INTEGRATED EDUCATION FOR MID-ADOLESCENT ENGINEERING STUDENTS IN KOSEN

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ABSTRACT

This study examines methods for imparting first-through-third-grade engineering students in KOSEN (one of the Japanese tertiary educational institutions, the National Institute of Technology, which conducts 5- or 7-year-rapid growth of engineers after grade 9) with fundamental reading competence in response to our finding that some students have difficulty understanding textbooks and dictionaries. We used the Reading Skill Test (RST) to determine students' reading competencies in October 2018. Students' results were relatively insufficient in some component skills such as paraphrasing, representing figures or tables with sentences, and instantiating with given definitions. In response, we aimed to develop effective methods to increase the reading skills of 15- to 18-year-old KOSEN students. Such students must acquire basic literacy to understand various types of documents and diverse topics in engineering. In our recent research, we have identified some potentially successful methods, such as keeping a short journal in a business diary to establish self-management skills; reflecting on lectures in Japanese focusing on connecting two sentences with conjunctions; and using figures and tables to comprehend English also verified the RST results with a language skill assessment. In this paper, we report our recent practices.

KEYWORDS

Reading comprehension, Reading Skill Test, TOEIC/TOEIC-IP, KOSEN, Standards: 8, 11.

INTRODUCTION

The implementation of active learning methods has urged educators to improve their lectures using several strategies such as group work, discussions, and flipped learning. However, these student-centered attempts cannot produce positive effects unless students themselves shift their learning attitudes to become more autonomous. Teachers should encourage students to be persistent and independent learners during the lectures as well as before and after class and outside school. According to *OECD Reviews of Tertiary Education: Japan* (2009), one of Japanese tertiary educational institutions, the National Institute of Technology, commonly known as KOSEN, provides educational opportunities in business and technology for "students who are not theoretically inclined in a college of technology after grade 9, focusing over the next 5 to 7 years," "while in other OECD countries such students may simply drop out of high

school, ending further education" (54). In fact, some students have high aspirations to become engineers or scientists, and others have difficulty understanding textbooks and dictionaries. This problem makes it difficult for such students to establish self-directed learning habits and also leads to the stagnation of lecture quality. Therefore, in this study, we focused on developing students' basic self-administration skills as well as their reading comprehension.
In 2016, we enhanced first-year students' fundamental competencies through homeroom activities in terms of "Fundamental Competencies for Working Persons," which consists of three competencies with twelve competency factors and defines the basic abilities required for working with various people in the workplace and in local communities, set forth by the Ministry of Economy, Trade and Industry in February 2006. We introduced a schedule book to train students in basic self-administration skills. In October 2018, we employed the Reading Skill Test (RST) to determine 81 students' reading competence. The results showed that some of the students' component skills were relatively insufficient, such as "representing tables and figures." As it goes without saying that these are compulsory skills for engineering students, we intentionally introduced figures and tables to aid students' comprehension of English articles. We also introduced reflection activities, in which students were required to connect two sentences with conjunctions in Japanese. Additionally, in this study we investigate the mutual relationship between RST and English competency, comparing the RST results with an English skill assessment, Global Test of English Communication (GTEC).
It is necessary to impart students with these basic skills in the early stage of engineering education, from the ages of 15 to 18. In this paper, we report the results of our attempt and future prospects in terms of facilitating students' literacy.

MATERIALS AND METHODS

- Analysis of *Self-Assessment of Fundamental Competencies for Working Persons*
- Individual coaching with a schedule book
- Structured Group Encounter (SGE) in Homeroom Activities
- Reading Skill Test (RST)
- Improving English Lectures: Diagrams, Precedent Vocabulary Test, and Reflection
- Comparison of the RST results with GTEC

RESULTS AND DISCUSSION

Fundamental Competencies for Working Persons, schedule book, and SGE in 2016

In 2016, we focused on the "Fundamental Competencies for Working Persons" to enhance first-year students' fundamental competencies through non-curricular activities: introducing a schedule book or diary to coach students individually and provide them with basic self-administration skills; providing students with activities to improve their interpersonal and communicative skills; and conducting questionnaire surveys to examine the efficacy of these approaches (Sekine et al., 2016).

Individual Coaching with a Schedule Book

In April, five first-year classes were recruited to use a schedule book, *Foresight FURIKAERI-RYOKU KOUJOU (improving the ability to review) TECHOU*. We then examine students' schedule books and offered personalized advice if necessary in order to encourage them to utilize the diary as a means for compiling their to-do lists, learning portfolio, and drafts of their reflections on their learning plans for examinations from the viewpoint of establishing the plan-do-check-action (PDCA) cycle. Many students mentioned that after using this schedule book, they became more motivated and were able to study systematically. In 2017, we supplied

students with the *KOSEN TECHOU Schedule book*, which was a small dairy specializing in KOSEN Education that was produced by KOSEN students and teachers, to continue to facilitate their basic self-administration skills.

Structured Group Encounter (SGE) in Homeroom Activities

Soon after entering college, students are required to discuss various topics as part of their homeroom activities, such as the division of duties and school festival events, even though they barely know each other. We promoted this time as an opportunity for arguments or discussions to enhance students' personal and interpersonal skills, such as consensus building, with some methods based on Structured Group Encounters (SGE). These activities contributed to a friendlier atmosphere.

Analysis of Self-Assessment of Fundamental Competencies for Working Persons

We conducted a questionnaire survey, a self-assessment of *Fundamental Competencies for Working Persons*, in the three first-year classes in July and February. Participating students were asked to evaluate "12 Competency Factors" with 36 questions using four scales: 4 corresponds to "Strongly agree," 3 to "Agree a little," 2 to "Disagree a little," and 1 to "Strongly disagree." The results and transitions are shown in Table 1. Given that the results indicated that average values all increased, the changes may account for the efficacy of our attempts to improve their feelings of self-esteem in Figure 1.

Table 1. Results of the Self-Assessment of Fundamental Competencies for Working Persons

3 Competencies	12 Competencty Factors	Average		Standard Deviation	
		Jul. 2016	Feb. 2017	Jul. 2016	Feb. 2017
Action	Initiative	2.94	3.03	0.55	0.55
	Ability to infuluence others	2.99	3.08	0.62	0.67
	Execution Skill	2.95	3.00	0.59	0.60
Thinking	Ability to detect issues	2.93	3.14	0.55	0.59
	Planning skills	2.82	2.98	0.58	0.60
	Creativity	2.87	2.91	0.67	0.62
Teamwork	Ability to deliver messages	2.85	2.96	0.57	0.63
	Ability to listen closely and carefully	3.18	3.23	0.56	0.53
	Flexibility	3.16	3.21	0.60	0.53
	Ability to analyze situations	2.94	3.08	0.62	0.62
	Ability to apply rules and regulations	3.36	3.44	0.52	0.52
	Ability to control stress	2.94	3.04	0.76	0.72

Many students evaluated these factors as significantly low, and some factors indicated a bimodal or trimodal wave in July. Although the tendency still existed in February, the deflections seemed to have improved; the lower group decreased (A) while the upper markedly elevated (B) in these eight factors. According to Yano et al. (2018), early and long-term engineering education and overcrowded curriculum in KOSEN could be inconsistent with mid-adolescent students' aspirations (18). Therefore, we should notice that the increase of the deviation in "Ability to control stress" (C) indicates the need for teachers to approach 15-year-old engineering students proactively because they might be dissatisfied their own choices of specialty or encounter problems in their school lives.

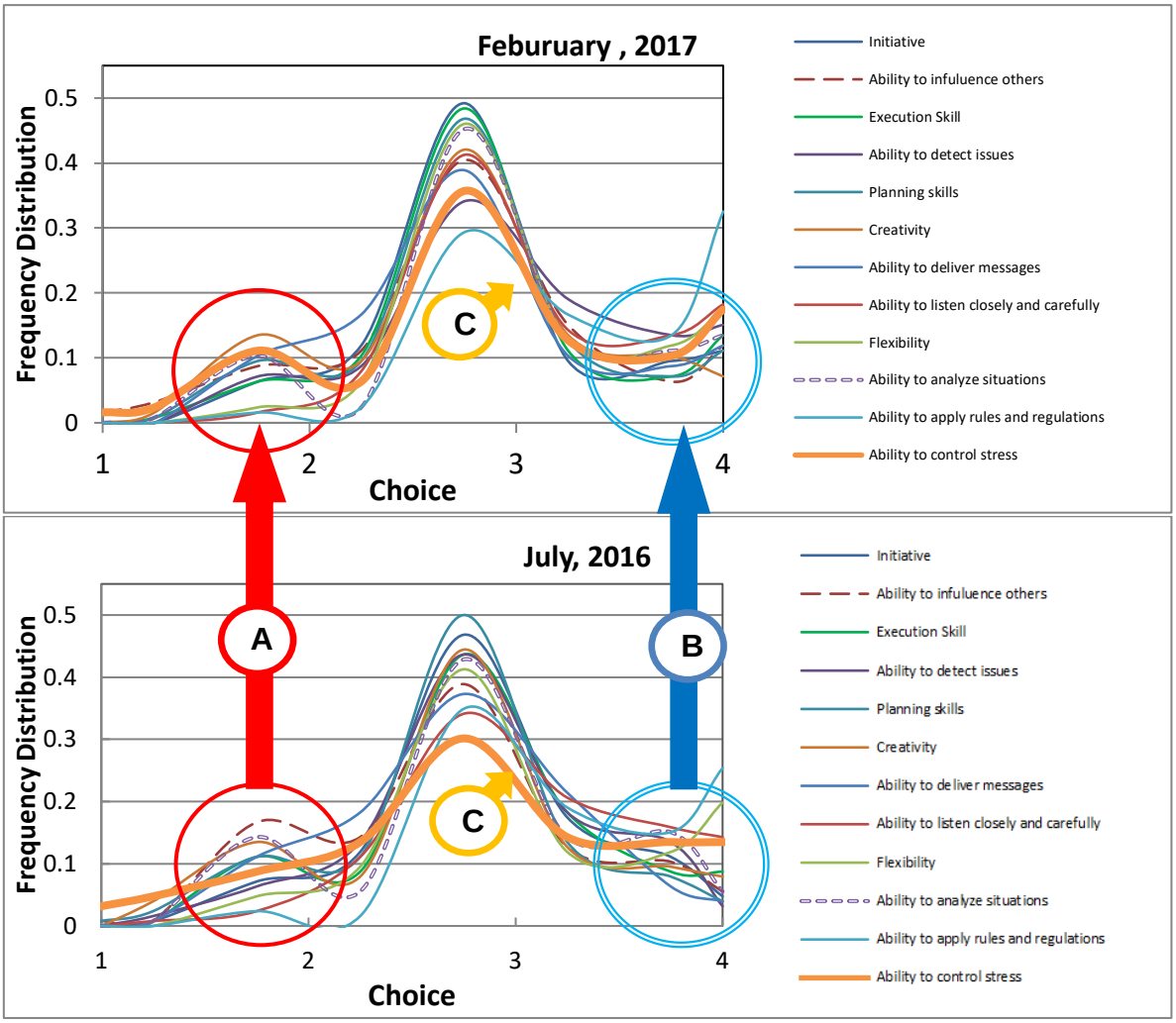

Figure 1. Transition of the Extracted Eight Competency Factors

RST and English Comprehension in 2018

We employed the Reading Skill Test (RST) because we found that many students had trouble understanding and reading textbooks or dictionaries and a remarkable number of students were not able to follow lectures. We then developed English lessons on the RST results (Sekine et al., 2019).

Analysis of RST results in October

According to Arai et al. (2017), RST is a new reading skills test that assesses examinees' basic language skills involved in the comprehension of texts. The test consists of sentences taken from junior high and high school textbooks and dictionaries. Arai et al., defined six component skills relevant to reading:

1. Dependency Analysis (DEP): the ability to recognize dependency relations between words and phrases in a given sentence.
2. Anaphora Resolution (ANA): the ability to understand references to earlier or later items in a text.
3. Paraphrasing (PARA): the ability to recognize similarities between sentences.

4. Logical inference (INF): the ability to determine what can be inferred from a sentence, what conflicts with it, and what does not relate to it.
5. Representation (REP): the ability to represent an image (figure or table) by comprehending a sentence of the textbook.
6. Instantiation (INST): the skill of understanding how to use a term correctly according to a given definition of the term. INST is comprised of two elements, INST1 (definitions taken from the dictionary) and INST2 (definitions taken from mathematics and science).

(Arai et al., 2018)

In October, we conducted RST to investigate 81 students' reading competence (42 first-year students and 39 third-years). The obtained results are shown in Figure 2; some of the component skills are relatively insufficient, such as paraphrasing (PARA), representing (REP), and instantiating (INST). In addition, bimodality is presented in several component skills. The results confirmed our impression that a certain number of students have trouble understanding the textbook, dictionaries, and teachers' explanations in KOSEN.

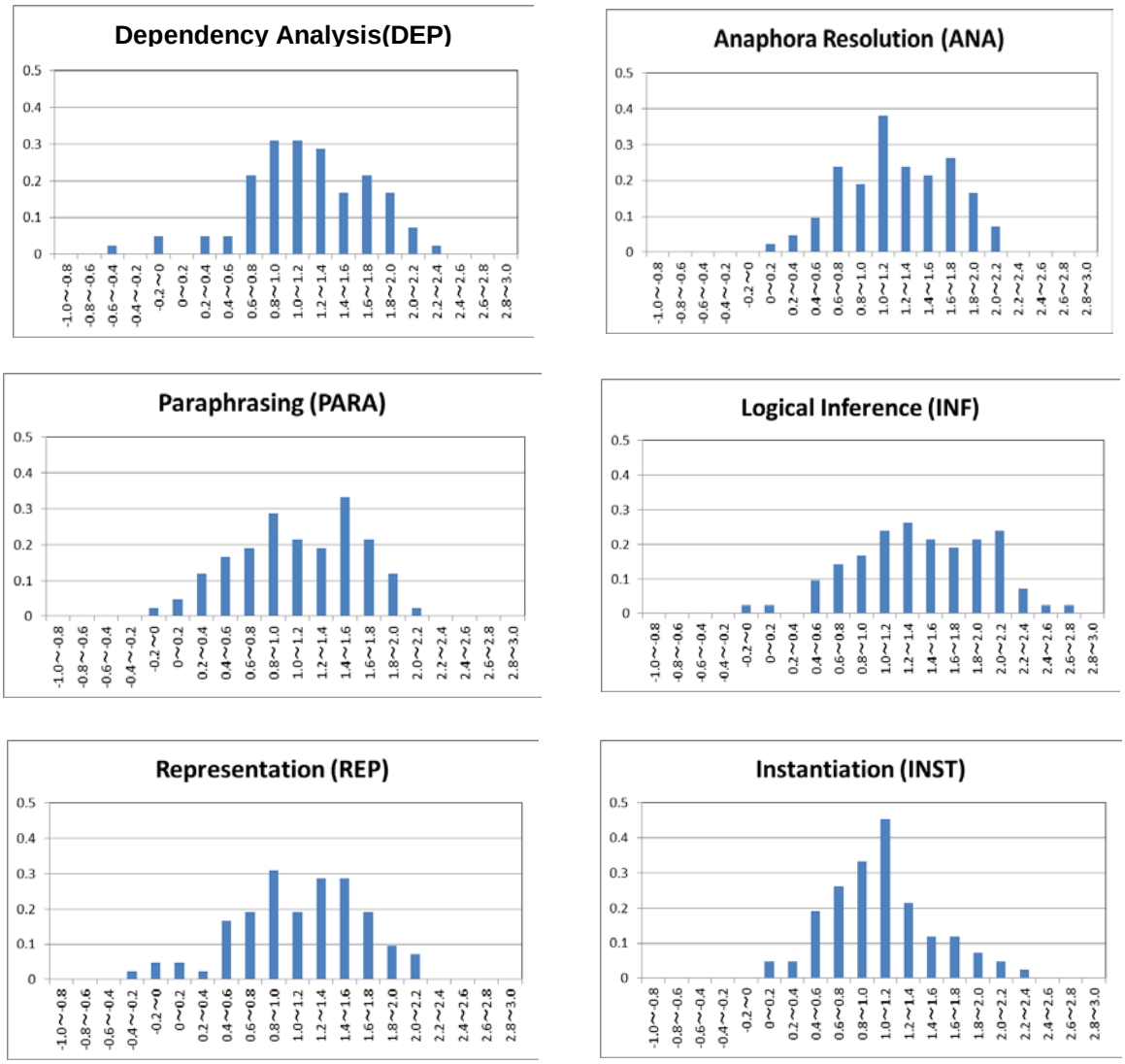

Figure 2. The results of RST in Six Component Skills (October 2018)

Improving English Lectures for Third-graders

As RST Component Skills may be adapted to English learning, we assume that the findings from RST can support recommendations to deal with English materials related to those three component skills. Accordingly, we developed some activities in English classes to help students develop basic literacy:

1. Figures and Tables to comprehend English articles: Tables and/or figures are used to summarize English articles. Students cooperate to determine the outline of texts in groups.
2. Precedent Vocabulary Test: Quick vocabulary tests have been included at the beginning of classes since May 2018. The questions on these tests are related to the words or phrases that will be discussed in the following lesson. The main purpose of this is to stimulate students to prepare for lectures autonomously and to make it easier for them to understand the contents of lectures.
3. Reflection to establish learning habits: Students review preparations, attitudes, and understandings.
4. Others: Assignments are given on definitions of newly presented or important words to provide students with paraphrasing skills. An experimental English class was carried out on December 17, 2018, to share teaching methods with other KOSEN teachers.

We frequently conduct questionnaire surveys to develop the lectures for third-graders. First, we can see the variation of the students' learning time per week and the difference between their preparation and review time per week in Figure 3. The students estimated their "learning time" for their English classes alone, including their autonomous learning for TOEIC or English conversation classes outside school. We can infer from the results that the Precedent Vocabulary Test is quite effective for preparation. In addition, many students wrote in their reflection papers that they realized the importance of preparation because preparation makes it easier for them to understand lectures. However, it is also necessary to introduce activities that will encourage students to review lectures.
Second, the results of class evaluations show the effectiveness of our approaches: around 80% of students regarded these activities as effective strategies (Figure 4).
We also assessed students' English competency with an objective assessment and compared with their RST scores. We will conduct RST again and verify the effect on Japanese reading skills and the causal nexus between Japanese and English reading skills with the TOEIC-IP scores in February 2019.

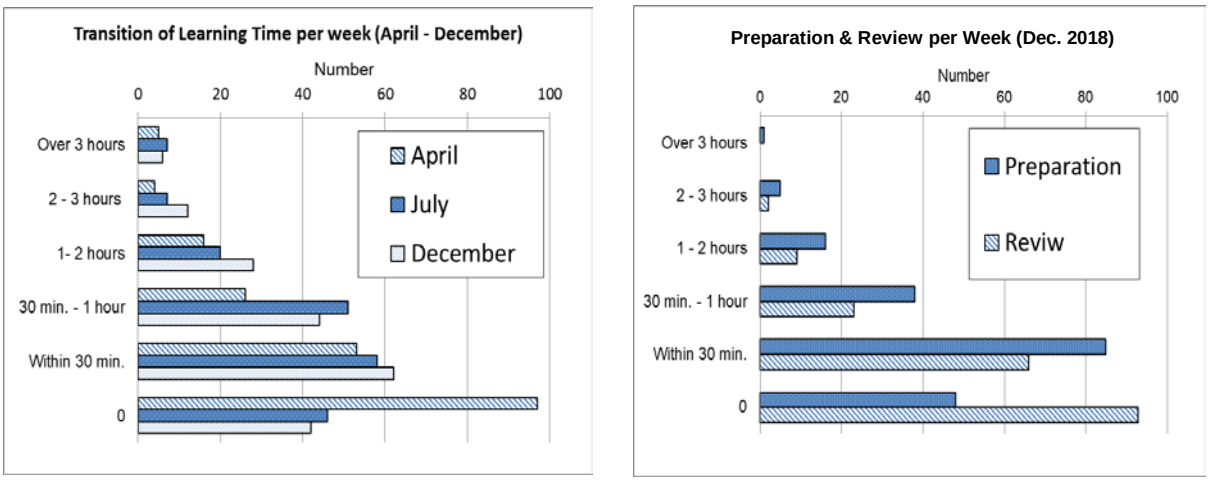

Figure 3. Students' Learning Time Per Week for English Classes

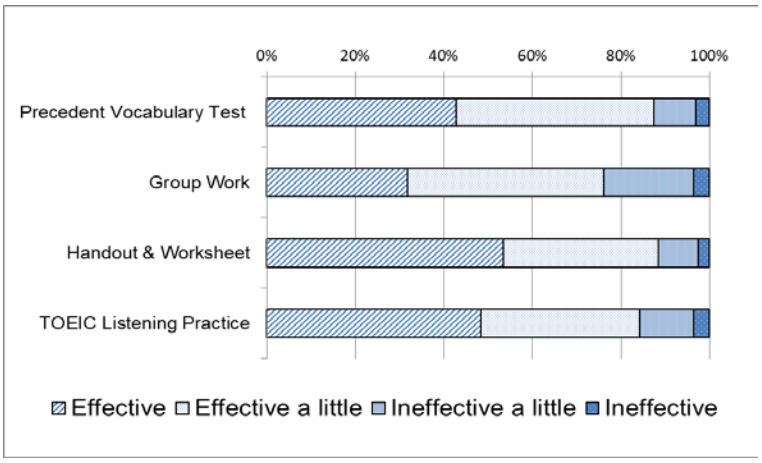

Figure 4. Questionnaire Survey Results of Students' Class Evaluation

Comparison of RST with English Assessment

First, we compared students' RST results and their scores on GTEC (paper-based), which is an English Skills certification examination produced by Benesse Corporation in Japan. The examinees were 41 first-graders that took both GTEC Core (April 2018) and RST (October 2018) and 38 third-graders that took both GTEC Basic (October 2017) and RST (October 2018). The scatter plots (Figure 5) indicate the interrelations between the RST average score (5=high, 1=low) of Six Component Skills and GTEC Reading (◆), Listening (□), and Writing (△) scores. This figure shows that students' Reading and Listening scores have some correlations with RST, while there is very little correlation between RST and Writing scores in both grades.

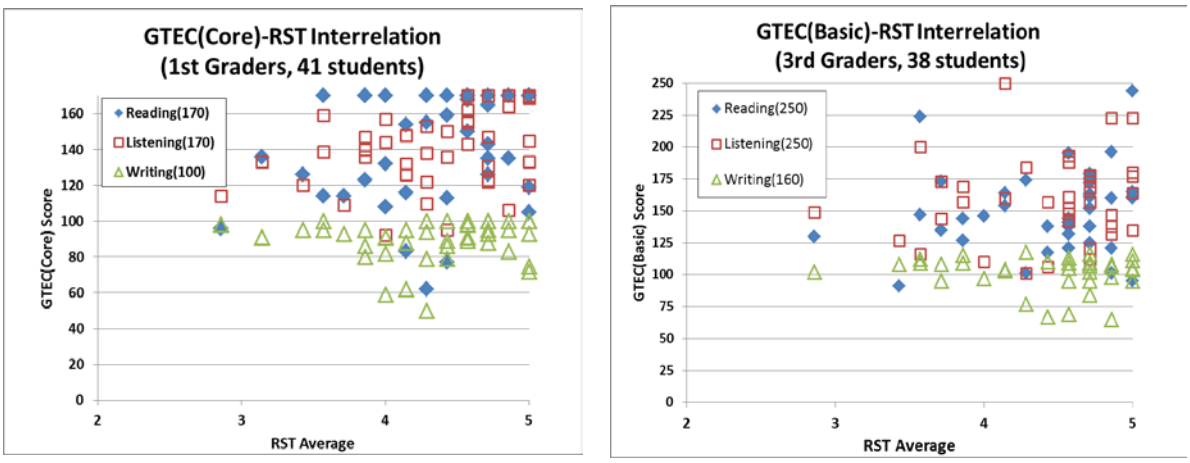

Figure 5. RST-GTEC Score Interrelations

Second, we classified the examinees into groups using the RST numerical values of Six Component Skills and compared the GTEC average points, because we had confirmed that some students had low values (3 or less) mixed with high (4 or 5) in RST Six Component Skills. Given that the low component skills substantially influence their Reading sequence, the comparison of those classified groups can clarify the mutual relation between RST and English Reading and Listening competency. As a result, we showed that the first-graders had remarkable gaps in Reading, and the third-graders had a slight difference in the Reading average points of the two classified groups (Table 2).

Table 2. Comparison of GTEC Average (Reading and Listening) Classified with the Evaluation of RST Six Component Skills

Classification with RST Six Component Skills		1st Graders			3rd Graders		
		Number	R(170)	L(170)	Number	R(250)	L(250)
(a1)	With “3 or less”	22	139.5	132.8	18	148.7	161.6
(a2)	All “4 or 5”	19	145.6	145.8	20	149.8	157.9
(b1)	With Multiple “3 or less”	13	134.2	133.7	11	148.6	159.5
(b2)	With Single “3 or less” and All “4 or 5”	28	146.0	141.2	27	150.7	159.0
	Examinees (Class)	41	142.3	138.8	38	150.1	159.2
	Grade	195	143.5	142.0	204	152.1	159.1

Third, we investigated the frequency of the classified groups. It is suggested that (D) the first-grade examinees bearing multiple “3 or less” in RST Six Component Skills could compose the lower group of bimodal or trimodal in Reading and Listening (Figure 3), and that (E) the third-graders with multiple “3 or less” also could compose the lower group in Reading and Listening (Figure 4).

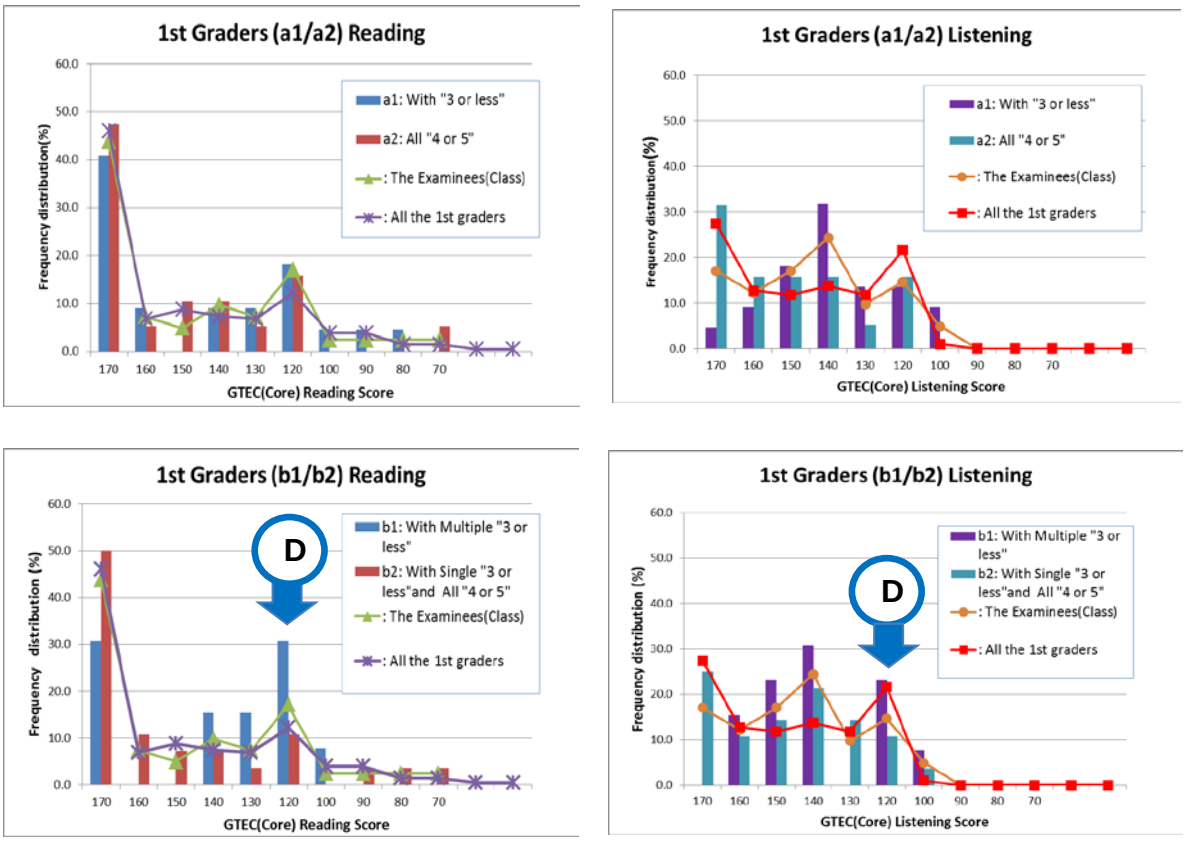

Figure 3. Comparison of GTEC Scores Classified with RST Grades (First-Graders)

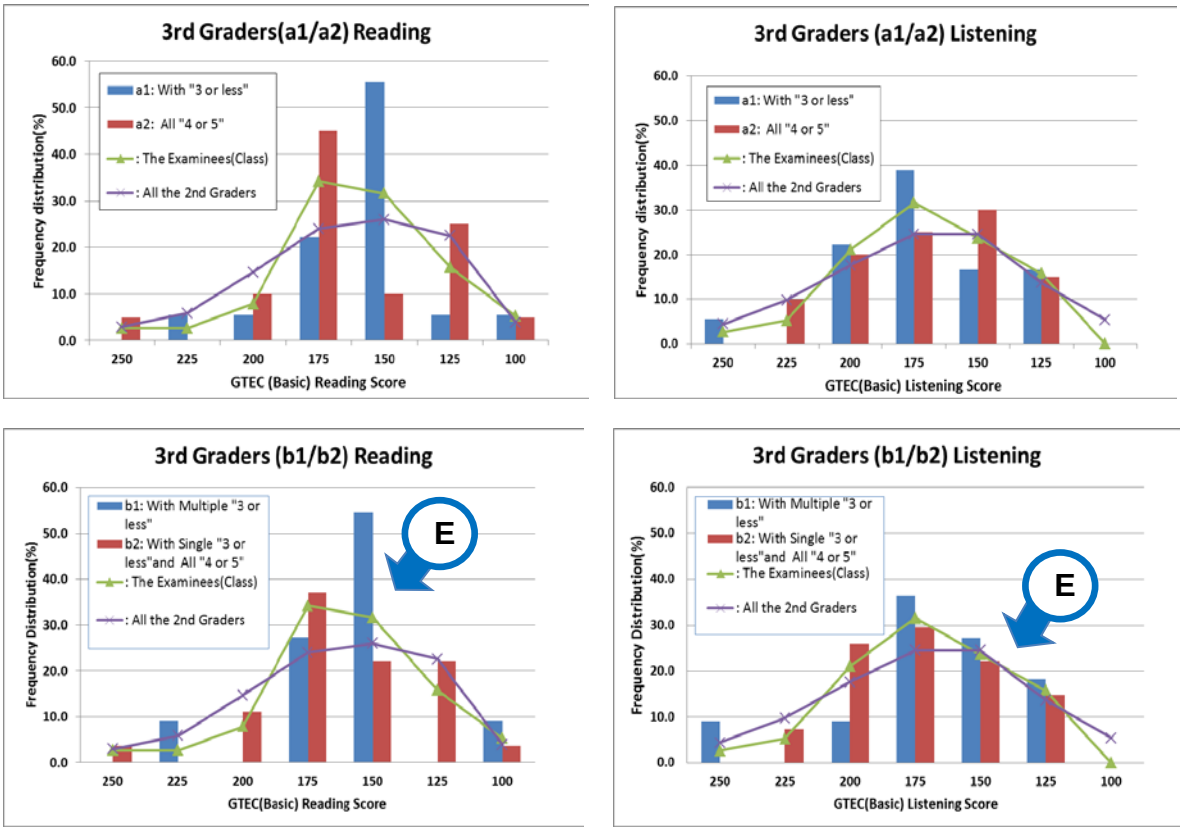

Figure 4. Comparison of GTEC Scores Classified with RST Grades (3rd Graders)

These results raise interesting implications concerning the mutual relation between RST Six Component Skills and Reading and Listening in English; slow learners might have trouble in some aspects of reading, and reading competency has a causal relationship with Listening scores. It is quite possible that reading competency significantly influences younger students' learning more than that of elder students, although we are unable to confirm this conclusion from our results, as the number of students and variations surveyed is relatively small in this study. It is also necessary to analyze each question connected with the component skills and compare the obtained results with other assessments or subjects. The next step would be to verify the results obtained from this study with scores from the TOEIC-IP test that the third-graders will take in February 2019.

CONCLUSION

The results of this study show that our investigations have a positive impact on mid-adolescent engineering students by cultivating their autonomy and reading competence in the early stage of their technical training and engineering education. Although non-curricular aspects are often ignored the subject instruction, this study is an important contribution because it may allow educators to encourage students to increase their self-esteem in various aspects of their school lives. Additional research is required to optimize the method to be a nexus between curricular and non-curricular approaches.

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BIOGRAPHICAL INFORMATION

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