Developing a Shared Understanding of Expected Learning Outcomes through Collectively Developing and Implementing Exemplary Test Items

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DEVELOPING A SHARED UNDERSTANDING OF EXPECTED LEARNING OUTCOMES : Why is this so important?

AUN/SEED-Net

(http://www.seed-net.org/info.php)

- Vision:
  - "Southeast Asia and Japan are developed sustainably through development of innovative and highly skilled human resources in engineering field."
- Missions:
  - "To nurture internationally competitive personnel with multicultural awareness through academic cooperation among leading engineering higher education institutions in ASEAN and Japan."
  - "To advance engineering education and research capacities of leading engineering higher education institutions in the region through collaboration and solidarity between the educational and industrial sectors in ASEAN and Japan."

What do we mean by:

- internationally competitive personnel with multicultural awareness?
- advanced engineering education and research capacities?

Do we have a shared understanding?

- the basis of academic cooperation at a more systemic level. (double/joint degrees; student mobility, credit transfer, etc.)

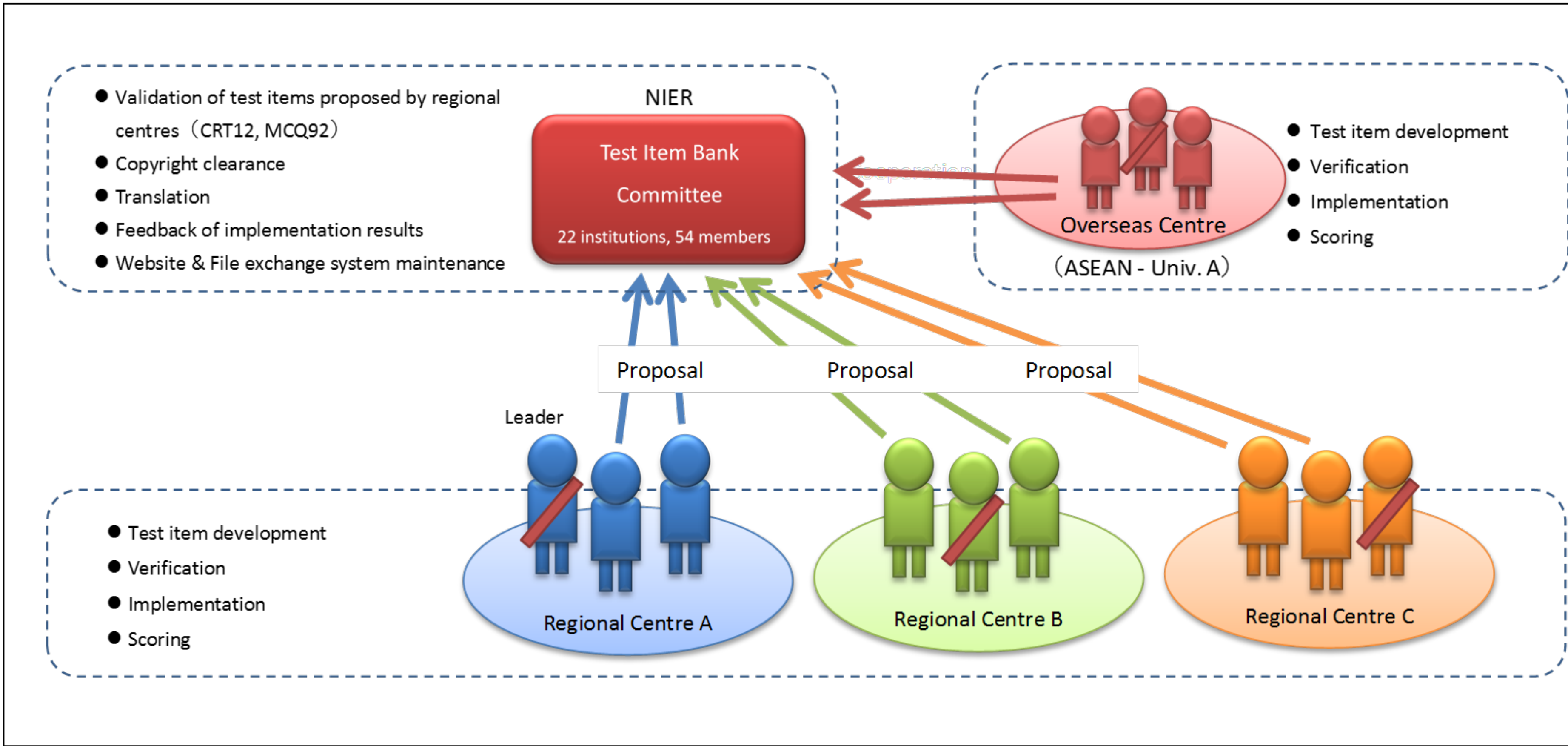
While respecting the diversity and autonomy of member institutions, we as a network of leading institutions should be working within a common framework of expected learning outcomes, in order to assure the quality of the human resources we develop.

DEVELOPING A SHARED UNDERSTANDING OF EXPECTED LEARNING OUTCOMES : How can this be done?

How can we develop a shared understanding of what students are expected to know, understand, and be able to do upon completion of their degree programs?

A Collaborative and Constructivist Approach: Tuning Test Item Bank

Tuning Test Item Bank Activities (2017)

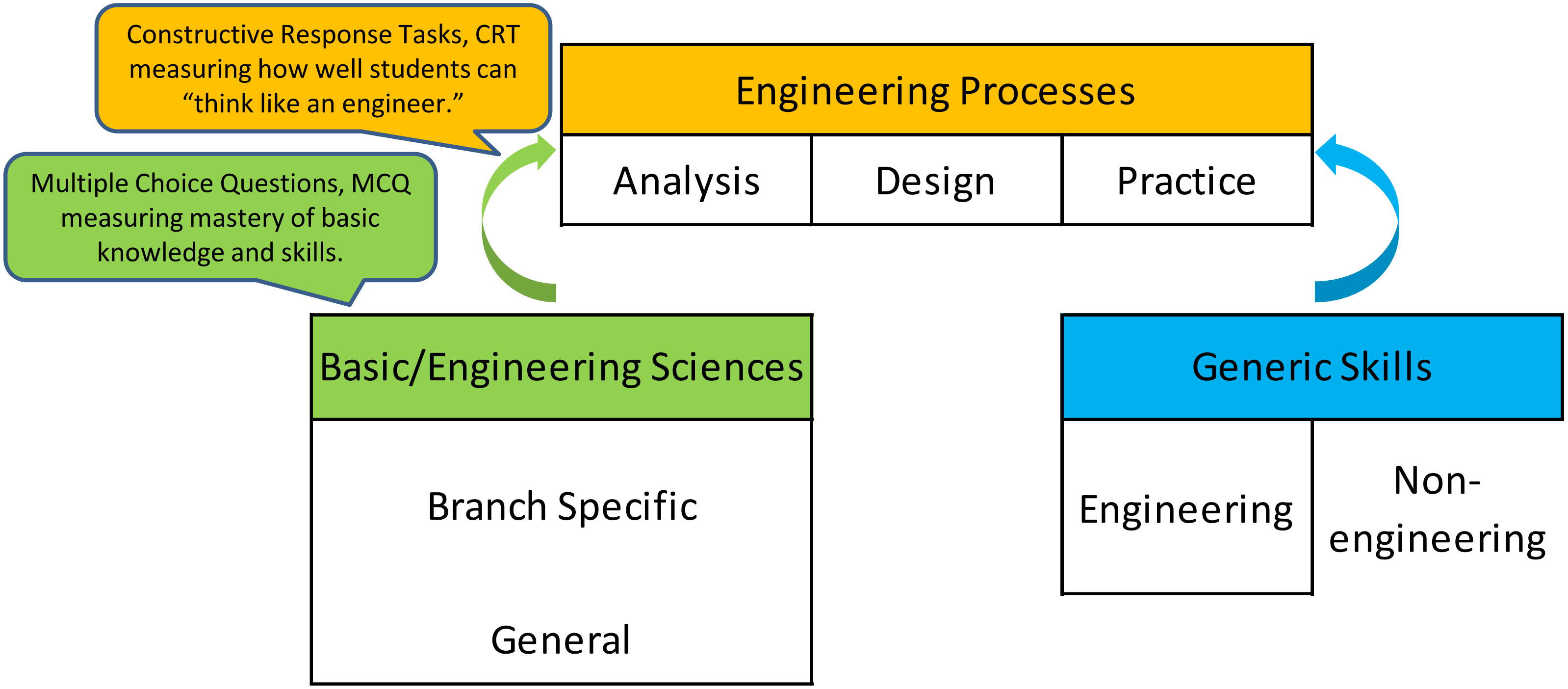


Host Institutions:
West Japan Hub: Kyushu University & Nagoya University.
Kanto Area Hub: Tokyo Institute of Technology & Meiji University.
Eas Japan Hub: Tohoku University & Hokkaido University

Global partners are invited to participate in the network!

Engineering Assessment Framework

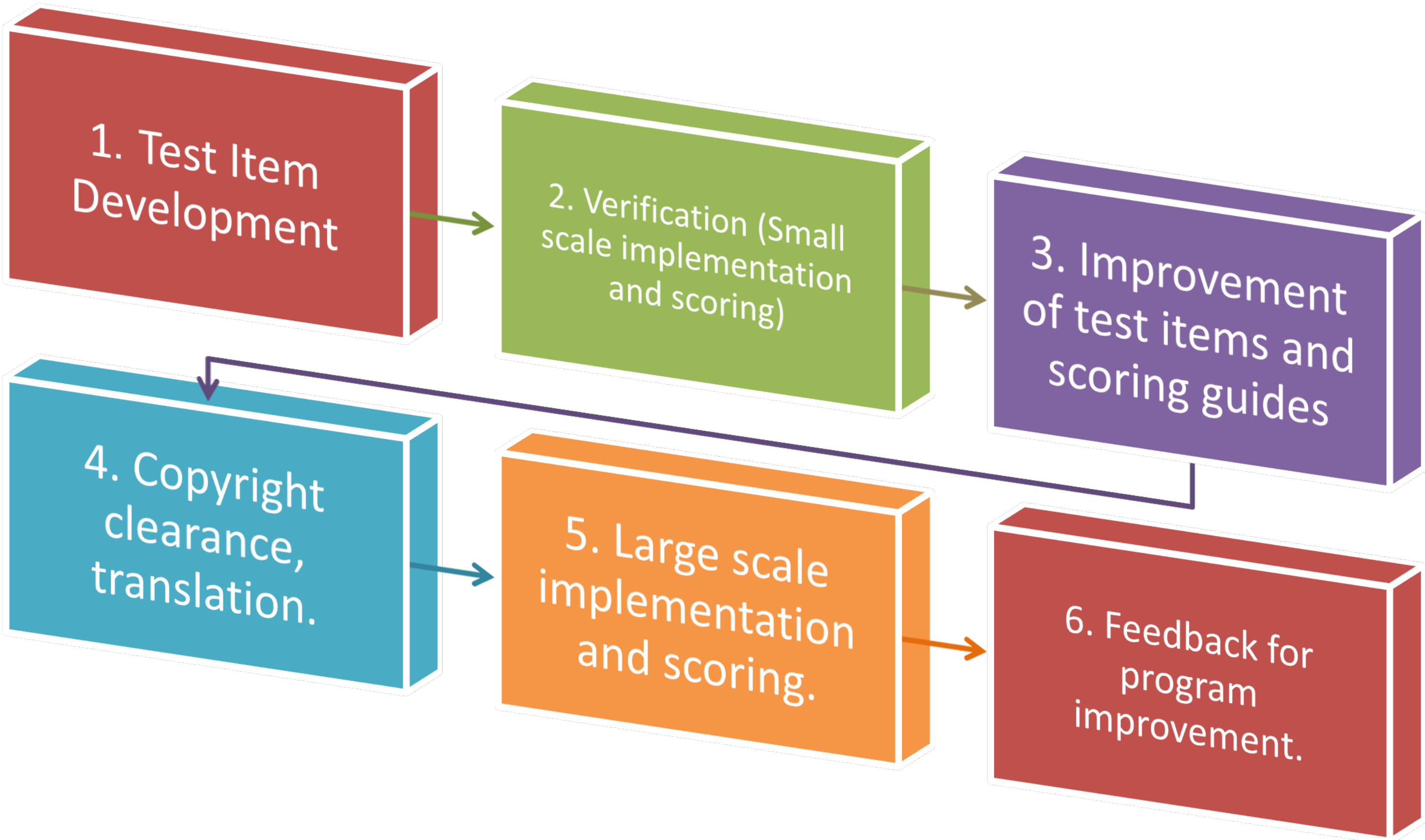
Sufficiently abstract for diverse institutions and autonomous faculty to accept and share.



- 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.

The shared 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

Sufficiently concrete 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.

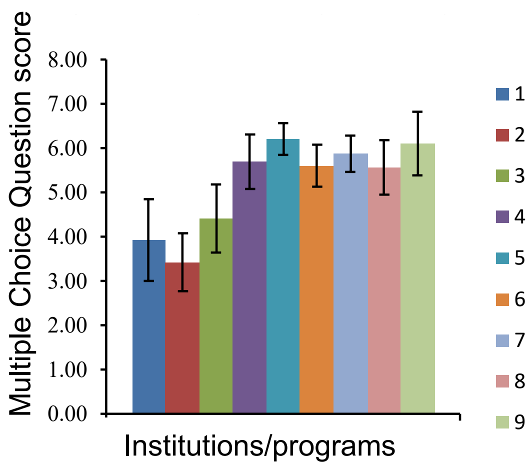
(c) No building or structure is located around the wind farm.

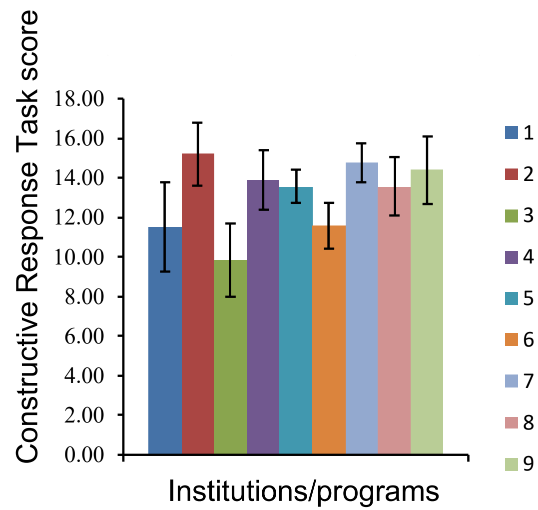
- A wind turbine can be designed specifically for the wind conditions at the location because there is no limitation on size of the wind turbine. This increases the efficiency in generating the electric energy.
- There is no possibility to cause damage to the neighboring buildings or structures in case of accidents such as the collapse of wind turbine column.

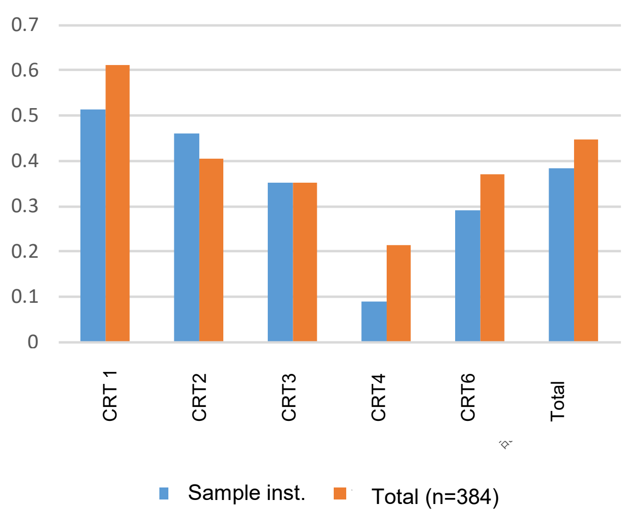
Large scale implementation

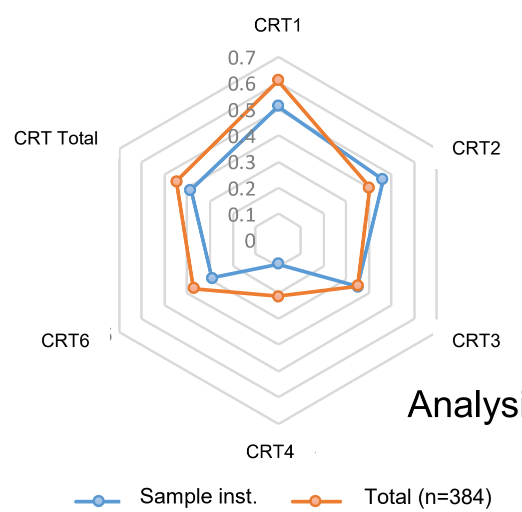
- 10 universities (Japanese and Indonesian) & 385 students
- June-September 2016
- Test items
  - Multiple choice questions (10 items, 30 minutes)
  - Constructive response task (“Machine Tools,” 50 minutes)
  - Contextual Survey (10 minutes)
- Feedback reports delivered to the project team, individual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

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









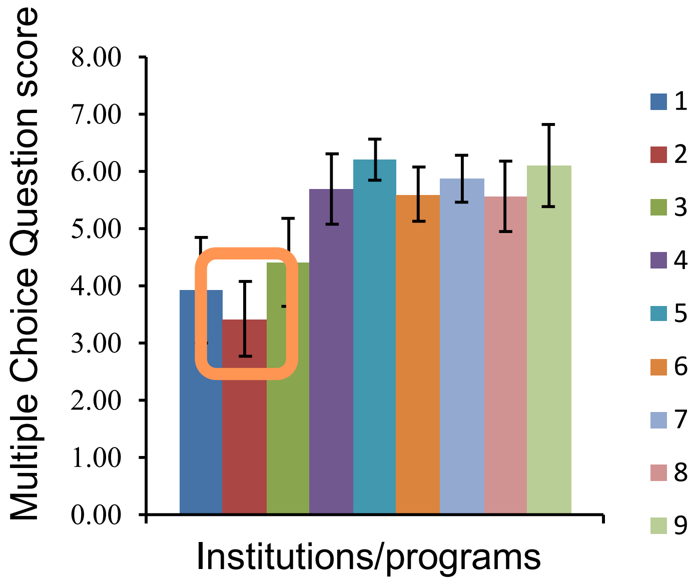
Analysis by Yugo Saito

Feedback for Educational Improvement

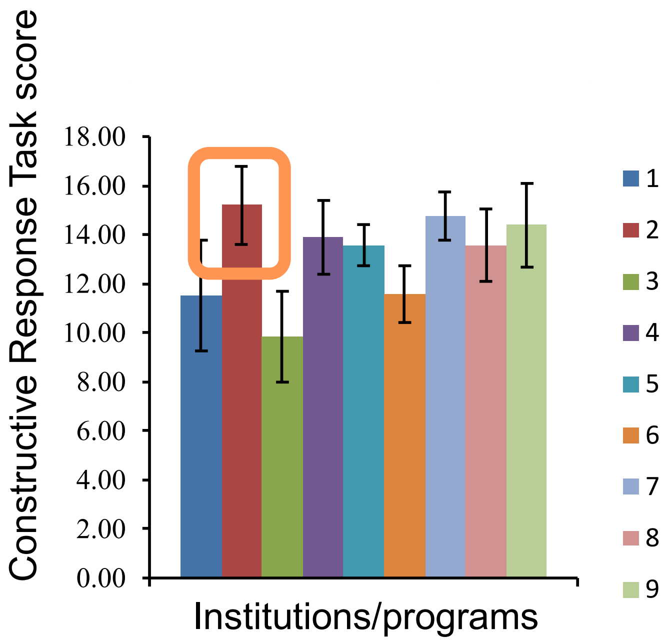
The Correlation between Multiple Choice Question (MCQ) scores and Constructive Response Task (CRT) scores was $r = .17$ ($p<.01$)

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



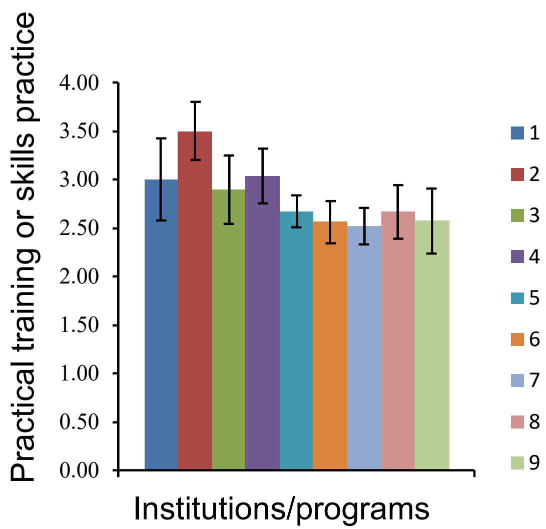
95% confidence interval

Analysis by Yugo Saito

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."



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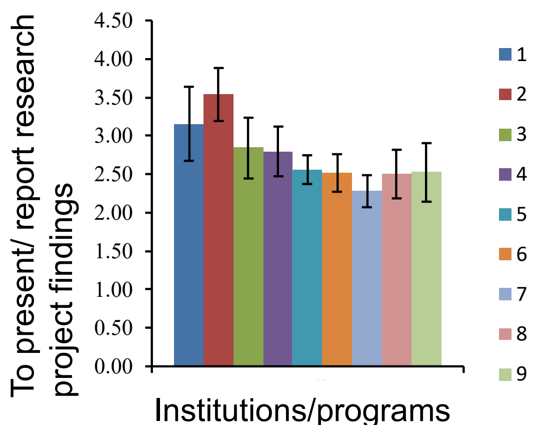

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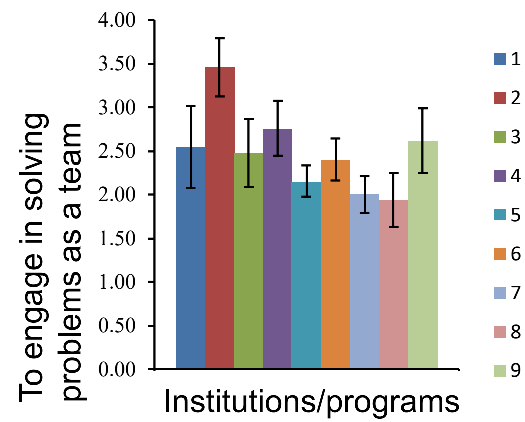


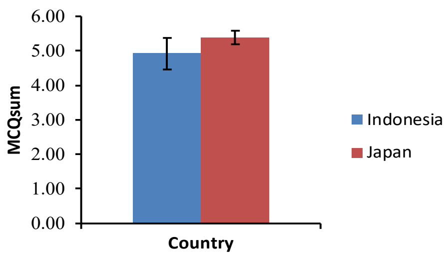
95% confidence interval

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 卜量

	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

Next steps

- Reconstruction of the "machine tools" item to reach a stronger alignment of tasks to expected learning outcomes.
  - More intentional effort to measure abstract level expected learning outcomes with concrete level performance tasks.
    - Application of optimal forms of item design.
    - Stronger focus on reaching agreement on the expected levels of achievement – development of a simple but informative meta rubric.
  - Repeat large scale implementation with the revised "machine tools" item to test its improvemd performance.
  - Develop theories and methodologies for measuring expected learning outcomes.

- Accumulating statistical information on student performance on the MCQ and CRT items.
- Development of protocols for scoring.
  - Reduce variability in inter-rater reliability scores of CRTs.
  - Development of effective and feasible approaches.

Contact 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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ASEAN UNIVERSITIES ARE CORDIALLY INVITED TO JOIN OUR EFFORT!
THANK YOU!