**Journal of Information Systems Engineering and Management**
2025, 10(52s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

**Research Article**

# The Relationship Between English Proficiency and Logical Thinking Ability, and the Influence of Native Language Differences on Logical Thinking: A Study Based on the Results of an International Survey

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**ARTICLE INFO**

Received: 10 Mar 2025

Revised: 02 May 2025

Accepted: 15 May 2025

**ABSTRACT**

Since 2013, our research team has been conducting tests and analyzing the results on English proficiency, logical thinking, and critical attitudes to junior high school, high school, and university students in Japan.

This paper will first present an analysis of the data we have collected. Our findings indicate that among the four components of logical thinking cognitive processes based on Bloom's Taxonomy (analytical ability, evaluation ability, reasoning ability, and expressive ability), students with higher analytical, evaluation, and expressive abilities—particularly the latter two—are positively correlated with higher English proficiency.

Next, the paper will introduce the results of our newly conducted survey and address new issues that have arisen. In 2023, we expanded our survey to include students whose native language is not Japanese to see if the same trends would emerge. During this process, two issues were identified: 1) whether the logicality of Japanese is the same as that of English, and 2) whether logicality varies across different languages.

**Keywords:** Cultural foundations for logical thinking, English proficiency, Logical thinking ability, Teaching of English as a Foreign Language.

## INTRODUCTION

The development of logical thinking skills is one of the most urgent issues in Japanese education, and since 2014, this goal has been incorporated into the *Guidelines for the Course of Study for Foreign Languages* [1] issued by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), which all the high schools in Japan is expected to abide by. Specifically, the *Course of Study* states that the objective of the "English Logical Expression" subject in high school is to "cultivate an active communication attitude through English and to further develop the ability to consider facts and opinions from multiple perspectives, and foster logical thinking skills." In other words, the high school English curriculum is expected not only to develop English language skills but also to foster logical thinking skills.

However, the textbooks currently used for teaching "English Logical Expression" in Japanese education often focus primarily on explaining grammatical items in each chapter, with students encouraged to use these items in conversation to reinforce their understanding. This approach does not place much emphasis on improving logical thinking skills.

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Since 2013, our research team has been collaborating with the Eiken Foundation of Japan, the most widely recognized English proficiency test in Japan that a lot of Japanese students take to measure their English ability, and the Japan Institute of Lifelong Learning, the think tank that is related to the above-mentioned EIKEN. And with the collaboration of the two institutes, we have administered both an English proficiency test that measures vocabulary and grammar and an English-language logical thinking test to junior high school, high school, and university students nationwide. Through the analysis of the results of these tests, we have explored the correlation between English proficiency and logical thinking ability. Specifically, our findings indicate that, among the four categories of logical thinking cognitive processes outlined in Bloom's Taxonomy (analytical, evaluative, reasoning, and expressive), students with higher levels of analytical, evaluative, and expressive skills tend to have higher English proficiency.

Building on these results, the same two tests have been administered to students whose native language is not Japanese since 2024 to determine whether similar trends are observed in these students. Our findings reveal some differences between languages, with some languages showing a correlation while others not.

Thus, our research questions are as follows:

**Research Questions**

a) Is there a correlation between English proficiency and logical thinking ability?

b) What factors, including the structural differences among languages, influence logical thinking abilities?

In order to address these questions, this paper will first review the findings from the tests administered in Japan in Section Two, presenting the results from surveys conducted by our team and exploring the correlation between English proficiency and logical thinking ability. Section Three will focus on the analysis of tests administered overseas, specifically our newly conducted tests in 2025. The fourth section will examine the factors, including the differences in language structure, that influence logical thinking abilities, while also exploring the cultural foundations of logical thinking, drawing on the work of Watanabe (2023) [2] and others. Finally, Section Five will summarize our arguments and offer recommendations for the future of English education, aiming to foster deeper reflection on the necessary steps for developing logical thinking skills.

## SUMMARY OF TESTS CONDUCTED IN JAPAN, THEIR RESULTS, AND ANALYSIS [1]

### The Summary of The Conducted Tests

Between 2013 and 2016, we conducted eight surveys in Japan, asking participants from 50 high schools and 5 universities to take both an English proficiency test and a logical thinking test. Some students participated for multiple years, allowing us to track changes in their English and logical thinking abilities over time.

The English test, developed in collaboration with EIKEN Japan, includes vocabulary, grammar, and reading questions. EIKEN, which is divided by seven levels, has been the most widely used test in Japan since 1963 to measure the English proficiency of Japanese people. A database containing past questions was used to measure the English proficiency of the test participants.

The logical thinking test was based on Kusumi and Hirayama (2004) [3] and Bloom's Taxonomy (Bloom et al (1956)[4], Anderson et al. (2001)[5]), evaluating four domains: 1) Analysis (distinguishing facts and opinions), 2) Evaluation (assessing the validity and credibility of arguments), 3) Reasoning (using induction and deduction to form arguments), and 4) Expression (clearly presenting facts and arguments).

For a more detailed explanation of the tests, please refer to our previous writings. (e.g. Hanazaki et al. (2024) [6], Hanazaki et al. (in press)[7], and Yoshikawa et al. (in press) [8])

High school students' data was used for quantitative analysis, while university students' data was analyzed quantitatively as well as qualitatively.

[1] This chapter is a summary of Hanazaki et al. (2024)[6], Hanazaki et al. (in press) [7] and Yoshikawa et al. (2024)[8].

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**The Quantitative Analysis of the Data, Mainly Based on High School Students' Data**

We analyzed the data both quantitatively and qualitatively. The key findings from the quantitative analysis are:

The findings of the quantitative analysis

a) **Age and Logical Thinking:** We found that logical thinking ability does not always improve with age.

b) **School Deviation:** Basic logical skills were closely linked to school deviation, though we cannot disclose specific details of this.

c) **High School Students:** A strong correlation was found between logical thinking and English proficiency, with a correlation score of 0.710.

d) **University Students:** Unlike high school students, university students showed a ceiling effect, with scores clustering at the high end, possibly due to an easier test.

We found that grade progression did not always result in improved scores at some schools. Fig. 1 shows the results from selected high schools over consecutive years. By testing the same students year after year, we were able to track score changes and observe that logical thinking skills do not necessarily improve with age. For instance, the average score of all students dropped when they turned 18. Additionally, at School B, students scored higher at ages 15 and 18, but lower at ages 16 and 17.

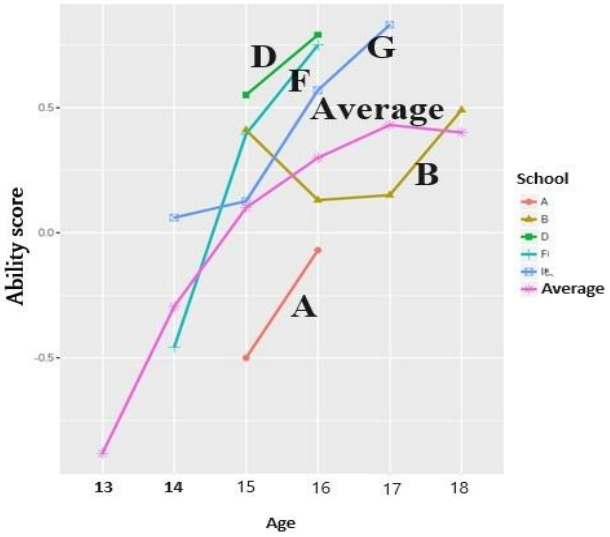


**Figure 1.** The Relation between Age and Logical Thinking Test of High Schools Students

Fig. 1 also reveals differences in scores between schools. Due to privacy concerns, we cannot disclose the names of each school, but the data suggest a correlation between school deviation and logical thinking scores.

Fig. 2 shows that the results for high school students reveal a strong correlation between language proficiency and logical thinking scores. The left diagram in Fig. 2 presents a scatter plot of both test scores for high school students, with language test scores on the vertical axis and logical thinking test scores on the horizontal axis. The correlation function of 0.710 indicates a clear relationship between language proficiency and logical thinking ability. In the next section, we will explore this connection further to identify which domains of logical thinking are linked to language proficiency.

On the other hand, while high school students show a correlation between language and logical thinking abilities, university students' scores do not show a similar correlation; instead, a ceiling effect is observed. This ceiling effect

Journal of Information Systems Engineering and Management
2025, 10(52s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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may be due to the language test being relatively easy for college students, as indicated by the clustering of scores at the higher end of the diagram.

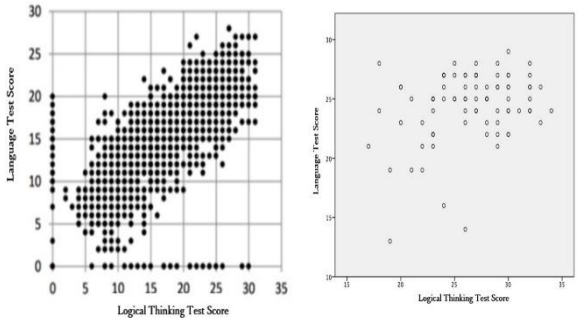


**Figure 2.** Scatter Diagrams of the Scores of Language Test and Logical Thinking Tests (Part A) Left: high school students (Part B) Right: university students (Correlation Function= 0.710)

In summary, the findings show that logical thinking ability does not always improve with age, is influenced by school deviation, and is correlated with English proficiency in high school students but shows a ceiling effect in university students.

**The Qualitative Analysis of the University Students' Data**

After analyzing the data quantitatively, we now focus on a qualitative analysis. Some questions showed significant differences in correct-answer percentages, varying between high school and college students, students with different language abilities, and science versus humanities majors. For example, in Question 27, only about one-third of high school students answered correctly, while 80% of college students did. In Question 15, science majors scored better than humanities majors, while Question 22 showed the opposite pattern. Question 18 had low correct-answer percentages for both high school and college students.

We selected 13 questions with unusual results (highlighted in Table 1) and examined their correlations with language proficiency. University students were asked to explain their answers.

Due to space, we will focus on four questions: Questions 5, 15, 21, and 29, which assess the four-subcategories of Logical Thinking Ability, i.e., Analysis, Evaluation, Expression, and Reasoning skills, respectively.

Question 5 (Analysis domain) showed that while university students correctly identified the statement as an opinion, fewer than 40% of high school students did. This was due to a misunderstanding of the word "seem," rather than a lack of logical thinking.

Question 15 (Evaluation domain) tested set theory and was easier for science majors, who grasped the concept better than humanities majors and high school students.

Question 21 (Expression domain) required students to order sentences logically. Incorrect answers indicated a misunderstanding of argument structure, suggesting that this domain improves with age and education.

Question 29 (Reasoning domain) was easier for humanities majors, who understood the logical flow better than high school students. This highlighted the connection between language proficiency and logical reasoning.

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2025, 10(52s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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**Table 1:** The Percentage of Correct Answers in Logical Thinking Test and Its IT Correlation to the Language Test

| Question Number | Domain | High School Student | University Science Major | University Humanities Major | High School IT Correlation with Language Test | Univesity IT Correlation with Langauge |
|---|---|---|---|---|---|---|
| 1 | Analysis | 63 | 80 | 79 | 0.28 | 0.12 |
| 2 | Analysis | 55 | 78 | 76 | 0.31 | 0 |
| 3 | Analysis | 76 | 94 | 94 | 0.29 | 0.05 |
| 4 | Analysis | 56 | 76 | 72 | 0.33 | 0.06 |
| 5 | Analysis | 39 | 72 | 68 | 0.43 | 0.16 |
| 6 | Analysis | 64 | 88 | 82 | 0.29 | 0.13 |
| 7 | Evaluatio | 82 | 98 | 97 | 0.33 | 0.06 |
| 8 | Evaluatio | 53 | 80 | 88 | 0.44 | 0.09 |
| 9 | Evaluatio | 64 | 94 | 100 | 0.32 | 0.33 |
| 10 | Evaluatio | 53 | 88 | 97 | 0.29 | 0.28 |
| 11 | Evaluatio | 29 | 41 | 44 | 0 | 0.09 |
| 12 | Evaluatio | 42 | 61 | 68 | 0.24 | 0.24 |
| 13 | Reasoning | 52 | 63 | 68 | 0.14 | 0.06 |
| 14 | Reasoning | 55 | 86 | 85 | 0.33 | 0.29 |
| 15 | Reasoning | 44 | 71 | 50 | 0.18 | 0.15 |
| 16 | Reasoning | 34 | 67 | 68 | 0.22 | 0.01 |
| 17 | Reasoning | 27 | 43 | 50 | 0.14 | 0.24 |
| 18 | Reasoning | 19 | 31 | 35 | 0.13 | 0.12 |
| 19 | Expressio | 63 | 98 | 97 | 0.42 | 0.01 |
| 20 | Expressio | 50 | 92 | 94 | 0.45 | 0.16 |
| 21 | Expressio | 31 | 71 | 72 | 0.25 | 0.04 |
| 22 | Expressio | 31 | 51 | 79 | 0.14 | 0.24 |
| 23 | Analysis | 67 | 96 | 94 | 0.36 | 0.01 |
| 24 | Analysis | 62 | 86 | 92 | 0.22 | 0.26 |
| 25 | Analysis | 44 | 76 | 79 | 0.29 | 0.21 |
| 26 | Expressio | 52 | 78 | 79 | 0.27 | 0.05 |
| 27 | Expressio | 31 | 78 | 79 | 0.31 | 0.06 |
| 28 | Expressio | 35 | 61 | 72 | 0.29 | 0.18 |
| 29 | Evaluatio | 31 | 73 | 91 | 0.41 | 0.26 |
| 30 | Analysis | 34 | 78 | 94 | 0.29 | 0.28 |
| 31 | Evaluatio | 47 | 76 | 92 | 0.38 | 0.36 |
| 32 | Analysis | 27 | 62 | 65 | 0.23 | 0.15 |
| 33 | Analysis | 44 | 73 | 97 | 0.33 | 0.22 |
| 34 | Reasoning | 36 | 67 | 85 | 0.39 | 0.25 |
| 35 | Evaluatio | 35 | 55 | 65 | 0.26 | 0.1 |
| | | | | Average | 0.28 | 0.15 |

**Table 2:** The Relation between the Reason for Errors and the 4 Sub-Domains of Logical Thinking

| Question Number | Domain | High School Student | University Science Major | University Humanities Major | |
|---|---|---|---|---|---|
| 5 | Analysis | 39 | 72 | 68 | Vocabulary knowledge (the meaning of seem) |
| 11 | Evaluation | 29 | 41 | 44 | Logical Thinking (thought of coincidence as reason) |
| 13 | Reasoning | 52 | 63 | 68 | Logical Thinking (the scope of the word some) |
| 15 | Reasoning | 44 | 71 | 50 | Logical Thinking (misunderstanding of the concept of sets) |
| 17 | Reasoning | 27 | 43 | 50 | Logical Thinking (misunderstanding of all and some) |
| 18 | Reasoning | 19 | 31 | 35 | Logical Thinking (misunderstanding of premise) |
| 21 | Expression | 31 | 71 | 72 | Logical Thinking (Argument structure, where to put examples) |
| 22 | Expression | 31 | 51 | 79 | Logical +Language (the referent of pronoun) |
| 26 | Expression | 52 | 78 | 79 | Logical +Language(lack in understanding the overall content) |
| 27 | Expression | 31 | 78 | 79 | Logical +Language(lack in understanding the overall content) |
| 29 | Evaluation | 31 | 73 | 91 | Language (lack in parsing, look ony at the previous sentence) |
| 32 | Analysis | 27 | 62 | 65 | Grammar (thought of them-people) |
| 35 | Evaluation | 35 | 55 | 65 | Language (couldn't understand the underlined part) |

**Analysis: Langauge Skills**

**Evaluation: Logical Thinking Skills + Language Skills**

**Reasoning: Logical Thinking Skills**

**Expression: Logical Thinking Skills + Langauge Skills**

**Journal of Information Systems Engineering and Management**
2025, 10(52s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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Our analysis of these 13 questions revealed that errors were often due to language issues, logical thinking difficulties, or a combination of both. Table 2 summarizes these findings. Errors in the Analysis domain were primarily language-related, while Evaluation errors involved both language and logical thinking challenges. Reasoning errors were mostly due to insufficient logical thinking skills, and Expression errors were linked to both factors.

Finally, we checked the IT correlation between each question and the language proficiency test. Table 3 shows that questions testing Analysis, Evaluation, and Expression had higher correlations with language proficiency, while Reasoning did not, validating our argument.

**Table 3:** IT Correlations between 13 Selected Questions and Language Proficiency Test

| Question Number | Domain | High School Student | University Science Major | University Humanities Major | IT Correlation with Language Test |
|---|---|---|---|---|---|
| 5 | Analysis | 39 | 72 | 68 | 0.42 |
| 32 | Analysis | 27 | 62 | 65 | 0.27 |
| 11 | Evaluation | 29 | 41 | 44 | 0.23 |
| 29 | Evaluation | 31 | 73 | 91 | 0.14 |
| 35 | Evaluation | 35 | 55 | 65 | 0.31 |
| 13 | Reasoning | 52 | 63 | 68 | 0.00 |
| 15 | Reasoning | 44 | 71 | 50 | 0.41 |
| 17 | Reasoning | 27 | 43 | 50 | 0.26 |
| 18 | Reasoning | 19 | 31 | 35 | 0.14 |
| 21 | Expression | 31 | 71 | 72 | 0.18 |
| 22 | Expression | 31 | 51 | 79 | 0.14 |
| 26 | Expression | 52 | 78 | 79 | 0.16 |
| 27 | Expression | 31 | 78 | 79 | 0.25 |
| | | | | | 0.287 |

Through our qualitative analysis, we identified the following four key findings:

The findings of the qualitative analysis of the data

a) The Analysis domain of logical thinking is solely influenced by language proficiency.

b) The Evaluation domain of logical thinking is influenced by both language proficiency and logical thinking skills.

c) The Reasoning domain of logical thinking is primarily related to logical thinking ability.

d) The Expression domain of logical thinking is strongly influenced by both logical thinking ability and language proficiency.

## RESULTS AND ANALYSIS OF TESTS CONDUCTED OUTSIDE OF JAPAN

### Objectives and Methods of the Tests Conducted

A To address our research questions further, we conducted similar tests outside of Japan: To repeat, our research questions were:

**Research Questions:**

a) Is there a correlation between English proficiency and logical thinking ability?

b) What factors, including the structural differences among languages, influence logical thinking abilities?

And the details of the survey conducted from 2024 to 2025 were as (4);

2024-2025 Survey Summary

- **Survey Period:** March 2024 to March 2025
- **Tests Conducted:** English Test + Logic Test
- **Test Duration:**
    - English Test: 30 minutes

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2025, 10(52s)
e-ISSN: 2468-4376
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- Logic Test: 30 minutes

- **Sample Size:** 133 (March and October 2024) ＋108 (January) + 200 (March) participants
- **Participants:**
  - Students enrolled in the Malaysian language school ELS (March and October 2024)
  - 2nd-4th year Japanese students from Hosei University, Faculty of Information Science and Technology (October 2024)
  - Native English speakers from the United States (October 2024)
  - Vietnamese and Arabian speakers recruited on Survey Monkey (January 2025)
  - Thai speakers and Korean speakers (March 2025)
- **English Proficiency Level:** CEFR B1-A2 (excluding native English speakers)

We asked non-Japanese participants to take the same English proficiency and logical thinking tests that Japanese high school and university students completed, as outlined in the previous chapter. These tests were administered in five sessions over the course of 2024, from March to March 2025. The tests were hosted on an online platform called Monkey Survey, and the link was distributed to the participants, and they completed the tests online. A total of 441 participants took part in the survey.

The decision to conduct the survey online was driven not only by its efficiency in data collection but also by the ability to gather additional information, such as the correlation with demographic factors (age, nationality, gender, native language, language proficiency, education level, education field, etc.). Additionally, the online format allowed us to control the time participants took to complete the tests. We also obtained Consent Letters from all the participants regarding the handling of their personal information.

**The Results: The Correlation between English Proficiency and Logical Thinking Ability Seen in the Tests Conducted Outside of Japan, Specifically in Vietnam, UAE, and Saudi Arabia**

The surveys carried out in 2024, that is the test administered in Malaysia, Japan and to American subjects have been analyzed in Hanazaki et al. (2024)[6], Hanazaki et al. (in press)[7] and Yoshikawa et al. (in press)[8]. Conducting a quantitative as well as qualitative analysis on the data obtained, we have found the following;

Findings of Hanazaki et al. (2024)[6], Hanazaki et al. (in press)[7], and Yoshikawa et al. (in press)[8]

a) **Correlation between Logical Thinking and English Proficiency**: The Malaysian, Japanese, as well as American data, too, show a strong correlation between logical thinking and English proficiency.

b) **Relationship between the Four Subdomains of Logical Thinking and Language Proficiency:** This relationship was confirmed in both domestic and international studies.

- **Analysis Domain:** Strongly related to language proficiency.
- **Evaluation Domain:** Influenced by both language proficiency and logical thinking.
- **Reasoning Domain:** Primarily related to logical thinking.
- **Expression Domain:** Strongly influenced by both logical thinking and language proficiency.

c) **Logical Thinking Across Different Countries:** Our survey might be measuring logical thinking from an English perspective, and our data suggests that each country may have its own unique form of logical thinking. Among the four subdomains of logical thinking, there is a significant difference in the "expression" domain, indicating the need to pay particular attention to this aspect.

This paper will analyze the data obtained in January 2025 conducted on Monkey Survey platform targeting Vietnamese speakers and Arabian speakers.

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2025, 10(52s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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First, we examined whether the correlation between English proficiency and logical thinking ability observed in our previous studies, including the data from Japanese high school students in Section 2.2 and the 2024 survey, holds true in this new dataset. Both earlier studies clearly demonstrated a correlation between English proficiency scores and logical thinking scores.

Similarly, the January 2025 survey results show the same trend, supporting the argument that there is a strong correlation between English proficiency and logical thinking ability.

The results are as follows:

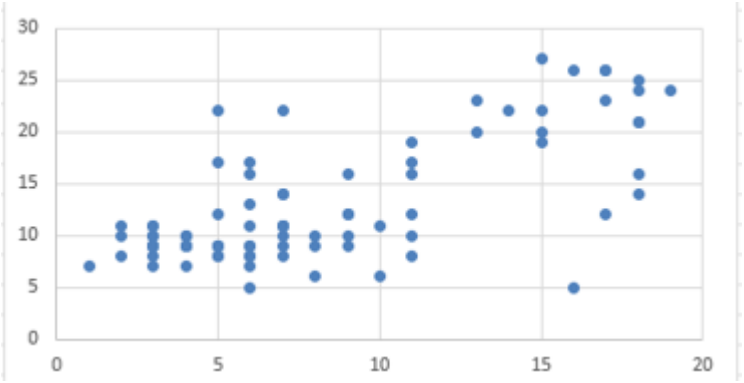


**Figure 3.** Scatter Diagrams of The Scores of Language Test and Logical Thinking Tests Conducted in January 2025

**Table 4:** The IT Correlation between Language Proficiency Test and Logical Thinking Test

| | English Test | |
|---|---|---|
| English test | 1.0000 | |
| Logical Thinking test | .704 | ** |
| Analysis | .582 | ** |
| Evaluation | .640 | ** |
| Reasoning | .584 | ** |
| Expression | .560 | ** |
| | | |
| | **p<.01, *p<,.05, p<.10 | |

The diagrams clearly illustrate a correlation between the language test scores and the logical thinking test scores, with a strong correlation function of 0.704. This value is very close to 0.710, which was obtained from the data of Japanese high school students. (Fig. 2)

However, the four sub-categories of logical thinking do not show the same pattern of correlation with the language test scores. In the data from Japan, Malaysia, and the United States, the "Analysis" and "Expression" sub-categories exhibit the strongest correlation with language proficiency, while “Reasoning” shows the least correlation as summarized in (5b). On the other hand, this pattern is not observed in the newly obtained data as we can see in Table 4.

A hierarchical multiple regression analysis was performed to examine which of the four sub-domains of logical thinking could be explained by the English test and other variables. In the first step, the effect of English proficiency was controlled for, followed by an assessment of how much additional explanatory power was provided by introducing variables such as age, which this study seeks to analyze. (we will come back to this in 3.3).

The results are presented in Table 5 below.

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e-ISSN: 2468-4376
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**Table 5:** Hierarchical Multiple Regression Analysis of Four Sub-Domain of Logical Thinking Ability

| | Variance explained by English Test | Variance explained by other variables $\Delta R^2$ |
|---|---|---|
| Analysis | 40.0% | 4.4% |
| Evaluation | 40.6% | 4.1% |
| Reasoning | 28.9% | 3.1% |
| Expression | 31.6% | 6.2% |

As shown in the table above, the proportion of variance in the dependent variable that is explained by the English test are about 30 to 40 %. Hence, we can easily say that all four sub-domains are strongly influenced by the English test. However, among the sub-domains, Reasoning scores are the least affected by English proficiency. The coefficient of determination is 28.9%, while other variances, especially Analysis and Evaluation, are about 40%. This finding is consistent with our previous analyses conducted in Japan (see 5b). Notably, the impact of the English test on "Expression" differs from the results of the Japanese survey; Expression is one of the variants that was mostly affected by the English test score in Japanese data, and the data here shows otherwise.

This observation may support the other findings of Hanazaki et al. (2024)[6], Hanazaki et al. (in press)[7] and Yoshikawa et al. (in press)[8]. Summarized as (5c), we have argued that our data suggests each country may have its own unique form of logical thinking. This finding suggests a need for identifying the factors (variables) that have the greatest influence on the Logical Thinking test.

**Discussion: Factors that May Have Impact on Logical Thinking Test Results**

In addition to the Language Proficiency and Logical Thinking tests, participants were asked to respond to questions regarding factors that could potentially influence their logical thinking ability. These factors (variables) included age, nationality, gender, native language, the number of languages spoken, language proficiency in each language spoken, education level, and field of study.

Table 6 is the basic statistics of the data to be analyzed.

**Table 6:** Basic Statistics of the Results of the Survey Conducted in 2025

Sample number =83

| Variables | number of valid answer | mean value | median | standard deviation | unbiased dispersion | minimum value | maximum value | |
|---|---|---|---|---|---|---|---|---|
| age | 83 | 3.843 | 4.000 | 0.757 | 0.573 | 1.000 | 5.000 | under12:1<br>13-17:2<br>18-22: 2<br>23-27: 4<br>over27: 5 |
| English test categories | 83 | 2.133 | 2.000 | 1.057 | 1.116 | 1.000 | 4.000 | 4 categories |
| English test score | 83 | 8.506 | 7.000 | 5.090 | 25.912 | 1.000 | 19.000 | score |
| Analysis Test Score | 83 | 3.434 | 3.000 | 1.789 | 3.200 | 0.000 | 7.000 | |
| Evaluation Test Score | 83 | 4.783 | 4.000 | 2.425 | 5.879 | 1.000 | 10.000 | |
| Reasoning Test Score | 83 | 2.964 | 3.000 | 1.401 | 1.962 | 0.000 | 7.000 | |
| Expression Test Score | 83 | 1.940 | 2.000 | 1.611 | 2.594 | 0.000 | 6.000 | |
| Logical Test score as a whole | 83 | 13.120 | 11.000 | 5.972 | 35.668 | 5.000 | 27.000 | |

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e-ISSN: 2468-4376
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gender

| appearance | number of data | percentage |
|---|---|---|
| Male | 42 | 50.60 |
| Female | 40 | 48.19 |
| missing value | 1 | 1.20 |
| total | 83 | 100 |

Home Country

| appearance | number of data | percentage |
|---|---|---|
| UAE | 12 | 14.46 |
| Saudi | 23 | 27.71 |
| Vietnam | 45 | 54.22 |
| missing value | 3 | 3.61 |
| total | 83 | 100 |

Native Language

| appearance | number of data | percentage |
|---|---|---|
| Arabic | 36 | 43.37 |
| Vietnamese | 41 | 49.40 |
| English | 2 | 2.41 |
| other | 2 | 2.41 |
| missing value | 2 | 2.41 |
| total | 83 | 100 |

Multilingualism
(How many languages a subject can speak other than native tongue)

| appearance | number of data | percentage |
|---|---|---|
| 0 | 7 | 8.43 |
| 1 | 14 | 16.87 |
| 2 | 53 | 63.86 |
| 3 | 7 | 8.43 |
| 4 or more | 2 | 2.41 |
| missing value | 0 | 0.00 |
| total | 83 | 100 |

Academic Background

| appearance | number of data | percentage |
|---|---|---|
| 1: high school or below | 4 | 4.82 |
| 2: university | 66 | 79.52 |
| 3: master | 13 | 14.46 |
| 4: doctorate | 1 | 1.20 |
| missing value | 0 | 0.00 |
| total | 83 | 100 |

We conducted a hierarchical multiple regression analysis using these variables. As discussed in the previous chapter, English proficiency has a great impact on logical thinking ability. Therefore, in the first step, we controlled for the English proficiency factor and proceeded with the analysis. Additionally, due to the strong correlation between home country and native language, we included only the home country as a variable in the analysis.

However, the results showed that none of the variables, other than English proficiency, showed significant differences. Besides the English proficiency, the variable of being a science student has a slight negative effect, but not a significant effect, for the Expression variable as shown in Table 7.

**Table 7:** IT Correlation between Expression and Each Variable

| | Objective Variable=Expression | | | |
|---|---|---|---|---|
| Variable | Expression | 95% lower bound | 95% upper limit | VIF |
| English Test score | .615 ** | 0.394 | 0.835 | 1.256 |
| age | - .090 | -0.303 | 0.122 | 1.166 |
| gender | .089 | -0.118 | 0.296 | 1.106 |
| academic background | - .039 | -0.258 | 0.18 | 1.239 |
| majored in humanities | - .133 | -0.393 | 0.128 | 1.752 |
| majored in STEM | - .243 + | -0.521 | 0.035 | 1.994 |
| multilingual | .064 | -0.142 | 0.269 | 1.094 |
| UAE * | - .090 | -0.327 | 0.148 | 1.452 |
| Vietnam * | - .178 | -0.421 | 0.065 | 1.521 |
| $R^2$ | .379 ** | | | |
| | **p<.01, *p<.05, p <.10 | | | |
| | UAE and Vietnam: Using saudi Arabia as the standard value | | | |

One reason for the lack of significant differences may be due to the small number of data: the Survey Monkey platform took data for 100 people, but the number of missing values was so large that the number of complete data available for analysis was only 83.

**Journal of Information Systems Engineering and Management**
2025, 10(52s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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Although altering the explanatory variables could lead to an excessively large number of analyses and inflate the likelihood of finding significant results, hence not ideal, if we change the variables, we can pick up the following variables as showing observable trends.

**Observable Trends in variables:**

a) Logical Test as a whole: STEM (scientific major: "science, technology, engineering and mathematics") has a negative impact, and multilingualism has a positive impact

b) Analysis: STEM has a negative impact, while Multilingualism has a positive impact.

c) Evaluation: "Multilingualism" has a positive impact, while "Country of Origin - Vietnam" has a negative impact (according to Saudi standards).

d) Reasoning: "UAE" and "Vietnam" both have a negative impact (according to Saudi standards).

e) Expression: "STEM" has a negative impact, while "Vietnam" has a negative impact (according to Saudi standards).

To cite one of the above trends, Table 8 shows that the variable "multilingualism" has a positive impact on the logical test as a whole.

**Table 8:** IT Correlation between Logical Thinking Test and Other Variables

| | Objective Variable=Logical Thinking Test as a Whole | | | |
|---|---|---|---|---|
| Variable | Logical Thinking Test Score | 95% lower bound | 95% upper limit | VIF |
| English Test score | .647 ** | 0.451 | 0.842 | 1.195 |
| age | - .102 | -0.295 | 0.091 | 1.162 |
| gender | .049 | -0.138 | 0.237 | 1.093 |
| academic background | - .046 | -0.238 | 0.143 | 1.146 |
| majored in humanities | - .013 | -0.249 | 0.224 | 1.745 |
| majored in STEM | - .047 | -0.295 | 0.202 | 1.925 |
| multilingual | .156 + | -0.028 | 0.34 | 1.058 |
| native language Arabic/ Vietnam | - .059 | -0.256 | 0.139 | 1.128 |
| $R^2$ | .478 ** | | | |
| | **p<.01, *p<.05, p <.10 | | | |

Interestingly, (6) suggests that the factors influencing the observed trends are more related to countries than languages, and also multilingualism is playing a role, though its influence is not particularly strong.

Regarding multilingualism, this observation aligns with recent findings in bilingualism studies. In recent years, it has been suggested that learning a foreign language is closely linked to the development of logical thinking skills. For example, Bley-Vroman (1989)[9] argues that the process of language acquisition is directly related to the development of logical reasoning. Research in bilingualism supports this idea, with Carlson and Meltzoff (2008)[10] stating that bilingual children exhibit enhanced problem-solving abilities and greater cognitive flexibility—traits that are crucial for logical thinking—compared to monolinguals. Similarly, Bialystok and Barac (2012) [11] argues that bilingualism facilitates the ability to grasp structural aspects of language and manipulate language more easily.

Regarding the variable of countries, it is interesting to note that it is not the language itself, but rather the country, that appears to be associated with logical thinking skills. For instance, the language differences between Arabic and Vietnamese do not seem to influence logical thinking abilities, but the variations between countries—such as the UAE, Saudi Arabia, and Vietnam—do play a role in the development of logical thinking. Based on this observation, one might infer that it is not the structure of the language, but rather the education system, that may influence the development of logical thinking skills. In this regard, the work of Watanabe (2023[2], 2024[12]) offers valuable insights. She argues that cultures around the world can be categorized into four types based on two axes: 1) whether the culture

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values formality or practicality, and 2) whether it leans toward objectivity or subjectivity, drawing on Max Weber's framework. Watanabe uses Iran as an example of a culture that values objectivity and formality, while Japan exemplifies a culture that values practicality and subjectivity. She further argues that the differences in educational approaches and logical thinking, appropriate to each culture, reflect the impact of these two axes. However, lacking insight into the education systems of these countries, this remains an area for future research.

## CONCLUDING REMARKS

This paper has reviewed our previous work on the correlation between language proficiency and logical thinking ability, analyzing surveys administered in Japan, Malaysia, and the United States. Additionally, we expanded our investigation to include data from participants in Saudi Arabia, the UAE, and Vietnam to better answer our research questions. To reiterate, the central research questions guiding this study were:

### Research Questions

a) Is there a correlation between English proficiency and logical thinking ability?

b) What factors, including structural differences among languages, influence logical thinking abilities?

Regarding the first question, our analysis has shown a strong correlation between English proficiency and logical thinking ability. Specifically, the survey conducted in Japan produced a correlation coefficient of 0.710, while the survey examined in this paper yielded a similar result, with a correlation coefficient of 0.704. This pattern was not limited to Japanese participants; it was observed across participants from diverse countries, reinforcing the idea that English proficiency is closely tied to enhanced logical thinking skills. This trend appears consistent on a global scale, suggesting that there may be a universal link between language proficiency in English and the development of cognitive abilities related to logic and reasoning.

As for the second question, our analysis of newly collected survey data suggests that factors such as multilingualism and education may significantly contribute to the development of logical thinking abilities. While structural differences between languages were not found to have a direct impact, the role of multilingualism appears to be worth exploring further. Multilingual individuals, by virtue of speaking multiple languages, may develop more flexible thinking patterns and cognitive processes that enhance their logical thinking skills. If this hypothesis is correct, encouraging students to become multilingual could be a powerful strategy for cultivating logical thinking abilities. Moreover, multilingualism might enable individuals to approach problems from various cultural and cognitive perspectives, fostering a broader and more adaptable way of thinking.

Furthermore, it is important to consider the role of education in shaping logical thinking. Different educational systems and teaching methods across countries may impact on how logical thinking is nurtured in students. If multilingualism and education indeed play a significant role in developing logical thinking, future research could focus on examining the specific educational practices that best support this development.

In conclusion, while the relationship between language proficiency and logical thinking is clear, the influence of multilingualism and educational systems warrants further investigation. Our findings open up potential avenues for future research into how language learning, cognitive flexibility, and educational practices interact in fostering logical thinking skills.

### Acknowledgements

This work was supported by JSPS KAKENHI Grant Number 20K00841.

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