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Elevating Educational Evaluation: A Case Study on the Implementation of Higher-Order Thinking Skill Assessment in English Entrance Examinations

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This investigation seeks to improve Higher-Order Thinking Skills (HOTS) assessments in English items for Japanese national and public university entrance exams by analyzing 115 items from 65 universities. Focusing on these items' types, formats, and features, the study identifies key deficiencies—such as 53.9% lacking necessary texts or diagrams for resolution—and proposes targeted enhancements illustrated with examples from Kobe University. The findings advocate for a refined approach to developing unbiased and cognitively demanding HOTS items, including a strategic pairing of Lower-Order Thinking Skills (LOTS) items preceding HOTS items to progressively assess candidates' cognitive abilities. The study also explores the potential for assessing HOTS through well-designed multiple-choice items alongside traditional descriptive formats to measure advanced cognitive skills, thereby enhancing educational evaluation more effectively.

Keywords: Higher-Order Thinking Skills (HOTS), university entrance examinations, English assessments, test item analysis

1 Introduction

Higher-Order Thinking Skills (HOTS) involve advanced cognitive processes such as analysis, evaluation, and creation, going beyond basic memorization and understanding which are categorized as Lower-Order Thinking Skills (LOTS) (Anderson and Krathwohl, 2001; Ueda, 2021a, 2021b). The development of HOTS is increasingly recognized as essential in education (Sandag, 2023; Lim, 2023). HOTS enable students to acquire complex problem-solving abilities, critical thinking, and creativity. Integrating HOTS into diverse educational frameworks not only enhances cognitive abilities but also prepares students to tackle real-world challenges.

Incorporating HOTS into English language learning offers benefits (Helsa et al., 2022). For instance, HOTS-based and project-based learning activities engage students in authentic tasks that not only deepen their understanding of English but also strengthen their critical thinking skills. Additionally, research has shown that HOTS-based materials enhance students' engagement and satisfaction in English language learning (Ni et al., 2024).

With the growing emphasis on HOTS, university entrance examinations increasingly incorporate items designed to assess these skills. Research indicates that assessments can enhance learning through a testing effect (Shanks et al., 2023; An and Campelo, 2022; Yang et al., 2021). Furthermore, Mellanby et al. (2009) showed that a test assessing a deep learning approach could reveal candidates' chances of thriving at top-tier universities and might be effectively integrated into the existing admission processes for such institutions. Therefore, incorporating items that measure HOTS into university entrance examinations might enhance candidates' learning of these skills and serve as a valuable tool for identifying students with the potential to succeed in rigorous academic environments.

Recent studies have investigated the inclusion of HOTS items in university entrance examinations. For instance, Aydin and Birgili (2023) examined the alignment between mathematics HOTS items and educational objectives in Turkish university exams. Similarly, Reza et al. (2021) confirmed the reliability and appropriateness of chemistry HOTS items in

university admissions tests. Additionally, Ueda (2021a, 2021b) noted significant shifts toward fostering HOTS in Japan's Common Test for University Admissions.

Despite these developments, research into the development of HOTS-based exam items in Japan is still evolving. This study aims to address this gap by analyzing English entrance exam items from public and national universities in Japan, possibly improving HOTS assessments and educational evaluations.

2 Method

This section outlines the research method employed to examine the types, formats, and characteristics of HOTS assessment items in English entrance exams at Japanese national and public universities. Given the profound impact of these exams on students' academic trajectories, a comprehensive analysis was necessary.

The dataset for this study comprised English entrance examination items from 65 national and public universities in Japan, selected for their extensive applicant pools and significant influence on students' academic trajectories. These universities collectively represented approximately 71% of all public university applicants in 2022 and 2023, according to data from the Ministry of Education, Culture, Sports, Science and Technology (2022, 2023). This selection underscores the wide reach and importance of these exams in the landscape of Japanese higher education. Table 1 presents a list of 65 national and public universities in Japan whose English entrance examination items from 2022 and 2023 were analyzed.

Table 1

List of 65 National and Public Universities in Japan with Analyzed English Entrance Examination Items from 2022 and 2023

1)	Aichi Prefectural University	23)	Kyoto Prefectural University	45)	Takasaki City University of Economics
2)	Akita University	24)	Kyoto University	46)	The University of Electro-Communications
3)	Chiba University	25)	Kyushu University	47)	The University of Shiga Prefecture
4)	Fukui Prefectural University	26)	Miyagi University	48)	The University of Tokyo
5)	Fukuoka Women's University	27)	Nagasaki University	49)	Tohoku Univerisity
6)	Gifu University	28)	Nagoya City University	50)	Tokushima University
7)	Gunma University	29)	Nagoya Institute of Technology	51)	Tokyo Institute of Technology
8)	Hirosaki University	30)	Nagoya University	52)	Tokyo Medical and Dental University
9)	Hiroshima University	31)	Nara Women's University	53)	Tokyo University of Agriculture and Technology
10)	Hitotsubashi University	32)	Niigata University	54)	Tokyo University of Foreign Studies
11)	Hokkaido University	33)	Ochanomizu University	55)	Tottori University
12)	Hokkaido University of Education	34)	Oita University	56)	University of Aizu
13)	Ibaraki University	35)	Okayama University	57)	University of Fukui
14)	Iwate University	36)	Osaka Metropolitan University	58)	University of Hyogo
15)	Kagashima University	37)	Osaka University	59)	University of Miyazaki
16)	Kagawa University	38)	Otaru University of Commerce	60)	University of Nagasaki
17)	Kanazawa University	39)	Saga Univerisity	61)	University of Tsukuba
18)	Kobe City University of Foreign Studies	40)	Saitama University	62)	Utsunomiya University
19)	Kobe University	41)	Shiga University	63)	Yamagata University
20)	Kochi University	42)	Shimane University	64)	Yokohama City University
21)	Kumamoto University	43)	Shinshu University	65)	Yokohama National University
22)	Kyoto Institute of Technology	44)	Shizuoka University		

The analytical stage involved a comprehensive review of these examination items, which were identified and classified according to the revised Bloom's Taxonomy. This classification covered three major dimensions of HOTS: Analyze, Evaluate, and Create (Anderson and Krathwohl, 2001; Ueda, 2021a, 2021b). Table 2 presents examples of English examination items classified under the categories of Analyze, Evaluate, and Create.

Table 2

Examples of English Examination Items Classified Under the HOTS Categories

Category	Example
Analyze	The following (A) through (C) are parts of the instructions for an experiment. Which of the six engineering design process steps does each experiment fall into? (Kobe University, 2024a: 5) (See 4.3)
Evaluate	Evaluate your graph with the above-mentioned passage and information, including two true statements based upon the data you collected. (Kobe University, 2023a: 2)
	Concerning the underlined part, do you agree or disagree with the author? Explain the reason. (Kobe University, 2024b: 9)
Create	Among the types of nudges—perception nudges, motivation nudges, or simplicity nudges—choose one and design example measures of that type to solve the problems mentioned in Issue A (Kobe University, 2023b: 11) (See 4.2)

Each item was subsequently categorized as either multiple-choice or open-ended written response. The analysis extended to evaluating whether the items required an understanding of text content and the ability to interpret diagrams.

To ensure a thorough and consistent analysis, four expert coders independently classified each item. Inter-rater reliability was assessed, yielding a high coefficient of 91%, indicating excellent agreement among the coders. Discrepancies encountered during the coding process were collaboratively addressed, enhancing the coding scheme's robustness and the study's overall validity.

3 Findings

3.1 Prevalence of HOTS

Among Japan's 65 national and public universities, items assessing HOTS were identified in 47 universities in 2022 or 2023. It was found that approximately 72.3% of these universities included HOTS items in their English entrance exams. Furthermore, 11 universities, representing about 16.9%, featured multiple HOTS assessment items in a single exam in either 2022 or 2023. The number of items assessing HOTS showed a slight increase, from 55 in 2022 to 60 in 2023. Data were collected on 115 HOTS-assessing entrance exam items administered at national and public universities during this period.

3.2 Types of HOTS

In this section, an analysis of the types of HOTS identified in Japanese public university entrance exam items in 2022 and 2023 is presented. Specific results of the analysis indicate which types of HOTS each item assessed. Table 3 displays the number and percentage of items that evaluated HOTS for each identified type in the 2022 and 2023 national and public English entrance examinations.

Table 3

Distribution of HOTS Item Types in 2022 and 2023 National and Public University English Entrance Examinations

	Analyze	Evaluate	Create	Total
Frequency	17	95	3	115
%	14.8	82.6	2.6	100

The analysis revealed that a significant majority of the items, 82.6% (95 out of 115), were categorized under the Evaluate dimension of HOTS in national and public university English entrance exams. This indicates a predominant emphasis on evaluating abilities in these examinations. In stark contrast,

only a minimal proportion, 2.6% (three out of 115), of the items were designed to assess creative abilities, falling into the Create category of HOTS. This highlights the infrequency of items that aim to evaluate creative thinking in the national and public university English entrance exams.

Furthermore, 11 universities included multiple HOTS assessment items in a single exam administered in either 2022 or 2023. However, the distribution of HOTS item types within a single exam showed similar biases, with a notable absence of exams that included all three dimensions—Analyze, Evaluate, and Create. This lack of comprehensive representation further underscores the limited scope of HOTS assessment in these entrance exams.

3.3 Forms and Characteristics of HOTS

The results of the analysis of the forms and characteristics of HOTS identified in the Japanese national and public university entrance examinations for 2022 and 2023 are presented. It was observed that all 115 items were in an open-ended format, suggesting a preference for written item formats in the assessment of HOTS at national and public universities. Table 4 displays the distributions of characteristics of items assessing HOTS in the national and public English entrance examinations during the specified years.

Table 4

Distribution of Item Characteristics Assessing HOTS in 2022 and 2023 National and Public University English Entrance Exams

	Analyze	Evaluate	Create	Total	%
Need texts	3	31	1	35	30.4
Need diagrams	14	4	0	18	15.7
No texts or diagrams required	0	60	2	62	53.9
Total	17	95	3	115	100

Concerning all categories, approximately 53.9% of the items (62 out of 115) did not necessitate the use of texts or diagrams, suggesting that a substantial portion of the examinations did not depend on material comprehension. Despite expectations that HOTS items typically require a comprehensive understanding of the material, about half of these items were designed without the need for prior texts or diagrams.

Regarding the Evaluate category, it was noted that 63.2% (60 out of 95) could be answered without a prior understanding of the material. This indicates that many items categorized as Evaluate did not necessitate an understanding of the material to formulate a response.

Regarding the Analyze category, it was found that the Need figures category, implying that all items in this category (100%) required understanding of the preceding sentences or diagrams. The findings imply that the items intended to evaluate analytical abilities were predicated on considerable presuppositions regarding prior knowledge.

3.4 Challenges in HOTS Assessment

The analysis of HOTS in English entrance examinations at Japanese national and public universities suggests notable variations in the assessment of different cognitive skills, particularly between the Evaluate and Create dimensions. Although the Evaluate dimension is well-represented, the limited inclusion of Create-based items, which constitute only 2.6% of the total, highlights a potential area for enhancement in assessing students' abilities to generate original ideas and solutions.

These findings suggest that there may be an imbalance in the breadth and depth of cognitive skills being assessed. The prevalence of Evaluate items may indicate a focus on judgment-based skills; however, the scarcity of Create items could suggest an area for further development in innovation and originality, which are crucial for nurturing well-rounded cognitive abilities in students. This imbalance could possibly restrict the scope of HOTS assessment and might inhibit the development of creative thinking skills, which are increasingly important in today's innovation-driven environment.

Moreover, the observation that a significant portion of the items (53.9%) did not require deep engagement with texts or diagrams indicates that many items may rely on shallow cognitive processes. This design approach appears to diverge from the core objectives of HOTS, which are to promote deep analysis, evaluation, and creation through intricate cognitive processing.

4 Exploration of Approaches to HOTS Assessment

4.1 Balanced Assessment of HOTS

Based on the gaps identified in the Findings section, this paper presents specific examples of English entrance exam items designed to more effectively assess HOTS. The examples were selected due to the well-established reliability and validity of the English section of the Kobe University Kokorozashi Special Selection Exams. The reliability, defined as the test's consistency in producing stable results across multiple administrations (Babu and Kohli, 2023), is demonstrated by a Cronbach's alpha coefficient exceeding 0.8, meeting established reliability standards. The validity, or the accuracy in measuring the intended constructs (Devi and Rajkumari, 2017), was confirmed through factor analysis, indicating that the exam effectively assesses the targeted competencies.

Exploring several directions to enhance the assessment of HOTS in admissions would be beneficial. One such direction involves striving for a balanced evaluation of cognitive abilities across all aspects of HOTS. Table 5 displays the number and percentage of items that assessed HOTS in the English section of the Kobe University Kokorozashi Special Selection Exams conducted in October 2022 and 2023, categorized by the identified types of HOTS.

Table 5

Distribution of HOTS Item Types in 2022 and 2023 Kobe University Kokorozashi Special Selection English Exams

	Analyze	Evaluate	Create	Total
Frequency	12	10	7	29
%	41.4	34.5	24.1	100

The Analysis of the English items in the Kobe University Kokorozashi Special Selection Exams conducted in 2022 and 2023 revealed that 29 items assessed HOTS. The distribution of these items was as follows: 12 in the Analyze category (41.4%), 10 in the Evaluate category (34.5%), and seven in the Create category (24.1%). This configuration exemplifies a balanced approach and ensures that each category is adequately represented, thus supporting a robust assessment of HOTS across Analyze, Evaluate, and Create dimensions. The distribution aligns with the comprehensive evaluation objectives, encapsulating the spectrum of cognitive skills targeted by the exam creators.

4.2 Integrating LOTS with a Creativity Assessment in HOTS

In the evaluation of HOTS in Japanese English entrance examinations, it could be considered beneficial to include items aimed at assessing creativity. Such items are likely to require candidates to demonstrate comprehension and application of material presented in texts or diagrams, potentially aiding in the evaluation of their capabilities for creative and innovative thinking. A pertinent example is observed in the 2022 Kobe University Kokorozashi Special Selection. Within the English segment, candidates initially tackled an item that directed them to understand three distinct nudges—perception, motivation, and simplicity—derived from

the provided content. The item was articulated as: "According to the passage, explain each of the three categories of nudge theory" (Kobe University, 2023b: 11).

The aforementioned item aimed to gauge the candidates' LOTS, particularly their comprehension skills. Following this, the examination posed two additional items intended to measure creativity abilities. The first of these asked: "Among the types of nudges—perception nudges, motivation nudges, or simplicity nudges—choose one and design example measures of that type to solve the problems mentioned in Issue A" (Kobe University, 2023b: 11). A similar item was presented subsequently, which asked: "Again, choosing one among perception nudges, motivation nudges, or simplicity nudges, design measures of that type to solve the problems mentioned in Issue B" (Kobe University, 2023b: 11). This methodical sequencing of items ensures that candidates demonstrate a comprehensive understanding of foundational concepts through LOTS-oriented items before progressing to tackle more intricate HOTS-oriented tasks. This structured evaluative approach not only sequentially challenges candidates but also provides potential insights into their capacity to synthesize information and generate innovative solutions.

4.3 Integrating LOTS with a Multiple-Choice Item for HOTS Assessment

The English items in the 2022 and 2023 Kobe University Kokorozashi Special Selection Exams included items designed to assess HOTS. These HOTS-oriented items were presented in both multiple-choice and descriptive formats. For example, one multiple-choice item required candidates to apply their understanding of the engineering design process by categorizing and selecting the appropriate steps for given instructions related to an experiment. The item is presented as follows: "The following (A) through (C) are parts of the instructions for an experiment. Which of the six engineering design process steps does each experiment fall into? Choose the most appropriate step and write the number on your answer sheet" (Kobe University, 2024a: 5). To respond correctly, candidates needed a thorough understanding of the six steps involved in the engineering design process. This necessity to grasp and apply these steps tests analytical abilities, a component of HOTS that builds on a foundational understanding of LOTS. This method of item design underscores the exams' emphasis on assessing both comprehension and advanced cognitive skills, wherein candidates must demonstrate their capacity to analyze and apply knowledge.

5 Discussion and Conclusion

This study analyzed English entrance examination items from national and public universities in Japan, identifying infrequently used types, formats, and characteristics. Building on these insights, the HOTS items were introduced, which diverged from the typical item types identified in the initial analysis. It is suggested that this introduction of atypical HOTS items may contribute to the evolution of entrance examination items in Japan, enhancing the assessment of HOTS.

The first such introduction involved a HOTS item that was paired with a LOTS item, indicating a strategic approach to progressively assess candidates' cognitive abilities within the examination context. It appears that HOTS items should inherently require the understanding of corresponding texts or diagrams. Moreover, it is suggested that LOTS items precede HOTS items within the examination format due to the greater complexity and difficulty level of HOTS items compared to LOTS items (Armala et al., 2022). It may be beneficial to progressively evaluate candidates, beginning with the less challenging LOTS items and progressing to the more demanding HOTS items, as this approach could potentially enhance the reliability and validity of the assessment process. It is posited that this introduction could play a significant role in advancing the design of entrance examination items in Japan, particularly in the

assessment of HOTS.

In this study, the implementation of multiple-choice items to assess HOTS, which were seldom included in the English entrance examinations in Japan, was introduced. There appears to be a widespread misconception that HOTS can only be assessed through descriptive items. This study might provide a basis for challenging this misconception.

Recent research shows the suitability of multiple-choice items in assessing HOTS across various educational disciplines. Liu et al. (2024) conducted a qualitative study on the effectiveness of multiple-choice questions in assessing HOTS. Their findings indicate that the study participants believed multiple-choice questions have the potential to assess higher-order cognition. Alfarisa et al. (2022) crafted valid and reliable items aimed at fourth-grade mathematics students, focusing on their HOTS. Furthermore, Nur and Istiyono (2020) generated reliable items for assessing HOTS in the context of acids and bases. Collectively, these studies demonstrate the potential of well-designed multiple-choice items to measure complex cognitive skills effectively.

Ahmad et al. (2020) highlighted the challenges involved in designing items that assess HOTS. Their findings demonstrated that training programs were effective in enhancing educators' ability and expertise in developing HOTS-related items. It is recommended that exam creators incorporate more HOTS-focused items into examination frameworks to better prepare students for future challenges. This integration could enhance students' readiness for real-world problems, emphasizing the need for further research into the effectiveness of training programs aimed at fostering HOTS. However, this study does not examine the long-term impact of such integration, which may limit the findings discussed.

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