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Interdisciplinary learning in Japanese lower secondary school: A questionnaire survey of students' understanding of enzymes as life or matter

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Abstract: The new Japanese Government Curriculum Guidelines include a framework that comprises the four core ideas of energy, particle, life, and earth. These are primarily relevant to physics, chemistry, biology, and earth sciences, respectively. The four core ideas allow the boundaries between subjects to be flexible, which may foster interdisciplinary or multidisciplinary viewpoints. An enzyme is an interdisciplinary learning item that lies between life and particle (or matter), and may be used as a marker for the evaluation of students' interdisciplinary viewpoints. The results of the questionnaire show that Japanese lower secondary students have only a vague concept of an enzyme, and of the boundary between life and matter.

Keywords: Questionnaire, Interdisciplinary Learnings, Japanese Lower Secondary School, Enzyme, Life or Matter

1. Introduction

The Japanese Ministry of Education produced the new Government Curriculum Guidelines in 2008 and 2009 [1]. The Guidelines include a new framework that comprises four core ideas, energy, particle, life, and earth, which are relevant to physics, chemistry, biology, and earth sciences, respectively. Each core idea is consistently systematic from elementary school to high school in the corresponding subject construction. Although the four core ideas cannot be completely separated [2], the learning items included in Japanese textbooks have been almost completely segregated in higher secondary school; there is few overlap between the four textbooks.

On the other hand, the core ideas [2, 3] proposed by the National Research Council in the USA show overlap between core ideas. Many of the words used in the names of the core and component ideas overlap. Energy, life, matter, interaction, bio- (: prefix of biological), and human are typical examples. The core ideas comprise one of the three dimensions of the Framework for K-12 Science Education (K-12: kindergarten through twelve years). The other two dimensions are Crosscutting Concepts and Practices. The former contains seven viewpoints that bridge the disciplinary boundaries of natural phenomena [4], and the latter, which includes science and engineering practices, stresses the coordination of both knowledge and skill, as well as the importance of developing students' knowledge of how science and engineering achieve their ends [5]. The Framework for K-12 Science Education in the USA is designed to introduce multiple viewpoints of learning to science education using the three-dimensional framework strategy. The direction of science education meets "Interdisciplinary Science Teaching" [6].Thus, compared with the USA, sectionalism between the conventional subjects seems to be stronger in Japan.

This research uses a questionnaire survey of Japanese lower secondary school students to investigate their recognition of one learning item, namely the existence of an enzyme between life and matter. This learning item may be a good indicator of the depth and accuracy of students' understanding of life.

2. Questionnaire Survey of Students

2.1. Survey Method

A questionnaire survey of the students in the seventh, eighth, and ninth grades of the lower secondary school

attached to the Naruto University of Education (Tokushima City, Tokushima, Japan) was carried out in July 2012 (henceforth referred to as 'Naruto'). There were 40 students in each class with four classes in each grade, giving a total of 480 students. In addition, an eighth-grade class of 24 students from the Ichiba Lower Secondary School (Awa, Tokushima, Japan) was surveyed in December 2012 ('Ichiba'). Considering survey items, intended students, and circumstances suggested the validation of the survey.

2.2. Contents of Questionnaire

The survey questions are shown in Table 1. The survey included 19 fixed-choice questions and a free response question. For the fixed-choice questions, students were asked to select and circle the most appropriate answer from five options: 'no' (1); 'moderately no' (2); 'yes and no' (3); 'moderately yes' (4); 'yes' (5). The numbers in brackets indicate the marks allocated to each response option during data analysis. The free response question asked students to list examples of enzymes.

Table 1. *Survey questions.*

No.	Questions
1	I have heard of the word enzyme.
2	An enzyme is the same as yeast.
3	An enzyme is a life (: an organism).
4	An enzyme is not a life (: an organism) but a matter.
5	An enzyme relates to digestion.
6	An enzyme is a catalyst.
7	An enzyme brings about chemical reactions.
8	All live forms have enzymes.
9	An enzyme is a poison.
10	An enzyme is a medicine.
11	An enzyme is included in fruits.
12	An enzyme is included in laundry soaps.
13	An enzyme is included in cleaners for artificial teeth.
14	An enzyme is included in tooth pastes.
15	An enzyme is useful for our life.
16	An enzyme deconstructs starches.
17	An enzyme is a protein.
18	An enzyme deconstructs proteins.
19	An enzyme deconstructs fats.
20	Write down the names of the enzymes you know in the space at the right.

3. Results and Discussion

3.1. Comparison of the Average Scores at Each Grade Level

Figure 1 summarizes the average of the students' response scores. It is useful to see the median value and the outline feature. Students generally gave high scores for questions 1 and 5, with students at higher grade levels generally giving higher scores for these questions. Most students knew the word enzyme (*kohso* in Japanese) and that an enzyme related to digestion. Students learn about digestion in organisms at elementary school, and again in more detail in the second grade in June. The ninth-grade students showed higher scores than the lower-grade students for questions 15, 16, 18, and 19, as well as questions 1 and 5. The ninth-grade students may better understand the importance of an enzyme for life and for the digestion of starch, proteins, and fats than the lower-grade students.

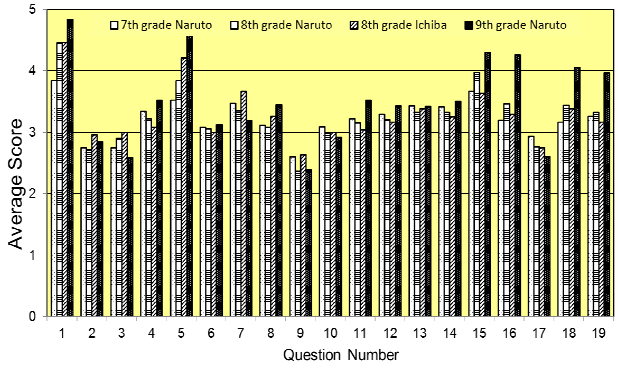

Figure 1. *Average scores on enzyme questions for each grade level.*

The results can be explained by the fact that the ninth-grade students had already learned about digestion the previous year; digestion in the human body is briefly covered in science textbooks in the eighth grade, but lower-grade students have no previous exposure to the concept. The average score for question 9 was the lowest for all questions. Most students had a positive perception of enzymes, and did not have a negative perception of enzymes as poisons. The average scores for questions 2, 3, and 17 were less than 3 for each grade level. The results show that not many students knew whether an enzyme was life or matter. More detailed consideration of this issue will be given in section 3.3.

3.2. Sample Standard Deviation

Figure 2 shows the sample standard deviation for each question. We can see what questions make the answer of the students different.

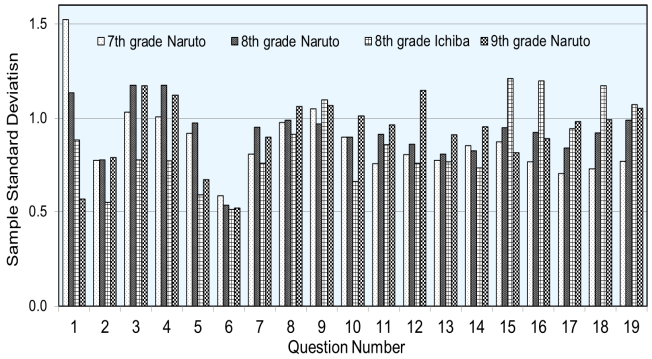

Figure 2. *Standard deviation of scores for each question*

The standard deviations of the scores for each question ranged from 0.5 to 1.2, with the exception of the seventh-grade students' scores for question 1, which had a wider range. In order to see the reason of the wider range of

standard deviation, the percentage of answer for each score considerable. Figure 3 shows the percentage of answers for each score for question 1.

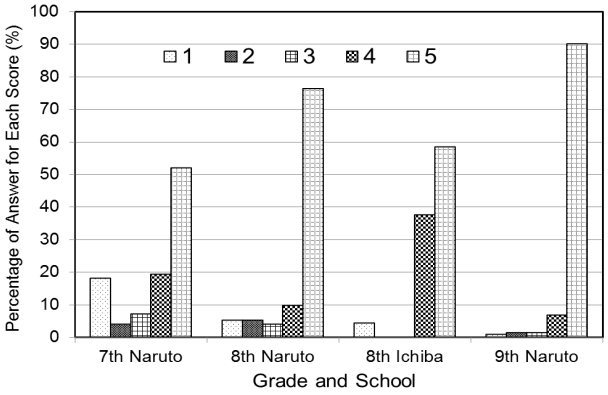

Figure 3. *Percentage of students selecting each response option for question 1.*

About 18% of the students in the seventh grade at Naruto selected the response option 'no' (1) for question 1, indicating they had never heard of the word enzyme, while 52% selected 'yes' (5). This would account for the larger standard deviation, as shown in Figure 2.

However, the number of the students who selected lower-value options decreased as grade levels increased. The percentage of the students who had heard of the word enzyme increased with the higher grade of students.

3.3. Recognition of Enzyme as Life or Matter

Questions 3 and 4 are important for determining whether the students recognized an enzyme as life or matter. Figure 4 shows detailed data of the responses given to questions 3 and 4.

More than 70% of the students in each grade and school selected 'yes and no' (3) for question 2. They did not know whether an enzyme was yeast or not. Fewer students selected this response option for question 3. The percentage of students who selected 'yes and no' (3) decreased with the higher degree of students in Naruto. More students at higher-grade levels selected 'no' (1) or 'moderately no' (2), indicating they understood that an enzyme is not a life.

Similarly, for question 4, the percentage of students who marked 'yes and no' (3) decreased with the higher degree of students in Naruto. More students at higher-grade levels selected 'moderately yes' (4) or 'yes' (5), indicating they understood that an enzyme is not an organism but is matter. However, more than 38% of students, including ninth-grade students in Naruto, selected 'yes and no' (3) for this question, indicating they did not know whether an enzyme is life or matter.

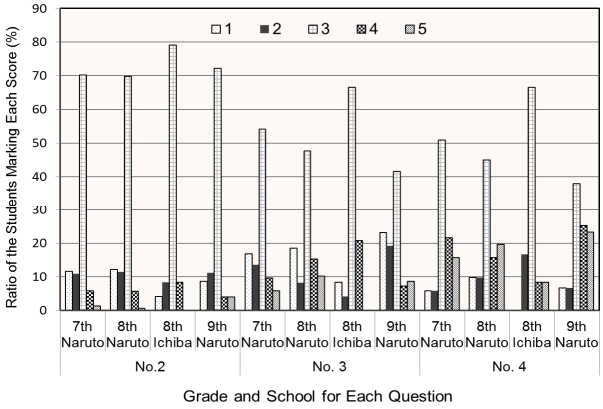

Figure 4. *Percentage of students selecting each response option for questions 2, 3, and 4.*

3.4. Free Description of Enzymes

Question 20 asked students to list the names of the enzymes they knew; Table 2 summarizes their responses.

Only one of the seventh-grade students wrote the name of an enzyme. The number of enzymes named increased as the grade level of the students increased; 112 (74%) ninth-grade students provided amylase and 107 (71%) provided pepsin. There was a big difference between the responses of eighth-grade and ninth-grade students at Naruto on this point, but only a small difference between the responses of eighth-grade Ichiba and ninth-grade Naruto students.

Table 2. *Summary of the responses to question 20.*

Grade and School	Number of answered names of enzymes					
	Amylase	Pepsin	Lipase	Trypsin	Other enzyme	Not enzyme
7th grade Naruto (155)*	0	0	0	0	1 (0.6%)**	16 (10%)
8th grade Naruto (157)	13 (8.3%)	12 (7.6%)	3 (1.9%)	2 (1.3%)	7 (4.5%)	11 (7.0%)
8th grade Ichiba (24)	15 (63%)	10 (42%)	3 (13%)	12 (50%)	0	0
9th grade Naruto (151)	112 (74%)	107 (71%)	5 (3.3%)	4 (2.6%)	12 (7.9%)	10 (6.6%)

* Total number of students of each grade.

** Percentage of the students who responded with the enzyme name.

The differences may be explained by the differences in the delivery times of lessons about digestion. The questionnaire was administered to the Naruto students in July 2012, and to the Ichiba students in December 2012. The seventh-grade and eighth-grade students of Naruto had not learned about enzymes by July 2012, but the ninth-grade students had. The eighth-grade students of Ichiba learned about enzymes in December 2012.

Therefore, the differences in the number of enzymes that students at different grade levels were able to name suggest that the lessons in both lower secondary schools about enzymes may be effective. It is known that the lower secondary school attached to Naruto University of Education educates students to an excellent level, and Ichiba lower secondary school educates them to a standard or higher level. Although this survey has not been administered to many lower secondary schools, the results may reflect a part of science education in Japan.

4. Conclusion

The questionnaire survey about enzymes was administered to two lower secondary schools in Tokushima Prefecture in Japan. The results show that the students had learned enough about enzymes by the ninth grade to be able to provide enzyme names, but most were not able to recognize enzymes as life or matter. As an interdisciplinary learning item, the concept of an enzyme may be used as an indicator of students' comprehension about the border between life and matter.

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References

[1] Ministry of Education, Culture, Sports, Science and Technology: Government Curriculum Guidelines, 2008, 2009; http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/index.htm.(accessed: July 3, 2013).

[2] T. Munegumi, Interdisciplinary Science Education and "Origin of Life": An Exemplification with Teaching Aids, 2013; Science Journal of Education, 1(2): 20–27.

[3] National Research Council of the National Academies. Framework for K-12 Science Education, 2012; http://www.nap.edu/catalog.php?record_id=13165#

[4] National Research Council of the National Academies. Framework for K-12 Science Education, 2012; p. 83.

[5] National Research Council of the National Academies. Framework for K-12 Science Education, 2012; p. 41.

[6] C. M. Czerniak, Interdisciplinary Science Teaching, In Handbook of Research on Science Education, Ed. by S. K. Abell and N. G. Lederman, Routledge Taylor & Francis Group, New York, 2007, pp. 537–559.