Information Skills of University Freshmen and General Informatics Education

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Abstract

In Japan, the introduction of "Information I" into the Common Test for University Admissions in 2025, together with its adoption by many universities, marked a major shift in informatics education. This development followed the establishment of "Information I" as a compulsory subject in high school curricula under the revised Course of Study, implemented from the 2022 academic year. This systemic change is expected to reshape the information skills of incoming freshmen and necessitates an evidence-based redesign of general informatics education at universities. Using longitudinal results from the Information Placement Test (IPT) administered at Hiroshima University between 2022 and 2025, together with student-level response data from 2023, this study analyzes trends in correct, incorrect, and unknown responses. We demonstrate that a sharp improvement occurred between 2024 and 2025, accompanied by extremely large effect sizes (Cohen's *h*). Student-level analyses further reveal that uncertainty ("unknown" responses) constitutes a distinct and more severe learning state than incorrect answers. Across all content areas, learning gains are driven primarily by reductions in uncertainty rather than by decreases in incorrect answers. These findings underscore the central role of uncertainty reduction in the post-2025 context of general informatics education.

Keywords: information placement test, general informatics education, unknown responses

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Introduction

Information skills are essential competencies for all university freshmen in today's advanced information society. In Japan, general informatics education is often positioned within liberal arts curricula and is provided to all students regardless of major. Some universities have introduced placement tests to assess incoming students' readiness; however, these tests are used primarily for course assignment, with limited analytical application beyond basic accuracy rates (Chubachi, 2022; Inagaki & Murakami, 2023; Kawamura, 2019; Tokuno, 2024).

In 2025, Japan experienced a major policy shift: "Information I" was introduced into the Common Test for University Admissions and adopted by many universities (See for example, Nakano, 2026). This change formalized the assessment of information skills prior to university entry and is expected to substantially alter the academic preparedness of incoming freshmen. Under these new educational conditions, universities urgently require an evidence-based understanding of how freshmen's information skills are evolving and how general informatics education should respond. A longitudinal analysis of placement test data provides a unique opportunity to examine whether, and in what ways, this policy change is reflected in students' information skills.

This study addresses this need by analyzing longitudinal placement test data collected during the transition period (2022–2025) and by focusing on an often-overlooked response category: "I don't know" (unknown). We argue that uncertainty, as captured by unknown responses, represents a distinct cognitive state with important educational implications. Specifically, we demonstrate that learning gains are driven not only by reductions in incorrect answers but, more importantly, by decreases in uncertainty across content areas. Building on this context, this study addresses the following research questions:

1. How have university freshmen's information skills evolved from 2022 to 2025?
2. What role does uncertainty, as captured by unknown responses, play in learning gains?
3. What implications do these changes have for general informatics education in the post-2025 era?

Methods

This section describes the assessment instrument, participants, and analytical procedures used to examine longitudinal changes in freshmen's information skills during the 2022–2025 transition period. Particular emphasis is placed on the role of uncertainty, captured through explicit unknown ("I don't know") responses, as a key dimension of students' preparedness for general informatics education.

Instrument: Information Placement Test (IPT)

The Information Placement Test (IPT) is a standardized assessment developed by the Committee on General Informatics Education of the Information Processing Society of Japan. Its purpose is to assess students' readiness for general informatics education, rather than to select or exclude students.

The IPT is based on the General Education Body of Knowledge (GEBOK) framework and covers ten content areas spanning technical, conceptual, and societal dimensions of informatics (IPSJ, 2018). Eight of these correspond to the GEBOK core domains: Information and Communication, Digitization of Information, Fundamentals of Computing Systems, Data

Models and Databases, Information Networks, Information Systems and Society, Information Security and Ethics, and Academic ICT Literacy. The remaining two areas were added based on the Japanese high school curriculum guidelines and textbooks: Problem Solving and Algorithms and History and Future of Media and Computing.

The IPT consists of 51 multiple-choice questions selected from a standardized database of 188 items, including one basic check item. Each question provides four answer options and an explicit "I don't know" (unknown) option. Responses were classified into three categories: correct, incorrect, or unknown.

The present study analyzes aggregated IPT results from 2022 to 2025, as well as student-level response data from 2023. Longitudinal trends were examined at the content-area level, and paired statistical tests with effect sizes were used to evaluate changes between 2024 and 2025. Student-level analyses were further conducted to identify learner profiles and to compare unknown-rich and incorrect-rich groups.

Participants and Procedure

The participants were first-year undergraduate students at Hiroshima University enrolled in the general informatics course Introduction to Information and Data Science, which is offered as part of the university's liberal arts curriculum. The IPT was administered during the first class meeting each academic year in order to assess students' readiness for general informatics education upon university entry. In 2022 and 2023, a fixed test form was administered, whereas in 2024 and 2025, items were randomly drawn from the item pool. Students completed the IPT within approximately 20 minutes of scheduled class time, followed by an additional 15-minute break period. The test was conducted in a standardized format across all years of data collection.

The number of valid responses was 1,736 in 2022, 1,723 in 2023, 2,167 in 2024, and 2,381 in 2025. These samples represent more than 80% of the incoming freshman cohort each year, ensuring broad coverage of the first-year student population and enabling robust longitudinal comparisons.

Ethical considerations were addressed by analyzing only anonymized assessment data collected as part of regular educational activities. Participation had no effect on course grading, and all results were reported in aggregate form to ensure confidentiality. This design allows placement-test data to be used not only for course assignment but also as evidence for curriculum redesign in the post-2025 era.

Data Analysis

IPT responses were analyzed at both the aggregated and student levels to examine longitudinal changes in freshmen's information skills and the educational role of uncertainty. Each response was classified into one of three categories: correct, incorrect, or unknown ("I don't know"). For each year from 2022 to 2025, the proportions of these response categories were calculated overall and separately for each of the ten IPT content areas.

To investigate changes associated with the policy transition period, analyses focused on differences between 2024 and 2025. Two-proportion z-tests were performed at the item level to compare response-category proportions between the two cohorts. Effect sizes for these

proportion differences were quantified using Cohen's *h*, which is appropriate for evaluating changes in response rates. Content-area patterns were then examined by summarizing item-level effect sizes within each domain, providing descriptive indicators of the magnitude and consistency of changes across items.

The IPT was administered using a fixed test form in 2022 and 2023, whereas in 2024 and 2025 items were randomly drawn from the standardized question pool. To ensure comparability across years, all analyses for 2024 and 2025 were restricted to the subset of items that were identical to those used in 2022 and 2023, whereas the full fixed-form datasets were analyzed for 2022 and 2023. This approach enabled consistent longitudinal comparisons despite changes in item administration.

In addition, student-level response data from 2023 were used to explore heterogeneity in learner profiles. Students were grouped according to their relative proportions of unknown and incorrect responses, allowing the identification of unknown-rich and incorrect-rich response patterns. Comparative analyses were performed to examine how these profiles differed across content areas and to clarify the distinct educational implications of uncertainty versus incorrect knowledge.

All statistical analyses followed standard procedures, and results are reported with corresponding significance levels and effect-size measures. The basic check item was excluded from the analyses.

Results

This section presents the longitudinal results of the IPT from 2022 to 2025, with particular attention to changes observed during the policy transition in 2025. In addition to overall performance trends, we highlight the central role of uncertainty reduction, reflected in decreases in unknown responses, as a major driver of learning gains.

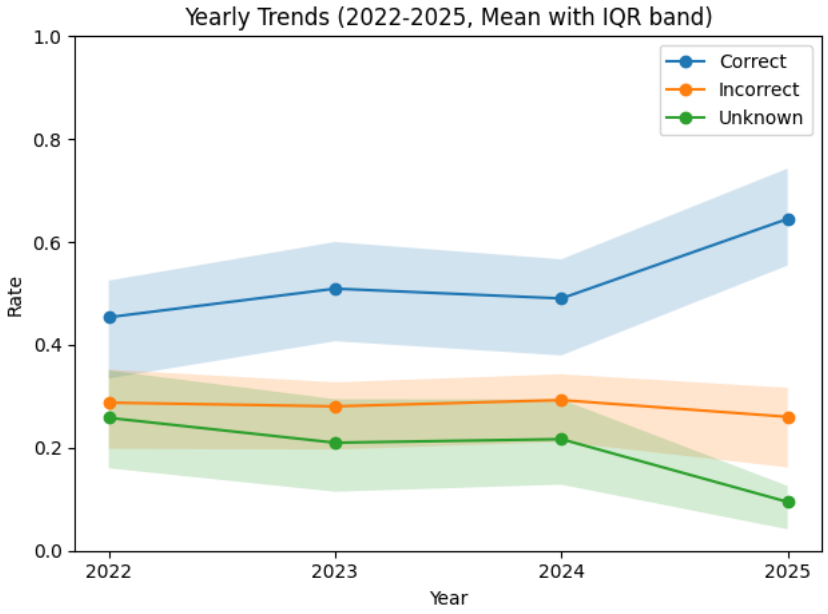
Overall Trends in Response Categories

Figure 1 presents the overall longitudinal trends in freshmen's IPT response patterns from 2022 to 2025, showing the proportions of correct, incorrect, and unknown ("I don't know") responses. Overall performance improved across the four-year period; however, changes were not uniform. In particular, response distributions remained largely stable between 2023 and 2024, with little evidence of substantial improvement during this interval.

In contrast, the most pronounced shift occurred between 2024 and 2025, coinciding with the introduction of "Information I" into the Common Test for University Admissions. This transition was characterized by an increase in correct responses accompanied by a marked reduction in unknown responses, suggesting that learning gains in the post-2025 cohort were driven primarily by decreased uncertainty rather than by simple reductions in incorrect answers.

Figure 1

Yearly Trends in IPT Response Categories (Correct, Incorrect, and Unknown) Among Hiroshima University Freshmen From 2022 to 2025, Based on Common Subset of Items



Content-Area Improvements

To quantify these changes at the domain level, Table 1 summarizes content-area differences in correct response rates between 2024 and 2025. Improvements were observed across all ten areas, with medium effect sizes in several foundational domains. The largest gains in correct responses were found in "Digitization of Information" (ΔCorrect = +0.198, Cohen's h = 0.45) and "Information Systems and Society" (ΔCorrect = +0.204, Cohen's h = 0.44), highlighting substantial strengthening of core informatics competencies.

Table 1

Content-Area Changes in Correct Response Rates Between 2024 and 2025

Content Area	Correct 2024	Correct 2025	ΔCorrect	Cohen's h
Information and Communication	0.611	0.715	0.104	0.24
Digitization of Information	0.598	0.796	0.198	0.45
Fundamentals of Computing Systems	0.421	0.570	0.149	0.31
Data Models and Databases	0.444	0.604	0.160	0.32
Information Networks	0.485	0.638	0.153	0.31
Information Systems and Society	0.547	0.751	0.204	0.44
Information Security and Ethics	0.410	0.603	0.193	0.41
Academic ICT Literacy	0.462	0.593	0.132	0.28
Problem Solving and Algorithms	0.657	0.795	0.137	0.31
History and Future of Media and Computing	0.324	0.467	0.143	0.30

Note. Correct response rates are based on the common subset of IPT items administered across all years. Two-proportion *z*-tests were performed at the item level to compare the 2024 and 2025 freshman cohorts. Content-area results are reported as domain-level summaries of item-level outcomes, including changes in correct response proportions (ΔCorrect) and mean effect sizes (Cohen's h). Cohen's h represents the magnitude of proportion differences, with values around 0.20, 0.50, and 0.80 typically interpreted as small, medium, and large effects, respectively.

Given the particularly strong improvement in Digitization of Information, Figure 2 focuses on this domain as a representative example. As shown in Figure 2, performance in this area remained largely stable between 2023 and 2024, but exhibited a sharp increase in correct responses between 2024 and 2025. This shift was accompanied by a pronounced decline in unknown responses, indicating a major reduction in uncertainty in one of the most fundamental content areas related to binary representation, data units, and the principles of digital information.

Figure 2

Yearly Trends in Response Categories (Correct, Incorrect, and Unknown) in the Digitization of Information Content Area From 2022 to 2025

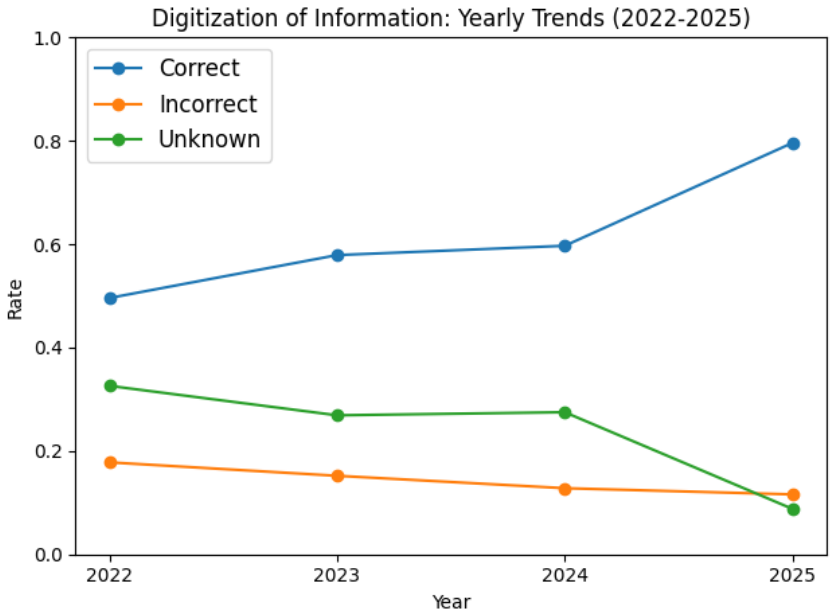


Table 2

Content-Area Changes in Unknown Response Rates Between 2024 and 2025

Content Area	Unknown 2024	Unknown 2025	ΔUnknown	Cohen's h
Information and Communication	0.216	0.131	−0.085	−0.22
Digitization of Information	0.275	0.088	−0.187	−0.52
Fundamentals of Computing Systems	0.307	0.127	−0.180	−0.45
Data Models and Databases	0.316	0.149	−0.168	−0.41
Information Networks	0.243	0.094	−0.149	−0.41
Information Systems and Society	0.231	0.073	−0.158	−0.46
Information Security and Ethics	0.321	0.187	−0.134	−0.32
Academic ICT Literacy	0.249	0.154	−0.095	−0.23
Problem Solving and Algorithms	0.198	0.091	−0.107	−0.27
History and Future of Media and Computing	0.332	0.204	−0.128	−0.30

Note. Unknown responses correspond to the explicit "I don't know" option in the IPT. Rates are based on the common subset of IPT items administered across all years. Two-proportion *z*-tests were conducted at the item level to compare unknown-response proportions between the 2024 and 2025 cohorts. Content-area values represent domain-level summaries of item-level results, including changes in unknown response proportions (ΔUnknown) and mean effect sizes (Cohen's h). Negative values of Cohen's h indicate decreases in unknown responses, reflecting reductions in uncertainty. Values of |h| around 0.20, 0.50, and 0.80 are typically interpreted as small, medium, and large effects.

Table 2 further demonstrates that reductions in unknown responses were consistently observed across all content areas. The largest decrease in uncertainty was again found in "Digitization of Information" (ΔUnknown = −0.187, Cohen's h = −0.52), followed by "Fundamentals of Computing Systems" (ΔUnknown = −0.180, Cohen's h = −0.45). These findings support the central argument of this study: that the most significant learning gains associated with the post-2025 transition are reflected not only in increased accuracy, but more importantly in substantial reductions in student uncertainty.

Together, Figures 1–2 and Tables 1–2 indicate that the 2025 policy shift was associated with a clear improvement in freshmen's information skills, with domain-specific gains driven largely by decreased unknown responses. The following section further explores learner-level heterogeneity through unknown-rich and incorrect-rich response profiles.

Learner Profiles: Unknown-Rich Versus Incorrect-Rich Groups

To further examine learner-level heterogeneity underlying the aggregated trends, we analyzed student-level response patterns using the 2023 dataset. Students were classified into two contrasting profiles based on their proportions of unknown and incorrect responses. The unknown-rich group was defined as students with an unknown response rate of at least 0.40 (Unknown Rate ≥ 0.40; N = 323), representing learners with high levels of uncertainty. The incorrect-rich group was defined as students with a incorrect response rate of at least 0.40 combined with a low unknown rate (Incorrect Rate ≥ 0.40 and Unknown Rate ≤ 0.20; N = 286), representing learners who tended to provide incorrect answers rather than selecting "I don't know."

These two profiles exhibited markedly different overall performance levels. The unknown-rich group showed a substantially lower mean correct rate, 0.280, and a high mean unknown rate, 0.569, whereas the incorrect-rich group demonstrated a higher mean correct rate, 0.451, and a very low mean unknown rate, 0.041, accompanied by a high incorrect rate, 0.508. A Welch's t-test confirmed that the difference in correct response rates between the two groups was extremely large and statistically significant, t = −21.57, p < .001.

Table 3

Content-Area Correct Response Rates for Unknown-Rich and Incorrect-Rich Student Profiles in 2023

Content Area	Unknown-rich	Incorrect-rich
Information and Communication	0.360	0.536
Digitization of Information	0.191	0.427
Fundamentals of Computing Systems	0.134	0.427
Data Models and Databases	0.141	0.476
Information Networks	0.240	0.492
Information Systems and Society	0.301	0.505
Information Security and Ethics	0.274	0.451
Academic ICT Literacy	0.276	0.420
Problem Solving and Algorithms	0.533	0.633
History and Future of Media and Computing	0.108	0.304

Note. Values indicate mean correct response proportions within each IPT content area. The unknown-rich group was defined as students with Unknown Rate ≥ 0.40 (N = 323), whereas the incorrect-rich group was defined as students with Incorrect Rate ≥ 0.40 and Unknown Rate ≤ 0.20 (N = 286).

Table 3 further represents how these profile differences vary across content areas by comparing domain-level correct response rates. Across nearly all areas, the incorrect-rich group consistently achieved higher correct rates than the unknown-rich group, indicating that incorrect-rich students often possess partial knowledge or misconceptions, whereas unknown-rich students exhibit substantially lower mastery accompanied by pronounced uncertainty. Particularly large gaps were observed in foundational domains such as Digitization of Information, Fundamentals of Computing Systems, and Data Models and Databases, highlighting areas where uncertainty may reflect deeper deficits in preparedness.

Together, these findings reinforce the central argument of this study: uncertainty, captured through explicit unknown responses, represents a distinct and educationally meaningful dimension of freshmen's information skills. Distinguishing between uncertainty-rich and error-rich learners may therefore be critical for designing effective post-2025 general informatics education.

Discussion

The present study provides clear evidence that university freshmen's information skills improved markedly during the 2022–2025 transition period, with the most pronounced shift occurring between 2024 and 2025 following the introduction of "Information I" into the Common Test. Importantly, these gains were characterized not only by increased accuracy but, more fundamentally, by substantial reductions in unknown responses across content areas. This pattern highlights uncertainty reduction as a central mechanism of learning progress in the post-2025 era.

Moreover, the learner-profile analysis demonstrated that uncertainty represents a distinct educational state rather than simply another form of error. Unknown-rich students exhibited significantly lower mastery than incorrect-rich students, suggesting that general informatics education must differentiate between learners who are uncertain and those who are confidently incorrect.

Conclusion

This study examined longitudinal changes in university freshmen's information skills during the 2022–2025 transition period using Information Placement Test (IPT) data collected at Hiroshima University. The results revealed that improvements were not gradual across all years but showed a pronounced shift between 2024 and 2025, coinciding with the introduction of "Information I" into the National Common Test for University Admissions.

A key finding is that these learning gains were driven primarily by substantial reductions in unknown ("I don't know") responses, rather than by decreases in incorrect answers alone. This highlights uncertainty reduction as a central dimension of student preparedness in the post-2025 era. Student-level analyses further demonstrated that unknown-rich learners exhibit significantly lower mastery than incorrect-rich learners, indicating that uncertainty represents a distinct educational state rather than simply another form of error.

These findings carry important implications for general informatics education. Universities should explicitly address uncertainty in addition to correctness and differentiate instructional strategies for diverse learner profiles: unknown-rich students may require conceptual scaffolding and confidence-building support, whereas incorrect-rich students may benefit from

targeted misconception correction. Placement assessments such as the IPT can therefore serve not only for course assignment but also as evidence for curriculum redesign under the new educational conditions after 2025.

Several limitations should be noted. This study was conducted at a single institution, and broader validation across universities is needed. In addition, cohort differences may reflect factors beyond the policy change alone. Future work should extend multi-institutional analyses and evaluate instructional interventions aimed at reducing uncertainty and strengthening foundational competencies.

Overall, the introduction of “Information I” marks a new phase for university informatics education in Japan, and evidence-based approaches will be essential for supporting incoming students in the post-2025 era.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that ChatGPT (OpenAI), an AI-assisted writing tool, was used to support proofreading and language refinement in this manuscript. Its use was limited to correcting grammatical and spelling errors and to minor rephrasing for clarity and accuracy. The authors take full responsibility for the content of the manuscript.

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