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資料６

Test Item Bank for Assessing Mechanical Engineering Learning Outcomes in Japan and Indonesia

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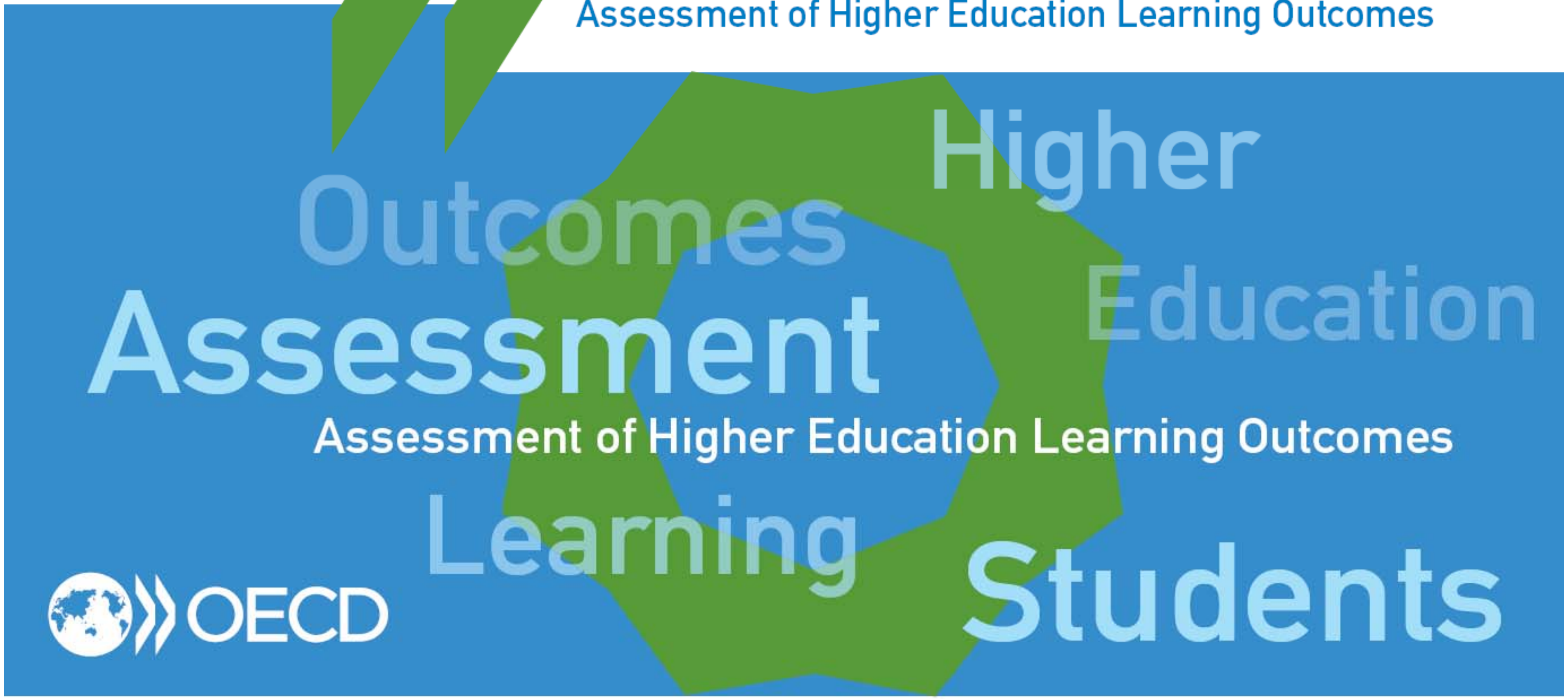
http://www.oecd.org/edu/skills-beyond-school/AHELO%20Brochure.pdf

OECD 2008-2013

AHELO

Assessment of Higher Education Learning Outcomes



2008-13 OECD AHELO: Assessment of Higher Education Learning Outcomes

- What was the OECD-AHELO Feasibility Study?
  - AHELO tested what univ. students know and can do upon graduation.
  - AHELO assessed student performance around the world across diverse cultures, languages, and institutions.
- Background
  - The expansion of Higher Education, demands for quality assurance.
  - The globalization of Higher Education, requires transferability and comparability of degrees and credits.
- Methods
  - The Feasibility Study looked at outcomes in:
    - **Generic skills** common to all students (such as critical thinking, analytical reasoning, problem-solving, and written communication).
    - Discipline-specific skills in **economics and engineering**
  - Contextual questionnaires given to the students, faculty

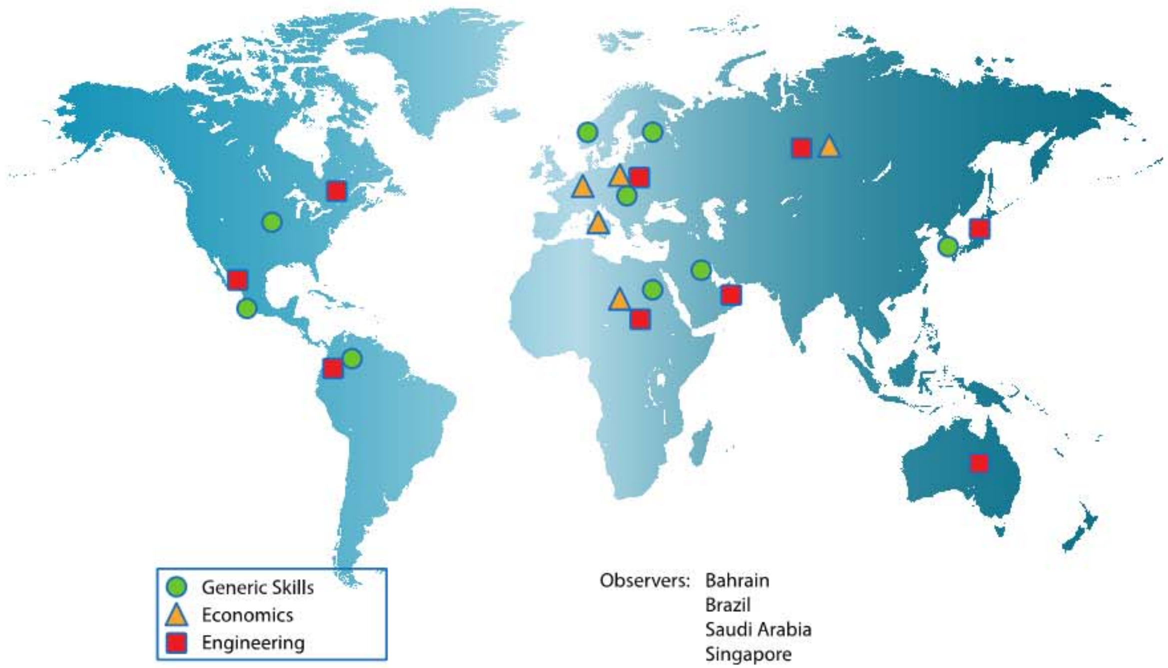
OECD AHELO: 17 countries participated

Countries and institutions

Seventeen countries, spanning a wide range of languages and cultures, are participating in one or more of the assessments: Abu Dhabi, Australia, Belgium, Colombia, Egypt, Finland, Italy, Japan, Korea, Kuwait, Mexico, the Netherlands, Norway, the Russian Federation, the Slovak Republic, Sweden, and the United States.

There are about 10 higher education institutions participating in each country.

Figure 2. AHELO Country-specific strand of work



http://www.oecd.org/edu/skills-beyond-school/AHELO%20Brochure.pdf

ahelo
Assessment of Higher Education Learning Outcomes

OECD AHELO: Engineering Strand & Final Conf.

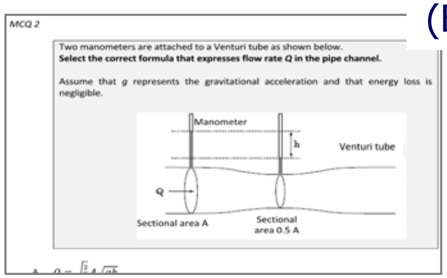
Phase 1 Jan 2010 to Jun 2011	**Small-scale Validation of Instruments:** ■Pencil and Paper test(60 minutes)(1CRT, 20MCI) ■Survey about the instrument(60 minutes) ■Faculty and Institution Survey Australia and Japan (Japan; 10 University, 75 students)
Phase 2 Jan 2011 to Dec 2012	**Large-scale Administration of Instruments:** ■Online test(90 minutes)(1CRT, 25MCI) ■Contextual Instrument(10 minutes) ■Faculty and Institution Survey online 9 countries (Japan: 12 University, 504 students)
Feasibility study conference 11-12 March 2013 (Paris)	**Lessons learnt from the AHELO Feasibility Study and next steps:** Volume 1 of the Feasibility Study report on the Design and Implementation Volume 2 on Data Analysis and National Experiences http://www.oecd.org/edu/ahelo

Phase 2: International Scorers Training at OECD, Nov 2011, Mar 2012

Phase 2: Domestic Scorers Training and Scoring Session at Tokyo Tech, Jun 2012

*23 (out of 34) senior students of Civil & Envr. Engr. Dept. participated from Tokyo Tech

Multiple choice items
(Basic and Engineering Sciences)



Constructive Response Tasks
(Engineering Process)

NIER Test Item Bank

Online system for answering and scoring

2008-2013 OECD AHELO: Main Lessons

1) Educational and professional accords for mutual recognition of qualifications and registration in engineering are developing

2) Several accrediting bodies for engineering qualifications have developed outcomes-based criteria for evaluating program

3) Designing constructive response tasks to “measure” how students can “think” like an engineer requires a thoughtful balance between preciseness and open-endedness.

Ongoing efforts to construct and reconstruct scoring rubrics are necessary.

Not suitable for high stakes testing.

4) The exercise of scoring and modifying scoring rubrics by an international and national team of experts is extremely important to reach consensus on the scope and level of expected learning outcomes.

This invaluable experience should be shared with the wider public.

5) An international assessment of higher education learning outcomes can become a useful tool for educators to globally benchmark and update their teaching practices.

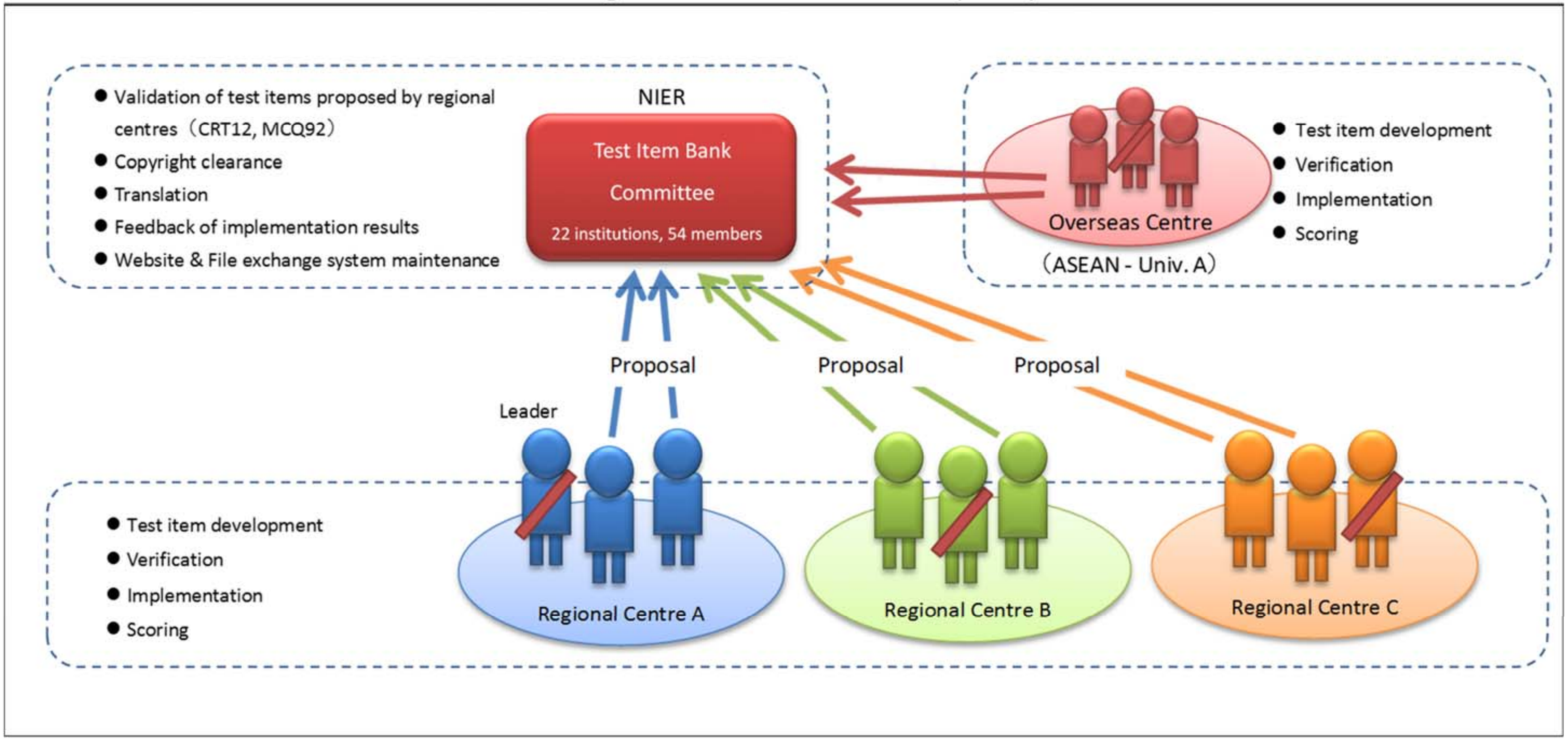
It raises student awareness of their learning, too!

From OECD-AHELO to Japan Tuning Test Bank

- AHELO team in Japan decided to continue work on engineering learning outcomes upon conclusion of AHELO.
- Formed working group of Mechanical Engineering Faculty at 12 universities in 2014. Developed test bank items to assess competencies.
- Lead by Dr. Satoko Fukahori in Tokyo at NIER (Japan Tuning Center) in Japan and Tokyo Tech Engineering Deans Kikuo Kishimoto and Nobuyuki Iwatsuki
- Conducted trial test in 2015 and full scale testing in 2016 in Japan and collaborated with ITB (Indonesia).

Collaborative and Constructivist Approach: Tuning Test Item Bank

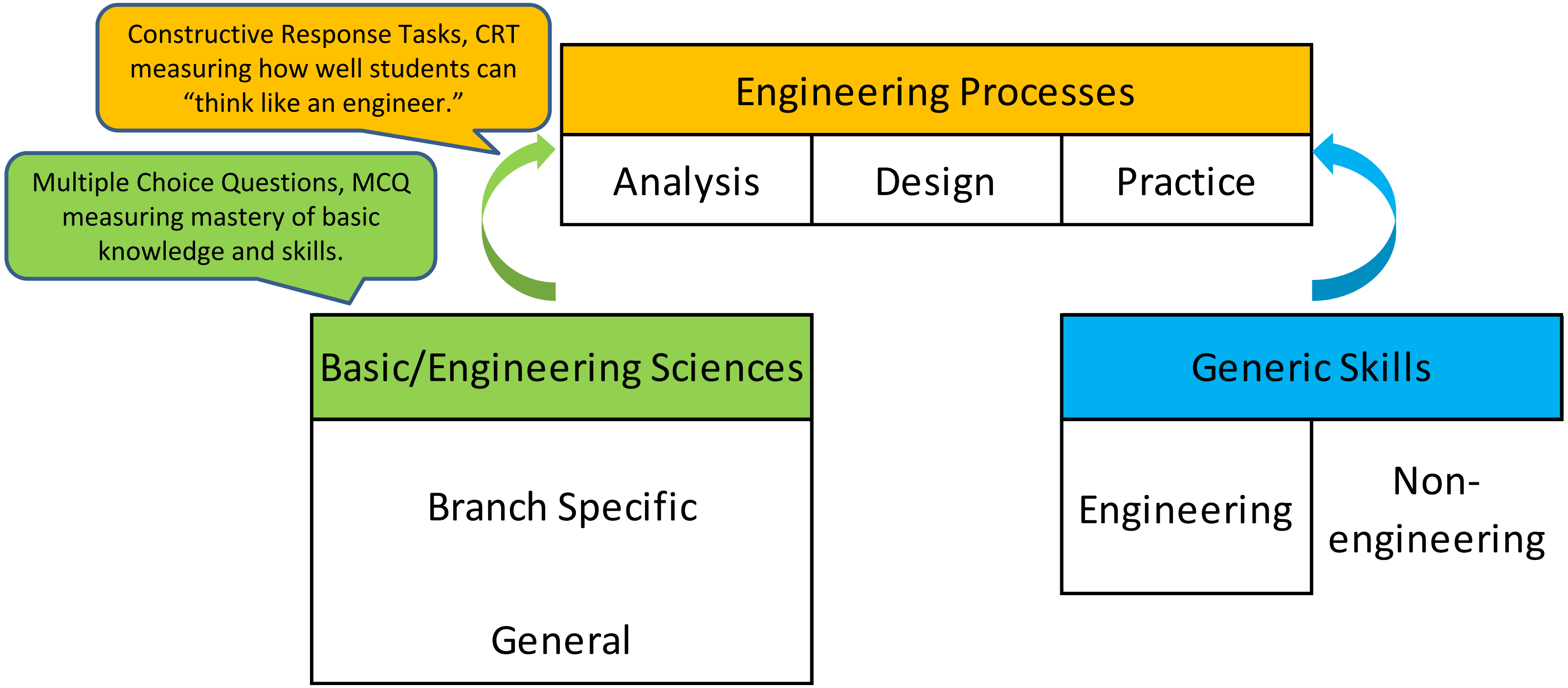
Tuning Test Item Bank Activities (2017)



Host Institutions:
West Japan Hub: Kyushu University & Nagoya University.
Kanto Area Hub: Tokyo Institute of Technology & Meiji University.
East Japan Hub: Tohoku University & Hokkaido University

Engineering Assessment Framework

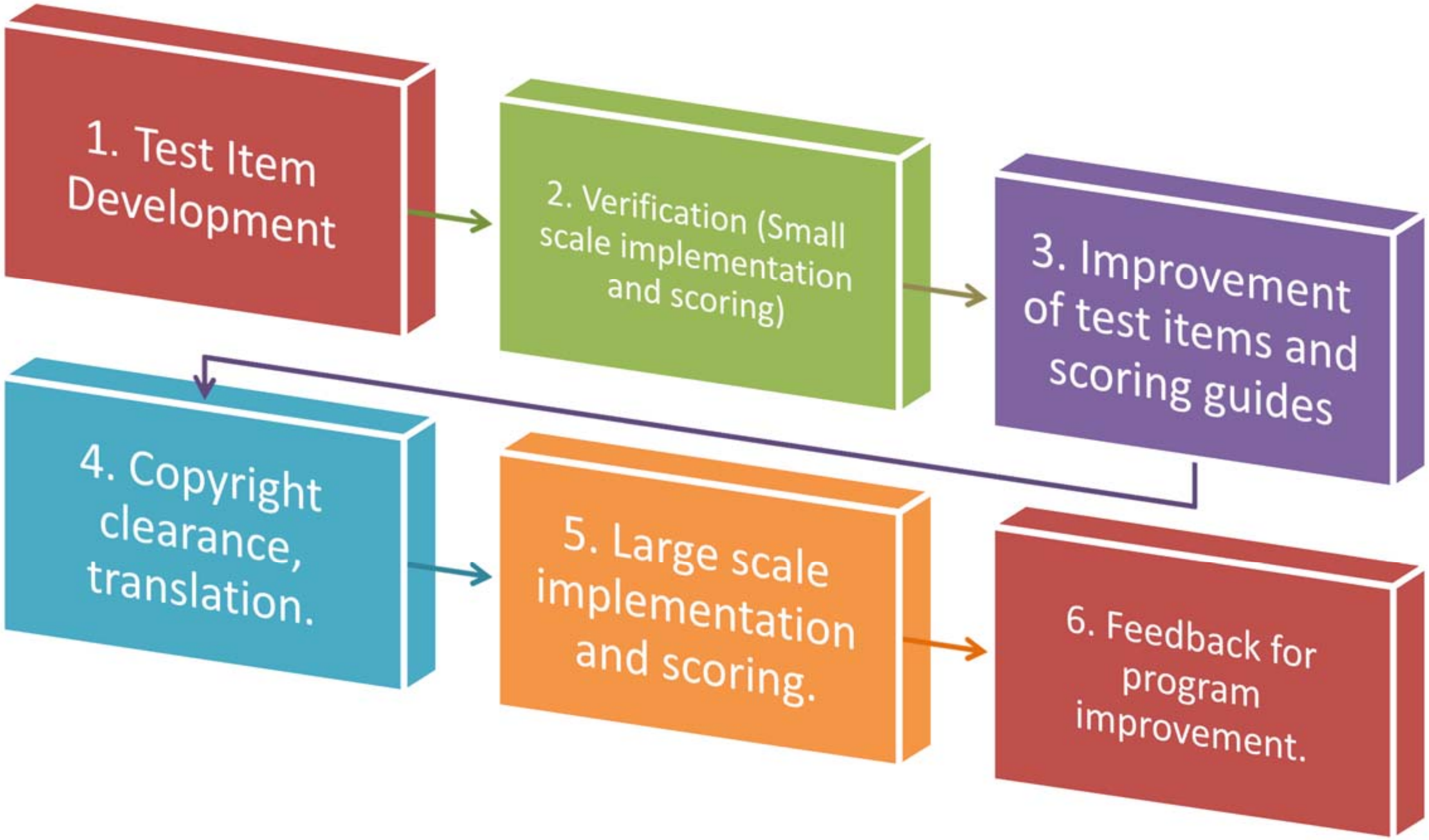
Sufficiently abstract for diverse institutions and autonomous faculty to accept and share.



- ENGINEERING ASSESSMENT FRAMEWORK （http://search.oecd.org/officialdocuments/displaydocumentpdf/?cote=edu/imhe/ahelo/gne(2011)19/ANN5/FINAL&doclanguage=en）
- A Tuning-AHELO Conceptual Framework of Expected/Desired Learning Outcomes in Engineering (http://www.oecd-ilibrary.org/education/a-tuning-ahelo-conceptual-framework-of-expected-desired-learning-outcomes-in-engineering_5kghtchn8mbn-en)
  - European Network for Accreditation of Engineering Education, ENAEE: EUR-ACE quality label.
  - International Engineering Association – Graduate Attributes（Washington Accord)
  - Japan Accreditation Board for Engineering Association
  - Japan Science Council Reference Points for Curriculum Design – Mechanical Engineering.

Engineering Generic Skills	
EGS1	The ability to function effectively as an individual and as a member of a team.
EGS2	The ability to use diverse methods to communicate effectively with the engineering community and with society at large.
EGS3	The ability to recognise the need for and engage in independent life-long learning.
EGS4	The ability to demonstrate awareness of the wider multidisciplinary context of engineering.
Basic and Engineering Sciences	
BES1	The ability to demonstrate knowledge and understanding of the scientific and mathematical principles underlying their branch of engineering. The basics of mathematics include differential and integral calculus, linear algebra, and numerical methods.
BES2	The ability to demonstrate a systematic understanding of the key aspects and concepts of their branch of engineering.
BES3	The ability to demonstrate comprehensive knowledge of their branch of engineering including emerging issues: high-level programming; solid and fluid mechanics; material science and strength of materials; thermal science: thermodynamics and heat transfer; operation of common machines: pumps, ventilators, turbines, and engines.
Engineering Analysis	
EA1	The ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods.
EA2	The ability to apply knowledge and understanding to analyse engineering products, processes and methods.
EA3	The ability to select and apply relevant analytic and modelling methods.
EA4	The ability to conduct searches of literature, and to use data bases and other sources of information.
EA5	The ability to design and conduct appropriate experiments, interpret the data and draw conclusions.
EA6	The ability to analyse mass and energy balances, and efficiency of systems; hydraulic and pneumatic systems; machine elements.
Engineering Design	
ED1	The ability to apply their knowledge and understanding to develop designs to meet defined and specified requirements.
ED2	The ability to demonstrate an understanding of design methodologies, and an ability to use them.
ED3	The ability to carry out the design of elements of machines and mechanical systems using computer-aided design tools.
Engineering Practice	
EP1	The ability to select and use appropriate equipment, tools and methods.
EP2	The ability to combine theory and practice to solve engineering problems.
EP3	The ability to demonstrate understanding of applicable techniques and methods, and their limitations.
EP4	The ability to demonstrate understanding of the non-technical implications of engineering practice.
EP5	The ability to demonstrate workshop and laboratory skills.
EP6	The ability to demonstrate understanding of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice.
EP7	The ability to demonstrate knowledge of project management and business practices, such as risk and change management, and be aware of their limitations.
EP8	The ability to select and use control and production systems.

Circular Test Item Development Process



An Example :
Wind Electrical Power Generation (http://www.nier.go.jp/tuning/centre.html)

Wind power generation is the conversion of wind kinetic energy into electrical energy or electricity, through the use of wind turbines....Respond to the following questions which focus on the wind turbines used for wind power generation from a mechanical engineering point of view.

Question 1. Examine the locational condition or site of a wind farm for wind power generation.

Figure 2 shows a wind farm for wind power generation. List and explain two reasons below why this is a good site for wind power generation.

Figure 2: An example of a wind farm
Photograph of Otonrui Wind Farm, provided by Horonobe City

Question 2. Examine the “shape of the blades” of wind turbines used for wind power generation.

Compare the shapes of the blades for a traditional windmill and a wind turbine shown in Figures 3a and 3b, respectively. Explain from a mechanical engineering point of view two features of blades that characterize wind turbines for wind power generation.

Figure 3a Traditional windmills.
Martijn Roos. www.mroosfotografie.nl
http://free-photos.gatag.net/2014/11/07/040000.html

Figure 3b Wind turbines used for wind power generation.
http://sozai-free.com/sozai/01541.html

Scoring Guide for Q1

<u>Sufficiently concrete</u> to provide a meaningful framework for institutions/faculty to refer to when designing programs and courses.

Learning outcomes to be assessed: The ability to analyze and to examine the function and efficiency of machines by applying basic knowledge of mechanical engineering by explanation of the locational condition of a wind farm.

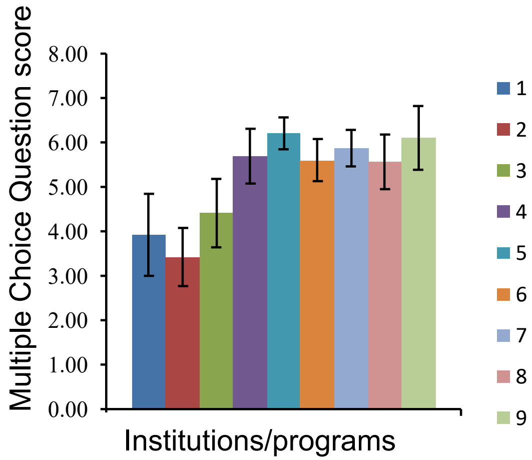
Underlying competences:
BES2: The ability to demonstrate a systematic understanding of the key aspects and concepts of their branch of engineering.
EA2: The ability to apply knowledge and understanding to analyze engineering products, processes and methods.
EA6: The ability to analyze mass and energy balances, and efficiency of systems.

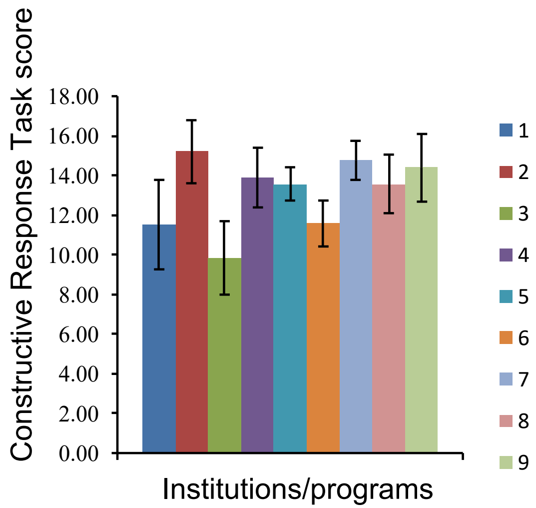
Viewpoints: Lists two features out of three below or equivalent, and explains the reasons for each of them appropriately.
(a)The wind farm is located on flat land along a seashore and hence there is no obstacle to block the wind from flowing around the wind turbines.
• The wind kinetic energy can be utilized effectively with little loss because the wind directly blows against the wind turbines to a maximum degree.
•The wind turbine blades rotate freely because the wind flows around the stationarily tower and against the turbines.
(b) Many wind turbines are installed in one location.
•All wind turbines can be manufactured to the same design requirements because the local environment for all turbines is basically the same. This reduces the manufacturing and design costs required in designing and producing the turbines.
•The cost for installation and maintenance of wind turbines is reduced because many turbines are located adjacent to each other.
•The cost for installation and maintenance of accompanying facilities to recover the electric energy generated by all turbines is reduced because such facilities can be also installed on-site.
(c) No building or structure is located around the wind farm.
•A wind turbine can be designed specifically for the wind conditions at the location because there is no limitation on size of the wind turbine. This increases the efficiency in generating the electric energy.
•There is no possibility to cause damage to the neighboring buildings or structures in case of accidents such as the collapse of wind turbine column.

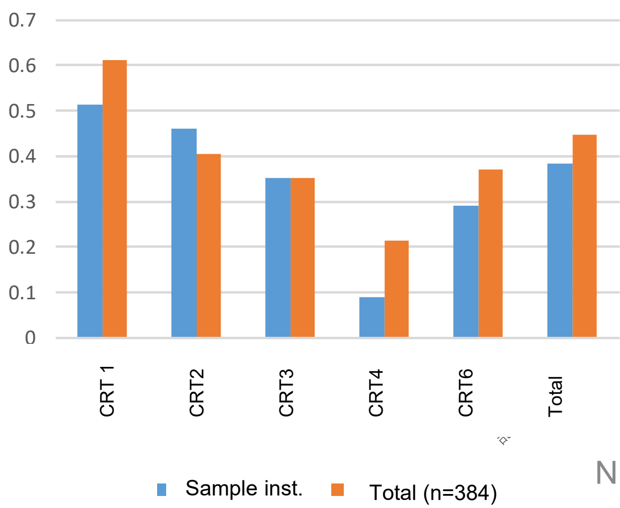
Large scale implementation

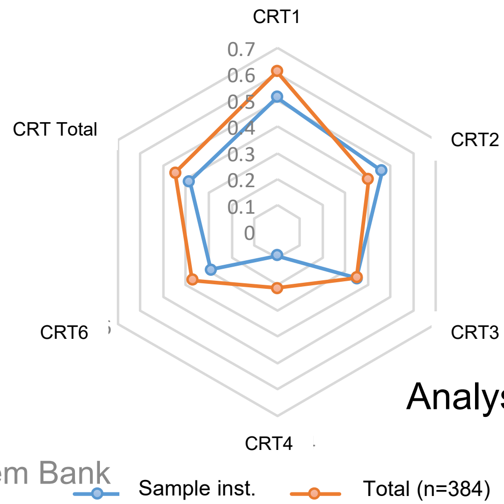
- 10 universities (Japanese and Indonesian) & 385 students
- June-September 2016
- Test items
  - Multiple choice questions (10 items, 30 minutes)
  - Constructive response task (“Machine Tools,” 50 minutes)
  - Contextual Survey (10 minutes)
- Feedback reports delivered to the project team, individual participating universities and individual participating students.

Feedback for Educational Improvement
Benchmarking institutional performance
Highlighting the strengths and weaknesses









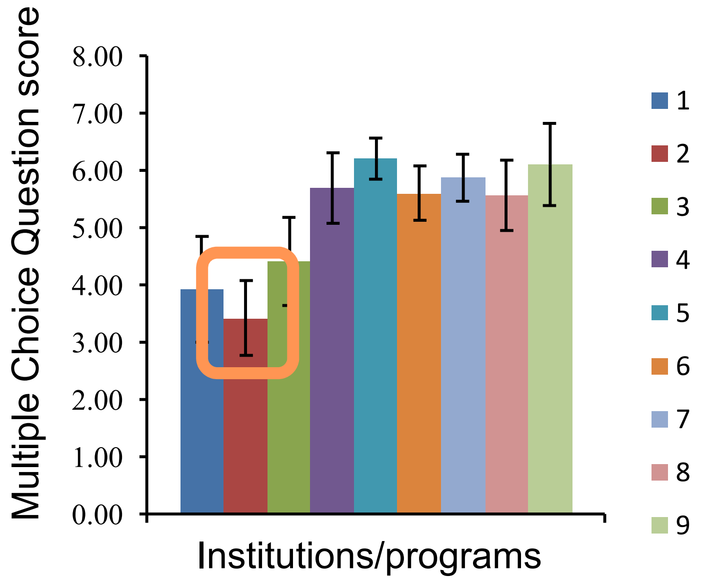
Analysis by Yugo Saito

Feedback for Educational Improvement

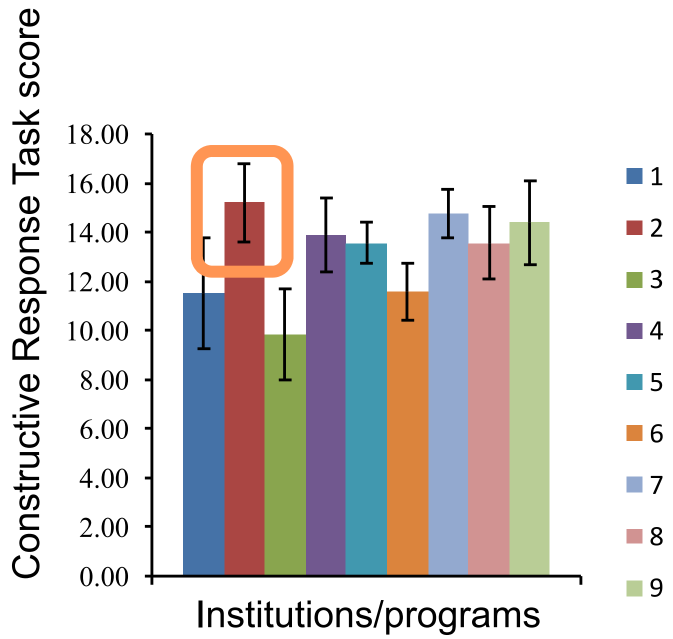
The Correlation between Multiple Choice Question (MCQ) scores and Constructive Response Task (CRT) scores was r = .17 (p<.01)

High MCI scores do not necessarily lead to high CRT scores, vice versa.

Focus on Institution 2 with low MCI but high CRT scores.



95% confidence interval



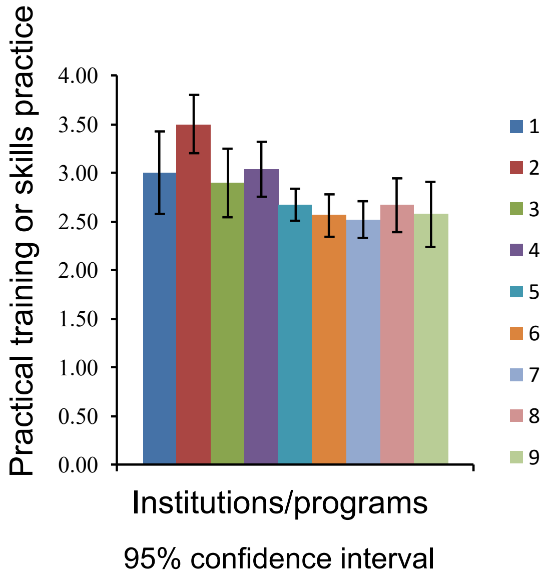
95% confidence interval

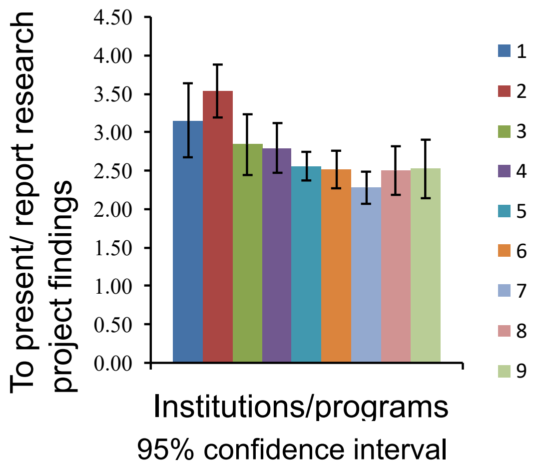
Analysis by Yugo Saito

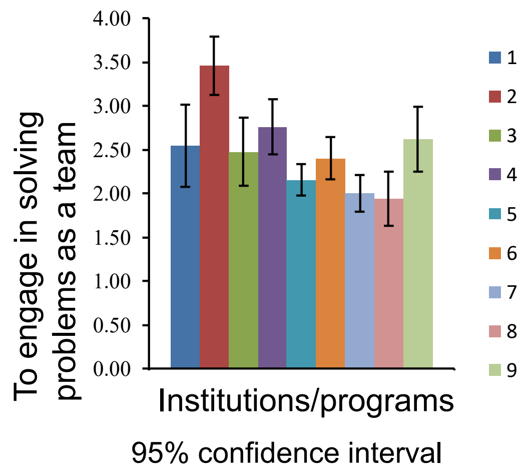
Student Feedback for Educational Improvement

What are the educational characteristics of institution 2?

Students in institution 2 responded more affirmatively that they:
committed themselves to “practical training or skills practice” before joining the laboratory; and
had opportunities “to present/ report research project findings” and “to engage in solving problems as a team.”







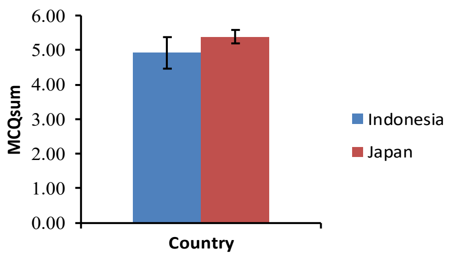
Analysis by Yugo Saito

Feedback for Educational Improvement

Comparison of Indonesian and Japanese universities.

No significant difference in the total score for MCQ.

Some differences in CRT, possibly reflecting curriculum content coverage, sequence, and educational experience.



MCQ Total
95% confidence interval

・Before joining the laboratory, more Indonesian students responded that they committed themselves to studies in "foreign language," "general education subjects," and co-curricula engineering activities," whereas more Japanese students responded that they committed themselves to "paid part-time jobs." After joining the laboratory, more Japanese students responded that they committed themselves "writing graduation thesis."

・ More Indonesian students responded that they had opportunities "to engage in solving problems as a team," "to engage in solving real life engineering problems," and "to engage in solving problems that require knowledge beyond engineering (society, economy, politics, etc.)"

Constructive Response Task ト量

	Indonesia				Japan			
	Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum
CRT1	9.39	2.07	3.33	11.33	7.34	2.20	0.00	12.00
CRT2	2.11	1.41	0.00	6.00	1.62	1.07	0.00	5.33
CRT3	1.24	0.72	0.00	2.67	1.41	0.85	0.00	4.00
CRT4	0.74	0.66	0.00	2.33	0.86	0.97	0.00	4.00
CRT5	0.22	0.42	0.00	1.00	0.18	0.39	0.00	1.00
CRT6	0.49	0.71	0.00	3.33	2.22	1.79	0.00	6.00
CRT sum score	14.18	3.59	4.00	20.00	13.62	4.33	0.00	23.67

Members from both countries agreed on the importance of educational benchmarking.
Indonesia will be contributing test items starting 2017.

Analysis by Yugo Saito

Summary and Future Plan

- Assessment measured learning outcomes in general engineering skills and in Mech Engr.
- MCQ noted differences in several Japanese univ scores (aptitude or teaching?), many similar scores
- One particular Japan Univ. higher CRT compared to MCQ
- Compare Japan Univ. & ITB similar responses although systems are different (differences in CRT - coursework) .
- Need more MCQs to better assess general skills

Future plan

- Conduct longer (2hr) test this fall in Japan
- Publish paper in Tuning J. Higher Education Nov. 2017

FURTHER INFORMATION

The Tuning Test Item Bank in Mechanical Engineering,

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http://www.nier.go.jp/tuning/centre.html

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