ENGINEERING TEST ITEM BANK

FINDINGS FROM THE LARGE SCALE IMPLEMENTATION

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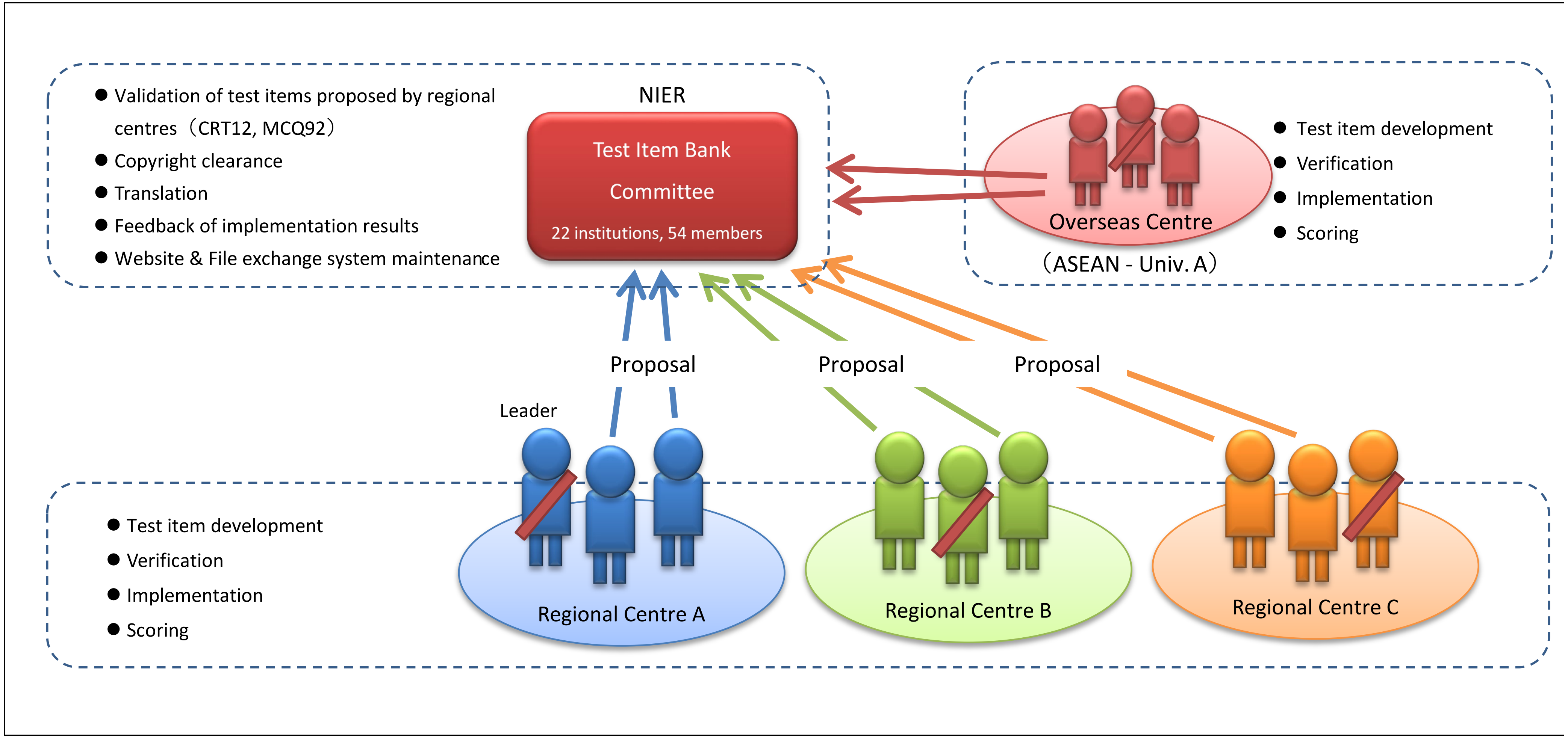
NIER TEST ITEM BANK(2014-)

Purpose:

- Developing a shared understanding of expected learning outcomes, through jointly engaging in the process of developing, verifying, implementing, and scoring test items.
  - Professional development at academic societies (Japan Society of Mechanical Engineers, annual meeting, as part of the JABEE accreditation program evaluator training)
  - Faculty improvement at universities.
- Drawing implications for program improvement.
  - Program self review report.
  - Development of new courses & modules.

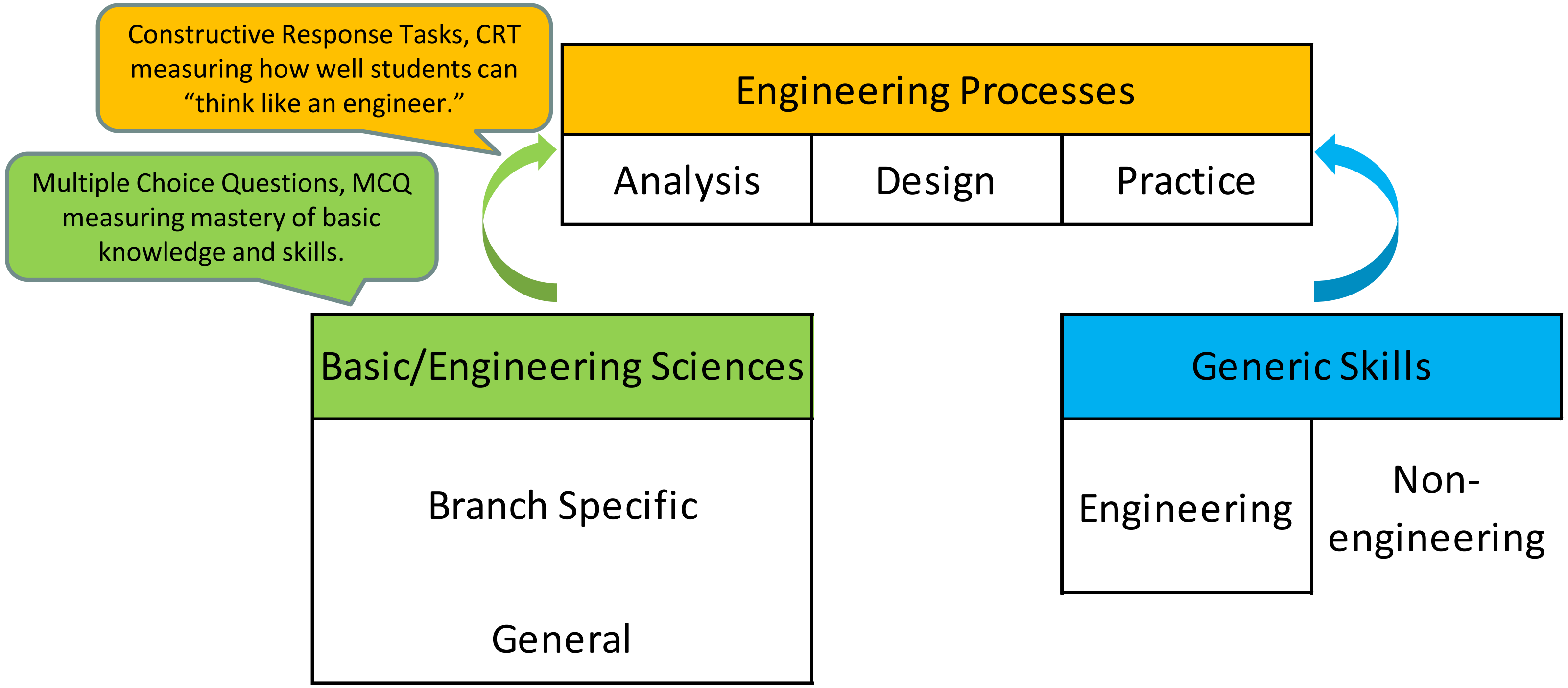
HOW CAN WE DEVELOP A SHARED UNDERSTANDING OF WHAT STUDENTS ARE EXPECTED TO KNOW, UNDERSTAND, AND BE ABLE TO DO UPON COMPLETION OF THEIR DEGREE PROGRAMS?
A COLLABORATIVE AND CONSTRUCTIVIST APPROACH

Tuning Test Item Bank Activities (2017)



Engineering Assessment Framework

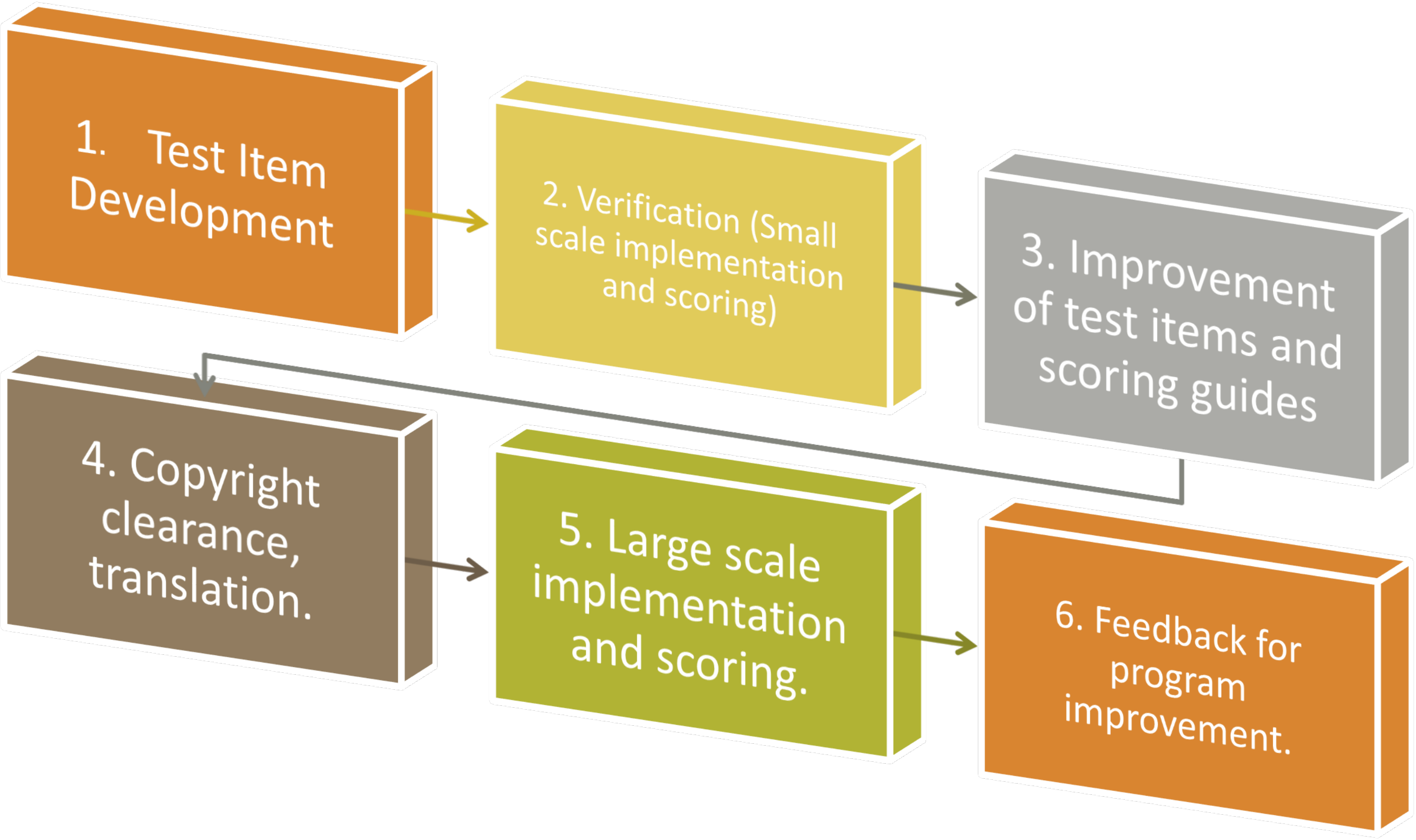
Sufficiently abstract for diverse institutions and autonomous faculty to accept and share.



- 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 stationary 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 ASEAN) & 385 students
- June-July 2016
- Test item
  - Multiple choice questions (10 items, 30 minutes)
  - Constructive response task (“Machine Tools,” 50 minutes)
  - Contextual Survey (10 minutes)
- Feedback reports to the project team, individual participating university and individual participating students (July, September, January)

FEEDBACK REPORT TO THE PROJECT TEAM
(FEEDBACK REPORTS TO PARTICIPATING UNIVERSITIES ARE TAILORED VERSIONS OF THE OVERALL REPORT)

1. Characteristics of participating university and students.

2. Multiple choice questions (10 items)
   - Distribution of responses for each item (to discern where students are experiencing difficulties).
   - Percentage correct for each item & total (for benchmarking achievement against peer universities).

3. Constructive response task
   - Descriptive statistics for each item & total.

4. Relationship between test scores and contextual survey responses.

Feedback report to individual students

〇〇大学

受験番号 00000000000

チューニングによる大学教育のグローバル質保証－テスト問題バンクの取組－(H28)

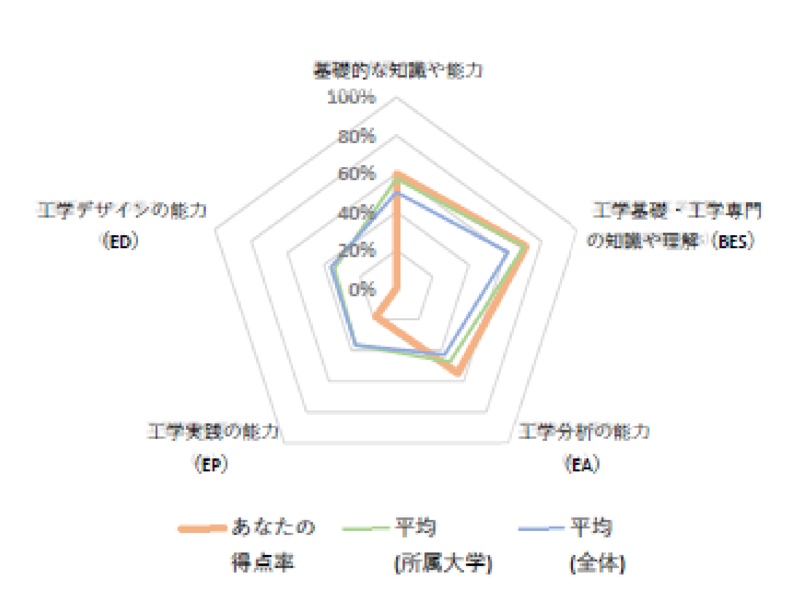
個人フィードバックシート

Areas of learning outcomes　% Correct: Student, Univ., Total

	あなたの得点率	平均（所属大学）	平均（全体）
基礎的な知識や能力	60.0%	57.3%	50.3%
工学基礎・工学専門の知識や理解（BES）	71.4%	70.3%	61.5%
工学分析の能力（EA）	54.8%	47.6%	43.0%
工学実践の能力（EP）	18.2%	36.5%	36.5%
工学デザインの能力（ED）	0.0%	34.1%	36.1%

※基礎的な知識や能力は多肢選択式問題，BESは記述式問題1,3,4，EAは記述式問題1-6，
EPは記述式問題2,5,6，EDは記述式問題6の得点をもとに算出しています。
なお，記述式問題は3名の評価者が採点し，その中央値を得点としています。

レーダーチャート



Multiple choice questions: Student, Univ., Total.

設問	分野	正誤	正答率（所属大学）	正答率（全体）	設問	分野	正誤	正答率（所属大学）	正答率（全体）
1	数学	〇	86.4%	71.3%	6	運動	×	45.5%	38.2%
2	数学	〇	77.3%	75.3%	7	ｴﾈﾙｷﾞｰ	〇	63.6%	60.6%
3	物理	×	59.1%	68.1%	8	ｴﾈﾙｷﾞｰ	〇	45.5%	48.0%
4	材料	×	31.8%	22.7%	9	情報	〇	45.5%	44.5%
5	運動	〇	81.8%	55.5%	10	加工	×	36.4%	53.7%

Constructive response tasks: Student, Univ., Total.

設問	問題内容	あなたの得点	平均得点（所属大学）	平均得点（全体）	評価
1	工作機械に用いられる動力伝達方法	12 ／12	7.67 ／12	7.34 ／12	各メリット・デメリットについて適切に説明できています
2	工作機械の主軸の構造	2 ／4	1.61 ／4	1.62 ／4	必要な側面を取りあげていますが，説明が不十分なようです
3	工作機械の振動問題	1 ／4	1.70 ／4	1.41 ／4	必要な側面を取りあげることができていないか，全体的に説明が不十分なようです
4	機械構造の振動計測	2 ／4	1.38 ／4	0.86 ／4	必要な側面を取りあげていますが，説明が不十分なようです
5	振動特性の計測	0 ／1	0.36 ／1	0.18 ／1	正答を導けていません
6	切削加工における振動現象	0 ／6	2.05 ／6	2.22 ／6	必要な側面を取りあげることができていません

FINDINGS FROM THE TECHNICAL ANALYSIS

1. Measuring a wide range of basic/engineering science competence with just 10 MCQs (in 30 minutes) was unrealistic.

- The results of the 10 items revealed to be largely uncorrelated, meaning that the items were measuring the achievement of different areas of knowledge and skills.
  - Solution: Implement more items (which require much more time) or focus on just one area of knowledge and skills.

2. Variability in inter-rater reliability scores of CRTs.

- Scorers at each university were trained by the project team members.
- For student x at University A: Two scorers from University A and one scorers from University B.
  - Solution: Intensive calibration at all universities. (jointly scoring several student responses).

3. The need for more intentional and closer alignment of tasks to competences.

- Engineering experts first developed the items, and then defined the competences that each question was trying to address.
  - Solution: Develop items tailored to the learning outcomes to be measured, applying optimal forms of item design.
- Multiple competences were measured with one question (one scoring guide and one score)
  - Solution: There should be one scoring guide and one score for each learning outcome to be measured.
- The problem of defining levels of achievement is still unsolved.
  - Solution: Develop meta-rubrics with benchmarks of achievement (while narrowing down assessable competences).

Keep it simple, but informative!

RECONSTRUCTION OF THE "MACHINE TOOLS" ITEM UNDERWAY- THANK YOU FOR YOUR ATTENTION!

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