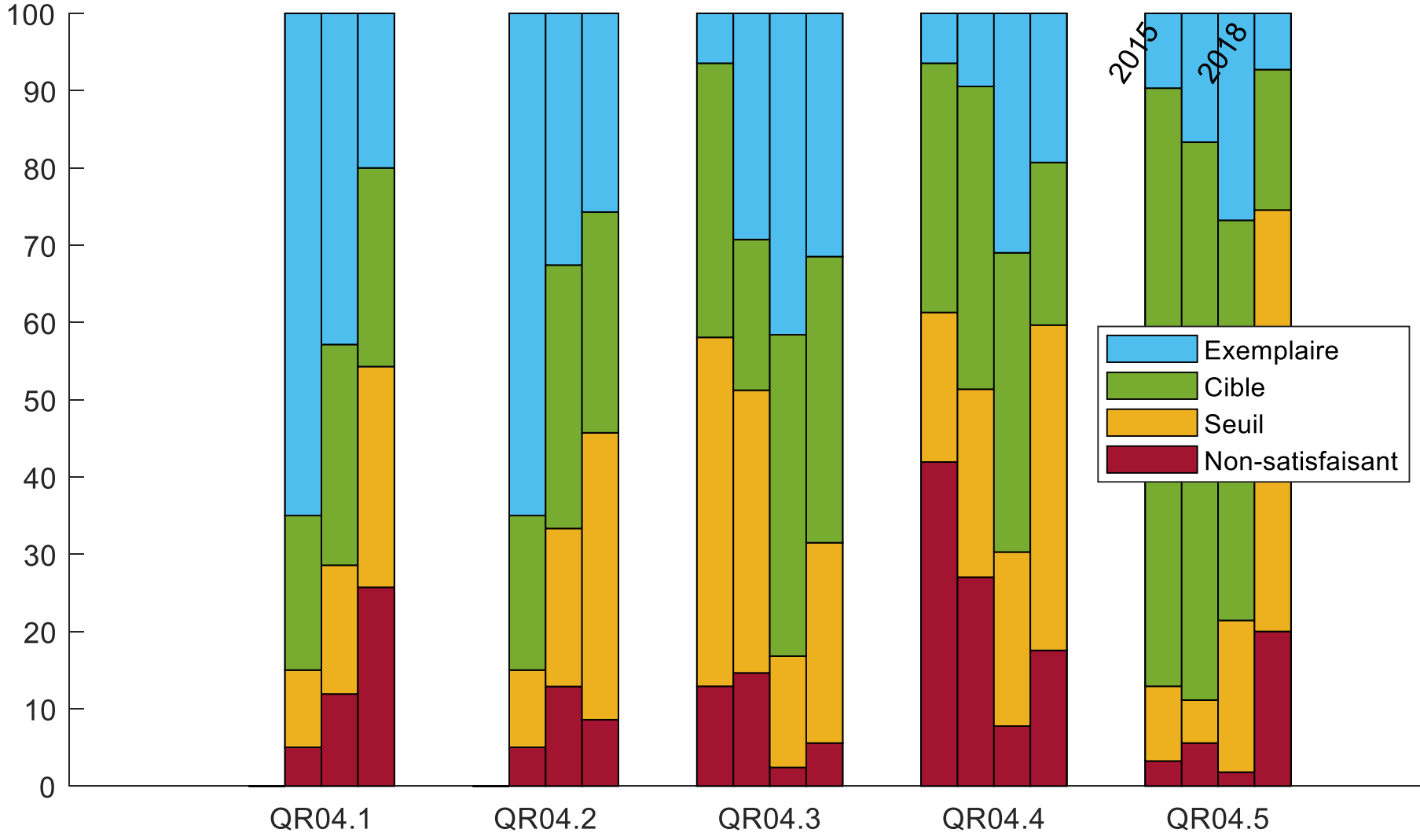


	KB		PA		IN		DE		ET		TW		CS		PR		IS		EE		EC		LL	
#	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ	Val	Targ
1	87.3	80	82.6	80	86.7	80	100.0	80	88.2	80	97.2	-	91.6	80	95.7	80	89.9	80	95.0	80	92.8	80	73.7	-
2	75.9	-	67.0	-	90.3	80	87.2	80	74.8	80	90.4	80	98.5	80	96.7	80	90.8	80	84.7	-	57.5	-	76.1	80
3	93.9	80	93.5	80	82.1	80	97.4	80	68.0	80	70.8	-	82.8	80	95.5	80	89.2	80	93.9	80	76.5	80	70.0	-
4	82.9	80	66.8	80	93.1	80	97.4	80	75.9	80	78.8	80	84.7	80	74.2	-	100.0	80	93.7	80	94.4	80	75.5	80
5	80.5	80	52.6	-	82.1	80	100.0	80	97.1	80	88.7	80	87.4	80	88.0	80	86.6	80		80	100.0	80	84.4	80
6	73.7	-	85.1	80	62.5	-	96.9	80	54.3	-	99.1	80	100.0	80			85.5	-	99.4	80	66.8	-	43.3	-
7	87.5	80	64.8	80	84.7	80	100.0	80	79.2	80	94.3	80	66.8	-			90.4	80	83.1	-	83.5	80	76.4	80
8	80.7	80	60.2	-			88.8	80			99.1	80	86.4	80					88.2	80			78.0	80
9	73.9	-	89.6	80			100.0	80			82.0	80											89.3	80
10	86.4	80	72.0	80			47.6	-			99.1	80											73.9	-
11	48.0	-	54.1	-			76.4	80			91.6	80											88.1	80
12	86.7	80	87.0	80							93.5	-												
13	84.4	80									96.8	80												
14	58.3	80									75.5	-												
15	74.0	80									82.5	80												
16	55.8	80																						
17	80.7	80																						
18	58.3	80																						

Target met or exceeded
Performance below target
Missing data
No target

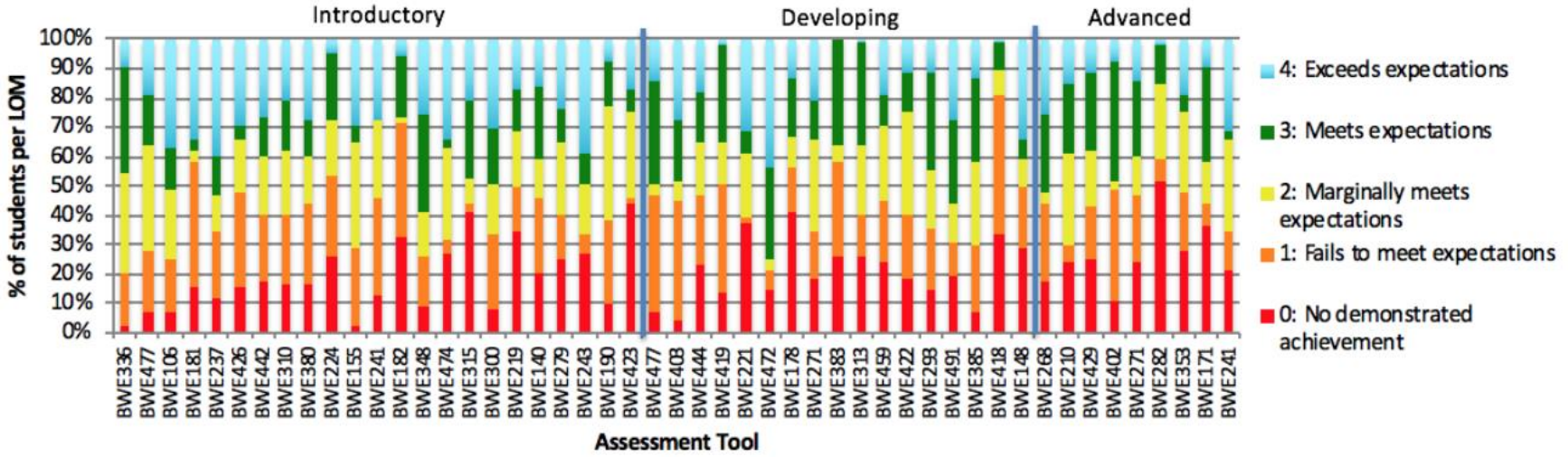
Factor	Approach
Aggregation target	Single values: Mean and % meeting target
Aggregation level	Attribute, but only for CEAB reporting, not internal use
Differentiation factors	Direct/peer/self assessment
Reliability measure	Factor analysis

GA4 (QR4) by year



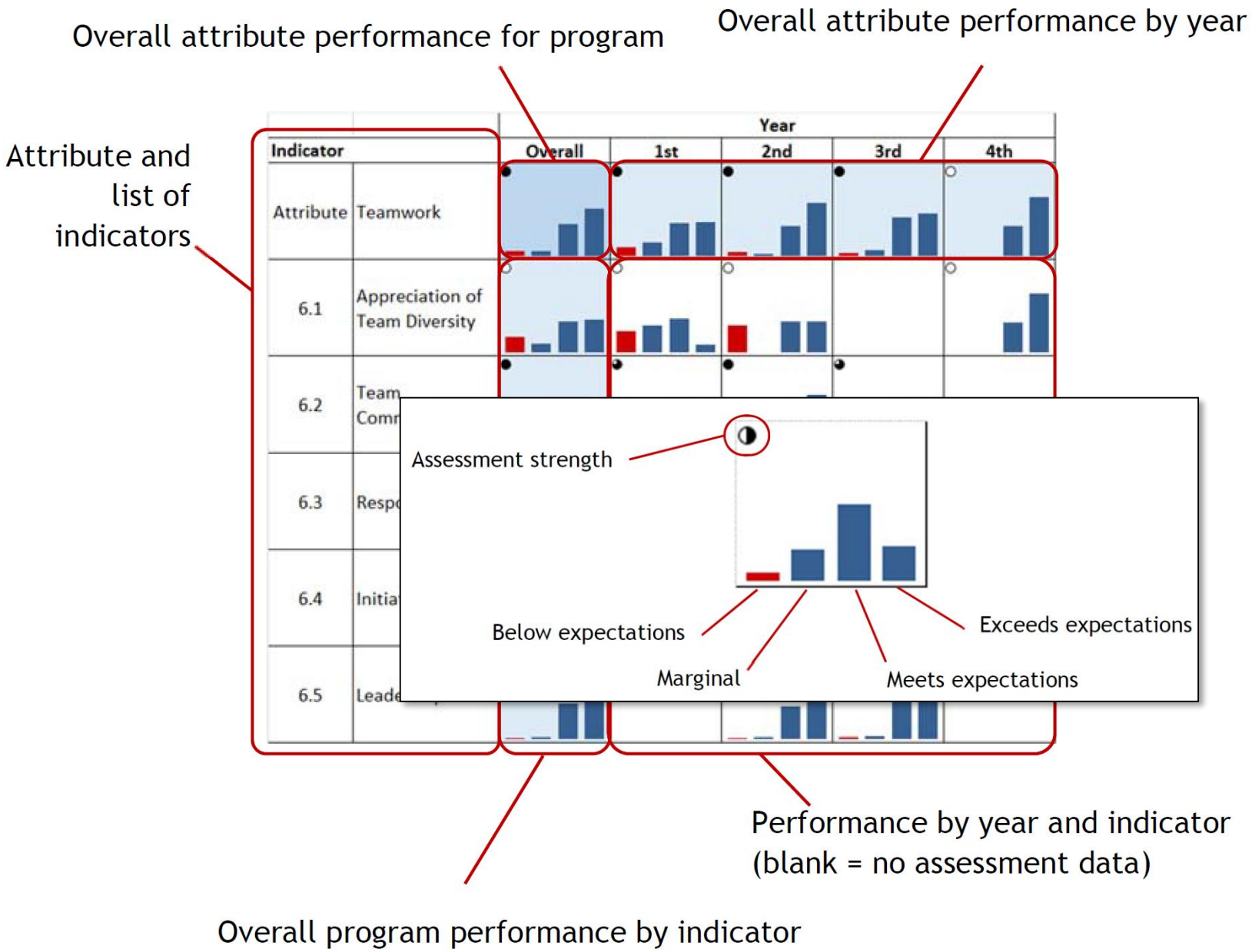
Factor	Approach
Aggregation target	Frequency distribution of performance
Aggregation level	Indicator
Differentiation factors	Year
Reliability measure	

2a) Problem Analysis: Indicator (a)

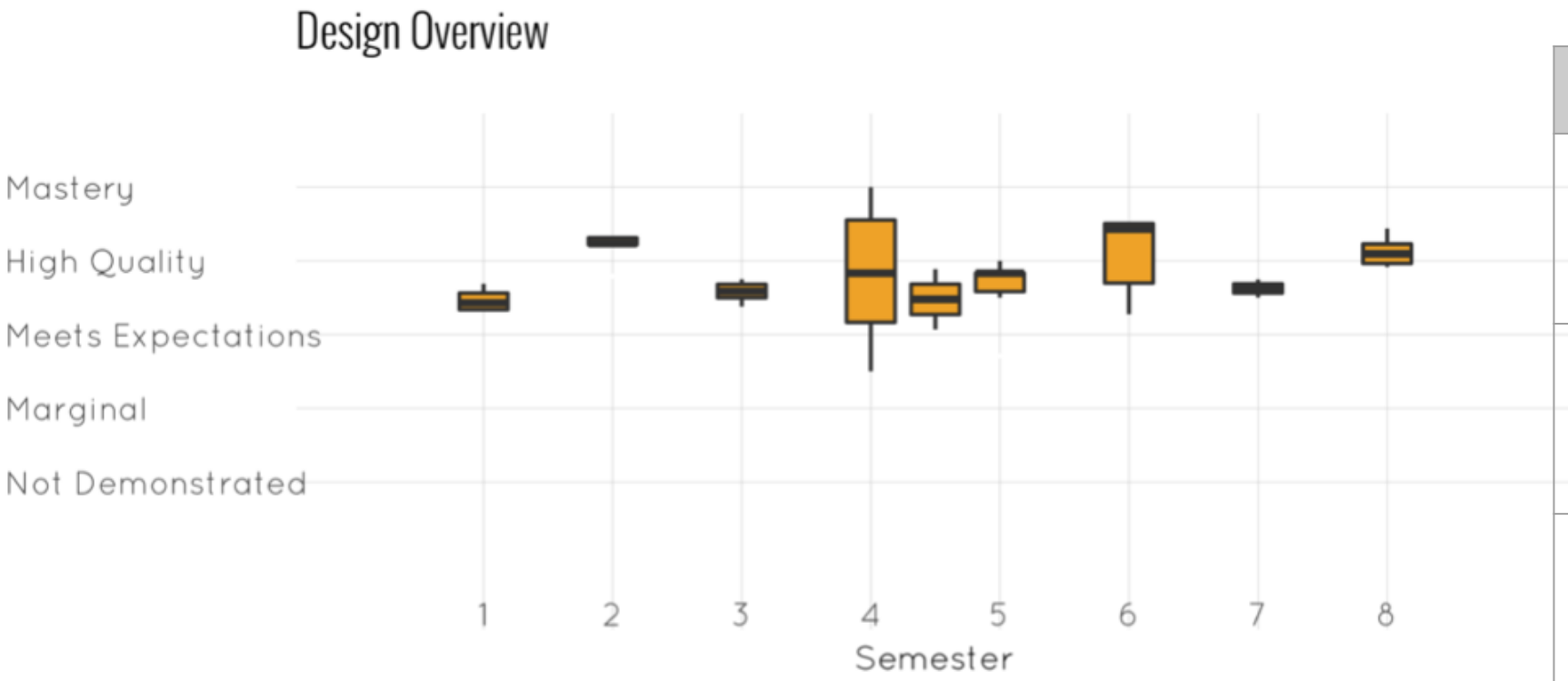


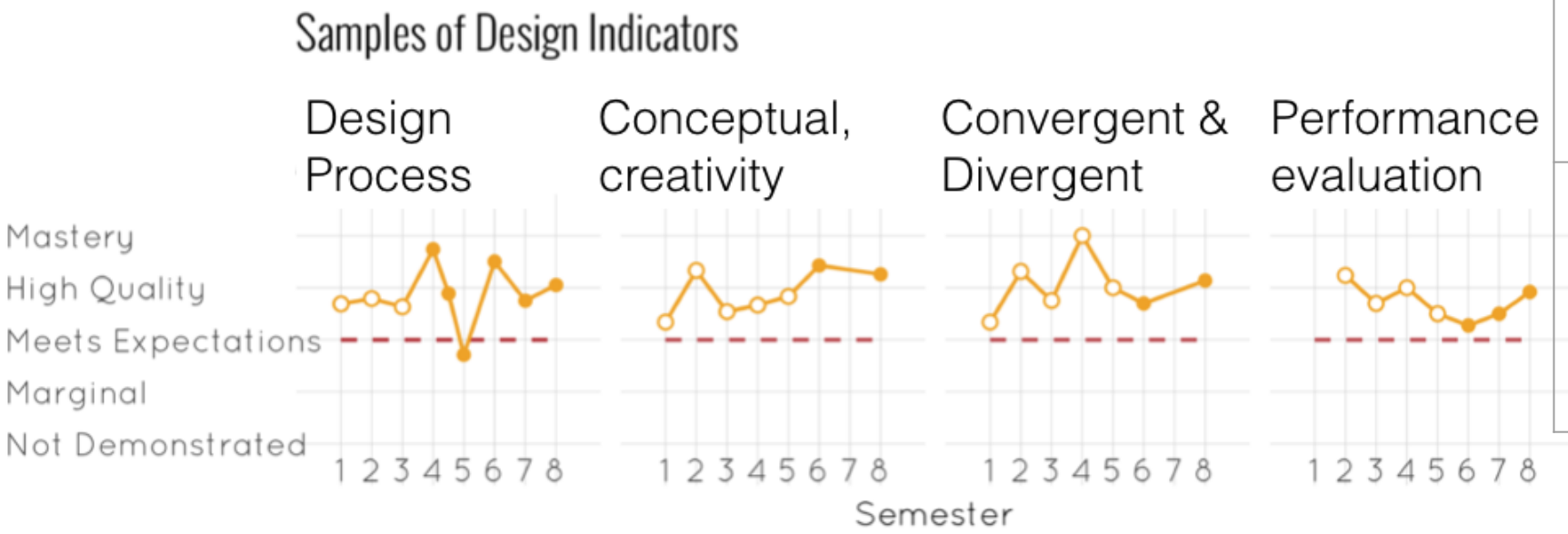
Tool	Ind	Level	Assessor	Question or course learning outcome	# of students at LOM...					% of students over threshold
					0	1	2	3	4	
BWE336	a	I	1. Instructor	CLO #5 (Awesome assessment method #5)	7	47	88	93	25	45%
BWE477	a	I	1. Instructor	CLO #4 (Awesome assessment method #5)	18	54	93	44	50	36%
BWE106	a	I	1. Instructor	CLO #11 (Awesome assessment method #7)	14	35	45	27	71	51%
BWE181	a	I	1. Instructor	CLO #11 (Awesome assessment method #6)	27	75	8	6	60	38%
BWE237	a	I	1. Instructor	CLO #11 (Awesome assessment method #1)	25	46	26	28	83	53%
BWE426	a	I	1. Instructor	CLO #7 (Awesome assessment method #8)	43	91	49	15	82	35%
BWE442	a	I	1. Instructor	CLO #6 (Awesome assessment method #1)	37	48	44	27	57	39%
BWE310	a	I	1. Instructor	CLO #3 (Awesome assessment method #2)	61	87	81	65	77	38%
BWE380	a	I	1. Instructor	CLO #8 (Awesome assessment method #1)	37	63	35	29	61	40%
BWE224	a	I	1. Instructor	CLO #2 (Awesome assessment method #6)	95	99	72	80	19	27%
BWE155	a	I	1. Instructor	CLO #11 (Awesome assessment method #6)	3	41	54	8	44	35%
BWE241	a	I	1. Instructor	CLO #6 (Awesome assessment method #3)	35	93	72	1	75	28%
BWE182	a	I	1. Instructor	CLO #10 (Awesome assessment method #3)	77	89	6	47	14	26%

Factor	Approach
Aggregation target	Frequency distribution of performance
Aggregation level	Multiple (learning outcome within indicator)
Differentiation factors	IDA
Reliability measure	

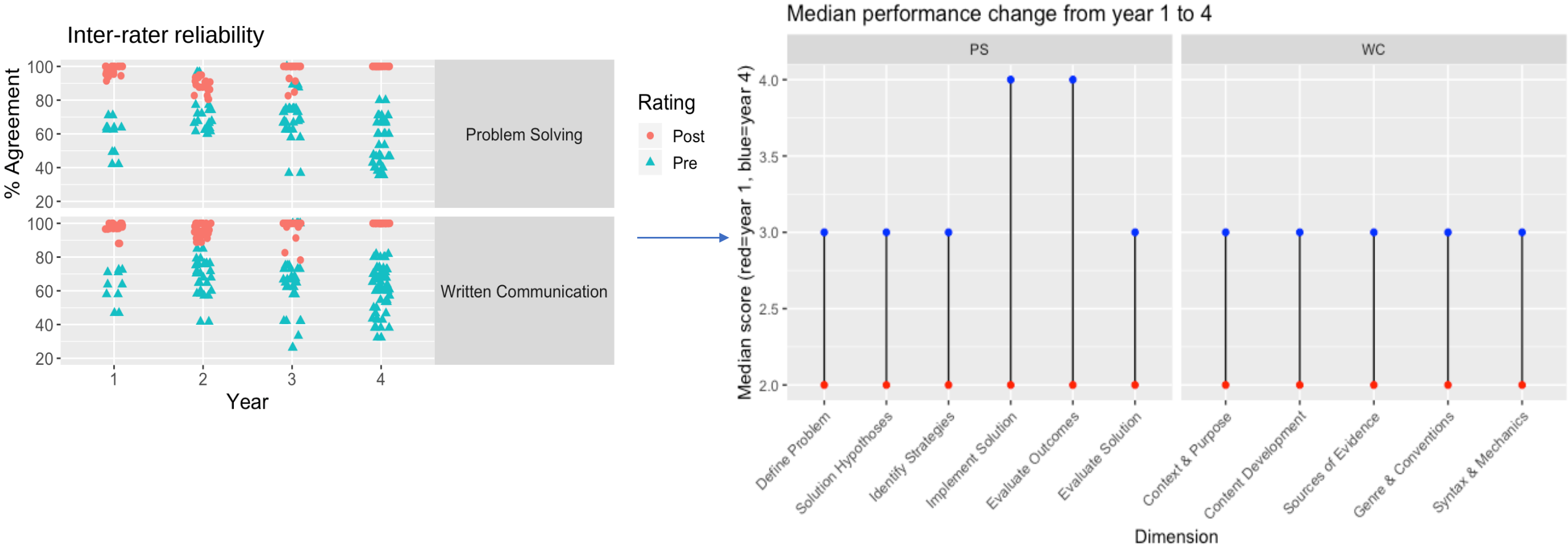


Factor	Approach
Aggregation target	Frequency distribution of performance
Aggregation level	Indicator
Differentiation factors	Year
Reliability measure	Assessment strength rating by instructor

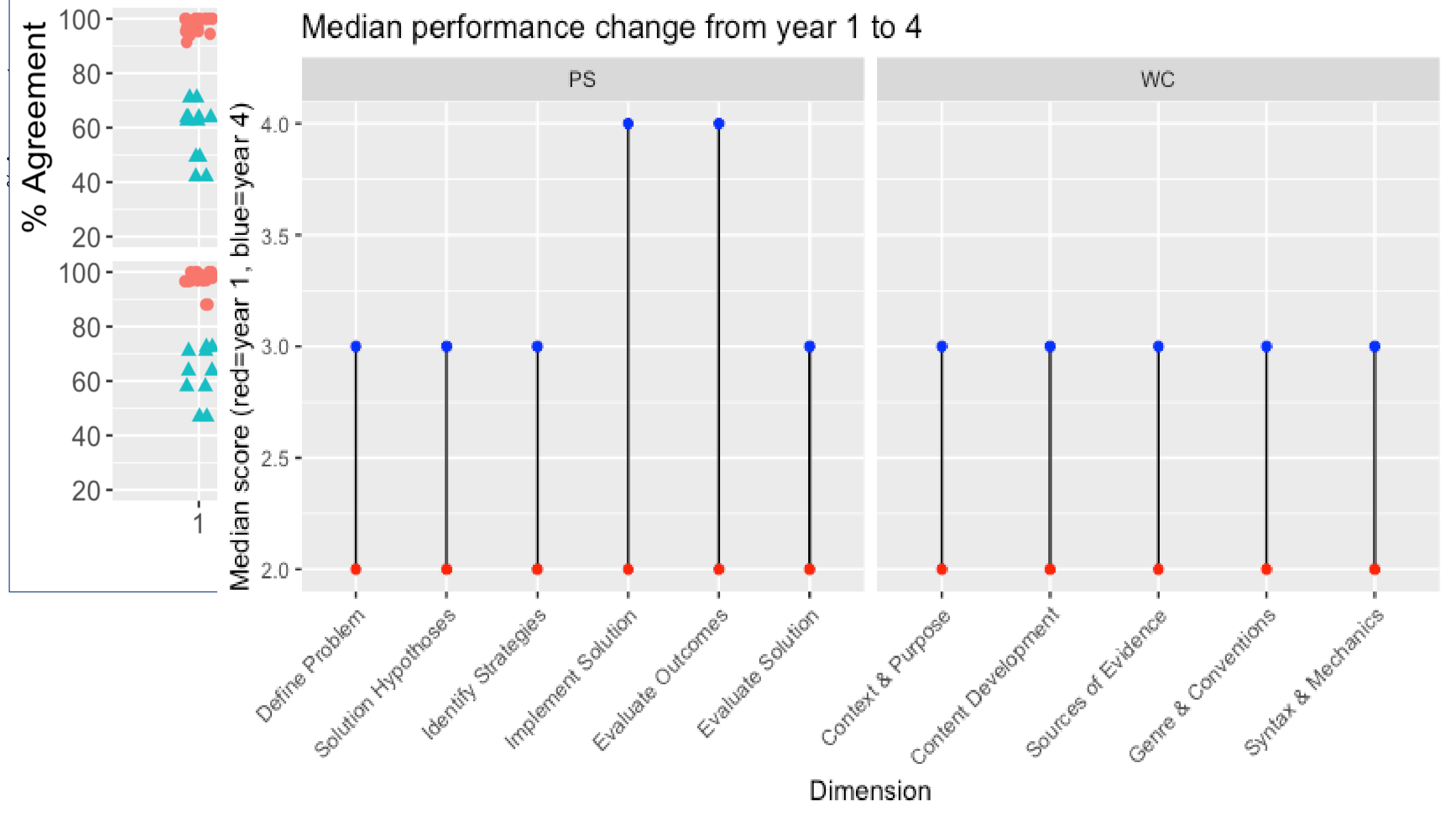




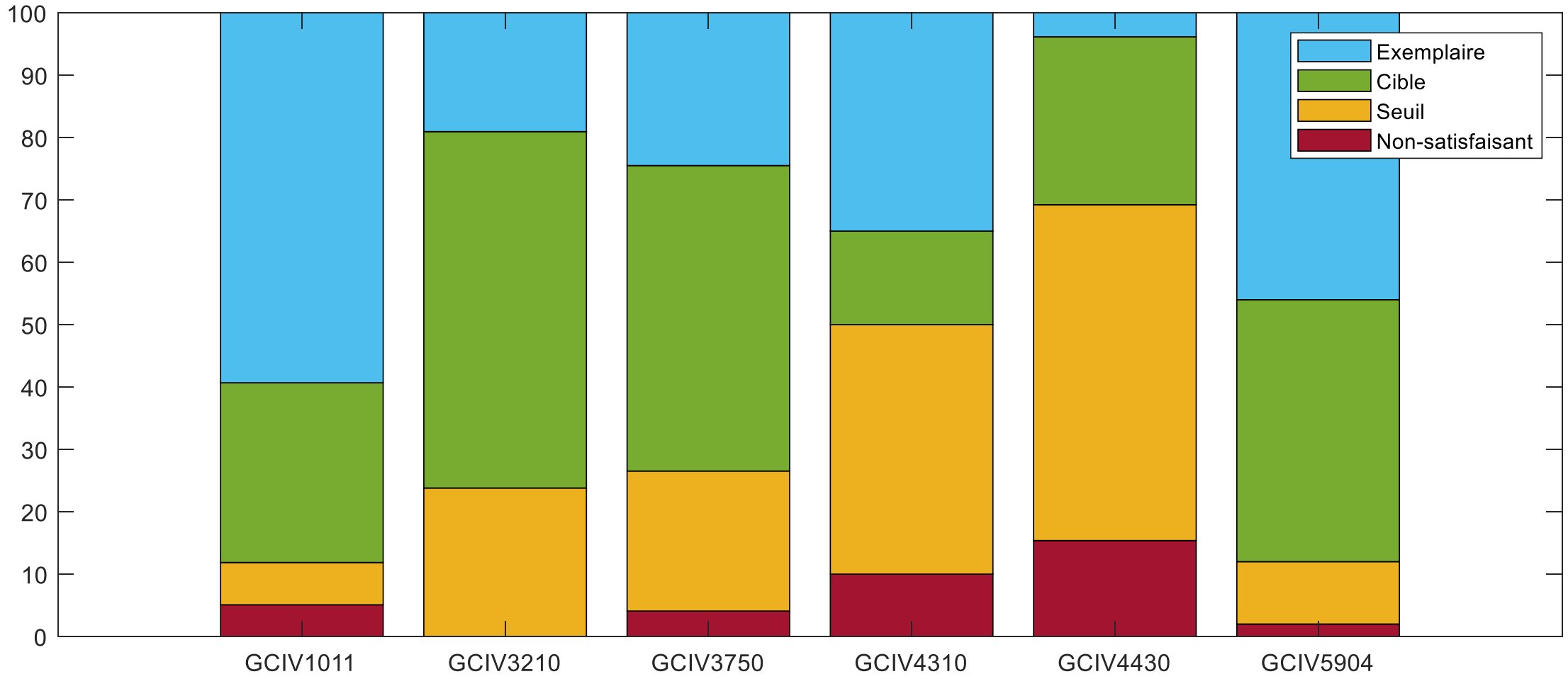
Factor	Approach
Aggregation target	Distribution of performance
Aggregation level	Indicator
Differentiation factors	Semesters
Reliability measure	



Factor	Approach
Aggregation target	Rubric dimension medians
Aggregation level	Indicator
Differentiation factors	Year level
Reliability measure	% agreement (Inter-rater reliability)


% Agreement
100
80
60
40
20
1
Median performance change from year 1 to 4
PS
WC
Median score (red=year 1, blue=year 4)
4.0
3.5
3.0
2.5
2.0
Define Problem
Solution Hypotheses
Identify Strategies
Implement Solution
Evaluate Outcomes
Evaluate Solution
Context & Purpose
Content Development
Sources of Evidence
Genre & Conventions
Syntax & Mechanics
Dimension

GA4.3 (QA4.3), same group, civil engineering



Task 3: Connect the factors to current institutional approaches

1. Identify how well the four factors describe the institutions' approaches represented within the group. Is there a key factor that is not captured by that list of four? If so add it to your list of factors to consider.

2. Briefly describe each institution's approach using the factors.

Task 3 discussion: Connect the factors to current institutional approaches

Report out:

1. Were there any key factors emerge that were not captured by the original list of four?

2. How well are institutional approaches captured by the factors? Are there two extremely different approaches between institutions represented at your table?

Task 4: Consider what aggregation means to key stakeholders

As a table group, identify what key stakeholders are looking for from aggregation. Consider

- Course instructors
- Department administration
- Faculty administration
- CEAB visiting team

Task 4 discussion: Consider what aggregation means to key stakeholders

Report out: what are key stakeholders are looking for from aggregation?

- Course instructors
- Department committees, staff, and administration (which may also consult with broader stakeholders)
- Faculty committees, staff, and administration (which may also consult with broader stakeholders)
- CEAB visiting team

Task 5: What mix of aggregation approaches would meet the collective needs of stakeholders?

Consider needs of key stakeholders:

- Course instructors
- Department committees, staff, and administration (which may also consult with broader stakeholders)
- Faculty committees, staff, and administration (which may also consult with broader stakeholders)
- CEAB visiting team

Consider factors in aggregation

1. Aggregation target: single value, distribution of performance, or qualitative description
2. Aggregated level: up to attribute, up to indicator within each attribute, up to task within indicator within attribute
3. Differentiation factor: differentiate by year, IDA level, program, student sub-group, student
4. Reliability measure: qualitative or quantitative instructor rating, correlation between tasks or years

Task 5 discussion: What mix of aggregation approaches would meet the collective needs of stakeholders?

Consider needs of key stakeholders:

- Course instructors
- Department committees, staff, and administration (which may also consult with broader stakeholders)
- Faculty committees, staff, and administration (which may also consult with broader stakeholders)
- CEAB visiting team

Consider factors in aggregation

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Slides available

bit.ly/EGAD-2019

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