STEM Education in English: A Case Study of a Japanese Technical College

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Abstract

Attempts to teach subject courses in English have become more widespread in Japanese universities. Methods such as Content and Language Integrated Learning (CLIL) is sometimes used to educate students in subject knowledge as well as English language. However, such practices hardly exist in Japanese technical colleges, where students are educated in vocational mechanical and engineering subjects. In view of the fact that technical colleges supply workers and engineers to rapidly globalizing technical fields, it is important for technical colleges to educate students to gain specialist knowledge and communication skills in English and Japanese. This paper reports one such attempt at a Japanese private technical college, where science courses are taught in English. The purpose of this paper is to report results from a research designed to gauge how much science learning was achieved in English–medium subject courses and whether English was a barrier in learning such subjects. We compared grades of 112 first year students who took English– medium courses and Japanese-medium courses in academic year 2016-17. We also analyzed course feedbacks and project assignments of the students. The results show that overall grade average of students in English-medium classes and Japanese-medium classes did not differ significantly. However, academically lower achievers may find English-medium classes more challenging. The grades and feedbacks of individual students indicate that students can gain sufficient subject course knowledge and technical abilities from English-medium courses. Research limitations do exist, but the results suggest the possibilities of educating subject courses to technical college students in English.

Keywords: STEM Education Active Learning English for Specific Purpose (ESP) Multicultural education Technical College

Introduction

In the 21st century, STEM and English form two pillars of education. Ever since Judith Ramaley coined the word STEM to refer to the education of science, technology, engineering, and mathematics in 2001, the importance of STEM education has been recognized in the U.S. and other developed and developing countries [1]. Japanese government has been emphasizing the importance of English education, and English medium language education has been introduced since the last Course of Study for upper secondary education. Even for Japanese Technical colleges, globalization is regarded to be essential, and the suggestions for Technical Colleges include special subject education taught in English (Committee of Research Supporters on Enriching Technical College Education, 2015[2]). There are now a few study concerning STEM education of non-native English speakers (Hoffman, Zollman, 2016). However, as far as we know, there is no study about English medium special education in a Japanese Technical College. This paper focuses on physics and chemistry courses taught in English to year 1 students (15-16 years old), in a Japanese private technical college.

Background

In May 2016, Education Ministers of G7 countries met in Kurashiki, Japan, and reached concensus on "the education paradigm for the future" which they published as Kurashiki Declaration (MEXT, 2016). In the declaration, one of the areas they stressed is the importance of improving the "links between education/training and employment in a technology-intenseive world" by promoting education and training in ICT and STEM fields. They also recognized the need for integrating STEM with "other fields including art and design to encourage flexible thinking, risk-taking, and creative problem solving." In their declaration, such education has to be conducted with the awareness of globalized world and international interaction for students as well as teachers.

STEM education is taught in Japan in science stream of Technical High Schools, science stream of normal high schools, government designated Super Science High Schools, and technical colleges. Although STEM education in globalized society is emphasized, there is no report on STEM education in high school taught in English except for Enlgish science presentation skills, English lessons about scientific topic, and short overseas science programs. Even in a governmental report on Super Science High Schools, there is no mentioning of the practice or recommendation of teaching STEM in English.(MEXT, 2017)

Teaching science subjects in English has its own challenges. One of the challenges is emotional effects felt by non-native speaking students who are taught in English. A survey was conducted to investigate changes in positive and negative effects for English Learning for year 1 new students at Kanazawa Technical College (KTC). This survey measured 1) Emotional experience about English, 2) Self-esteem in English Class, and 3)Anxiety in English Classes (Shiotani, 2014). Shiotani found that

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[1] Address by President Barack Obama (March 23, 2015) in "Science, Technology, Engineering and Math: Education for Global Leadership" by U.S. Department of Education, https://www.ed.gov/stem
[2]高等専門学校の充実に関する調査研究協力者会議, 2015

Ss of this survey were more anxious about English language education at the beginning of the year, and they had less self-esteem. Although the survey shows that the axiety level was reduced by the end of the year for all students, degree of reduction was the smallest for electrical engineering department students.

Current Study

Institution

This research has been conducted at a private technical college, Kanazawa Technical College (KTC), where English medium education forms a part of its curriculm. KTC is a college of technology, which is a special kind of school in Japan that is different from technical colleges in other parts of the world. A college of technology provides graduates with an Associate's degree upon graduation, but that degree also includes three years of high school education. Students who enter a college of technology usually do so upon completing junior high school. Literally translated from the Japanese, a college of technology is a "high specialty school," and as such it offers a 5-year intensive study curriculum that integrates the general education of a high school with specialized technical training of a vocational school. These schools are accredited as institutions of higher education by Japan's Ministry of Education (See Figure 1).

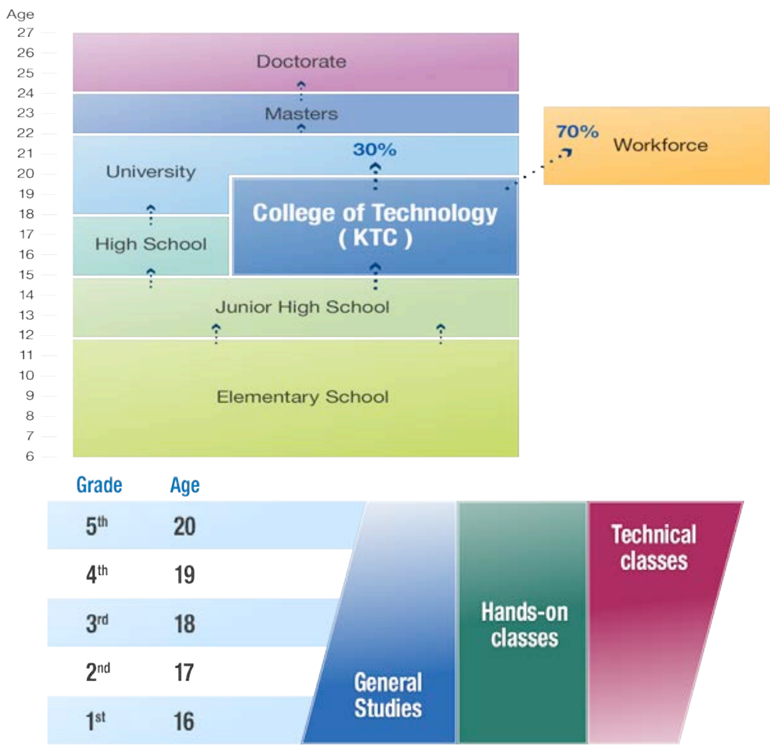


Figure 1: Educational System at KTC

With its 517 Ss and 55 faculty members, KTC is run by a Board of Directors that jointly overseas the neighboring 4-year university and graduate school of Kanazawa Institute of Technology (KIT) (See Figure 2).

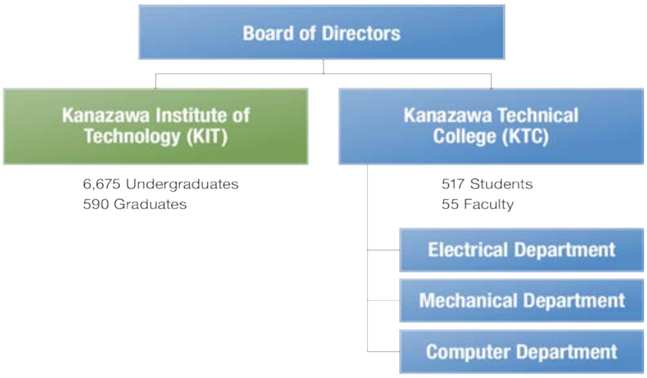


Figure 2: KTC Management

Teaching Method

English immersion science classes have been implemented for the Physics and Chemistry required courses at KTC from 2016-17. Physics and Chemistry I are required 2 credit-hour courses at KTC. They are taught by one Japanese and one non-Japanese teachers. The non-Japanese teacher is the main teacher when English is the vehicle language in the first two terms, then the Japanese teacher becomes the main teacher when Japanese is the vehicle language of the course in the following two terms (See Figure 3).

Figure 3: Year 2016-17 Physics and Chemistry I Flow

CLIL

In the first two terms, we used CLIL methodology to address the issue of teaching specific subject in English, as students need to be educated both in the subjects as well as the veihcle language. CLIL is useful in making teachers and students aware of the type of languages they need to focus on during each lesson. Coyle (2000, 2002) has divided language of instruction into the three distinct categories. They are Language of Learning, Language for Learning, and Language through Learning (See Figure 4).

Figure 4: CLIL Triptych

In indivisual lessons, teachers distribute activity worksheets to lessen students' anxiety about the veihcle language. The worksheets help students deal with language issues in separate categories one at a time. So, students learn new technical terms through a lesson taught by an interactive powerpoint presentation and simulation, use their limited English knowledge to link what they understood with what they read in their Japanese textbooks, and come up with a word-mapping, then intergrate them together to deduce the main concept taught in the lesson (See Figure 5).

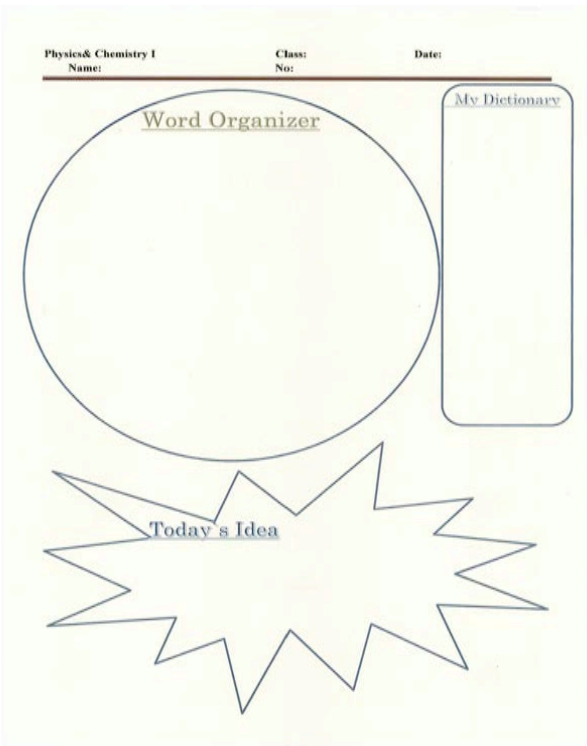
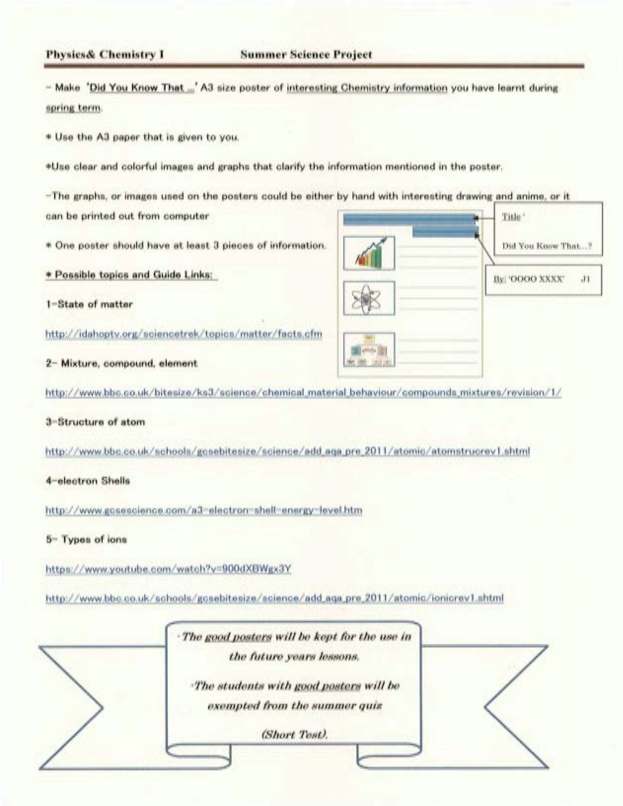


Figure 5: Worksheets for Categorizing language

Project

Apart from classroom instruction in English, Ss are required to create a poster in English. This is to give Ss opportunity to research and put their findings together in English, and give them a sense of achievement. So, before summer holiday, Ss are assigned to make A3 posters on the topics they found interesting, which were taught in chemistry lessons during spring term. Ss could create the poster either in English or

Japanese. Marking criteria were about punctuality, overall organization, clarity of images, and accuracy of language and information used (See Figure 6).



Physics& Chemistry I **Summer Science Project**

- Make 'Did You Know That ...' A3 size poster of interesting Chemistry information you have learnt during spring term.

* Use the A3 paper that is given to you.

*Use clear and colorful images and graphs that clarify the information mentioned in the poster.

-The graphs, or images used on the posters could be either by hand with interesting drawing and anime, or it can be printed out from computer

* One poster should have at least 3 pieces of information.

* Possible topics and Guide Links:

1-State of matter

http://idahoptv.org/sciencetrek/topics/matter/facts.cfm

2- Mixture, compound, element

http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/compounds_mixtures/revision/1/

3-Structure of atom

http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/atomic/atomstrucrev1.shtml

4-electron Shells

http://www.gcsescience.com/a3-electron-shell-energy-level.htm

5- Types of ions

https://www.youtube.com/watch?v=900dXBWgx3Y

http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/atomic/ionicrev1.shtml

Figure 6: Project Assignement

Research Objectives

The objectives of this research is to see if the change of language of instruction, vehicle Language, affects students learning outcomes or not.

Research Methodology

This study analyises student grades, project markings, and student survey results about English-medium Physics and Chemistry courses, and compare the results with Physics and Chemistry courses taught in Japanese. Data was collected in 2016-2017 school year for year 1 students (112 Ss).

1-Grade Analysis

Four criteria are used for assessment, and they are divided as follows:10% for attendance and attitude, 30% for class work and assignments, 10% for quizzes, and 50% for end of term exams.

2-Project Marking Analysis

Before summer holiday, Ss were assigned to make A3 posters to cover what they have thought of as interesting chemistry topics which they learned during the spring term. Ss were allowed to choose between English and Japanese, whichever the language they prefer to use. Teachers gave the choice of the language of the posters to the Ss. Marking criteria were about punctuality, overall organization, clarity of images, and accuracy of language and information used, the choice of language was not a marking criterion. Therefore, Ss chose the language of their posters without the fear of being marked differently.

3- School Survey Result Analysis

KTC has been conducting school surveys to measure Ss' satisfaction of individual courses. In the survey, the questions F, G, H, I, J and K are Ss` self-assessment questions about the main topics covered in a course throughout the schoolyear. In Physics and Chemistry courses the F, G, and H are question about topics taught in English in the first half of the year, and questions I, J, and K are questions about topics taught in Japanese in the second half of the year.

Results/Discussion

Grade Analysis

We compared Computer Department individual Ss total grades of the first 2 terms, and the second 2 terms correlation was 0.80, suggesting that there is a positive correlation between the performance on first and second halves. We ran a z-test on the grades, P value was 0.35 which is more than the most commonly used P value of 0.05, which means there is no significance between the grades in the both cases. That suggests that changing the vehicle language did not affect the Ss' grades (See Figure 7).

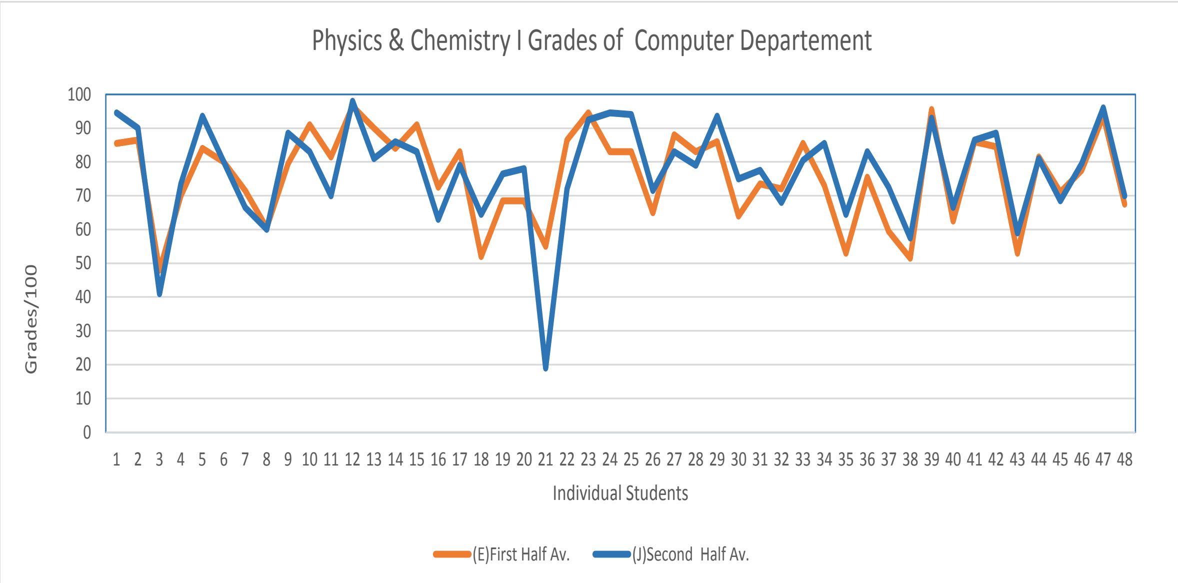


Figure 7: Physics and Chemistry I Grades of Computer Department

We compared Mechanical Department individual Ss total grades of the first 2 terms, and the second 2 terms correlation was 0.89, suggesting that there is a positive correlation between the performance on first and second halves. We ran a z-test on the grades, P value was 0.08 which is more than the most commonly used P value of 0.05, which means the grades were marginally significant. That suggests that changing the vehicle language did not affect the Ss' grades (See Figure 8).

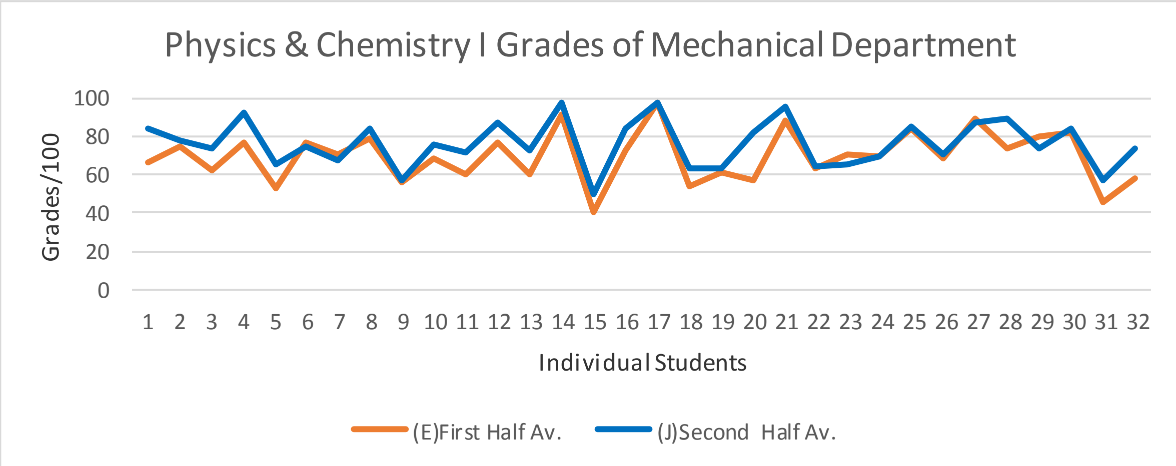


Figure 8: Physics and Chemistry I Grades of Mechanical Department

We compared Electrical Department individual Ss total grades of the first 2 terms, and the second 2 terms correlation was 0.84, suggesting that there is a positive correlation between the performance on first and second halves. However, the z-test showed different results, P value was 0.01 which is less than the most commonly used P value of 0.05. There is a significance in the grades of the 2 halves (See Figure 9).

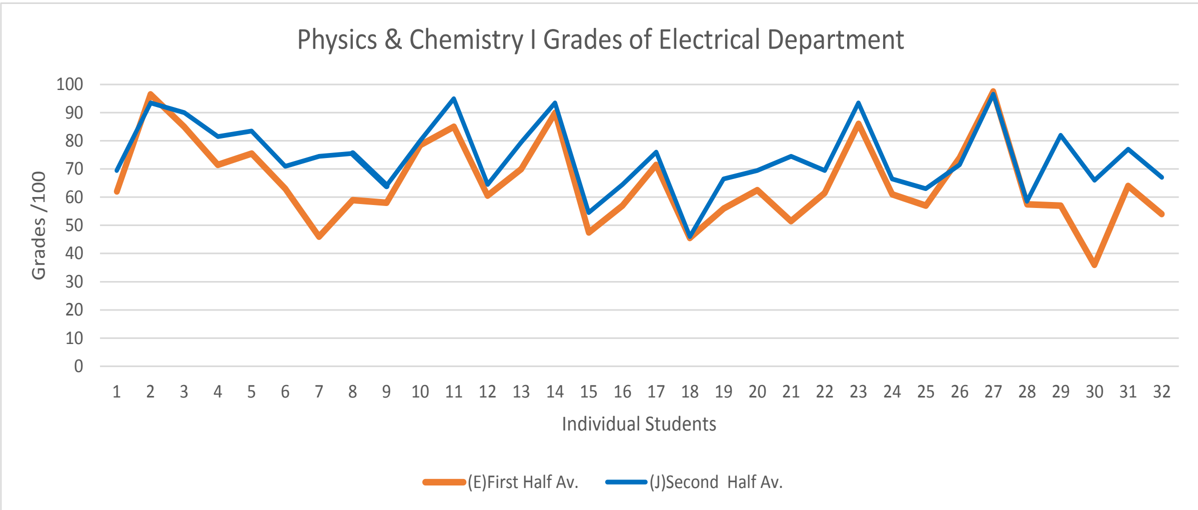


Figure 9: Physics and Chemistry I Grades of Electrical Department

Although their overall average of the first half was above the average, Ss of Electrical Department seem to be affected to some extent by changing the vehicle language. One of the reasons could be the anxiety students feel about the vehicle language. As shown in Figure 10, the Electrical department students have the lowest average points of all subjects amongst all first year students in all terms. Also, as Shiotani (2015) showed, the degree of reduction in anxiety level of electrical department was the smallest, so anxiety could affect academically lower-level students more.

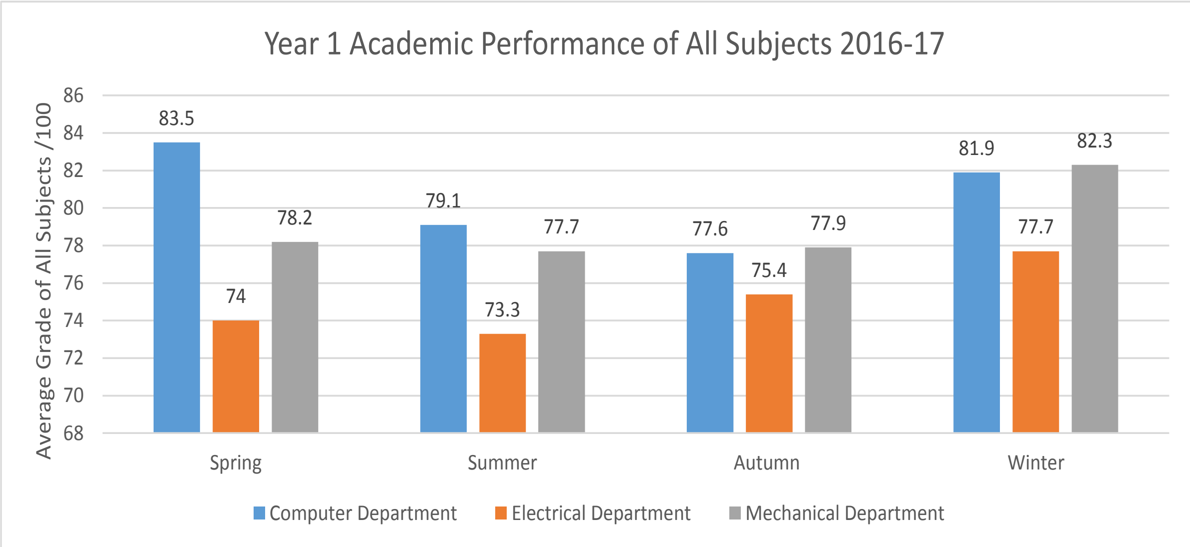


Figure 10: Year 1 Academic Performance of All Subjects of year 2016-17

Project Marking

The objective of project assignment analysis is to see how many students have chosen English rather than Japanese when given the choice. Another aim is to measure if the quality of the posters were affected by the choice of the language.
Divided by department, 79.2% of Computer Department Ss used English for their posters, and only one student (2.1%) used Japanese. The remaining 18.8 % did not submit any posters (See Figure 11).

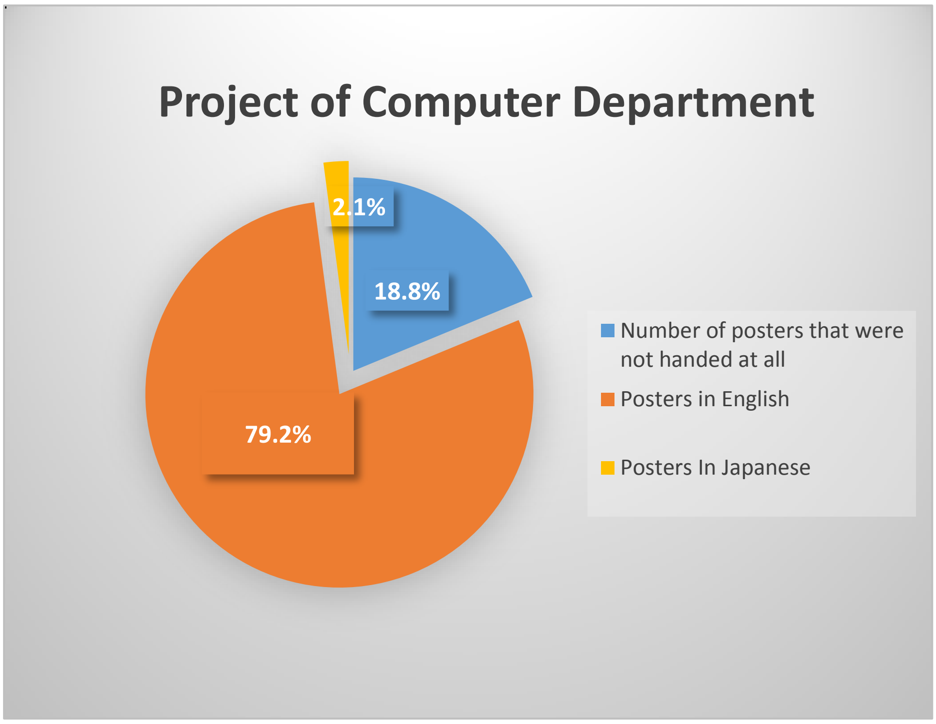


Figure 11: Poster Project of Computer Department

At Mechanical Department, 59.2% of Ss used English for their posters, and 31.3% used Japanese. 9.4 % did not submit any posters (See Figure 12).

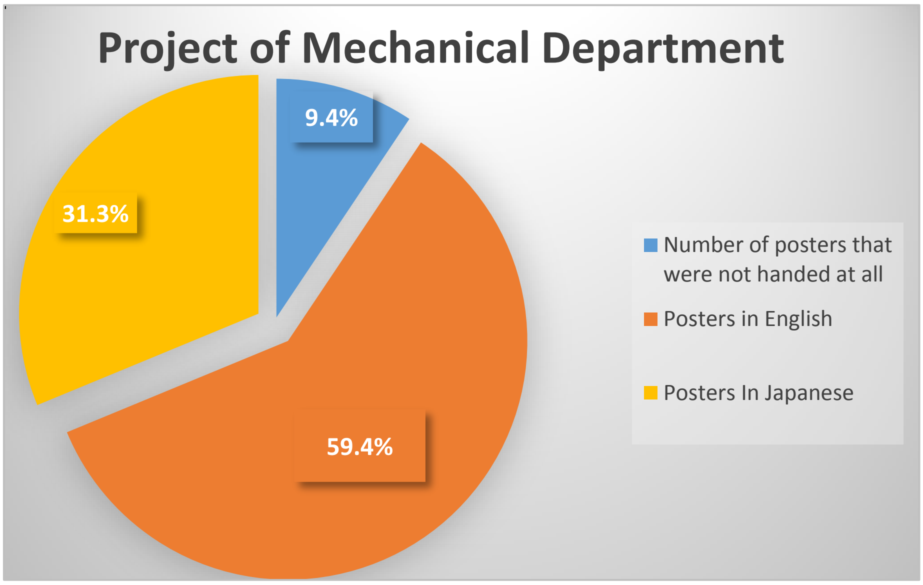


Figure 12: Poster Project of Mechanical Department

At Electrical Department, 40.6% of Ss used English for their posters, and 43.8% used Japanese. And, 15.6 % did not submit any posters (See Figure 13).

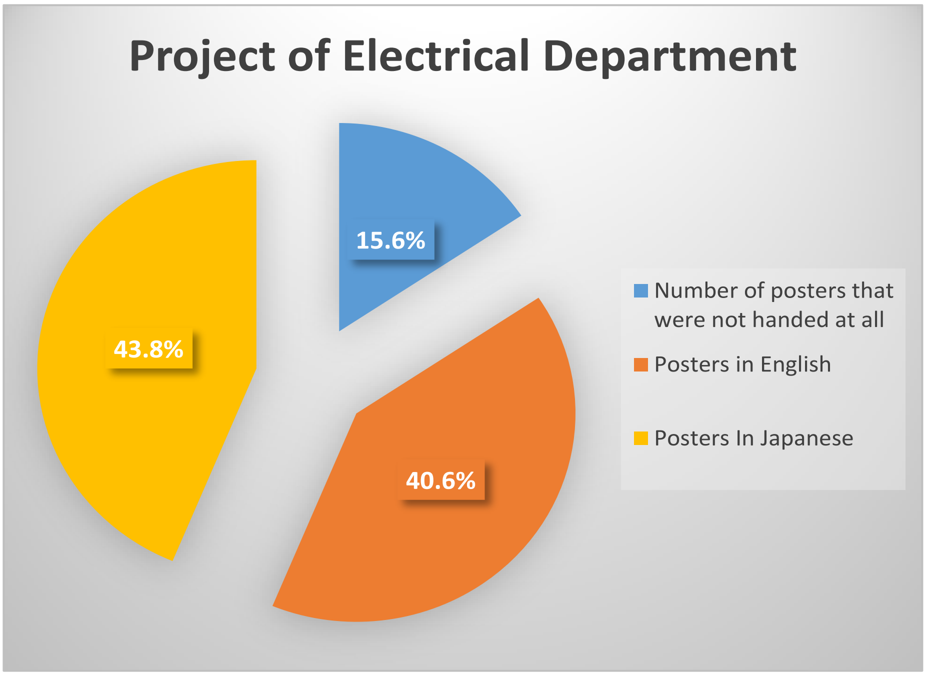


Figure 13: Poster Project of Electrical Department

Across the departments, a bigger percentage of Ss chose English (62.5%), and only 22.3% of Ss chose Japanese (See Figure 14).

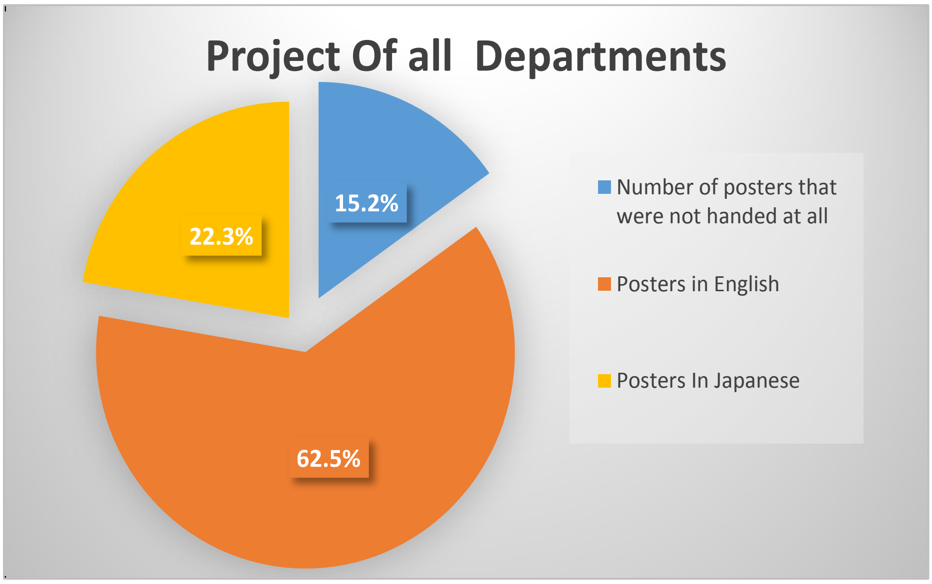


Figure 14: Poster Project of All Departments

The result of poster marking shows that English posters got slightly higher average score than Japanese posters. The average score of Japanese posters was 75.8, while that of English posters was 79.8 (even though one of the English poster had the mark of 20 points due to students' misunderstanding of the poster topic.) (See Figure 15).

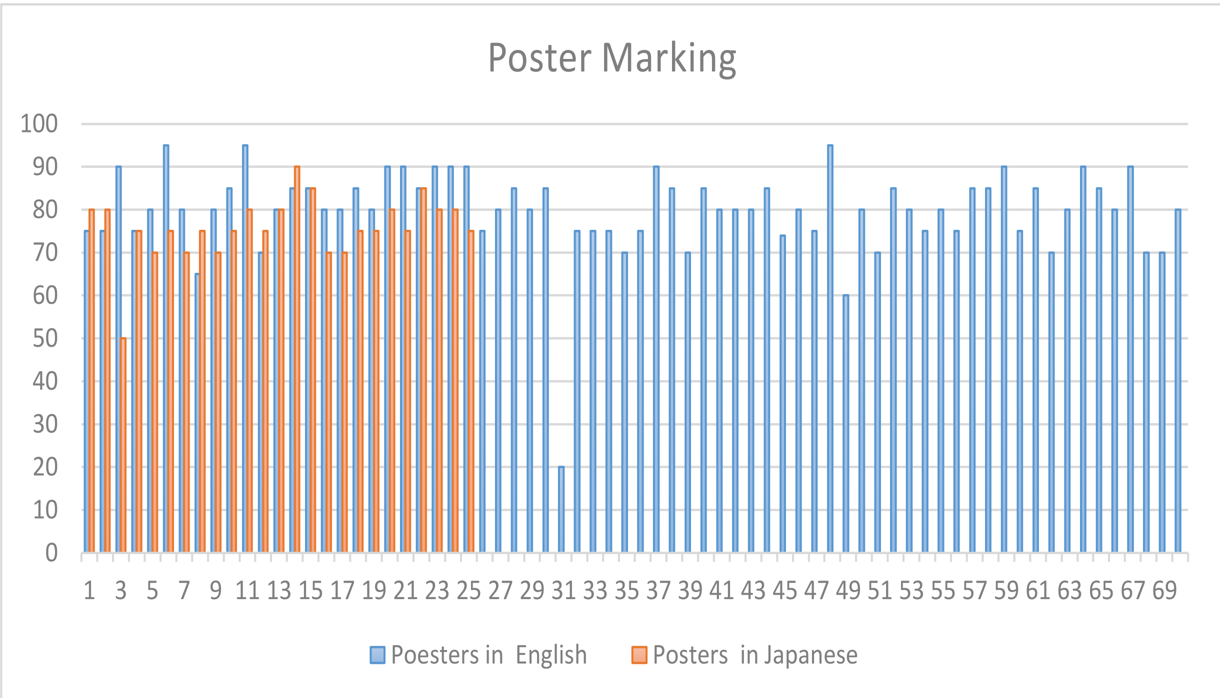


Figure 15: Poster Marking

School Survey

The objective of the self-assessment questions in the school survey are two folds: 1) to clarify how Ss see the content taught to them in English, ESP, and 2) to find out whether Ss` opinions of the lessons are affected by the vehicle language or the scientific topics.

As seen in Figure 16, there are actually students in Computer Department, who marked 0% (meaning that they did not understand anything about the topic) for topics taught in Japanese.

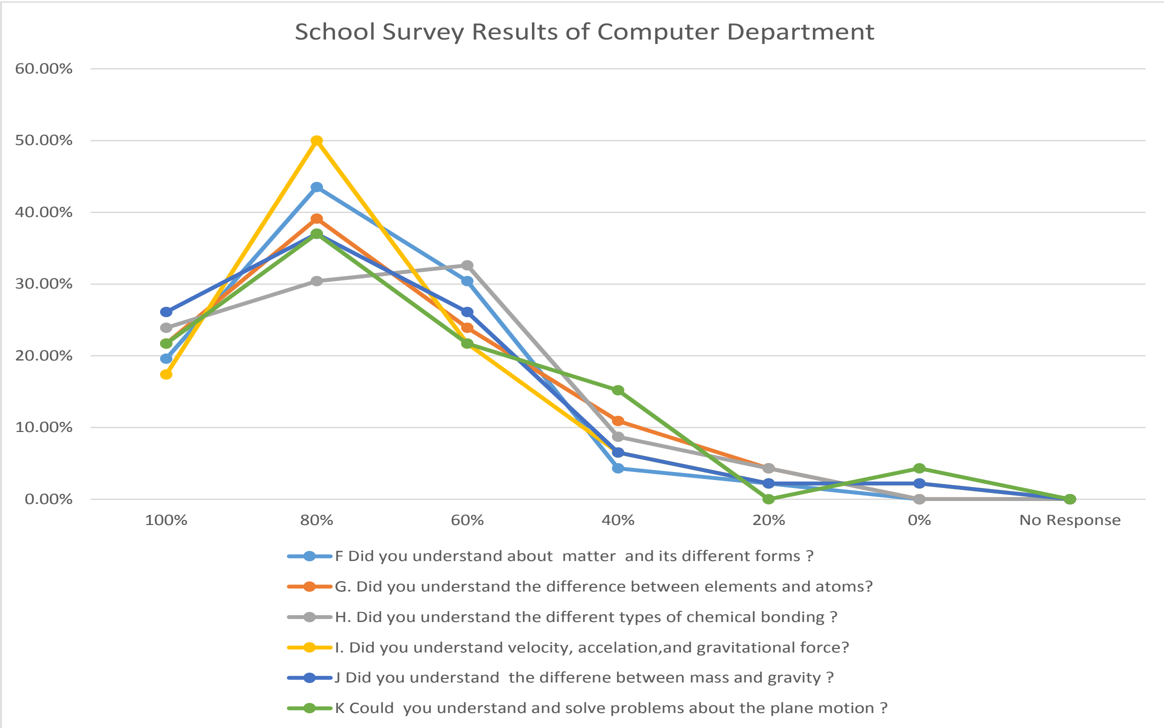


Figure 16: School Survey Results of Computer Department

In Mechanical Department, language is not necessarily the determining factor for the percentages of Ss' understanding of topics (See Figure 17).

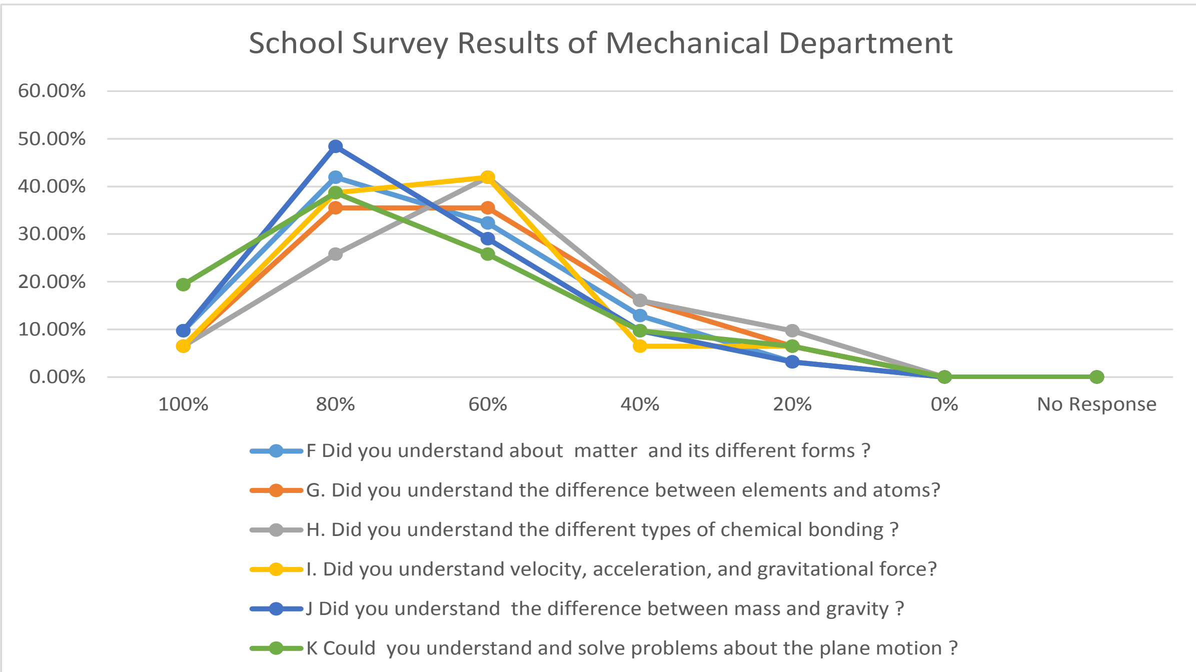


Figure 17: School Survey Results of Mechanical Department

In Electrical Department, Ss seem to be generally satisfied with topics of both languages. 19.4% of Ss marked question G to be fully understood, that was a question about a topic taught in English, that suggests language did not intervene the Ss understanding of topics. (See Figure 18).

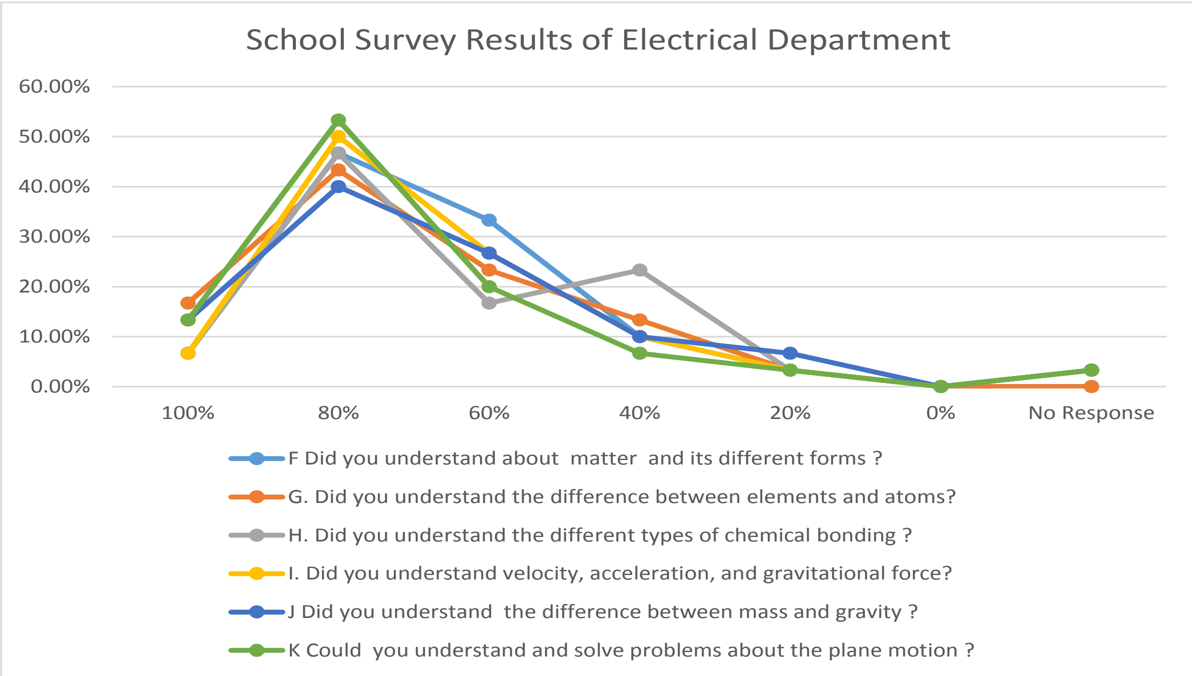


Figure 18: School Survey Results of Electrical Department

In All Departments, the response to all questions regardless the vehicle language change had a close pattern. In general, the majority of Ss marked more than 60 % understanding of topics which supports the idea that language did not affect Ss' understanding of topics (See Figure 19).

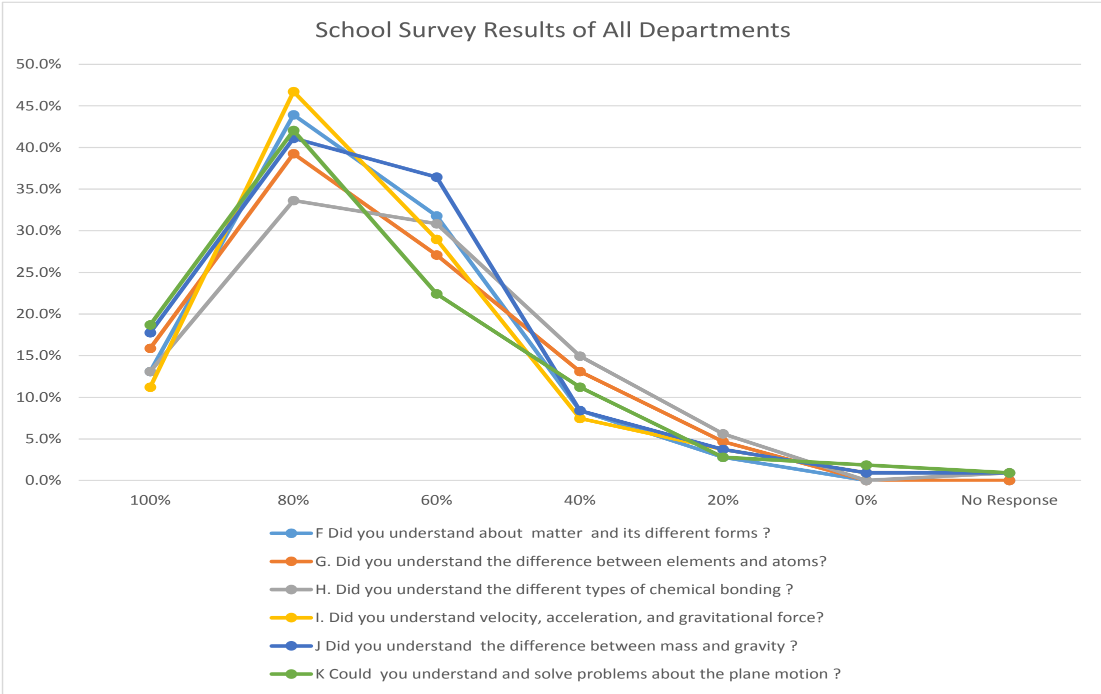


Figure 19: School Survey Results of All Department

Conclusion

Vehicle language did not affect students learning outcomes in departments with high and medium academic achievers. However, it seemed to affect low academic achievers' learning outcomes. Although it has partly been caused by the Ss anxiety about language, it might also have a relationship to their academic performance in general. On the other hand, the survey results showed that students were generally satisfied, and language was not a major parameter that affected the survey results. Research limitations do exist, but the results suggest the possibilities of educating subject courses to technical college students in English.

Future Work

The following areas need further research:
-Grade analysis and significance, if the vehicle language of Physics and Chemistry was Japanese first and then English.
-Measure whether there is improvement in students` English language ability. (Proficiency Tests)
-Follow up the performance of the same group of students in the following years.
-Study the differences of learning outcomes between introductory courses and advanced courses.

Acknowledgments

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Contact email: nagwa@neptune.kanazawa-it.ac.jp

Appendix I: School Survey Results of Computer Department

金沢工業高等専門学校　平成28年度　授業アンケート　1年生科目別集計表　（1／2）

コード　31133　物理化学 I

	設問	選択肢 回答数・%							回答者数	標準偏差・加重平均
A.	あなたは、この授業を興味を持って受け続けられたと思いますか？	そう思う 11 (23.9%)	まあそう思う 30 (65.2%)	あまりそう思わない 5 (10.9%)	そう思わない 0 (0.0%)			無回答 0 (0.0%)	46 (100.0%)	0.582 5.11
B.	この授業に対し宿題を含めて、どの程度予習・復習しましたか？	60分以上 12 (26.1%)	30～60分程度 12 (26.1%)	0～30分程度 4 (8.7%)	試験前だけした 17 (37.0%)	しなかった 1 (2.2%)		無回答 0 (0.0%)	46 (100.0%)	1.289 —
C.	あなたは、この授業に対して積極的に取り組みましたか？	積極的だった 5 (10.9%)	まあ積極的だった 31 (67.4%)	あまり積極的でなかった 9 (19.6%)	積極的でなかった 0 (0.0%)			無回答 1 (2.2%)	46 (100.0%)	0.557 3.56
D.	あなたはこの授業に満足していますか？	満足 11 (23.9%)	まあ満足 27 (58.7%)	少し不満 7 (15.2%)	不満 0 (0.0%)			無回答 1 (2.2%)	46 (100.0%)	0.633 4.67
E.	選択肢(3つまで選択)	そう思う		そう思わない		回答数の差(そう思う-そう思わない)				
	1 好きな科目である	9 (19.6%)		5 (10.9%)		4 (8.7)			46	
	2 教科書や教材、配布資料などが、授業を理解する上で役に立つ	19 (41.3%)		1 (2.2%)		18 (39.1)			46	
	3 課題やレポートなどが適切であった	7 (15.2%)		3 (6.5%)		4 (8.7)			46	
	4 授業の進め方(スピード)が適切であった	13 (28.3%)		2 (4.3%)		11 (23.9)			46	
	5 黒板やビデオ・OHPなどでの説明の仕方、書き方、表し方などがわかりやすかった	6 (13.0%)		2 (4.3%)		4 (8.7)			46	
	6 教員の授業中の話し方や説明の仕方が解りやすかった	3 (6.5%)		4 (8.7%)		−1 (−2.2)			46	
	7 授業は、学生が理解しやすいように工夫されていた	5 (10.9%)		1 (2.2%)		4 (8.7)			46	
	8 授業中や授業後に、学生からの質問に丁寧に対応してくれた	2 (4.3%)		0 (0.0%)		2 (4.3)			46	
F.	物質の成り立ちについて、理解できましたか。	100% 9 (19.6%)	80% 20 (43.5%)	60% 14 (30.4%)	40% 2 (4.3%)	20% 1 (2.2%)	0% 0 (0.0%)	無回答 0 (0.0%)	46 (100.0%)	0.905 —
G.	元素と原子のちがいについて、理解できましたか。	100% 10 (21.7%)	80% 18 (39.1%)	60% 11 (23.9%)	40% 5 (10.9%)	20% 2 (4.3%)	0% 0 (0.0%)	無回答 0 (0.0%)	46 (100.0%)	1.082 —
H.	化学結合について、理解できましたか。	100% 11 (23.9%)	80% 14 (30.4%)	60% 15 (32.6%)	40% 4 (8.7%)	20% 2 (4.3%)	0% 0 (0.0%)	無回答 0 (0.0%)	46 (100.0%)	1.085 —
I.	速度や加速度、重力加速度について、理解できましたか。	100% 8 (17.4%)	80% 23 (50.0%)	60% 10 (21.7%)	40% 3 (6.5%)	20% 1 (2.2%)	0% 1 (2.2%)	無回答 0 (0.0%)	46 (100.0%)	1.055 —
J.	質量と重力の大きさの違いについて、理解できましたか。	100% 12 (26.1%)	80% 17 (37.0%)	60% 12 (26.1%)	40% 3 (6.5%)	20% 1 (2.2%)	0% 1 (2.2%)	無回答 0 (0.0%)	46 (100.0%)	1.129 —
K.	運動方程式を立て、問題を解くことができましたか。	100% 10 (21.7%)	80% 17 (37.0%)	60% 10 (21.7%)	40% 7 (15.2%)	20% 0 (0.0%)	0% 2 (4.3%)	無回答 0 (0.0%)	46 (100.0%)	1.243 —

※「標準偏差」は値が少ないほど回答の偏りが少なく意見がまとまっているということを表します。　※加重平均は「そう思う・役に立った」などの肯定意見に10点、順に5点、マイナス5点、最も否定的な意見にマイナス10点の重さを乗じて平均を取った値であり、大きいほど肯定的な意見が多いことを表します。

Appendix II: School Survey Results of Mechanical Department

金沢工業高等専門学校　平成28年度　授業アンケート　1年生科目別集計表　（1／2）

コード　31132　物理化学 I

	設問	選択肢 回答数・%							回答者数	標準偏差・加重平均
A.	あなたは、この授業を興味を持って受け続けられたと思いますか？	そう思う 1 (3.2%)	まあそう思う 22 (71.0%)	あまりそう思わない 8 (25.8%)	そう思わない 0 (0.0%)			無回答 0 (0.0%)	31 (100.0%)	0.497 2.58
B.	この授業に対し宿題を含めて、どの程度予習・復習しましたか？	60分以上 0 (0.0%)	30～60分程度 8 (25.8%)	0～30分程度 10 (32.3%)	試験前だけした 12 (38.7%)	しなかった 1 (3.2%)		無回答 0 (0.0%)	31 (100.0%)	0.873 ―
C.	あなたは、この授業に対して積極的に取り組みましたか？	積極的だった 2 (6.5%)	まあ積極的だった 19 (61.3%)	あまり積極的でなかった 10 (32.3%)	積極的でなかった 0 (0.0%)			無回答 0 (0.0%)	31 (100.0%)	0.575 2.10
D.	あなたはこの授業に満足していますか？	満足 3 (9.7%)	まあ満足 22 (71.0%)	少し不満 4 (12.9%)	不満 1 (3.2%)			無回答 1 (3.2%)	31 (100.0%)	0.607 3.67
E.	選択肢(3つまで選択)	そう思う		そう思わない		回答数の差（そう思う－そう思わない）				
E. 1	好きな科目である	3 (9.7%)		4 (12.9%)		−1 (−3.2)			31	
E. 2	教科書や教材、配布資料などが、授業を理解する上で役に立つ	11 (35.5%)		1 (3.2%)		10 (32.3)			31	
E. 3	課題やレポートなどが適切であった	5 (16.1%)		1 (3.2%)		4 (12.9)			31	
E. 4	授業の進め方（スピード）が適切であった	5 (16.1%)		3 (9.7%)		2 (6.5)			31	
E. 5	黒板やビデオ・OHPなどでの説明の仕方、書き方、表し方などがわかりやすかった	4 (12.9%)		0 (0.0%)		4 (12.9)			31	
E. 6	教員の授業中の話し方や説明の仕方が解りやすかった	5 (16.1%)		1 (3.2%)		4 (12.9)			31	
E. 7	授業は、学生が理解しやすいように工夫されていた	3 (9.7%)		0 (0.0%)		3 (9.7)			31	
E. 8	授業中や授業後に、学生からの質問に丁寧に対応してくれた	5 (16.1%)		0 (0.0%)		5 (16.1)			31	
F.	物質の成り立ちについて、理解できましたか。	100% 3 (9.7%)	80% 13 (41.9%)	60% 10 (32.3%)	40% 4 (12.9%)	20% 1 (3.2%)	0% 0 (0.0%)	無回答 0 (0.0%)	31 (100.0%)	0.958 ―
G.	元素と原子のちがいについて、理解できましたか。	100% 2 (6.5%)	80% 11 (35.5%)	60% 11 (35.5%)	40% 5 (16.1%)	20% 2 (6.5%)	0% 0 (0.0%)	無回答 0 (0.0%)	31 (100.0%)	1.014 ―
H.	化学結合について、理解できましたか。	100% 2 (6.5%)	80% 8 (25.8%)	60% 13 (41.9%)	40% 5 (16.1%)	20% 3 (9.7%)	0% 0 (0.0%)	無回答 0 (0.0%)	31 (100.0%)	1.048 ―
I.	速度や加速度、重力加速度について、理解できましたか。	100% 2 (6.5%)	80% 12 (38.7%)	60% 13 (41.9%)	40% 2 (6.5%)	20% 2 (6.5%)	0% 0 (0.0%)	無回答 0 (0.0%)	31 (100.0%)	0.945 ―
J.	質量と重力の大きさの違いについて、理解できましたか。	100% 3 (9.7%)	80% 15 (48.4%)	60% 9 (29.0%)	40% 3 (9.7%)	20% 1 (3.2%)	0% 0 (0.0%)	無回答 0 (0.0%)	31 (100.0%)	0.926 ―
K.	運動方程式を立て、問題を解くことができましたか。	100% 6 (19.4%)	80% 12 (38.7%)	60% 8 (25.8%)	40% 3 (9.7%)	20% 2 (6.5%)	0% 0 (0.0%)	無回答 0 (0.0%)	31 (100.0%)	1.121 ―

※「標準偏差」は値が少ないほど回答の偏りが少なく意見がまとまっているということを表します。　※加重平均は「そう思う・役に立った」などの肯定意見に10点、順に5点、マイナス5点、最も否定的な意見にマイナス10点の重さを乗じて平均を取った値であり、大きいほど肯定的な意見が多いことを表します。

Appendix III: School Survey Results of Electrical Department

金沢工業高等専門学校　平成28年度　授業アンケート　1年生科目別集計表　（1／2）

コード　31131　物理化学Ⅰ

	設問	選択肢 回答数・%							回答者数	標準偏差・加重平均
A.	あなたは、この授業を興味を持って受け続けられたと思いますか？	そう思う	まあそう思う	あまりそう思わない	そう思わない			無回答		
		8 (26.7%)	19 (63.3%)	3 (10.0%)	0 (0.0%)			0 (0.0%)	30 (100.0%)	0.592 / 5.33
B.	この授業に対し宿題を含めて、どの程度予習・復習しましたか？	60分以上	30～60分程度	0～30分程度	試験前だけした	しなかった		無回答		
		1 (3.3%)	12 (40.0%)	5 (16.7%)	12 (40.0%)	0 (0.0%)		0 (0.0%)	30 (100.0%)	0.980 / —
C.	あなたは、この授業に対して積極的に取り組みましたか？	積極的だった	まあ積極的だった	あまり積極的でなかった	積極的でなかった			無回答		
		3 (10.0%)	22 (73.3%)	5 (16.7%)	0 (0.0%)			0 (0.0%)	30 (100.0%)	0.521 / 3.83
D.	あなたはこの授業に満足していますか？	満足	まあ満足	少し不満	不満			無回答		
		5 (16.7%)	23 (76.7%)	1 (3.3%)	0 (0.0%)			1 (3.3%)	30 (100.0%)	0.441 / 5.52
E.	選択肢（3つまで選択）	そう思う		そう思わない		回答数の差（そう思う−そう思わない）				
	1 好きな科目である	6 (20.0%)		1 (3.3%)		5 (16.7)			30	
	2 教科書や教材、配布資料などが、授業を理解する上で役に立つ	11 (36.7%)		1 (3.3%)		10 (33.3)			30	
	3 課題やレポートなどが適切であった	6 (20.0%)		1 (3.3%)		5 (16.7)			30	
	4 授業の進め方（スピード）が適切であった	6 (20.0%)		0 (0.0%)		6 (20.0)			30	
	5 黒板やビデオ・OHPなどでの説明の仕方、書き方、表し方などがわかりやすかった	9 (30.0%)		0 (0.0%)		9 (30.0)			30	
	6 教員の授業中の話し方や説明の仕方が解りやすかった	4 (13.3%)		0 (0.0%)		4 (13.3)			30	
	7 授業は、学生が理解しやすいように工夫されていた	7 (23.3%)		1 (3.3%)		6 (20.0)			30	
	8 授業中や授業後に、学生からの質問に丁寧に対応してくれた	1 (3.3%)		1 (3.3%)		0 (0.0)			30	
F.	物質の成り立ちについて、理解できましたか。	100%	80%	60%	40%	20%	0%	無回答		
		2 (6.7%)	14 (46.7%)	10 (33.3%)	3 (10.0%)	1 (3.3%)	0 (0.0%)	0 (0.0%)	30 (100.0%)	0.898 / —
G.	元素と原子のちがいについて、理解できましたか。	100%	80%	60%	40%	20%	0%	無回答		
		5 (16.7%)	13 (43.3%)	7 (23.3%)	4 (13.3%)	1 (3.3%)	0 (0.0%)	0 (0.0%)	30 (100.0%)	1.040 / —
H.	化学結合について、理解できましたか。	100%	80%	60%	40%	20%	0%	無回答		
		2 (6.7%)	14 (46.7%)	5 (16.7%)	7 (23.3%)	1 (3.3%)	0 (0.0%)	1 (3.3%)	30 (100.0%)	1.039 / —
I.	速度や加速度、重力加速度について、理解できましたか。	100%	80%	60%	40%	20%	0%	無回答		
		2 (6.7%)	15 (50.0%)	8 (26.7%)	3 (10.0%)	1 (3.3%)	0 (0.0%)	1 (3.3%)	30 (100.0%)	0.911 / —
J.	質量と重力の大きさの違いについて、理解できましたか。	100%	80%	60%	40%	20%	0%	無回答		
		4 (13.3%)	12 (40.0%)	8 (26.7%)	3 (10.0%)	2 (6.7%)	0 (0.0%)	1 (3.3%)	30 (100.0%)	1.088 / —
K.	運動方程式を立て、問題を解くことができましたか。	100%	80%	60%	40%	20%	0%	無回答		
		4 (13.3%)	16 (53.3%)	6 (20.0%)	2 (6.7%)	1 (3.3%)	0 (0.0%)	1 (3.3%)	30 (100.0%)	0.930 / —

※「標準偏差」は値が少ないほど回答の偏りが少なく意見がまとまっているということを表します。　※加重平均は「そう思う・役に立った」などの肯定意見に10点、順に5点、マイナス5点、最も否定的な意見にマイナス10点の重さを乗じて平均を取った値であり、大きいほど肯定的な意見が多いことを表します。