

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

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- 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

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4. Implementation Results and Analysis
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1. Informatics and AI-Driven Educational Change

The Impact of AI on Learning

- AI systems now achieve gold medal-level performance in math and programming contest (IMO, ICPC, etc.)
- AI is transforming 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
- Build a foundation for fair and reliable Informatics assessment

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):

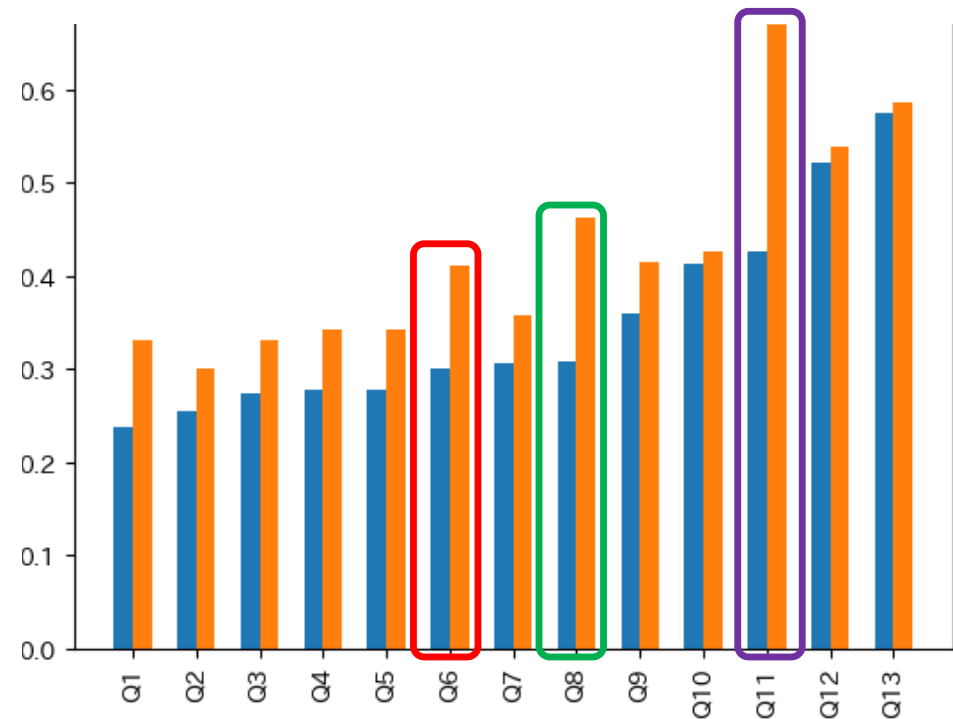
Calculate total train fare based on segment distances and fare rules.

- 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



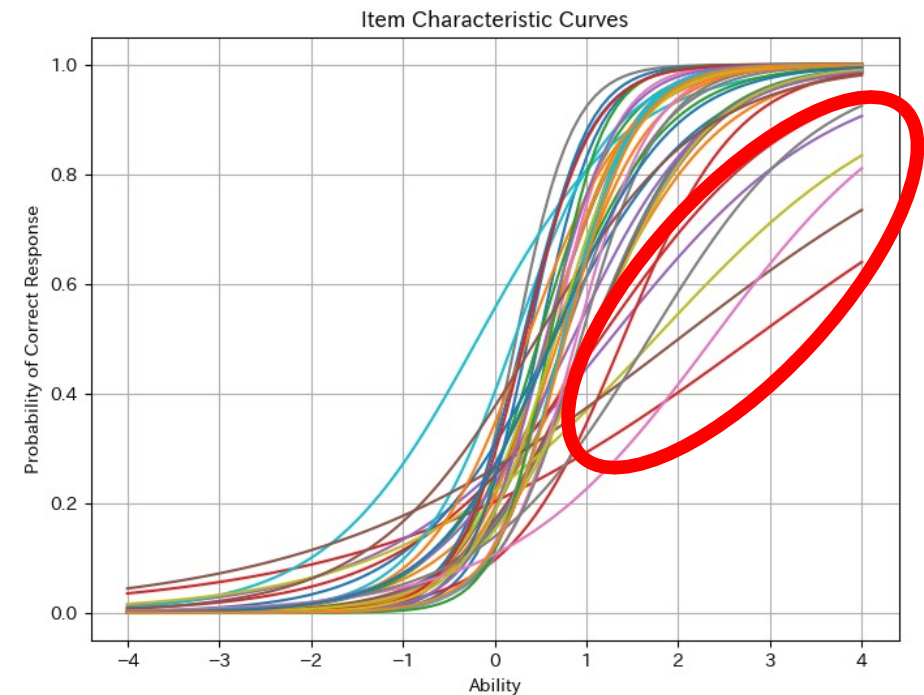
Nine IRT-based multiple-choice items arranged in order of difficulty, based on the percentage of correct answers

Orange: Summer 2024
Blue: Spring 2025

4. Implementation Results and Analysis

Item-Level Analysis by IRT

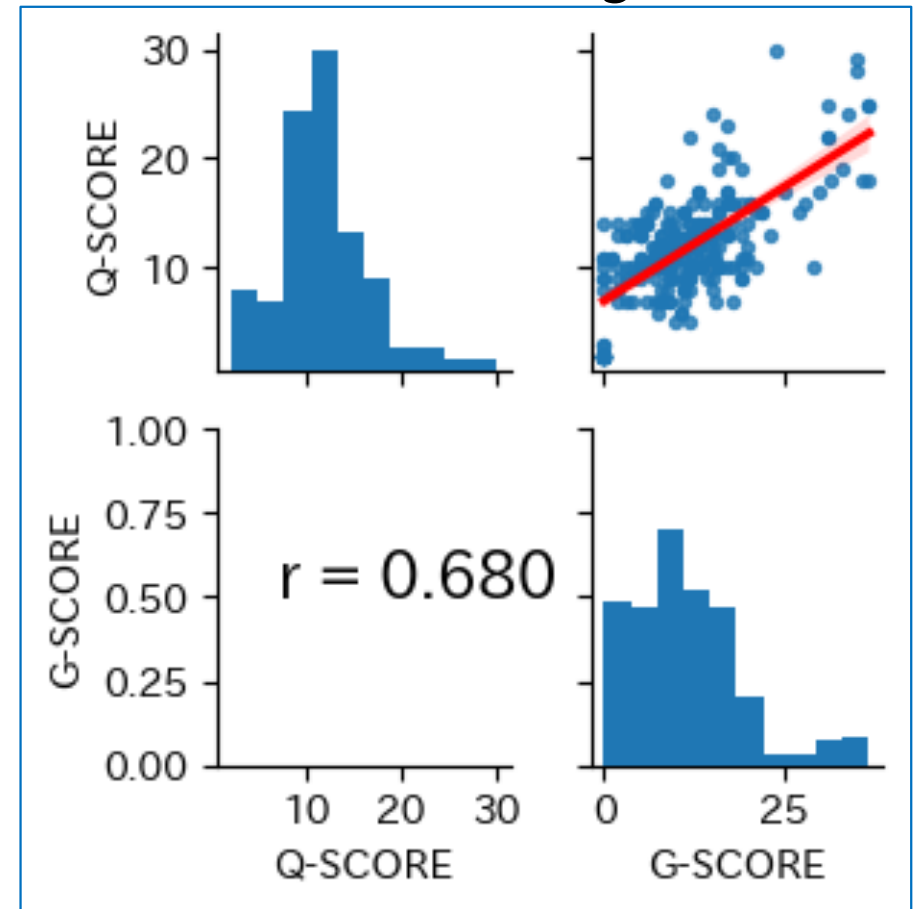
- Analyzed item difficulty (β) and discrimination (α) for Spring 2025:
 - Most items showed balanced difficulty and moderate discrimination
 - A few items were either too difficult or had low discrimination, indicating areas for improvement
- IRT analysis helps identify and refine question quality
 -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