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Impact of Lesson Study on Motivation and Achievement in Mathematics of Malaysian Foundation Programme Students

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Abstract

This quasi-experimental study was conducted to determine the impact of the implementation of lesson study on students' motivation in mathematics and mathematics achievement as well as gender in a public university in Selangor, Malaysia. Seven mathematics lecturers, a physic lecturer and researcher, formed a lesson study group. This group planned and designed five research lessons about the functions focusing on problem-solving. A lecturer was chosen randomly to teach these lessons to his classes as experimental and control groups. In this study, mathematics motivation test (5-point Likert-type scale ranging from 1 (not at all true) to 5 (very true)) and lecturers developed tests were used to investigate the impact of lesson study on mathematics motivation and achievement. The data were analyzed by using independent t-test, ANOVA test, MANOVA test and non-parametric the Kruskal-Wallis test. The results of this study showed that students in the experimental group obtained better results in both motivation and achievement tests. Also, there is no statistically significant interaction between the effects of educational method and gender on mathematics achievement scores. Furthermore, the results showed that the level of motivation is different among groups by gender, but there were no significant mean differences among groups in any of subscales.

Keywords: lesson study, mathematics, mathematics motivation, mathematics achievement

A. Introduction

Mathematics teachers, parents and students think that some students have high aptitude in mathematics while some students have low intelligent for learning mathematics but this idea has been resoundingly disapproved. An extensive review of the literature shows that all students are able to learn mathematics conceptually. National Council of Teachers of MathemSatics (NCTM) (2000) explained that mathematics is a meaningful, richly rewarding subject that all students can learn and enjoy. Generally, mathematics educators give some justifiable reasons such as lack of suitable materials and time to explain students' weaknesses in mathematics. On the other hand, the method of teaching plays an important role in encouraging and motivating students in mathematics learning.

Based on observation carried out in the field, students are less motivated in learning mathematics and lecturers still employ conventional learning methods, and the classes are more teacher-centred (Mekarina & Ningsih, 2017). However, many educators might be unfamiliar with methods for evaluating and enhancing motivation (Lai, 2011), particularly at the foundation level. In every country, in some classes, the traditional method of teaching is an important reason to highlight the memorization method among students. For example, according to the results of Program for International Students Assessment (PISA) in 2012, the United States was in top third of countries with respect to the proportion of memorizers because American teachers routinely present mathematics procedurally, as sets of steps to memorize and apply (Boaler & Zoido, 2016).

Many students believe that mathematics is a set of formulas that have to be remembered, so they fail to understand that mathematics is a creative science. This belief is associated with low motivation in mathematics learning. Motivation in mathematics is more likely to be the most important factor that educators can target in order to improve learning (Williams & Williams, 2011). Therefore, students without motivation cannot improve their abilities in mathematics problem-solving skills. Ricks (2010) explained the great ironic tragedy that most students who claim to have little motivation to study mathematics have never really experienced authentic mathematics. To deal with a lack of motivation, non-mathematical strategies are often employed to maintain students' attention in mathematics classes.

Mathematics is a core subject in the school curriculum in every country, and mathematics achievement strongly related to the mathematics problem-solving skills among students. In a foundation programme, students are supposed to deal with more complex topics and mathematics problems than those of elementary and lower secondary levels. Some students in the foundation and upper secondary levels have difficulties with solving the problem in mathematics because of their believes, skills and abilities. Therefore, they encounter some emotional and mental problems such as low motivation in learning mathematics related to mathematical thinking and problem-solving skills. Many students in each country believe that mathematics is not motivating and impossibly hard for a majority of high school and foundation students, hence, many of high school and foundation students are reluctant to continue formal mathematics study after school (Ricks, 2010).

Students obtain mathematics learning experience based on function of the brain, thus every students can improve their mathematics knowledge and motivated to understand the concept of mathematics (Mekarina & Ningsih, 2017). Motivation level for learning mathematics is different among students. Students with low level of motivation and interest in mathematics cannot learn the concept of mathematics easily. Therefore, this group of students usually gets confused about mathematics problem-solving process. The results of many studies showed that the lower of motivation, the lower score of students in mathematics achievement, vice versa(Mekarina & Ningsih, 2017; Pantziara & Philippou, 2015; Wang et al., 2017; Wise & DeMars, 2005). Malaysian students (8th grade) who participated in Trends of International Mathematics and Science Study (TIMSS), 2015 had the lowest (after Thailand) confident in mathematics. It means that motivation is a significant challenge for Malaysian students in mathematics learning. According to the report of TIMSS program 2015, only 4 percent of 8th-grade students were very confident in mathematics, 42 percent were confident in mathematics, and 54 percent of students were not confident in mathematics. In other words, the majority of students did not have an acceptable level of motivation in mathematics learning (TIMSS, 2015).

Sengodan and Iksan (2012) studied intrinsic motivation in learning mathematics among students from two departments of Electronics and Manufacturing Technology in IKTBNS, Malaysia. The findings of this study showed that among different learning styles, students preferred and practiced surface approach for mathematics learning. So they had low level of motivation in learning mathematics. Wang et al. (2017) conducted a study on students' motivation and outcomes in mathematics in Singaporean secondary schools. Researchers explained that different levels of motivation among students related to different levels of effort, value, competence and time spent on mathematics homework. Thus students need more effort and time into mathematics to improve their abilities in mathematics learning and mathematics problem-solving. About 51 percent of students had the highest level of intrinsic motivation towards mathematics. It means that in this investigation, more than half of Singaporean students are more interested in mathematics. Motivation in mathematics learning is an essential reason for best student's performance in international mathematics assessments such as TIMSS, TIMSS Advanced and PISA. Butler (2016)explained that many teachers avoid to giving students more freedom to solve problems in their way, as this requires the teacher to be able to recognize the correct solution that needs a higher content knowledge level. Some of the best way to promote students' achievement is per mathematical understandings, and enhancing their pedagogical practices that give students control over their learning, and carrying out research on the science of motivation.

Some students just memorize mathematics materials such as theorems, formulas, methods and shortcuts, so they have a superficial understanding of mathematics concepts. It is clear that this group of students faces some difficulties with small changes in mathematics exercises, and they fail to solve mathematics problems. So they have apprehension, anxiety and low motivation in mathematics learning and problem-solving. Their beliefs and ideas about mathematics subject are "mathematics is a hard subject and difficult to learn" (Mutawah, 2015). Many of educational researchers in the world try to find new ways of teaching, linking concept and real-life applications and motivating the students to take more interest in the subject to overcome mathematics phobia and anxiety (Hemmings et al., 2011). In the early 21st century, numerous researches have been conducted about lesson study (LS) in different countries, and some countries started this model in their education systems to enhance teachers' professional development. For example, LS was introduced among mathematics teachers in the United States since 2004 (Meyer, 2005), in Indonesia from 2005 (Harsono, 2016) and in Malaysia since 2011 (Zanaton & Marziah, 2017).

The purpose of this study is to investigate the impact of implementing LS approach on motivation in mathematics and mathematics achievement among foundation level students. In fact, mathematics lecturers collaboratively planned to use suitable mathematics problems, practical problems and share their knowledge and experience with students through employing interesting materials and transferring methods to motivate and encourage them in mathematics learning. Participating in class activities individually or in the form of teamwork helps students discover new methods of problem-solving skills in mathematics. This method helps them have a better perspective on their abilities in mathematics and improve their motivation in mathematics learning.

B. Literature Review

1. Motivation in Mathematics

Motivation in this study is based on prominent theories; Self-determination (Ryan & Deci, 2000), achievement goal orientations (Elliot & Church, 1997), and self-efficacy or expectancy-value (Bandura, 1986). These three theories included motivation as an internal impetus within students and encourage them to engage in a task. Intrinsic motivation and extrinsic motivation are two terms that used in self-determination theory, discuss how autonomy, relatedness, and competence can move students towards the intrinsic end of a motivation continuum. The students' mastery and performance orientations as being influential to academic achievement described in achievement goal theory. Self-efficacy describes how students' beliefs in their competency within a domain affect their engagement within that domain.

The expectancy-value theory is among the earliest theories about motivation. However, it is rooted in behaviorism. It has evolved into a theory of an expectation of success versus task value (Wigfield & Eccles, 2000). Achievement goal structures refer to relationships between curricular or pedagogical practices that encourage mastery or performance orientations in students. The goals emphasized in educational tasks affect how students approach the situation and these goal structures affect the quality of students' engagement with the task (Kaplan et al., 2002). In achievement structures, tasks have causal relationships with an agent's internal motivation (Anderman et al., 1996). The goal structures of a task affect students' motivations to engage in the task. There is a relationship between an agent's personal goal orientations and the goal structures inherent in the task. The relationships between an agent and a motivational structure are motivational relationships, and a relationship is motivational if it encourages motivation in an agent. Operationally, a relationship is considered motivational if it has a direct effect on motivation or engagement.

If a person tends to engage in mathematics when the opportunity presents itself, then the person understands to have motivation for mathematics. Operationally, a person has motivation for mathematics if he or she has high scores on an instrument, which has some evidence for validity, intended to measure motivation for mathematics.

2. Mathematics Problem Solving

National Council of Teachers of Mathematics (NCTM) (2000) defined a mathematics task is called mathematics problem if students engage with task for the first time and this question is challengeable on the other hand this task is called mathematics exercise. Therefore, mathematics problem-solving refers to engagement in a task that students have not learned to solve so far. Thus the border between mathematics problem and mathematics exercise depends on many factors such as country, education system, level of students' abilities, mathematics module (or mathematics textbook) and time. For instance, the following mathematics problem after discussing and explaining the solution method in the class becomes a mathematics exercise.

Problem: How many functions can we define from $A = \{1, 2, 3, 4\}$ to $B = \{5, 6, 7\}$?

If lecturers consider a little change in this mathematics exercise, students engage in another mathematics problem such as:

Problem: How many one-to-one functions can we define from $A = \{1, 2, 3, 4\}$ to $B = \{5, 6, 7, 8\}$?

Nowadays, mathematics teaching and learning are strongly related to problem-solving skills. Therefore, educators need a high level of problem-solving skills, content knowledge and pedagogical content knowledge. On the other hand, educators cannot enhance students' abilities in learning mathematics deeply. Because through the traditional method, educators emphasize mathematics exercises and students just memorize some methods, formulas, shortcuts, theorems and solutions superficially. Consequently, they do not be able to solve mathematics problems. They believe that mathematics is so hard subject and they cannot learn it. This trust is the start of some psychological problems among students about learning mathematics, such as low motivation in learning mathematics. In the foundation level, students should have suitable problem-solving skills because of the number of complex topics and complex problems. The suitable method of teaching is so essential for lecturers to encourage students in learning mathematics deeply through problem-solving and higher-order thinking. Hence, the researcher has selected the following model of mathematics problem solving:

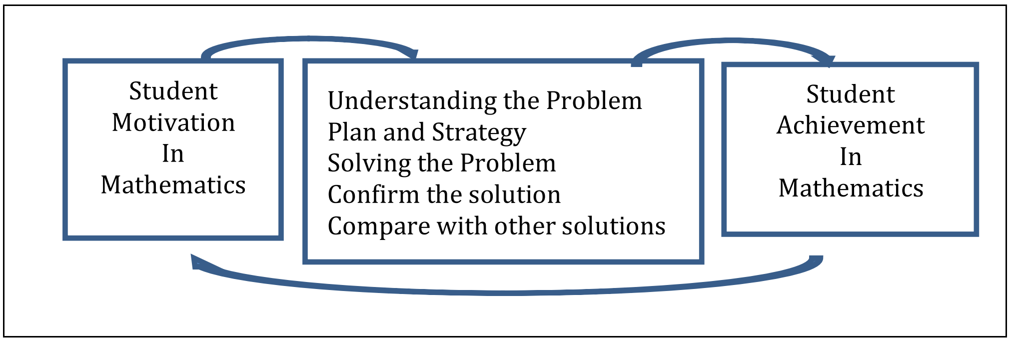

Figure 1.A Conceptual Model of Mathematics Problem-solving for this Study

3. Lesson Study

Two Japanese words "*Jugyo*" and "*Kenkyu*" mean lesson and study (or research) respectively thus the term "*JugyoKenkyu*" translated into LS byMakoto Yoshida in his doctoral dissertation in 1999 (Doig & Groves, 2011; Kazemi et al., 2014; Marsigit et al., 2019). This educational method was started a long time ago since the 1950s in Japan as a model for teachers' professional development (Abiko, 2011). Since 1999, a lot of educators and researchers integrated and employed this Japanese LS approach in their education systems and many countries such as United States, United Kingdom and Singapore started this approach as a model for teachers' professional development.

In 2011, LS was formally introduced to the Malaysian education system by the Ministry of Education through the Professional Learning Community (PLC) (Zanaton & Marziah, 2017). Matanluk et al. (2013) explained that LS was carried out in 42 secondary schools to improve the quality of teaching in 2011. However, there is no research that represents the impact of LSon mathematics motivation and achievement among foundation level students.

Japanese LS is a student-centred method and students learn mathematics through problem-solving based on cognitivist learning theory. In the past two decades, mathematics researchers and educators focus on the learning mathematics by problem-solving but before they believed that students need to learn mathematics materials such as definitions, formulas and theorems in order to solve mathematics problems. The aim of LS by using problem-solving method is to enhance students' understanding of mathematical concepts and skills. A teacher is expected to facilitate mathematical discussion for students to achieve this goal (Doig & Groves, 2011; Takahashi, 2006).

LS is a new approach in education that a group of educators collaboratively work on a mathematics topic and spend much time, plan a lesson, teach or/and observe the lesson and reflect and discuss on the taught lesson to improve student's achievement in mathematics learning and mathematics problem-solving by effective teaching (Matanluk et al., 2013). These lessons are called research lessons (Fujii, 2016).In 2014, Fujii defined model of LS, which contains five phases as follows:

a. Goal Setting: In this phase, mathematics teachers focus on long-term goals in order to improve students' learning, problem-solving skills and achievement.
b. Lesson Planning: Mathematics teachers collaboratively design a Research Lesson with suitable materials to improve students' abilities such as student's problem-solving and higher order thinking skills.
c. Research Lesson: After preparing the Research Lesson, a member of LS group teaches the Research Lesson and other members observe and collect data in order to improve it.
d. Post-lesson Discussion: Through post-lesson discussion, mathematics teachers consider students' learning, students' misunderstandings, and different solutions for problems to enrich the Research Lesson.
e. Reflection: Mathematics teachers discuss the new questions and the Research Lesson then they collaboratively plan to solve these problems in the next cycle of LS. Also, in this phase, mathematics teachers prepare a report about the Research Lesson.

The processes of the LS approach, as illustrated in Figure 2.

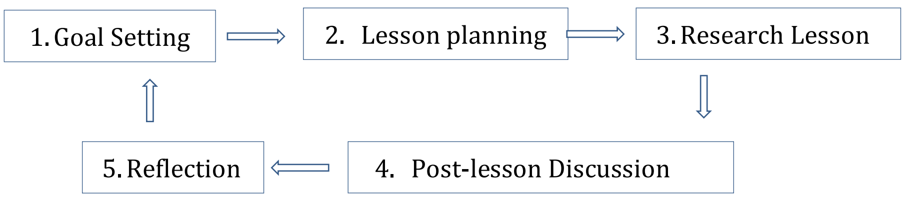

Figure 2. The Process of LS(Fujii, 2016)

C. Methodology

1. Research Design

This quasi-experimental research was conducted in a foundation center of a public university in Selangor, Malaysia in 2018-19. LS group consists of eight lecturers (seven mathematics lecturers and a physic lecturer), and the researcher and total of 86 students in the experimental group (44 students) and control group (42 students) have participated in this study. The measurement tools for this study were the mathematics motivation test (Butler, 2016) and two lecturers developed mathematics achievement tests.

The members of LS group collaboratively planned, designed and discussed to prepare five Research Lessons about the mathematics functions. A lecturer chose randomly and his classes as experimental and control groups. LS approach and the traditional method was employed for teaching mathematics functions for five weeks for experimental and control groups, respectively. In an experimental group, the lecturer taught the Research Lessons that contain suitable mathematics problems, practical problems and appropriate transferring method in order to improve students' abilities, motivation and interest in learning mathematics. Therefore, in LS group, the class was student-centered, and students worked on mathematics problems solving individually and teamwork, meanwhile the lecturer walked around the class in order to help, encourage, motivate and assess them. In the control group, the class was lecturer-centered, and the lecturer taught precisely the same topics by the traditional method and emphasized on exercise solving. Furthermore, there was no manipulation for control group from the LS group.

2. Instruments

Motivation test includes 16 items developed by Butler in 2016. In this instrument, the first four items are intrinsic motivation as per self-determination theory, the next four items are mastery orientation according to achievement goal theory, the next four items are performance orientation in line with achievement goal theory, and the last four items are expectancy as per expectancy-value theory. This instrument is a 5-point Likert type scale, ranging 1 (not at all true), 2 (not true), 3 (somewhat true), 4 (true) and 5 (very true), the minimum and maximum scores are 16 and 80 respectively. All items are positive, and high score indicated high mathematics motivation. The examples of this instrument are "I would describe mathematics as exciting subject" and "I had felt successful in my mathematics courses when I did better than the other students".

Besides, two lecturers developed tests which were used as a pre-test and a post-test. Meanwhile, the post-test was conducted one month after completing the study as a follow-up test. Each test contains 12 open-ended questions. Students' answers were scored by Polya' model (1945) of problem-solving if the student doesn't understand the problem (illogical and incorrect answer) or no answer, the problem scored 0, if some steps in the solution show a student understands the problem he/she is scored 1 (first step of Polya's model). If a student understands and designs a method for a solution including some errors, he/she is scored 2 (first and second steps of Polya's model). Finally, the completely correct answer is scored 3 (all steps of Polya's model). Consequently, the minimum and maximum scores for tests with 12 items are 0 and 36. Two correctors scored each student's sheet. If there was no difference between their marks, the researcher recorded the marks; otherwise, the final mark for each student calculated according to the following rule. Assume that first and second lecturers considered two marks a and b for a student respectively, the final mark (m) for this student was, $m = \left[\frac{a+b+1}{2}\right]$, where [ ] is the symbol of an integral part. For instance, for two scores 18 and 20, the final mark calculated as $\left\lceil\frac{18+20+1}{2}\right\rceil = \lceil 19.5\rceil = 19$. The examples are "$f = \{(2,3),\ (2, a+2b),\ (-1,6),\ (4,5),\ (4,7-2a)\}$ is a function. Find the value of b" and "If $g(x) = sinx + cosx$ without using the calculator, find the value of $g(\frac{\pi}{12})$".

Although in this foundation center, the language of instruction is English and all textbooks are in English the researcher translated these instruments back to back in Bahasa Melayu (Malaysian Language) by two experts in English language studies in a Malaysian public university. The final version of the motivation test was confirmed by two experts in mathematics education and an educational psychologist to ensure there is no problem in the translation. The researcher sent a permission letter to the author of this questionnaire, principal of foundation center, lecturers and students who were a part of this study. The validity of motivation instrument was confirmed by an educational psychologist, three experts in mathematics education and mathematics from a public university in Malaysia. Also, for reliability, this instrument piloted with 30 students. The Cronbach's Alpha was 0.926 for motivation test, 0.947 for intrinsic motivation (first four items), 0.867 for mastery orientation (second four items), 0.859 for performance orientation (third four items) and 0.906 for expectancy (last four items). Moreover, the lecturers developed seven experts confirmed mathematics tests in mathematics and mathematics education, and the reliability of these tests was proved by Cronbach's Alpha at 0.72 for pre-test with 31 participants and 0.80 for post-test with 40 participants. Meanwhile, these instruments confirmed by some experts who worked in RMC in a Malaysian public university.

3. The technique of Data Analysis

The motivation test and mathematics tests were administered at the beginning and the end of the study in order to compare the mathematics motivation and mathematics achievement among students between LS and traditional approaches. Data were analyzed using independent t-test, ANOVA test, MANOVA test and non-parametric The Kruskal-Wallis test.

D. Findings and Discussion

1. Findings

The findings of this research are discussed in four sections mathematics achievement, mathematics achievement by gender, mathematics motivation and mathematics motivation by gender.

Mathematics Achievement

Table 1 shows the normality of mathematics scores in the pre-test, post-test and follow-up test since the p-values are higher than 0.05.

Table 1 The Normality of Mathematics Scores

Group	Test	Skewness	Kurtosis	Kolmogorov-Smirnov		
				Statistic	df	Sig
Experimental	Pre-test	0.008	-0.895	0.120	44	0.115
	Post-test	-0.516	0.685	0.102	44	0.200
	Follow-up	-0.198	-0.892	0.119	44	0.135
Control	Pre-test	-0.224	0.714	0.100	42	0.200
	Post-test	-0.196	-0.342	0.107	42	0.200
	Follow-up	0.318	0.379	0.093	42	0.200

The result of independent sample t-test in Table 2 shows that there is no significant mean difference between experimental group (M = 18.22, SD = 3.99) and control group (M = 19.83, SD = 5.08) in pre-test t(84) = -1.632, p = 0.106.

Table 2 Comparing the Mean of Mathematics Scores in Pre-test

Group	Number	Mean	Standard Deviation	t	df	Sig
Experimental	44	18.22	3.99	-1.632	84	0.106
Control	42	19.83	5.08			

The independent sample t-test was used to compare the mean of mathematics scores between experimental and control group in post-test and follow-up test. The result revealed that there was significant mean difference between experimental group (M = 24.02, SD = 4.64) and control group (M = 19.07, SD = 3.92) in post-test t (84) = 5.326, p = 0.000. Also, there was significant mean difference between experimental group (M=23.52, SD=3.75) and control group (M = 19.28 SD = 3.92) in follow-up test t (84) = 5.117, p = 0.000 as shown in Table 3.

Table 3 Comparing the Mean of Mathematics Scores in Post-test and Follow-up Test

Test	Group	Number	Mean	Standard Deviation	t	df	Sig
Post-test	Experimental	44	24.02	4.64	5.326	84	0.000
	Control	42	19.07	3.92			
Follow-up	Experimental	44	23.52	3.75	5.117	84	0.000
	Control	42	19.28	3.92			

The results represented that LS improved the abilities of students in problem-solving and learning mathematics but there was not any improvements in problem-solving among students in traditional group.

Mathematics Achievement by Gender

The homogeneity of variances was showed in Table 4 and all p-values are greater than 0.05.

Table 4 Levene's Test for Homogeneity of Variances

Test	Levene statistics	df1	df2	Sig
Pre-test	4.522	3	82	0.060
Post-test	0.800	3	82	0.498
Follow-up test	1.260	3	82	0.294

The result of two-way ANOVA test about pre-test was shown in Table 5.

Table 5 Test of Between Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	58.301	3	19.434	0.913	0.438	0.032
Intercept	28053.960	1	28053.960	1318.531	0.000	0.941
Group	51.153	1	51.153	2.404	0.125	0.028
Gender	2.674	1	2.674	0.126	0.724	0.002
Group∗Gender	0.140	1	0.140	0.007	0.936	0.000
Error	1744.688	82	21.277			
Total	32887.000	86				
Corrected Total	1802.988	85				

Table 5 illustrates that there is no statistically significant interaction between the effects of educational method and gender on mathematics scores $F(1, 82) = 0.007, p = 0.936$. Two-way MANOVA test was conducted to show the interaction between the effects of educational method and gender on the scores of mathematics in post-test and follow-up test. Box's test of equality of covariance matrices was shown in Table 6.

Table 6 Box's Test of Equality of Covariance Matrices

Box's M	F	df1	df2	Sig
16.800	1.774	9	25437.196	0.068

In Table 6, the assumption of equality of covariance was met because $p = 0.068, p > 0.05$. Table 7 shows the multivariate tests.

Table 7 Multivariate Tests

Effect	Test	Value	F	Hypothesis df	Error df	Sig	Partial Eta Squared
Intercept	Wilks' Lambda	0.032	1206.939	2.000	81.000	0.000	0.968
Group	Wilks' Lambda	0.749	13.556	2.000	81.000	0.000	0.251
Gender	Wilks' Lambda	0.873	5.915	2.000	81.000	0.004	0.127
Group∗Gender	Wilks' Lambda	0.981	0.769	2.000	81.000	0.467	0.019

The result of Table 7 represented that there is no statistically significant interaction effect between type of educational method and gender on the mathematics scores in post-test and follow-up test, $F(2, 81) = 0.769, p = 0.467$; Wilks' Λ = 0.981.

Mathematics Motivation

Table 8 shows the normality of motivation scores in pre-test and post-test since the p-values are greater than 0.05.

Table 8 Normality Test for Scores

Group	Test	Skewness	Kurtosis	Kolmogorov-Smirnov		
				Statistic	df	Sig
Experimental	Pre-test	-0.424	-0.223	0.130	44	0.058
	Post-test	-0.517	-0.319	0.138	44	0.055
Control	Pre-test	-0.416	-0.633	0.117	42	0.166
	Post-test	-0.951	0.980	0.124	42	0.101

The result of independent t-test between experimental and control groups in pre-test is shown in Table 9. There was no significant mean difference between the mean scores of students in mathematics motivation in experimental (M = 61.20, SD = 8.40) and control (M = 61.52, SD = 8.71) groups, t(84) = -0.173, p = 0.863.

Table 9 Comparing the Means of Motivation Scores in Pre-test

Group	Number	Mean	Standard Deviation	t	df	Sig
Experimental	44	61.20	8.40	-0.173	84	0.863
Control	42	61.52	8.71			

The result of independent t-test between experimental and control groups in post-test was shown in Table 10. There was significant mean difference between the mean scores of students in mathematics motivation in experimental (M = 66.97, SD = 7.44) and control (M = 61.21, SD = 11.42) groups, $t(84) = 2.784, p = 0.007$. In the other words, LS approach increased the level of motivation in mathematics among students rather than the traditional method.

Table 10 Comparing the Means of Motivation Scores in Post-test

Group	Number	Mean	Standard Deviation	T	df	Sig
Experimental	44	66.97	7.44	2.784	84	0.007
Control	42	61.21	11.42			

Four subscales of intrinsic motivation, mastery orientation, performance orientation and expectancy in pre-test were compared between experimental and control groups through running independent t-test and results were shown in Table 11.

Table 11 The Comparison of Subscales between Two Groups in Pre-test

Scale	Group	No	Mean	SD	t	df	Sig
Intrinsic Motivation	Experimental	44	15.97	3.15	-0.292	84	0.771
	Control	42	16.16	2.84			
Mastery Orientation	Experimental	44	17.04	2.69	0.610	84	0.543
	Control	42	15.69	2.70			
Performance Orientation	Experimental	44	12.93	3.90	-0.394	84	0.695
	Control	42	13.23	3.25			
Expectancy	Experimental	44	15.25	2.49	-0.293	84	0.770
	Control	42	15.42	3.13			

In Table 11, the value of p ($p > 0.05$) show that there were no significant mean differences between experimental and control groups in any of subscales at 0.05 level of significance at the beginning of the study. Also, four subscales of intrinsic motivation, mastery orientation, performance orientation and expectancy in post-test were compared between experimental and control groups through running independent t-test and results were shown in Table 12.

Table 12 The Comparison of Subscales between Two Groups in Post-test

Scale	Group	No	Mean	SD	t	df	Sig
Intrinsic Motivation	Experimental	44	17.25	2.32	2.411	84	0.018
	Control	42	15.69	3.57			
Mastery Orientation	Experimental	44	17.45	2.56	1.688	84	0.095
	Control	42	16.35	3.42			
Performance Orientation	Experimental	44	15.25	3.47	2.239	84	0.028
	Control	42	13.59	3.37			
Expectancy	Experimental	44	17.02	2.16	2.536	84	0.013
	Control	42	15.57	3.08			

According to the Table 12, there was significant mean difference in intrinsic motivation between experimental (M = 17.25, SD = 2.32) and control (M = 15.69, SD = 3.57) groups, t (84)=2.411, p = 0.018. There was significant mean difference in performance orientation between experimental (M = 15.25, SD = 3.47) and control (M = 13.59, SD = 3.37) groups, t (84) = 2.239, p = 0.028. Also, there is significant mean difference in expectancy between experimental (M = 17.02, SD = 2.16) and control (M = 15.57, SD = 3.08) groups, t (84) = 2.239, p = 0.013. But there is no significant mean difference between these two groups in mastery orientation t (84) = 1.688, p = 0.095.

Mathematics Motivation by Gender

Since the assumptions of parametric tests are not met, the non-parametric The Kruskal-Wallis test was used to compare the mathematics motivation scores of students between experimental and control groups by gender. Table 13 shows the results of the Kruskal-Wallis test for motivation scores in pre-test by gender.

Table 13 The Results of the Kruskal-Wallis Test for Motivation Scores in Pre-test

Mean Rank					
LS Male	**LS Female**	**Control Male**	**Control Female**	**Chi-square**	**Sig**
37.94	46.46	45.43	42.75	1.30	0.729

In Table 13, $p = 0.729$, $p > 0.05$; thus, the level of motivation is not different among groups by gender. Table 14 shows the results of the Kruskal-Wallis test in post-test by gender.

Table 14 The Results of the Kruskal-Wallis Test in Post-test by Gender

	Mean Rank					
Scale	**LS Male**	**LS Female**	**Control Male**	**Control Female**	**Chi-square**	**Sig**
Motivation (Post-test)	49.79	50.57	44.57	32.50	8.636	0.035
Intrinsic Motivation	49.41	49.21	43.36	34.48	6.210	0.102
Mastery Orientation	40.41	50.89	45.46	36.89	4.886	0.180
Performance Orientation	49.00	50.11	39.89	35.55	5.910	0.116
Expectancy	52.28	47.80	42.25	34.80	6.371	0.095

As respect to Table 14, the level of motivation is different among groups by gender $p = 0.035$, $p < 0.05$. Mean ranks show that the level of motivation in the experimental group is higher than the control group. It means that female students in the experimental group had the highest motivation (MR = 50.57) and female students in the control group had the lowest motivation in mathematics (MR = 32.50). Furthermore, the levels of intrinsic motivation, mastery orientation, performance orientation and expectancy are not different among groups by gender ($p > 0.05$).

2. Discussion

The results of this study show LS improved the abilities of students in problem-solving as well as their motivation in mathematics. There was a significant mean difference between experimental and control groups in subscales intrinsic motivation, performance orientation and expectancy. However, there was no significant mean difference between two groups in mastery orientation. Most of the educators did not consider the motivational beliefs of their students (Middleton, 1995). The lecturer developed a friendly relationship with students and tried to engage students in immediate problem-solving activities individually and in teams to solve the tasks through different ways and explained their method of solutions to other students. Meanwhile, the lecturer was walking around the class and guiding, helping and assessing the students based on the individual differences. This method of teaching was enjoyable for students because they experienced the beauty of mathematics through conceptually learning instead of memorization method, thus their level of intrinsic motivation enhanced. Plass et al. (2013) explained that competition improves achievement among students, and both competition and collaboration enhance student's interest, enjoyment, and adoption of mastery orientations. In this study, there was no significant mean difference between experimental and control groups in mastery orientation subscale it seems students need more time to adapt themselves to the problem-solving method.

According to Anderson (2011), performance orientation was positively related to student-centered instruction. "Learning Structures were supported by focusing on process and explanation instead of quick responses and single-answer questions, allowing creative expression, encouraging students to develop new strategies, and making mathematics related to experience" (Butler, 2016, p.42). Performance goal structures were supported by encouraging students to follow mathematics and learn it conceptually so they can have better career choices and, reward students for completing advanced mathematics tasks (Anderson, 2011). In this research, students in experimental group improved in terms of performance orientation because their class was student-centered and they engaged in many problem-solving activities to improve their skills in problem solving. Furthermore, there was a significant mean difference between two groups in the expectancy subscale. Tolman (1932), explained expectancy as an agent's expectation of success when performing a task with the expectation as a motivating factor. According to Wigfield and Eccles (2000), expectation for success is directly related to mathematics achievement. Therefore, the reason for students' improvement in expectancy subscale was related to their improvement in mathematics problem solving.

The LS approach improved students' skills in problem-solving through actively engaging them in suitable problems, practical problems and fun concepts. Therefore, they had higher self-confidence in their abilities in learning mathematics. Thus, students in experimental group enhanced their motivation in mathematics especially the lecturer in experimental group had suitable content knowledge and pedagogical content knowledge through working collaboratively with other lecturers (He knew how to encourage, motivate and assess students in their activities) rather than the lecturer who copied notes through traditional method.

Teaching method plays an important role in mathematics teaching and learning. In fact, there is a close relationship between teaching method and some components such as content knowledge, time management, lecturers' module, students' assessment and students' activities. When a lecturer uses a new method of teaching, he needs to change and improve the quality of his teaching in all components. Therefore, an appropriate method of professional development can enhance lecturers' content knowledge and pedagogical content knowledge. Mathematics educators with a high level of content knowledge and pedagogical content knowledge can encourage and motivate students in problem-solving not only to let students experience the beauties of mathematics but also to teach mathematics meaningfully through problem solving. Meanwhile, students can improve their abilities to solve numerous real problems in their real-life situations. Considering some puzzles and funs in Research Lessons can change the students' beliefs to love mathematics. For instance, the following examples which are discussed in experimental class are suitable to improve the level of motivation among foundation students.

Example 1: (Practical Problem): to convert Fahrenheit to Celsius $f(F) = \frac{5}{9}(F - 32)$. Show the inverse function (Celsius back to Fahrenheit) is $f^{-1}(C) = \frac{9}{5}C + 32$.

Example 2: (fun about exponential function): What is wrong in the following statement?

$$-1 = (-1)^1 = (-1)^{\frac{2}{2}} = (-1)^{2\times\frac{1}{2}} = ((-1)^2)^{\frac{1}{2}} = (1)^{\frac{1}{2}} = \sqrt{1} = 1 \to -1 = 1$$

Example 3: (fun about logarithmic function): In the relation $A = -\log_2 \log_2 \sqrt{\vdots\sqrt{\sqrt{2}}}$ increase or decrease the number of radicals. What happen for the value of A? (The value of A is equals to the number of radicals in the other words all the natural numbers generate by this formula).

Example 1 shows the application of function and inverse function in human life. This kind of examples is suitable to discuss in mathematics classes in order to make students believe in mathematics application in real life. Furthermore, fun concepts such as Example 2 and Example 3 not only are fun for students but also transfer some concepts interestingly to students and motivate them to learn something new in mathematics.

Reeve and Jang (2006) found that two factors providing solutions and answers and making statements about how mathematics problems should be solved to be negatively correlated with perceived autonomy and motivation in learning mathematics among students. These factors are common problems in traditional method among some educators that their students cannot improve their abilities, skills and creativity in problem solving. For example, in this foundation center, lecturers emphasize on inverse function method $(f(f^{-1}(x)) = x)$ and the graph of the function to find the range of functions. Therefore, students cannot think about different and interesting methods to find the range of some functions. Meanwhile, the inverse function method has an assumption (the function should be one-to-one). Hence, students use the graph of functions to find the range of them (because these functions are not one-to-one), but the majority of students have difficulty withdrawing the graph of functions. Additionally, there are different methods and solutions that students can use to find the range of functions through proper ways. For instance, the ranges of the three functions are discussed as follows:

a. $f(x) = 4x^2 - 4x + 2 \to y = (2x-1)^2 + 1 \to y - 1 = (2x-1)^2 \geq 0 \to y \geq 1 \to R_f = [1, +\infty[$

b. $g(x) = 1 + 2sin^2x \to -1 \leq \sin x \leq 1 \to 0 \leq sin^2x \leq 1 \to 0 \leq 2sin^2x \leq 2 \to 1 \leq 1 + 2sin^2x \leq 3 \to R_g = [1,3]$

c. $h(x) = \frac{x^2}{1+x^2} \to 0 \leq x^2 < 1 + x^2 \to \frac{0}{1+x^2} \leq \frac{x^2}{1+x^2} < \frac{1+x^2}{1+x^2} \to 0 \leq \frac{x^2}{1+x^2} < 1 \to R_h = [0,1[$ or

$$y = \frac{x^2}{1+x^2} \to y + yx^2 = x^2 \to \frac{y}{1-y} = x^2 \geq 0 \to \frac{y}{1-y} \geq 0 \to 0 \leq y < 1 \to R_h = [0,1[$$

When educators make the range of limitations for the method of solutions or educators introduce a specific method for the solution and provide many examples for students to follow the educator's steps and procedures. Students cannot experience the beauty of mathematics through practical techniques and creative solutions. Therefore, in the foundation level, lecturers need to improve their pedagogical content knowledge in order to encourage, motivate and support their students to solve mathematics problems through their methods. This attitude to mathematics teaching increases the motivation of students in learning mathematics. According to Kusukar, Croiset, and Ten Cate (2013), there is a correlation between student motivation and performance. This means that if teachers want students to perform at a higher level academically, they must find ways to motivate the students. The students need a reason to want to learn. Motivation in mathematics is an important factor in learning mathematics through problem-solving method.

E. Conclusions

The results of this study show there was no significant mean difference between the experimental and the control groups in mathematics achievement and any subscales; intrinsic motivation, mastery orientation, performance orientation and expectancy by gender. The reason was related to the policy of foundation centers, in which students with high grades in mathematics registered and the level of students in mathematics learning were approximately the same, and there was no significant difference in learning mathematics and motivation in mathematics. Butler (2016) described that female students had lower perceived competence in mathematics than male students; however, their mathematics achievement was higher because of their hard-working. Although the social and biological difference between gender affects gender differences which associated with mathematics achievement and motivation in mathematics in this study, some reasons such as equal basic knowledge by gender, sensitively of female students about the grades and their hard-working contribute to this result that there was no significant mean difference in mathematics achievement and motivation by gender.

It is concluded that a suitable method of teaching such as LS can improve the ability of students in problem solving. They are motivated to learn mathematics conceptually through understanding the theory behind the concepts instead of memorizing method and learning superficially. Therefore, students spend more time on solving the problems. These processes increase the power of students in problem-solving and make them believe in beauties of mathematics which enhance their motivation to learn it.

F. References

Abiko, T. (2011). A response from Japan to LRP's ten principles for effective pedagogy. *Research Papers in Education*, *26(3)*, 357–365.

Anderman, E. M., Maehr, M. L., & Midgley, C. (1996). Declining motivation after the transition to middle school: Schools can make a difference. Unpublished manuscript, University of Kentucky, Lexington. *Journal of Research & Development in Education*. https://psycnet.apa.org/record/1999-05484-001

Anderson, K. J. (2011). Science education and test-based accountability: Reviewing their relationship and exploring implications for future policy. *Science Education*, *96*, 104–129.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Boaler, J., & Zoido, P. (2016). Why math education in the U.S. does not add up. *Sci. Am. Mind*, *27*, 18–19. https://doi.org/doi: 10.1038/scientificamericanmind1116-18

Butler, K. L. (2016). *Motivation for Mathematics: The Development and Initial Validation of an Abbreviated Instrument*. University of South Florida, United States.

Doig, B., & Groves, G. (2011). Japanese Lesson Study: Teacher Professional Development through

Communities of Inquiry. *Mathematics Teacher Education and Development*, *13*(1), 77–93.

Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology*, *72*, 218–232.

Fujii, T. (2016). Designing and adapting tasks in lesson planning: a critical process of Lesson Study. *ZDM - Mathematics Education*, *48*(4), 411–423.

Harsono, M. (2016). *The Impact of Lesson Study on Primary School Teacher's knowledge and Skills in Differentiating Primary School Mathematics Instruction: A Digital Mixed Methods Approach*. Unpublished doctoral dissertation, Curtin University, Australia.

Hemmings, B., Grootenbore, P., & Kay, R. (2011). Predicting mathematics achievement: The influence of prior achievement and attitudes. *International Journal of Science and Mathematics Education*, *9*(3), 691–705.

Kaplan, A., Middleton, M. J., Urdan, T., & Midgley, C. (2002). Achievement goals and goal structures. *Goals, Goal Structures, and Patterns of Adaptive Learning*, 21–53.

Kazemi, F., Zaman, A., & Ghafar, A. (2014). *Localizing Lesson Study for the Math Teachers ' Professional Development, Necessities and Prohibitions*. *4*(9S), 504–508.

Kusukar, R., Croiset, G., & Ten Cate, O. (2013). Implications of gender differences in motivation among medical students. *Medical Teacher*, *35*(2), 173–174.

Lai, E. R. (2011). Motivation: A Literature Review. *Research Report*. https://doi.org/https://images.pearsonassessments.com/images/tmrs/Motivation_Review_final.pdf

Marsigit, M., Retnawati, H., Sugiman, S., & Ningrum, R. K. (2019). Teachers' readiness in implementing lesson study. *Journal of Physics: Conference Series*, *1320*(1), 012079. https://doi.org/10.1088/1742-6596/1320/1/012079

Matanluk, K., Johari, K., & Matanluk, O. (2013). The Perception of Teachers and Students toward Lesson Study Implementation at Rural School of Sabah: A Pilot Study. *Procedia - Social and Behavioral Sciences*, *90*, 245–250.

Mekarina, M., & Ningsih, Y. P. (2017). The Effects of Brain Based Learning Approach on Motivation and Students Achievement in Mathematics Learning. *Journal of Physics: Conference Series*, *895*, 1–6.

Meyer, R. D. (2005). *Lesson Study: The Effects on Teachers and Students in Urban Middle Schools*. Baylor University, United States.

Middleton, J. A. (1995). A Study of Intrinsic Motivation in the Mathematics Classroom: A Personal Constructs Approach. *Journal for Research in Mathematics Education*, *26*(3), 254–279.

Mutawah, M. A. A. (2015). The Influence of Mathematics Anxiety in Middle and High School Students Math Achievement. *International Education Studies*, *8*(11), 239–252.

National Council of Teachers of Mathematics (NCTM). (2000). *Executive summary - Principals and standards for school mathematics*. 1–6.

Pantziara, M., & Philippou, G. N. (2015). Students' motivation in the mathematics classroom. Revealing causes and consequences. *International Journal of Science and Mathematics Education*, *13*(2), 385–411.

Plass, J., O'Keefe, P., Homer, B., Case, J., Hayward, E., Stein, M., & Perlin, K. (2013). The impact of individual, competitive, and collaborative mathematics game play on learning, performance, and motivation. *Journal of Educational Psychology*, *105*, 1050–1066.

Polya, G. (1945). How to solve it; a new aspect of mathematical method. Princeton. *NJ: Princeton University Press*.

Reeve, J., & Jang, H. (2006). What teachers say and do to support students' autonomy during a learning activity. *Journal of Educational Psychology*, *98*(1), 209–218.

Ricks, T. E. (2010). Mathematics Is Motivating. *The Mathematics Educator*, *19*(2), 2–9.

Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*, 68–78.

Sengodan, V., & Iksan, Z. H. (2012). Students' learning styles and intrinsic motivation in learning mathematics. *Asian Social Science*, *8*(16), 17–23.

Takahashi, A. (2006). Characteristics of Japanese Mathematics Lessons. *Tsukuba Journal of Educational Study in Mathematics*, *25*(1), 37–44.

TIMSS. (2015). *Trends in international mathematics and science study, International Associations for the Evaluation of Educational Achievement*.

Tolman, E. C. (1932). *Purposive behaviour in animals and men*. New York: Century.

Wang, C. K. J., Liu, W. C., Nie, Y., Chye, Y. L. S., Lim, B. S. C., Liem, G. A., Tay, E. G., Hong, Y. Y., & Chiu, C. Y. (2017). *Latent profile analysis of students' motivation and outcomes in mathematics: an organismic integration theory perspective*. 1–18.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68–81.

Williams, K., & Williams, C. (2011). Five key ingredients for improving motivation. *Research in Higher Education Journal*, *11*, 1–23.

Wise, S. L., & DeMars, C. E. (2005). Low examinee effort in low-stakes assessment: Problems and potential solutions. *Educational Assessment*, *10*, 1–17.

Zanaton, I., & Marziah, R. (2017). Reflections on teaching and learning of mathematics through lesson study and video critique. *Advances in Social Sciences Rsearch Journal*, *4*(1), 50–61.