A STUDY ON SCORES OF PROOF AND DEMONSTRATIVE QUESTIONS – THE CASE OF MALAYSIAN UNIVERSITY STUDENTS IN A JOINT DEGREE PROGRAM BETWEEN JAPAN AND MALAYSIA

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Abstract

In a joint degree program between Japan and Malaysia, Malaysian university students were not necessarily good at proof and demonstrative questions in the subjects of fundamental mathematical sciences compared with Japanese university students because they had seldom solved such questions. According to the result of tests, it was suggested that the amount of Japanese to write did not affect the scores of the questions and that sorting parts of sentences of proofs appropriately was more useful for improving their scores than writing all sentences of proofs. Lastly, it was proposed that Malaysian students should solve those kinds of questions from secondary education.

Keywords

Demonstrable Ability, Japanese, Joint Degree Program, Malaysian International Student, Proof and Demonstrative Question, Sorting

1. Introduction

Malaysia has had a good relation with Japan in many fields, especially in the field of education. Malaysia had been sending about 14,000 international students and trainees by 2012, 30th anniversary of Look East Policy, proposed in 1982 by former Prime Minister Mahathir bin Mohamad. From 2,300 to 2,400 international students from Malaysia study in Japan every year. For Japan, Malaysia is the 8[th]country in the number of the students who study in Japan now and is one of the significant countries which provide international students to Japan.

There are three major international student programs between Japan and Malaysia, which are AAJ (Ambang Asuhan Jepun), KTJ (Kumpulan Teknikal Jepun) and MJHEP (Malaysia Japan Higher Education Program). In these programs students spend their preparation years for higher education or for upper secondary education andoccasionally spend university first and second years in institutions in Malaysia and then they study at universities or organizations in Japan. In MJHEP, which I belong to as a mathematics and informatics lecturer, students spend one year as matriculation students and spend two years as university students (U1 and U2 students) in Malaysia and then they study for two years as junior and senior at universities in Japan.

I noticed U1 and U2 students were not necessarilyas good at proof anddemonstrative questions in my classes as equivalent Japanese students. This isshared by many lecturers in MJHEP. Why we lecturers think so? According to Malaysian lecturers in MJHEP, general secondary education in Malaysia seldom deals with such questionsin mathematics classes. Generally speaking, the education in U1 and U2 is supported by secondary education,it is thus understandable that they are not necessarilygood at those kinds of questions because they had few chances to solve those kinds of questions in secondary education. As it is natural that there are differences between the curriculums in secondary education in two countries, it does not matter that Malaysian U1 and U2 students are not as necessarily good at those kinds of questions as equivalent Japanese students. However, when it comes to studying mathematics among Japanese students in universities in Japan, their weak point may cause some difficulties.

Are they really not good at proof and demonstrative questions in comparison with Japanese university students? If so, the most likely reason may be some lack of their experiences and demonstrable abilities to be cultivated. In addition to that, the difficulty of writing Japanese may be barrier for solving proof and demonstrative questions because almost all the students at

MJHEP starts to study Japanese when they are in matriculation. Is writing Japanese really obstacle for them to solve such questions? Furthermore, is there any method for improving their scores of those kinds of questions? In this paper I want to introduce some speculation about these problems.

The rest of this paper is organized as follows. In section 2, a brief study is conducted on how proof and demonstrative questions are dealt with in secondary education in Japan and Malaysia. Experimental results show whether Malaysian university students are not good at such questions in section 3 and whether writing Japanese can be obstacle for them to solve such questions in section 4. In section 5, the possibility of improving their scores of those kinds of questions is explored. Section 6 concludes this paper with some suggestions and future work.

2. Preliminary Survey –How Proof and Demonstrative Questions Are Dealt with in Japan and Malaysia

In this section, result of a preliminary survey is given about how proof and demonstrative questions are dealt with in secondary education in Japan and Malaysia. How those kinds of problems are dealt with in higher education in Japan is briefly described, too.

In secondary education in Malaysia, it is said that the general curriculum of mathematics seldom deals with proof and demonstrative questions in classes as mentioned in section 1. In fact, looking at general collection books of SPM questions (Sijil Pelajaran Malaysia, Malaysian certificate of secondary education), many numeric questions can be found but proof and demonstrative questions can hardly be found. Of course simple questions of propositional logic are found. However, such questions are about the format of propositional logic and thus it seems that they are not recognized as proof and demonstrative questions. These things suggest that secondary education in Malaysia does not place much emphasis on such questions.

On the other hand, Japanese students in secondary education are encouraged to solve proof and demonstrative questions. The curriculum guideline in high school in Japan by Ministry of Education, Culture, Sports, Science and Technology, says teachers should consider that students express their ideas mathematically and students proof and discuss matters with evidence in the subject of mathematics. These things suggest that secondary education in Japan places much emphasis on those kinds of questions than in Malaysia.

In higher education in Japan, it is said that proof and demonstrative questions become

stricter than in secondary education (e. g. $\varepsilon - \delta$ proof for limitation learned in the beginning of classes of calculus). This worries some Japanese university students a lot though they must have been used to studying such questions in secondary education in Japan.

3. Experiment 1. Comparison of Scores of Proof and Demonstrative Questions between University Students in Japan and Malaysia

Experimental results show whether Malaysian university students are not good at proofand demonstrative questions in comparison with Japanese university students in this section.

3.1 Method

Subjects: 107 U1 students at MJHEP, who had my classes of calculus and were going to study at universities in Japan, and 20 U1 students at Kyoto University in Japan.

Questions: Questions to solve we reproof and demonstrative ones about theorems and mathematical facts students learned and were based on the textbook, which was used in U1 classes in MJHEP and was thought to be a general textbook for calculus. Questions were made and checked by three Japanese mathematics lectures to keep difficulties of the questions appropriate for U1 students. In questions, students had to write answer in Japanese. However, they did not have to write all the descriptions because the fact was taken into consideration that Malaysian students were not used to solving proof and demonstrative questions. Looking at textbooks was prohibited. The intention of the questions is shown in Table 1.

Table 1: *The intention of the questions in experiment 1*

classes	intention
1	necessary and sufficient conditions, relation between total differential and continuity
2	definition of integration, linearity of integration
3	distinction between variables and constants, linearity of integration
4	Jacobian
5	necessary and sufficient conditions, negation, improper integration
6	volume of solid of revolution
7	volume of solid sphere, differential of irrational function
8	linearity of integration

Period: For Malaysian university students, they solved questions in the last 15 minutes in 8 classes of calculus (17/11/2014 – 26/01/2015), which was equivalent to over half of one semester. For Japanese university students, they solved the same questions in 15 minutes (06/01/2015 – 26/02/2015) for each question.

Procedures: In grading questions with marks, 2 meant excellent, 1 average and 0 poor or fatal mistake. Any slight mistake in words or phrases did not deduct marks.

3.2 Result

The change in average scores of proof and demonstrative questions for university students in Japan and Malaysia are shown in Figure 1. Continuous line shows the average scores of Japanese university students and dashed line those of Malaysian university students. Horizontal axis shows the class of solving questions and vertical axis average score of all subjects respectively. The average score of the questions in all the classes for Japanese university students was about 1.856 and for Malaysian university studentsabout 1.261.
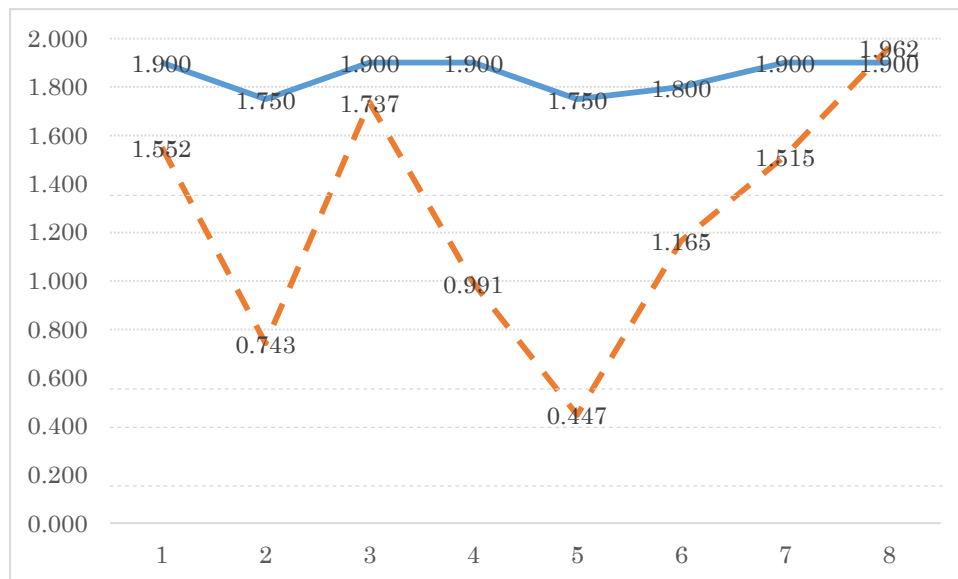

Figure 1: *The change in average scores of proof and demonstrative questions for university students in Japan and Malaysia*

Let H_i: $\mu_{ji} = \mu_{mi}$ be a null hypothesis, μ_{ji} be a population mean for Japanese university students of ith question and μ_{mi} be a population mean for Malaysian university students of ith question such that $1 \leq i \leq 8$, $i \in N$. Null hypotheses H_i such that $1 \leq i \leq 7$, $\in N$were rejected by using Benjamin and Hochberg method. Q-Value in Benjamin and Hochberg method was 0.05

and P-values are indicated in Table 2.

Table 2: *P-values in experiment 1*

Classes	1	2	3	4	5	6	7	8
P-Value	1.889E-04	3.401E-13	3.462E-02	3.354E-06	6.485E-17	1.492E-05	5.096E-05	1.975E-01

3.3 Analysis

The average scores of Malaysian university students fluctuated violently while those of Japanese university students were stable in Figure 1. This may be because Malaysian university students struggled with unfamiliar proof and demonstrative questions while Japanese university students solved those familiar questions.

The result of the test by Benjamin and Hochberg method confirmed the hypothesis that all population means were equal was rejected and confirmed the differences between average scores from 1st to 7th questions were statistically significant. Considering that the average scores of Japanese university students were higher than those of Malaysian university students from 1st to 7th questions, the result of the test suggests that Malaysian university students at MJHEP were not as good at proof and demonstrative questions in the field of calculus as Japanese university students at Kyoto University.

3.4 Consideration

Experiments were conducted to show whether Malaysian university students were not good at proofand demonstrative questions in comparison with Japanese university students in this section. The result of the test only suggests that Malaysian university students at MJHEP were not as good at such questions in the field of calculus as Japanese university students at Kyoto University. However, it may be true for other field of mathematics that they are not good at those kinds of questions because calculus is most a fundamental mathematics subject in universities in Japan as well as linear algebra and islearned by almost all the university students majoring in science in Japan in their first and / or second semester. In addition to that, almost all the Malaysian university students may have the same inclination because only students who got all A (the highest score) in SPM are permitted to enter MJHEP and they are said to be the smartest in Malaysia.

4. Experiment 2. Comparison of Scores of Proof and Demonstrative Questions Due to the Amount of Japanese to Write

Looking at answer sheets in experiment 1, some of them lacked appropriate Japanese in appropriate positions. Almost all the students at MJHEP start to learn Japanese from matriculation, it is thus hard to say that they have sufficient ability to write Japanese to solve proof and demonstrative questions by U1 though all matriculation students at MJHEP usually pass JLPT N4 (Japanese-Language Proficiency Test Level 4). Can their insufficient ability to write Japanese be barrier for them to solve such questions? Experimental results show whether the amount to write Japanese can be obstacle for Malaysian university students to solve those kinds of questions in this section.

4.1 Method

Subjects: 58 U1 students at MJHEP, who had my classes of calculus and were going to study in universities in Japan. Subjects in experiment 1 had already been promoted and subjects in experiment 2 were one grade below them. 58 students were arranged into two groups (Group A and B) randomly before the beginning of the semester. All the students took mathematics tests including proof and demonstrative questions in the beginning of the semester and a t-testconfirmed that the difference between group A and Bwas not statistically significant at the 0.05 probability level ($t = 0.126, df = 56, n.s.$). Therefore, Group A and B were regarded as homogeneous.

Questions: Questions to solve we reproof and demonstrative ones about theorems and mathematical facts students learned and were based on the textbook. Questions were also made and checked by three Japanese mathematics lectures to keep difficulties of the questions appropriate for U1 students. Looking at textbooks was prohibited. To examine whether writing Japanese was obstacle for Malaysian university students to solve proof and demonstrative questions, such questions were prepared as had different amount of Japanese to write but had the same contents for each group. Questions for group A had only question sentences, students thus had to write all descriptions in Japanese to answersheets (amount of Japanese to write: much). Questions for group B had question sentences and options which were all parts of answers and were randomly ordered, students thus had to sort the options correctly with adding some

appropriate conjunctions in Japanese (amount of Japanese to write: less). The intention of the questions is shown in Table 3.

Table 3: *The intention of the questions in experiment 2*

classes	intention
1	limitation of Since function
2	differentiation of exponential function
3	higher derivative
4	mean value theorem
5	Euler formula and additional theorem
6	extreme value
7	formula of partial integration
8	mathematical induction

Period: Students solved questions in the last 15 minutes in 8 classes of calculus (27/04/2015 – 19/06/2015), which was equivalent to over half of one semester.

Procedures: In grading questions with marks, 2 meant excellent, 1 average and 0 poor or fatal mistake. Any slight mistake in words or phrases did not deduct marks.

4.2 Result

The change in average scores of proof and demonstrative questions for Group A and B are shown in Figure2. Continuous line shows the average scores of Group A and dashed line those of Group B. Answer sheets of Group Ain 2nd class were not collected due tounavoidable circumstances. Horizontal axis shows the class of solving questions and vertical axis average score of all subjects respectively. The average score of questions for Group A in all the classes was about 1.561 and for GroupB about 1.673.

Let H_i: $\mu_{ai} = \mu_{bi}$ be a null hypothesis, μ_{ai} be a population mean of i th question for Group A and μ_{bi} be a population mean of ith question for Group B such that$i = 1, 3 \leq i \leq 8, i \in$ N. Noneof the null hypotheses except forH_7 was rejected by using Benjamin and Hochberg method. Q-Value in Benjamin and Hochberg method was 0.05 and P-values is indicated in Table 4.
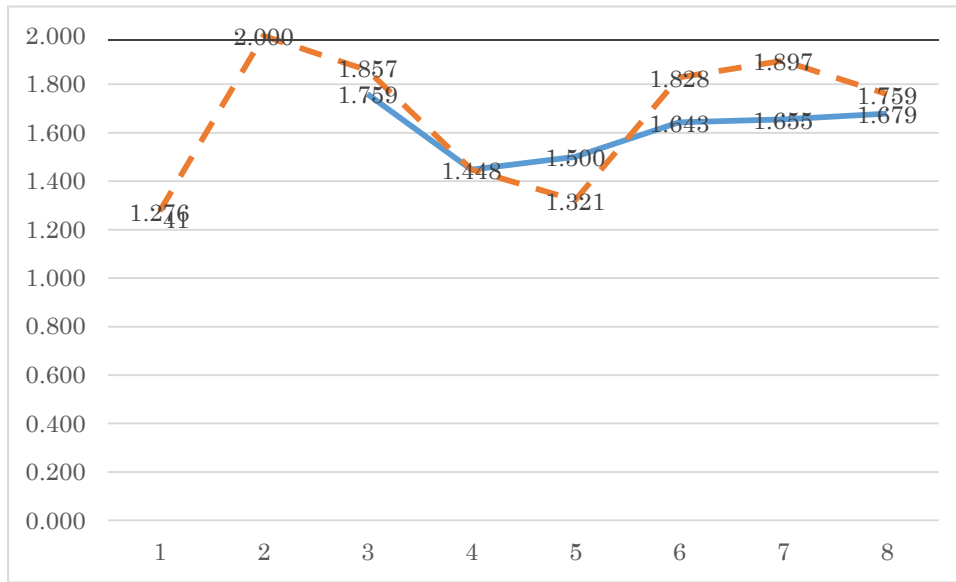
Figure 2: *The change in average scores of proof and demonstrative questions for Group A and B*

Table 4: *P-values in experiment 2*

Classes	1	2	3	4	5	6	7	8
P-Value	0.400	-----	0.247	0.500	0.090	0.075	0.014	0.325

4.3 Analysis

As you can see in Figure 2, there are fewdifferences between average scores of Group A and B. The result of the test by Benjamin and Hochberg method confirmed the hypothesis that all population means were equal was not rejected.Almost all the hypotheses were not rejected suggests that the amount of Japanese to write did not affect solving proof and demonstrative questions.

5. Experiment 3. Comparison of Scores of Proof and Demonstrative Questions for U1 Students at MJHEP

It was suggested that the amount of Japanese to write is not necessarily essential for solving proof and demonstrative questions in section 4. Now, is there any method for improving their scores of such questions?

Not only in the midst of but also after experiment 2 in section 4, Group A continued to be given guidance and trainings so that they could write all descriptions in Japanese in proof and demonstrative questions, while Group B continued to be given guidance and trainings so that they could sort given options correctly with adding some appropriate conjunctions in Japanese in such questions in my classes. The period of guidance and trainings was almost all the semester (27/4/2015 – 03/07/2015). Summary test about those kinds of questions in calculus was run at the end of the semester.

5.1 Method

Subjects: 58 U1 students at MJHEP, who had my classes of calculus and were going to study at universities in Japan.The grouping of A and B was the same as in experiment 2 in section 4. They continued to be given guidance and trainings by each method during almost all the semester.

Questions: Questions to solve consisted of 6 questions and were proof and demonstrativeones about theorems and mathematical facts students learned during the semester and were based on the textbook. Questions were also made and checked by three Japanese mathematics lectures to keep difficulties of the questions appropriate for U1 students and the same questions as in experiment 2 were not used. Looking at textbooks was prohibited. Questions for both groups had only question sentences, students thus had to write all descriptions in Japanese to answer sheets. Namely, Group A and Group B solved the same kind of questions simultaneously and the question and answer style was the same as for Group A. The intention of the questions is shown in Table 5.

Table 5: *The intention of the questions in experiment 3*

question number	intention
1	limitation of sequence
2	intermediate value theorem
3	differentiation of inverse trigonometric function
4	derivative, increase and decrease of function
5	integration by substitution
6	mathematical induction

Period: Students solved questions in 45 minutes in classes of calculus in the last week of the semester (29/06/2015 – 03/07/2015).

Procedures: Each question was graded with marks from 0 to 5 (0: lowest and 5: highest). There were 6 questions and the full score was thus 30. Any slight mistake in words or phrases did not deduct marks.

5.2 Result

The average score of Group A was about 16.379 and GroupB about 20.276.

Let H_0: $\mu_a = \mu_b$ be a null hypothesis, μ_a be a population mean of Group A and μ_b be a population mean of Group B.A t-test confirmed the difference of population means between group A and Bwas statistically significant at the 0.05 probability level ($t = -2.548$, $df = 56$, $p < .05$). Therefore, the null hypothesis H_0 was rejected.

5.3 Analysis

The result of the t-test suggests that students who had struggled with proof and demonstrative questions with sorting options in experiment 2 in section 4 (Group B) were better at such questions than those with writing all descriptions in Japanese (Group A). This is interesting and runs counter to our intuition because Group A solved those kinds of questions which style was familiar to Group A and the average score of Group A was thought to be better than Group B.

5.4 Consideration

One of the likely reasons why Group A was not better at proof and demonstrative questions may not be the difficulty of writing Japanese because experiment 2 in section 4 suggests that the amount of Japanese to write did not have an impact on solving such questions. It is not obvious why Group B was better at those kinds of questions, but the guidance and trainings of sorting proof and demonstrative options may consist of enhancing their demonstrable abilities.

6. Conclusion, Suggestions and Future Work

In this paper, it was suggested first that U1 students at MJHEP were not good at proof and demonstrative questions in the field of calculus in comparison with students at Kyoto University in Japan. There was a possibility that general Malaysian international students had the same inclination in other field of mathematics. Second, it was indicated that the amount of

writing Japanese did not affect the scores of such questions statistically.Third, the guidance and trainings of sorting proof and demonstrative options may be a good influence to enhancing their demonstrable abilities. The reason was not apparent at this point.

Here I want to make some suggestions about dealing with proof and demonstrative questions in mathematics education for Malaysian students. MJHEP students were not good at the subjects of fundamental sciences, especially fundamental mathematical sciences in universities in Japan and other Malaysian international students in Japan may have the same inclination. Enhancing their demonstrable abilities may thus be useful for improving their grades in fundamental mathematical sciences because proof and demonstrative questions are emphasized in classes of fundamental mathematical sciences in universities in Japan. I also suggest that such questions should be dealt with from secondary education because the importance on education with "why" is indicated.

For future work, I want to investigate why it is likely that guidance and trainings of sorting options is more useful for improving the grades of proof and demonstrative questions than writing all sentences of proofs. I also want to offer some suggestions for smooth study connection for not only Malaysian international students but also general international students in joint degree programs.

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