

Mock Examinations in Informatics as a Foundation for Assessment Design in Japanese University Admissions

Seiichi Tani (Nihon U.), K. Uehara (Keio U.), H. Kakuda (UEC), K. Kakehi (Tokyo Online U.), N. Takahashi (Kokugakuin U.), T. Tatsumi (Open U. of Japan), Y. Nakano (Kogakuin U.), Y. Nakayama (UEC), T. Nishida (Kogakuin U.), K. Hagihara (U. of Osaka), H. Bandoh (Dokkyo Medical U.) and Y. Yasuda (Kyoto Sangyo U.)

tani.seiichi@nihon-u.ac.jp / emiu@sfc.keio.ac.jp

- This work was supported by JSPS KAKENHI Grant Number 23H00068.
- This study was conducted with the approval of the Research Ethics Committee of Keio University Shonan Fujisawa Campus (SFC). (Application No.: 536, Application Date: January 8, 2024, Approval Date: January 30, 2024)

Outline of the Presentation

1. Informatics and AI-Driven Educational Change
2. Informatics Education Reform in Japan
3. The EMIU Project — Purpose and Design
4. Implementation Results and Analysis
5. Future Work — Toward Interactive Assessment
6. Conclusion and Implications

1. Informatics and AI-Driven Educational Change

The Impact of AI on Learning

- AI systems now achieve medal-level performance in Olympiads (IMO, ICPC, etc.)
- AI is changing what and how we learn
- Informatics education needs to change to keep up

1. Informatics and AI-Driven Educational Change

Informatics as a Meta-Discipline

- Foundational knowledge for all, not only engineers
- Integrates logic, creativity, and design across disciplines
- Programming and data literacy are essential for all citizens in the AI era

2. Informatics Education Reform in Japan

National Curriculum Guidelines Reform Overview

- Japan revises its national curriculum guidelines about every ten years.
- Programming made mandatory at all school levels:
 - Elementary (2020): introduced as a new subject area
 - Junior High (2021): strengthened within Technology and Home Economics
 - High School (2022) : new compulsory subject “Informatics I”
- A unified Informatics curriculum builds a clear learning path

2. Informatics Education Reform in Japan

Informatics in the Common Test

- 2025: First Informatics section introduced in the Common Test for University Admissions
- Over 300,000 students (about one-fourth of 18-year-olds) took
- Average score was good overall, but programming items were relatively low
- This highlights the challenge — and the importance — of developing better assessment methods.

3. The EMIU Project — Purpose and Design

Project Overview

- Evaluation Methods for Informatics Competence with a Focus on University Entrance Examination (EMIU)
- Funded by JSPS KAKENHI (2023–2027)
- Objectives:
 - Develop guidelines for Informatics I assessment
 - Conduct CBT/IRT-based mock exams
 - Provide evidence-based feedback to schools

3. The EMIU Project — Purpose and Design

Structure of EMIU Mock Exams

- Part 1: Q-type questions
 - Short, independent multiple-choice items
 - Designed using Item Response Theory (IRT)
 - Measure distinct informatics competencies
- Part 2: G-type questions
 - Applied, scenario-based problems
 - General questions similar in format to Japan's National Common Test
 - Require integration of multiple topics and cross-context reasoning

3. The EMIU Project — Purpose and Design

Structure of EMIU Mock Exams

Exam	Duration	Questions	Remarks
Summer 2024	40 min	Q (IRT): 20 min / 20 items G (General): 20 min / 2 problems	10 shared items enabled cross-cohort comparison among Q- type questions
Sprint 2025	50 min	Q (IRT): 30 min / 30 items G (General): 20 min / 2 problems	

- Conducted using TAO-based Computer-Based Testing (CBT).
- Two rounds completed:
 - Summer 2024: 520 participants
 - Spring 2025: 244 participants

3. The EMIU Project — Purpose and Design

Example of Question Types

- Q-type question

Example:

$X = [1, 5, 8, 9, 3]$

$Y = [3, 5, 2, 2, 9]$

for i in $0..4$:

 if $X[i] > Y[i]$:

 print($X[i]$)

Choices:

(1) 8 9

(2) 5 8 9

(3) 1 3

(4) 1 5 3

- G-type questions

Example:

Problem G2 (Summer 2024):

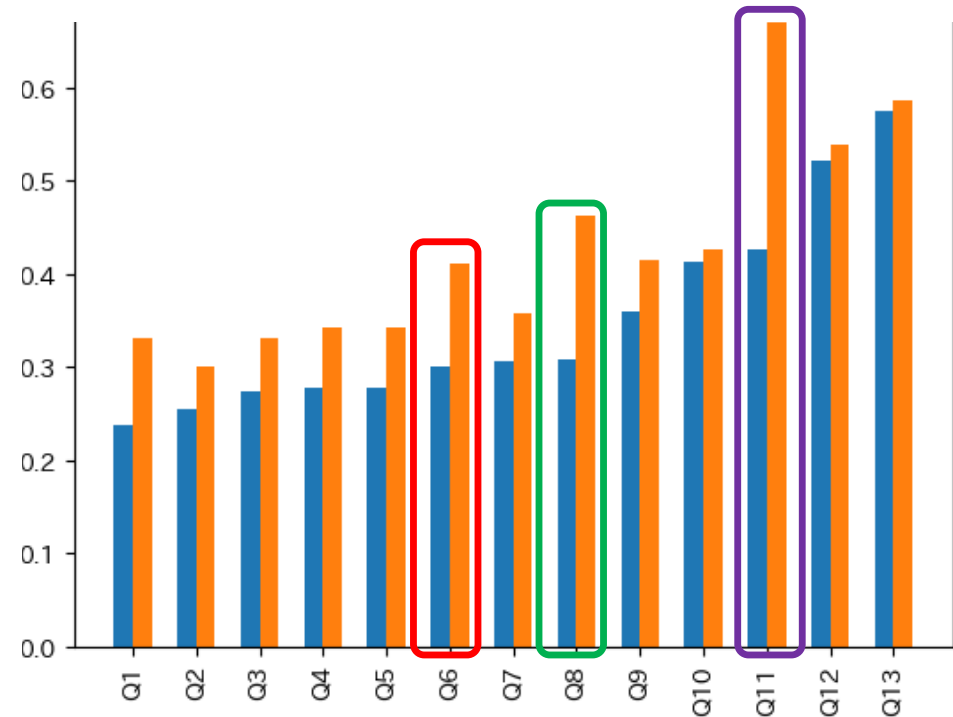
Calculate total train fare based on segment distances and fare rules.

Requires reading multi-page scenario and implementing a stepwise reasoning process.

4. Implementation Results and Analysis

Comparison between Summer 2024 and Spring 2025 mock exams

- 9 IRT-based multiple-choice items compared:
 - Summer 2024: Mean 4.17 (SD 2.40)
 - Spring 2025: Mean 3.35 (SD 1.95)
- Similar difficulty patterns indicate stable measurement.
- Graph (right): items arranged by difficulty, same shape across cohorts
- Results confirm reliability of the test design



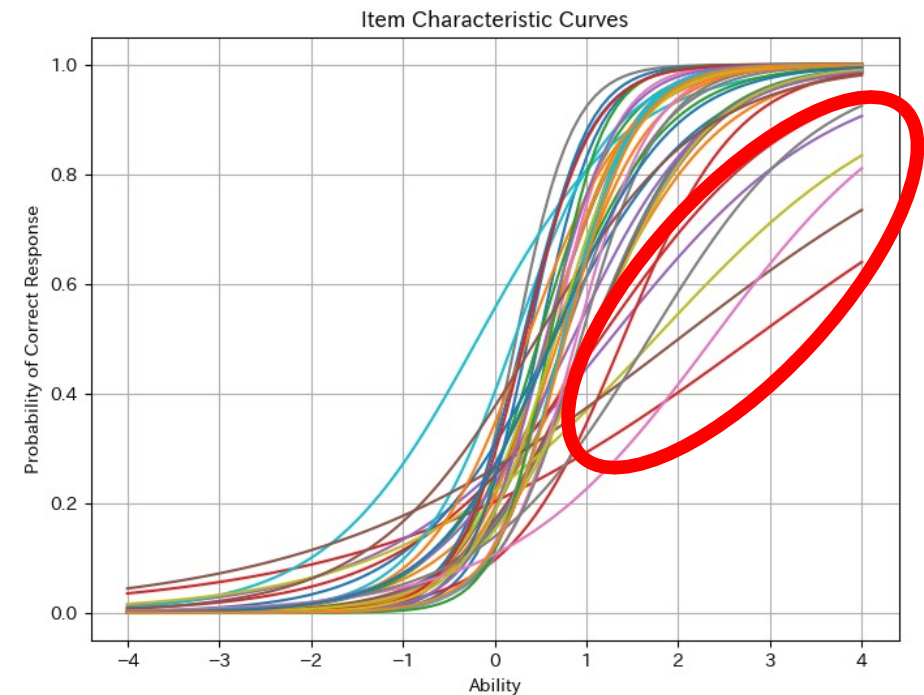
Nine IRT-based multiple-choice items arranged in order of difficulty, based on the percentage of correct answers

Orange: Summer 2024
Blue: Spring 2025

4. Implementation Results and Analysis

Item-Level Analysis by IRT

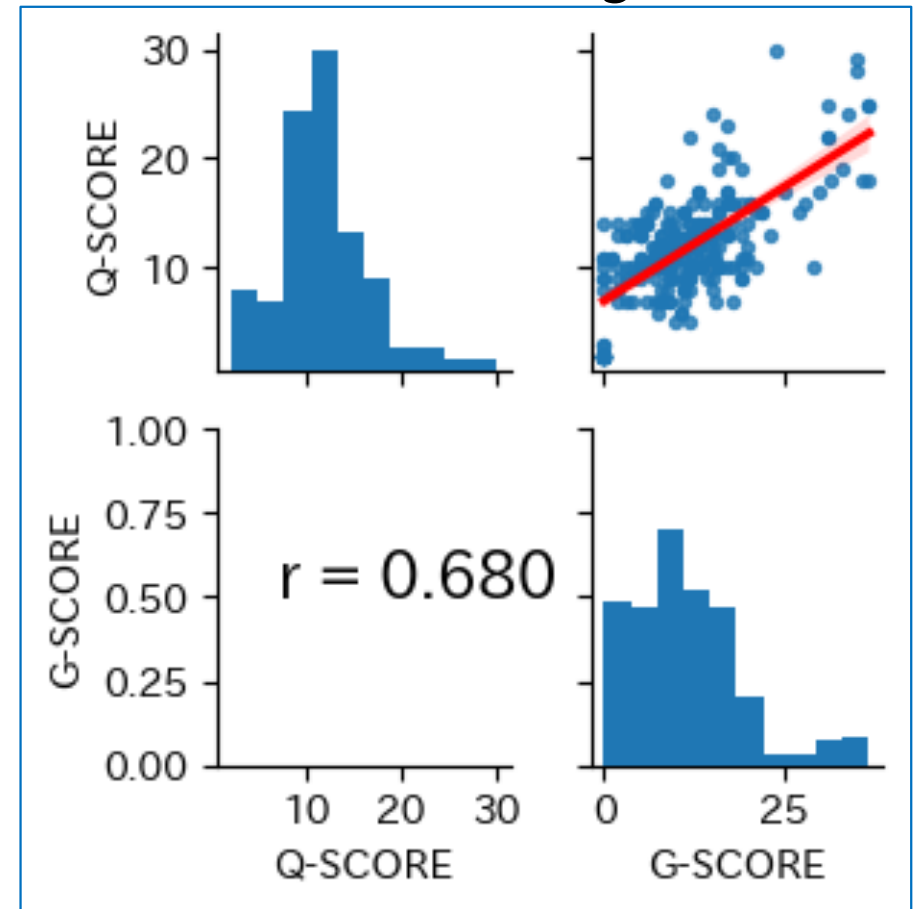
- Analyzed item difficulty (β) and discrimination (α) for Spring 2025:
 - Most items showed balanced difficulty and moderate discrimination
 - A few items were either too difficult or had low discrimination, indicating areas for improvement
- IRT analysis helps identify and refine question quality
 - Essential for building reliable large-scale assessments in informatics



4. Implementation Results and Analysis

Correlation and Reliability

- Correlation between IRT-based (Q-SCORE) and general (G-SCORE) results (Spring 2025 Mock Exam)
 - Moderate positive correlation observed ($r \approx 0.6$)
- Test Information Function shows stable reliability across ability range
- Indicates that IRT-based items align well with general assessment results
 - Supporting the validity of using IRT for Informatics evaluation.



5. Future Work — Toward Interactive Assessment

Ongoing Challenges

- EMIU Autumn 2025 Mock Exam (Oct–Nov 2025)
 - IRT section: 30 multiple-choice items (30 min)
 - New interactive assessment formats:
 - Block-based programming task (5 min) — execution with feedback
 - Debugging scenario (15 min) — adaptive branching by learner responses
 - Aim: measure process and use of feedback, not just answers
- Parallel validation study
 - Summer 2024 mock exam re-administered to university students
 - Half took it via CBT (TAO), half via mark sheet
 - Comparison across delivery modes and student groups

5. Future Work — Toward Interactive Assessment

From Assessment to Learning

- Interactive tasks record students' actions and feedback use
- Enables analysis of problem-solving processes and learning strategies
- Provides personalized feedback and supports reflection
- Bridges the gap between testing and learning

6. Conclusion and Key Takeaways

Key Takeaways

- EMIU project provides a framework for evaluating Informatics competencies
- IRT-based analysis supports fair and scalable assessment
- Ongoing studies aim to explore interactive and process-oriented tasks
- Goal: integrate assessment and learning for deeper Informatics education