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Reports and Suggestions on Physical and Mathematical Thinking- Expressions and Understanding in Japanese Engineering College Students

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Abstract

It is generally said that thinking of things is done in the native language. This applies to all aspects of daily life, especially in the acquisition of study. We are a higher education institution specializing in engineering and teach to students aged 15 to 20 years. In the process of organizing their thoughts and expressing them, the higher the understanding and knowledge required of them, the higher the thinking and expressive ability in their native language is required. This paper requires a basic understanding of physics and mathematics among our students, first and second year college students and students aged 18 to 20 who belong to a college of engineering in Japan. The results of a survey based on task reports, regular exams, and questionnaire surveys on the relationship between the ability to explain thoughts in the test native language and mechanical analytical thinking using mathematical formulas through the aquatic class and regular exams. Report and make suggestions. In our study, there was a marked correlation between the two, and they could be roughly classified into five types. Furthermore, as a result of conducting a questionnaire survey on the students and collating them with assignment reports and regular examinations, we were able to discover a type that is an intersection of five types. This type has a small number of people, but they are highly active people who can expect growth in thinking ability. By understanding the individuality of this type of person and repeating careful instruction and education*, we were able to confirm their improvement in academic ability.*

Keywords: *Physics, Mathematics, Understanding and Thought Expression, Engineering Education*

1. Overview

It is said that thinking of things is done in the Native language, and in every aspect of our daily lives, we unknowingly repeat thinking in our Native language. Of course, the importance of the Native language is the same in study, and the more complicated the thinking, the greater the need for reading comprehension and expressiveness in the Native language [1-3].

We are educating students aged 15 to 20 at a higher education institution specializing in engineering. Students belonging to this engineering education institution major in engineering at the age of 15, which is equivalent to a general first-year high school student in Japan, so while they have a strong interest in science subjects, they are also interested in liberal arts subjects. Interest tends to be lower than that of ordinary high school students.

We are targeting students aged 18 to 20 who are taking hydraulics, which is the basis of fluid mechanics and requires university-level physics and mathematics, to understand their theory, think and express themselves. Was analyzed based on the task report, regular examination, and questionnaire survey. As a result, there was a remarkable correlation between the basic ability of the Native language and the expression of thought, and these could be roughly classified into five types. Furthermore, as a result of conducting a questionnaire survey on the students and collating them with assignment reports and regular examinations, a type that is an intersection of these types was found. Although this type has a small number of people, they are highly active people who can expect growth in thinking ability and have aspirations. Therefore, we could confirm the improvement of their academic ability and motivation by understanding the learning tendency of this type of person and repeating careful instruction and education to them.

2. Thinking ability and basics of native language

As in other countries, teachers at Japanese educational institutions often discuss the decline in student foundations. We are teaching at a higher education institution specializing in engineering for students aged 15 to 20 years, and this phenomenon is one of the major issues in our educational institution. Students in our education period enter a college specializing in engineering at the age of 15, which is equivalent to the first year of an ordinary high school in Japan. Therefore, many of the

students are interested in science subjects, and their interest in their native language, which is a liberal arts subject, tends to be slightly lower than that of general high school students.
These factors include the problem of teachers' leadership ability, the problem of educational outline, and the thinking ability of students due to the spread of the Internet. Nowadays, we hardly see the common appearance of students as students, such as investigating tasks by themselves, asking teachers questions, going to the library and examining literature.

They search for task reports and questions on the Internet, but many people end up copying the answers obtained from the search into the task report. In other words, many of them are not able to express their own thoughts.

As it is generally said that both everyday thinking and theoretical thinking require basic skills in their native language, their mastery of theoretical thinking is related to their basic skills in their native language. What seems to be is the common understanding of teachers.

3. Investigation situation

In order to understand the factors related to the relationship between the tendency of the students of the engineering college as in Chapter 2, their theoretical thinking, and the basic ability of the native language, we are required to think in the analysis of basic physics and mathematics. For students aged 18 to 20 who are taking physics, we worked on their theoretical understanding, thinking and their expressiveness based on task reports, regular exams, and questionnaire surveys.
The method of implementation is described below.

3.1.1 About routine exam

The regular hydraulic tests we conducted on our students were as follows:

1. Target students: 18 to 19 years old, 19 to 20 years old, total: 76 students, male-female ratio 5 to 1.
2. Hydraulics class held once a week
3. Submit the assignment report every week and describe the answer to the assignment in detail.
4. Conduct a regular examination once every 6 weeks.
   - Questions to be solved using formulas and problems that require theoretical thinking
   - The former includes problems that require thinking in mathematics
   - The latter answer was explained with sentences and figures, and the problem was described as "from scientific and engineering knowledge, explain the reason briefly."
5. Period: 10 months

3.1.2 Examples of routine exam questions and assignment reports

The routine exam which, we conducted on our students were as follows:

- Examples of exam questions 1:

  “Many people say that Bernoulli's theorem is important in hydraulics and fluid mechanics. However, many say that Euler's equations of motion are important. Explain the reason briefly from the engineering knowledge.”

  →Our aim:

  It is confirmed that students can understand and explain that Bernoulli's theorem was derived from Euler's equation of motion [4].

- Examples of exam questions 2:

  “Carefully supplement the parts omitted in the formulas in the textbook example by adding explanations. “

  →Our aim:

  Check if students can understand and explain mathematical formulas and their calculation process.

3.2 About the questionnaire survey

The questionnaire survey which, we conducted on our students were as follows:

1. Select 1st to 3rd place in the order of recall of "favorite subjects" and "dislike subjects" for all subjects
2. Freely describe each reason
3. Conducted only once 3 months after the start of class

During the three months after the class started, we grasped the current academic ability and thinking tendency of each student based on their assignment reports and regular examinations. Then, they analyzed their questionnaire survey conducted in the third month as a task report and the contents of the regular examination.

3.3 Trends in the start

At the time of 3 months, there were the following 5 types of tendency of theoretical understanding of examination answers and sentence expression of thinking. In Table 1. Each symbol is ◎: very good, ○ good, △: slightly inferior, ×: inferior.

Table I: Trends in early exam answers

Type	Understanding the theory	Sentence expression of thought	Number of people	Ratio (%)	Type A
1-1	◎	◎	0	0	0
1-2	◎	○	7	9.2	1
1-3	○	○	25	32.9	2
1-4	△	△	36	47.4	2
1-5	×	×	8	10.5	10.5

The indicators in this table are not classified based on the examination scores themselves, but based on the examination question distribution.

The results of the questionnaire survey on hydraulics were of the following five types.
Students who answered that they like hydraulics: 5 students make up 6.4% of the total. And the reason was as follows.

1. The subject is fun
2. I like the teacher of the subject
3. Required for university transfer exams

4. Encourage students for half a year

We focused on students who answered "I like the subject" despite their low scores in the regular hydraulic exams, and they belong to types 1 to 4 of the exam answer tendencies. Then, when they confirmed their answering tendency, it was confirmed that the sentence expression of thinking was expected to be improved by instruction. In other words, he is a student whose thought expression is in a state of development. Hereinafter, these are referred to as type A.

Therefore, we provided general instruction on writing skills and problem-solving methods to all hydraulics students. This is an instruction based on "books that Japanese science students should read", and was given when we teachers felt it was necessary during regular classes, when returning exams, when explaining report assignments, etc.

In addition to class hours, we also spoke to the assignment reports and regular examination results submitted to Type A. At this time, I tried to speak to all the students of type A when they were acting with other students so as not to be unequal to the students other than type A.

5. Trends after half a year from the start

Table Ⅱ: Trends in exam answers after half a year

Type	Understanding the theory	Sentence expression of thought	Number of people	Ratio (%)	Increase / decrease in ratio
1-1	◎	◎	1	1.3	+1.3
1-2	◎	○	8	10.5	+1.3
1-3	○	○	28	36.8	+3.8
1-4	△	△	31	40.8	-6.7
1-5	×	×	8	10.5	0

Table Ⅱ shows the tendency of the theoretical understanding of the examination answers and the sentence expression of thinking as a result of encouraging as in Chapter 5 for 6 months after.

As a result, there was an increase in the proportion in 1-3 and above, and the effect was seen in all Type A students. Among them, two students were particularly fast-growing, and they changed from 2 to 1 and from 4 to 2.

In addition, the qualified details of these two task reports and exam answers are particularly good compared to the other students, and they are able to explain in their own words the specific points of problems which, they cannot solve or do not understand.

6. Hearing to students

We interviewed students about our 10-month approach. Hearings were conducted for each student from Type 1-1 to 1-5, two for each Type A student. The students' impressions were as follows.

1. I started to think about report assignments and exam questions.
2. It is fun to understand the problem.
3. It takes time to report the task.
4. It is difficult to do because the tendency of the exam questions is different from other subjects.

The students who answered 1 to 3 above were effective students, and Type A answered as 1 and 2 above. The students who did not respond were the answers in 3 and 4 above.

We are feeling the effect of this approach to students.

7. Conclusion

In this paper, in order to understand the factors related to the relationship between the tendency of the students of the engineering college, their theoretical thinking, and the basic ability of the native language, we require thinking in basic physics and mathematical analysis. For students aged 18 to 20 years old, we conducted a survey on their theoretical understanding, thinking and their expressiveness based on task reports, regular exams, and questionnaire surveys, and to the students. We reported the result of encouraging on.

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