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The Effectiveness of Excellence Camp: A Study on Paired Sample

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Abstract

Problem solving is one of the important aspects in mathematics problem solving. Strengthening the basic knowledge and understanding the problem can guide the students to become better problem solver. The Mathematics Excellence Camp was conducted to recap the basic knowledge and expose the students to the problem-based learning. The study focused on the effectiveness of educational camp in improving students' understanding in Mathematics. The camp was targeted on the repeaters of pre-Calculus students. Each day, the students were given the pre- test before the lesson began and post- test after the lesson ended. The study is statistically conducted indirectly to investigate the effectiveness of the program. The different mean values for pre-test and post-test were tested, and the hypothesis testing using paired sample t-test was used. . The results of the study are expected to have higher mean value for post-test than pre-test.

*Keywords:*Mathematics Camp; paired sample; problem solving; problem-based learning; mathematics performance

1. Introduction

In UiTM Johor, there are two programs offered by Faculty of Computer & Mathematical Sciences namely Diploma in Computer Science (CS110) and Diploma in Mathematic Science (CS143). Furthermore, a total of eight mathematics courses offered to CS110 and CS143 students. For the past semesters, the failure rate of mathematics

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subjects was in the worrying stages. Figure 1 shows the failure rate of eight mathematic courses of both programs for semester June – October 2014. It seems that the mathematics subjects are always the main contributors of high failure rate as compared to other courses.
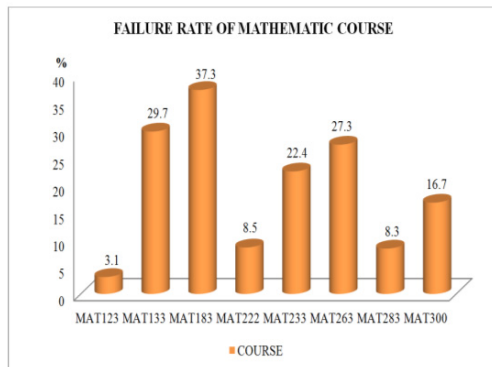

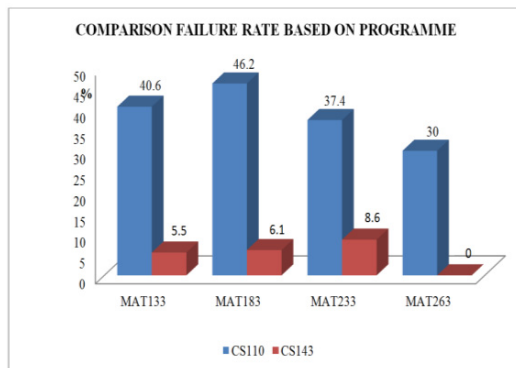Figure 1: Failure Rate of Mathematic Course

Figure 2: Comparison Failure rate Based on Programme

Among the eight subjects, there are four common subjects for both programs which are: MAT133, MAT183, MAT233 and MAT263. Three of the subjects, MAT133, MAT183 and MAT233 are prerequisite to others where the students are not allowed to take other advanced subjects until they pass these subjects. Figure 2 shows the comparison of common subject's failure rate between the two programs. It also depicts that CS110 students have the highest failure rate as compared to CS143 students.

In order to tackle the high failure rate, the lecturers have initiated to conduct a mathematics workshop named as "Excellence Camp". We believe that the underlying reason of high failure rate is the students do not have strong foundation of mathematics. CS110 students who are the major contributors to the high failure rate were selected to join the camp. These are the students that need to repeat MAT133. The program was made compulsory to all the repeaters of this subject since it is the prerequisite for other advanced mathematics subject such as MAT183 and it also serves as the fundamental for the other mathematics subjects.

The program was held on 5th and 6th December 2014 from 8 am to 5 pm. The experienced lecturers who have been teaching for more than four years were invited to conduct the program. There were seven topics covered in the workshop. Two set of pre and post tests were given to the students in order to test the effectiveness of the program. The first set of pre and post test was conducted on the first day which consisted of three topics. The second set consisted of four topics was distributed to the students on the second day. Table 1 shows the topics tested to the students for both days.

Table 1: The Workshop Contents

TEST	CHAPTER	TITLE	DESCRIPTIONS
Pre and Post Test 1	Chapter 1	Algebra & Polynomial	This chapter covered *operations on polynomial and the factorization techniques* by using *simple and long division method*.
	Chapter 2	Equation (Solving Linear Equation in One Variable)	This chapter covered *the equation in one variable* in finding the value of variable by using the *simultaneous method*.
	Chapter 3	Equation (Quadratic)	This chapter covered *the quadratic equation in one variable* to find the value of variable by using the *simple factorization and quadratic formula*.
Pre and Post Test 2	Chapter 4	Inequality	This chapter covered the *methods of expressing of the solution to an inequality, rules of solving inequality and solving linear inequality*.
	Chapter 5	Indices	This chapter covered *the rules of indices* and solving the indices question by using the rules and special case of indices.
	Chapter 6	Log	This chapter covered *the rules of logarithms* and solving the logarithms question by using the rules and special case of logarithms.
	Chapter 7	Linear Equation in Two Variable	This chapter covered *the function of tangent line, slope, parallel and perpendicular line*.

The hypothesis testing using paired sample t-test was used for this study. The outcomes are expected to get higher mean value for post-test than pre-test.

1.1. Research Objective

The aim of this study is to investigate the mean value for pre-test and post-test.

1.2. Hypotheses

The null hypothesis H_0: There is no difference in mean for pre and post- marks
The alternative hypothesis H_1: There is a difference in mean for pre and post-marks.

1.3. Problem statement

This study tries to answer the following research question:
Is there any difference in terns of marks on pre-test and post-test?

1.4. Significance of the study

The "Excellence Camp" was conducted with the objective of providing the students with the basic knowledge of mathematics. This program was held during the first week such that the students are able to strengthen their foundation at the beginning of the semester. Hence, it will lead to a better understanding towards their mathematics subjects during the semester. It is an initiative of reducing the failure rate thus, the findings of the post test is expected to have higher mean than the pre-test.

2. Literature review

The ability to solve the problem algebraically is the elementary for all the students who enroll in science or social sciences. In order to master mathematics and avoid misconception in solving mathematics problem, students need to build up their analytical skill during process of learning (Yin, L. Y, 2005). There are always some common mistakes in solving mathematics problem. Many researchers are interested in investigating the difficulties and the obstacles faced by most students. According to Nguyen, P. L and Tran, C. T. H. (2014), the types of errors may include incorrect calculations, misleading in mathematics concept or theorem, misinterpreted memory and careless.

2.1. Academic camp

Academic camp may be viewed as a very useful approach in assisting students for improving their problem solving skill. Through the camp, those students who are weak in the foundation may intensify their skill before the semester begins. In the meantime, students' self confidence can also be built hence, further reducing the time spent in understanding advance knowledge.

For instance, an Arabic Language Camp conducted by Khairuzaman et al. (2012) showed that it had the positive impact on students. The level of interest and motivation were greatly increased after the camp. A total of 68.4 % of the participants agreed that the activities carried out in the camp help them to solve the problem that they are facing in learning the Arabic language.

A similar concept of academic camp was introduced by Ling, S. E. et.al, (2010) in conducting a series of twelve mathematics camps since 2008. The research model was targeted on primary schools, the observation data were randomly selected from the group of participants, teachers and parents. The exploratory design of mixed method was used in investigating the results. From the research, it shows that the camp has produced the students who have enthusiasm, motivation and positive attitude towards Mathematics subject.

Mohd Salmi, et.al (2010) had conducted a research which is quite similar to Ling (2010) on Mathematics camp but with a group of 16 year-old students. The camp was an outdoor with several hands on activities and the students were divided into small groups. The topics related to group theory and number theory were introduced to the participants. At the end of the camp, questionnaires were distributed to students in order to investigate their responses towards the camp.

2.2. The students' common mistakes in elementary mathematics

There are seven topics chosen to be used in the "Excellence Camp" as shown in Table 1.The aforementioned topics are the elementary mathematics knowledge and it is essential for those who take advanced mathematics subjects such as calculus. These selected topics are vitally important since any misleading concepts in it will lead to misinterpretation of algebraic problems.

Majid, H. et al. (2012) had examined the relationship among different kinds of students' mistakes and the knowledge required to solve problems algebraically. His findings revealed that the majority of students' mistakes came from the miscalculation. However, Swedosh, P (1996) stated that the major problem comes from misconception. For example, he found that there were students who are still confused in solving factorization. In order to illustrate the problem, the students were tested in factorize some mathematics equation such as $(2x + y)^2 - x^2$. Around 27% of students were found expanding the equation incorrectly with $3x^2 + 4xy + y^2$ rather than $(2x + y)^2 - x^2 = ((2x + y) + x)((2x + y) - x)$. Swedosh, P (1996) also discussed on the common mistakes done by students while simplifying the polynomial. As an example, the students were asked to simplify $\dfrac{x^2 - 5x - 6}{x^2 - 2x - 3}$. Those weak in mathematics may cancel the identical terms in numerator and denominator without completing factorization. It seemed difficult for them to figure out that priority should give to factorization before the omission.

In the chapter of quadratic, quadratic equation can either be solved by using factorization or quadratic formula, $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. Yet, many students had solved the quadratic equation incorrectly. The example in Swedosh, P (1996) paper shown that for quadratic equation $x^2 = 1$, students gave the incorrect answer $x = 1$ instead of $x = \pm 1$. Another example is problem solving in the equation of $x^3 - 3x + 2 = 0$ given one of the solutions is $x = 1$. Not surprisingly, there are students who still solved it with the wrong approach in which the equation was incorrectly rearranged as $x^3 - 3x = -2$ before finding the values of x. Pongchawee, V and Clements, M. A. (2006) had studied on the effects of classroom instruction on students' understanding of quadratic equations. The same question of quadratic equations is given before and after lessons. The results show that the students who have some ideas of quadratic equations concept before the lesson have greatly improved after the lesson.

In the chapter of linear equation, research has shown that students tend to use different approaches in problem solving. Lagasse, A (2012) had done a descriptive study on the different approaches applied by the college students when solving systems of linear equations problems. There are three types of methods which include substitution method, elimination method and graphing. The results show that most of the students are prone to apply substitution method as this method is easier than the others. Gunawardena (2011) observed that some students tend to make mistake in the last step of equation solving process. For example, $-7n = 0$, $n = 7$. This happens because the students assume a plus sign instead of multiplication sign between the number and the letter.

According to Swedosh, P. (1996), the major common mistakes made by students in the chapter of inequalities were about the signs of 'greater than (>)' and 'less than (<)'. Based on his observation, around 13% had incorrectly written down the inequality solution. For example, most of students simply solving $-6 < 3x$ as $x < -2$ which is totally incorrect. The situation became worse if the students had sketched and shaded the wrong region in graph due to the incorrect inequality. Lorenzo, J. B, and Manuel, G. (2007) have also studied the errors and difficulties in learning inequalities with the objective to improve the process of teaching and learning. Many students have difficulties in interpreting and recognizing the inequalities expressions such as $x > 1$ and $1 < x$, difficulty in giving a single expression for compound inequalities and could not differentiate between equation and inequality. As the educational implications, teachers must clearly explain the concept of inequalities with different approaches in order to allow the student to acquire the concept of inequalities.

In the chapter of indices, there are some rules and special cases of indices that students should be aware of. According to Foo, F. Y. et al. (2013), there are five rules and four special cases in indices as shown in Table 2 and Table 3.

Table 2

RULES	
RULE 1	$a^m \times a^n = a^{(m+n)}$
RULE 2	$a^m \div a^n = a^{(m-n)}$
RULE 3	$(a^m)^n = a^{(m \times n)}$
RULE 4	$a^n \times b^n = (ab)^n$
RULE 5	$a^n \div b^n = \left(\dfrac{a}{b}\right)^n$

Table 3

SPECIAL CASES	
SPECIAL CASE 1	$a^0 = 1$
SPECIAL CASE 2	$a^{-n} = \dfrac{1}{a^n}$
SPECIAL CASE 3	$a^{\frac{1}{n}} = \sqrt[n]{a}$
SPECIAL CASE 4	$a^{\frac{m}{n}} = \sqrt[n]{(a^m)} = \left(\sqrt[n]{a}\right)^m$

In Swedosh, P (1996) paper, he pinpoints some of the common mistakes through an example such as simplifying $2^x + 2^x$. The correct answer should be $2^x + 2^x = 2(2^x) = 2^{x+1}$ but students will give $2^x + 2^x = 4^x = 2^{2x}$ which is totally wrong in the concept of indices. The same situation happens in the logarithm. Table 4 and Table 5 show the rules and special cases in logarithm Foo, F. Y. et al. (2013).

Table 4

RULES	
RULE 1	$\log_a XY = \log_a X + \log_a Y$
RULE 2	$\log_a \dfrac{X}{Y} = \log_a X - \log_a Y$
RULE 3	$\log_a X^n = n\log_a X$

Table 5

SPECIAL CASES	
SPECIAL CASE 1	$\log_a 1 = 0$
SPECIAL CASE 2	$\log_a a = 1$
SPECIAL CASE 3	$\log_a X$ is not defined if $X < 0$
SPECIAL CASE 4	$\log_a 0$ is not defined.

The common mistake made by students is they often view the notation for logarithm "log" as an object rather than as an operation. Yen's (1999) report had shown the types of errors made by Australian students in 1998 High School Certificate (HSC) Mathematics examination. For instance, some students divided both sides of the equation $\ln(7x-12) = 2\ln x$ by "ln" as if it was a variable to obtain $7x-12 = 2x$ when solving the equation. A study conducted by Kaur and Boey (1994) in a Junior College in Singapore found that not all students realized that the simplification of $\log 18 - \log 8 + \log 4 = \log(18 - 8 + 4)$ was incorrect. This error is actually quite common and often called as the linear extrapolation error (Matz, 1980). For example, when a student asked to solve the equation $\ln(7x-12) = 2\ln x$, the student may claim that $\ln(7x-12) = \ln 7x - \ln 12$, clearly treating "ln" as a variable and distributing it over $7x$ and 12 (Yen, 1999).

According to Harel and Dubinsky (1992), the concept of a function is one of the important concepts in mathematics education at all levels. The abilities to work with graphical representations of functions will be affected if the students have trouble with the language of functions such as image, domain, range, pre-image, one-to-one and onto. According to Markovits et al. (1988), most of students experience difficulty with functions because of the notations. For example, Herscovics (1989) reported that 98% of the students could evaluate the expression $a + 7$ when $a = 5$ whereas only 65% of this same group could evaluate $f(5)$ when $f(a) = a + 7$.

2.3. The Pre-Test and Post-Test

According to Swedosh, P (1996), the high frequency of mathematical misconceptions among students should be attended with great concern. By using diagnostic test, he had examined the nature and frequency of mathematical misconceptions which have been commonly exhibited in tests at the University of Melbourne and LaTrobe University.

In order to help and understand students' capability, pre-test and post-test can be applied to see the students' improvement in Mathematics camp. Pre-test is given before the lesson sessions while post test is given after the lesson sessions. Soo, K. Y and Nor Haniza, H (2014) have used pre-test and post-test to determine the impact of learning styles for English subject. They found that, the grades improved after the lesson sessions.

In the study related to the lack of knowledge in basic mathematical competence, Holly Gritsch de Cordova et al. (2005) have conducted pre-test and post-test for students who enrolled in Math 2 and Math 3 courses in UCSC in Fall 2003. Based on the result, the post-test shows the increases in percentage compared to pre-test for topic rational expressions, exponents and radicals, linear equations and inequalities, polynomials, function, logarithmic and exponential and also geometrical applications. Only conceptual geometry shows the decreasing of percentage.

3. Methodology

This experimental study is to test the effectiveness of "Excellence Camp" in reducing the failure rate for pre-calculus subject in UiTM Johor. A 2-day workshop was conducted due to the high failure rate for the subject of pre-calculus. It includes pre and post test with seven chapters of lessons that have been prepared by members of the Mathematics department. The study involved 70 students who are repeating pre-calculus.

The test papers were evaluated by the lecturers and the marks were classified into grade according to UiTM's final examination standard. Then, the descriptive analysis was used to elaborate the mean and the standard deviation of the marks. Since the percentage marks for pre and post-test were collected from the same students, the paired t-test was used to test the significant difference for pre and post-test marks. The paired t-test was conducted to test the hypothesis for all chapters. The alternative hypotheses for the study are;

H1: there are no difference in pre and post-mark in chapter 1
H2: there are no difference in pre and post-mark in chapter 2
H3: there are no difference in pre and post-mark in chapter 3
H4: there are no difference in pre and post-mark in chapter 4
H5: there are no difference in pre and post-mark in chapter 5
H6: there are no difference in pre and post-mark in chapter 6
H7: there are no difference in pre and post-mark in chapter 7

4. Findings

Table 6: Frequency distribution of Pre-Test and Post-Test results

Grade	Mark	Pre-Test		Post-Test	
		Frequency	Percentage	Frequency	Percentage
Poor	0-49	56	80.00	4	5.71
Moderate	50-59	9	12.86	4	5.71
Good	60-79	5	7.14	36	51.43
Excellent	80-100	0	0.00	26	37.14
Total		70	100	70	100

The data collected from pre-test and post-test were tabulated in order to investigate the effectiveness of Mathematics Camp. Table 6 depicts the overall score for both tests in which the students' performance was classified into four category, poor, moderate, good, and excellent. From Table 6, the students' results are seen improving remarkably after attending the Mathematics Camp. There are 37.14% of students achieved grade of excellence in post-test compared to none of the students achieved it in pre-test. It is followed by the students in good grade, the rate has increased tremendously, and there are 51.43% of good grade students in post-test compared to 7.14% in pre-test. In contrast, there are almost 93% of students fall under the category of poor and moderate initially, and the frequency has skidded to 5.71% respectively in the post test.

Table 7: The Paired Samples Statistics of Seven Chapters

Chapter	Pre Test Mark (%)		Post Test Mark (%)	
	Mean	Standard Deviation	Mean	Standard Deviation
Chapter 1	44.23	20.40	66.26	14.98
Chapter 2	64.29	28.88	81.36	21.14
Chapter 3	25.31	33.45	90.61	23.35
Chapter 4	63.02	28.56	83.98	15.76
Chapter 5	29.20	27.06	70.71	24.18
Chapter 6	9.29	14.07	61.96	23.86
Chapter 7	34.76	34.34	86.79	23.76
Overall	38.70	14.11	72.97	12.43

Table 7 shows the paired samples statistics of seven chapters' pre-test and post-test mark. The lowest mean with the mean value 9.29 is found in chapter 6 pre-test implied that students have very weak basic in the concept of logarithm. On the other hand, pre-test of chapter 2 with the mean value of 64.29 and chapter 4 with the mean value of 63.02 indicated that students have better understanding in solving the equation in one variable and inequality beforehand. The chapter of logarithm is still reported having the lowest mean with the mean value of 61.96 in post-test yet the result shows that there is about 52% of improvement after the camp. The highest mean value is found in chapter 3 post-test with the mean value of 90.61 and an increase of 65% makes it become the highest percentage of increase among seven chapters. The figure revealed that the program had intensifying the students' capability in solving the quadratic equation. In pre-test, the standard deviations are quite dispersed compared to post-test. Generally, the overall disperses have greatly reduced in the post-test with the standard deviation values reduced to 24% or below. The standard deviation value increased in chapter 6, however, the mean values show the increment which means students had gained more understanding in the particular chapter.

Table 8: Paired Samples Correlations between Pre-Test and Post-Test

Chapter	Correlation	Sig.

Chapter 1	.302	.011
Chapter 2	.261	.029
Chapter 3	.114	.349
Chapter 4	-.057	.637
Chapter 5	.314	.008
Chapter 6	.323	.006
Chapter 7	.196	.104
Overall	.483	.000

Table 8 shows that the percentage marks of pre and post-test for chapter 1, chapter 2, chapter 5 and chapter 6 are significantly positive correlated. This means that if the students score high marks in pre-test in those chapters, he will also be expected to score high in post-test. However, the percentage marks of pre and post-test for chapter 3, chapter 4 and chapter 7 are not significantly correlated with each other. Overall, it can be concluded that the percentage mark of pre and post-test is significantly correlated with each other.

Table 9 shows the results of paired t-test for all chapters and the overall. At 5% significance level, all null hypotheses are rejected, thus it can be concluded that there is a statistically significant difference between mean mark of the pre and post-tests for each chapter. Hence, it is strongly evident that the camp is able to enhance the students' understanding in Mathematics effectively.

Table 9: Results of Paired Samples t-Test

Paired sample (Post – Pre)	Paired Differences (%)		Sig. (2-tailed)
	Mean	**Std. Deviation**	
Chapter 1	22.03	21.36	.000
Chapter 2	17.07	31.03	.000
Chapter 3	65.31	38.56	.000
Chapter 4	20.95	33.40	.000
Chapter 5	41.52	30.10	.000
Chapter 6	52.68	23.45	.000
Chapter 7	52.02	37.74	.000
Overall	34.26	13.57	.000

5. Conclusion

The result of study showed that mathematics camp has positive impact in enhancing elementary mathematics knowledge. In the pre-test, it was found that 80% of students were ranked in poor grade (Table 6). However, the scores had greatly improved after the camp and the post test showed that 37.1% of students were in excellence grade, 51.4% were in good grade and only 5.7% were moderate and only 5.7% failed.

Refer to Table 7, the further analysis on comparison by chapters showed that students were very weak in Chapter 6 (Logarithm) with the mean value of 9.29. However, post test of chapter 6 showed an improvement with the mean value of 61.96, increased by 52.67. The mean values for seven chapters were increased, from 38.70 to 72.97. The increasing in the mean values showed that the students have a better understanding after they attended the camp.

The paired t-test result in Table 9 further concluded that there is a statistically significant difference between mean marks of the pre and post-tests for each chapter since all null hypotheses are rejected at 5% significance level. Thus, the statistical analysis may serve as a proof that education camp is effective in strengthening the students's

understanding in Mathematics. The result of this study is parallel with the result found by Soo, K. Y and Nor Haniza, H (2014).

Acknowledgements

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