TEACHING AND LEARNING ALGEBRA IN ATTRACTIVE WAYS: PERCEPTION AND ACCEPTANCE OF PRE-DIPLOMA STUDENTS IN UiTM JENGKA, PAHANG

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Abstract

Algebra is one of the basic topics in Mathematics and it is quite abstract as it involves non-number or unknowns. This nature of algebra has caused difficulties among students worldwide in understanding the topic. Using attractive ways in understanding algebra helps teachers to provide better explanation such that students understand the topic in a better way. Since algebra is one of the main topics in Intensive Mathematics I (MAT037) which is a compulsory course for students taking pre-diploma in commerce in UiTM, it is very important to introduce ~~the~~ attractive and simpler methods in solving the mathematical problems. Some new and interesting methods are introduced to the students to see if their performance improves throughout the course. 57 of the students from UiTM Jengka, Pahang are given a survey to study their understanding and interest in learning mathematics before and after taking the course. The results show that using these attractive techniques in solving mathematical questions help them perform better in examinations. Their interest towards the subject has also improved. Hence, it is applicable to use these techniques in teaching future students.

Keyword: Mathematics education; algebra; metaphor; mathematics learning.

Introduction

Mathematics is a very common subject taught since primary school until university level. Some programmes in the university make this subject compulsory for all students, so does the Pra Pendidikan Tinggi (PPT) programme offered by Universiti Teknologi MARA. This programme is categorized into two different streams; pre-diploma in science and pre-diploma in commerce. Intensive Mathematics I (MAT037) is one of the core subjects for students taking pre-diploma in commerce, in which algebra and equations are two of the basic topics discussed in the subject.

Large number of students face difficulties in understanding the basic concepts of mathematics (Berch & Mazzocco, 2007). Lack of cognitive abilities and incompetency in obtaining the skills in solving mathematical problems are two main difficulties faced by students (Tambychik & Meerah, 2010). Algebra is a difficult topic in mathematics to be understood by students and even to be taught by the teachers (Stacey *et al.*, 2004; Watson, 2009). Students who find mathematics ~~is~~ difficult tend to make mistakes in tests or examinations (Soedjadi, 1996). The mistakes done on the algebra topic is an indicator of the difficulties experienced by the students (Sugiarti & Retnawati, 2019). Common misconceptions on algebra are related to equality, unknowns, fractions, order of arithmetic operations and functions (Booth *et al.*, 2017).

Danesi (2007) revealed the main difficulty faced by students in learning mathematics is their inability to understand the concepts beyond the mathematical problems and the teachers' frustration to explain such concepts. Wang (2015) has reviewed on the students' difficulties in learning algebra by dividing into five main categories: (1) algebra content; (2) cognitive gap; (3) teaching issues; (4) learning matters; and (5) transition knowledge.

To overcome these difficulty issues, mathematics teachers need to develop teaching strategies and improve their competences (Wijaya *et al.*, 2019) to attract students and make learning interesting. Interest can be defined as an interaction between a peron and his or her surrounding (Fink, 1991; Hidi, 1990; Renninger, 1990). Mitchell (1993) found out that meaningfulness and involvement are among the situational interest in a mathematics class. In-depth diagnosis of students' difficulties need to be performed by the teachers to identify their thinking process related to the mathematical concepts as suitable teaching methods can only be identified once the teachers have enough information about the students' thinking process (Çiltas & Tatar, 2011).

Some Attractive Ways of Learning Algebra

In this section, some attractive methods of teaching and learning algebra are reviewed. These methods are used to expand algebraic expressions and solve linear equations.

Rabbit Method

This method was introduced by YM Tengku Noorhalina YM Tengku Ahmad Putra, a mathematics teacher from Sekolah Menengah Kebangsaan Dewan Beta, Kota Bharu, Kelantan. This method helps students better understand the expansion of algebraic expression in the form of $(a+b)^2$. The usual method used by most of the students is as follows:

$$(a+b)^2 = (a+b)(a+b)$$

$$= a^2 + ab + ab + b^2$$

$$= a^2 + 2ab + b^2.$$

However, using Rabbit Method in expanding this algebraic expression is much easier to be understood and remembered by students. Expanding $(a+b)^2$ using Rabbit Method is shown in the following:

$(a+b)^2$	$(a+b)^2$	$\overset{\times 2}{(a+b)^2}$
a^2	a^2+b^2	a^2+b^2+2ab

The first step is to multiply a with itself to obtain a^2, and the same goes for b, which forms the rabbit's ears. The last step is to put "$\times 2$" on its head to illustrate the multiplication of 2 with a and b to give $2ab$. Thus, the final result will give the algebraic expression a^2+b^2+2ab.

Salam Method

The "Salam" method was also introduced by YM Tengku Noorhalina YM Tengku Ahmad Putra. In Malay language, "salam" means shaking hands when greeting someone. This method is used to illustrate the expansion of algebraic expression as follows:

$$2a\left(3a+4b-5c\right)=6a^2+8ab-10ac.$$

The arrow signifies multiplication of the term outside the bracket with each term in the bracket. The common mistakes students do when performing this expansion is they forget to multiply all the terms in the bracket.

As a metaphor, the arrow is named as "salam" and the bracket is assumed as "house". In Malay culture, when a guest visits a house, he must greet everyone in the house. In this case, $2a$ must "greet" $+3a$, $+4b$ and $-5c$. As "greet" or "salam" means multiplication, thus the result is obtained as $6a^2+8ab-10ac$. Difficult situations can be explained easily and in more understood words by using metaphors (Latterell & Wilson, 2017). The use of metaphors demands the learners to actively search for the meaning, which makes the learning more attractive (Ashton, 1994).

TSA Method

In solving linear equations, YM Tengku Noorhalina YM Tengku Ahmad Putra has introduced the "Tembak-Salam-Asing" (TSA method). "Tembak" means "shoot", where it is used for the linear equations with fractions. "Salam" means "greet", which is used for expansion of algebraic expression and "asing" means "separate", which is to put those terms with the unknowns on one side, and those without the unknowns on another side. The TSA method is illustrated using the following example in **Table 1**.

Table 1 TSA method for solving linear equation

Steps	Method	Explanation
$\dfrac{x+1}{2}=5-x$	"Tembak" or "shoot"	Since the term on left hand side (LHS) of the equation has a denominator of 2, it must be multiplied to the right hand side (RHS). 2 is assumed to be a "bullet" and it is "shot" towards RHS.
$x+1=2\left(5-x\right)$ $x+1=10-2x$	"Salam" or "greet"	Once 2 has been "shot" towards RHS, the algebraic term on RHS must be expanded. To expand this term, the "salam" concept is used for multiplication.
$x+2x=10-1$ $3x=9$ $x=\dfrac{9}{3}=3$	"Asing" or "Separate"	The final step in TSA is "asing", which is to separate the terms with unknown and those without the unknown. In this case, $-2x$ is moved to LHS and $+1$ is moved to RHS. Once the terms have been separated, they can be simplified and the linear equation can easily be solved.

Hiding Method

This method is used by the author to help students understand how to do comparisons of the LHS and RHS of an equation. Since comparison method is used frequently in MAT037 subject, the metaphor needs to be employed so that students can remember which method to use when solving index equations, logarithmic equations and others. Suppose we have the following logarithmic equation:

$$\log(x+1) = \log 5.$$

Some students may not know what to do to solve the above equation. However, using the word "hide" to ignore the log on both LHS and RHS makes it easier to understand the comparison method. "Hiding" the log using the fingers makes students clearly see what is left for comparison as shown in **Figure 1**.

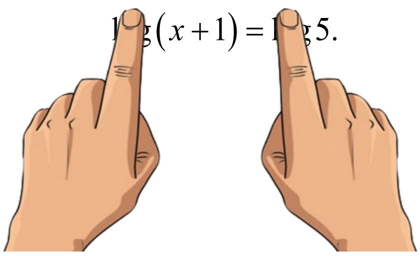

Figure 1 Hiding some parts of logarithmic equation when comparing LHS and RHS

The next step of solving the logarithmic equation is dealing with linear equation $x+1=5$ which can be solved easily. This method can also be employed for solving the index equation as follows:

$$2^{x+1} = 2^5.$$

Since both the LHS and RHS have the same base, which is 2, hence the comparison method is applicable in this case. To compare both sides, the hiding method is used by putting the fingers to "hide" or ignore the base as shown in **Figure 2**.

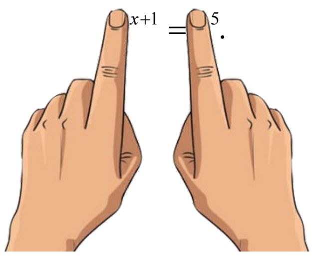

Figure 2 Hiding some parts of index equation when comparing LHS and RHS

After hiding the base, it is clearly seen that the linear equation $x+1=5$ is left to be solved. Using the simple word such as "hide" makes students understand better since the mathematical vocabulary instruction demands for informal explanation and usage of our own words (Marzano, 2004).

"Gajah = Elephant" Method

The author uses this method to explain the meaning behind the equality. "Gajah" in Malay language means "elephant". This analogy is used to show that when an equality is written as "Gajah = Elephant", then it can also be written as "Elephant = Gajah" since they mean the same thing. Students tend to make mistakes when solving the linear equation such as

$$5 = x+1$$

as they have to move the variable x to LHS and the constant 5 to RHS. This involves the change of positive or negative symbols as follows:

$$-x = -5+1.$$

The next step is to solve the equation $-x=-4$ by multiplying -1 on both sides to give $x=4$. Using the "Gajah$=$Elephant" Method, students know that the equation $5=x+1$ can also be written as $x+1=5$ since "Elephant$=$Gajah". Hence, the linear equation can be solved easily in a faster way as compared to the previous method.

Methodology

In this study, the authors conducted a survey among 57 pre-diploma students from Semester 2, Session 2019/2020 and Semester 1, Session 2020/2021 in Universiti Teknologi MARA Pahang, Jengka. These students took the Intensive Mathematics I course (MAT037) and the algebra and equation topics were taught using the attractive methods as discussed in the previous section. At the end of each semester, they were given online questionnaires.

The questionnaires consist of three sections; the first one is on the demographic profile of the students which includes their gender, age, origin and SPM Mathematics grade; the second section is on their understanding and interest before taking the course; and the last one is on their understanding and interest after completing the course. The obtained results are analyzed and some findings are presented and discussed in the next section.

Findings and Discussion

Table 2 shows the socio-demographic characteristics of 57 students from pre-diploma in commerce involved in this study. Out of 57 students that have been investigated, majority of them are female with 71.9% and 28.1% are male students. 93% of the students age between 16 and 20 years old and the rest are between 21 – 25 years old. The table below also shows the student's mathematics grade from Sijil Pelajaran Malaysia (SPM). Most of them were found to have not performed well in their mathematics subject. 29.8% of the students obtained grade E followed by 24.6% of them obtained grade C and D mathematics subjects. Meanwhile, only 7% of the students obtained grade A in mathematics subject.

Table 2 Demographic characteristics

Characteristic	Frequency (%)
Gender	
Male	16 (28.1)
Female	41 (71.9)
Age	
16 to 20 years old	53 (93.0)
21 to 25 years old	4 (7.0)
26 to 30 years old	0
30 years and above	0
Mathematics Grade (SPM)	
A	4 (7.0)
B	8 (14.0)
C	14 (24.6)
D	14 (24.6)

E	17 (29.8)
G	0

Table 3 shows the situation of the students' understandings and interest towards mathematics before taking MAT037 course. On average, all items are scored within less than 3 which indicates that the students seem to disagree with the statement. The result shows that 33 (57.9%) students disagree with the statements that they are good at mathematics. However, the students are still interested to learn the mathematics especially algebra. Based on the result, 36 (63.2%) out of 57 students are interested in learning mathematics. Meanwhile, 35 (61.4%) are interested in learning mathematics with algebra topic. On the other hand, the students are still lacking good techniques to solve the algebra questions. 40 (70.1%) of the students agreed that they do not have interesting methods to solve the algebra questions. They also cannot relate the algebra concept with their daily life problems with 44 (77.2%) of them disagree on the statements.

Table 3 Distribution of students' understanding and interest before taking MAT037 course

Before taking MAT037 course.	Mean (SD)	Frequency (%)			
		Strongly Disagree	Disagree	Agree	Strongly Agree
I am interested in Mathematics	2.77 (0.791)	3 (5.3)	18 (31.6)	27 (47.4)	9 (15.8)
I am good at Mathematics	2.30 (0.680)	7 (12.3)	26 (45.6)	24 (42.1)	0
I am interested in Algebra topic	2.65 (0.719)	3 (5.3)	19 (33.3)	30 (52.6)	5 (8.8)
I am good at solving questions related to Algebra	2.46 (0.781)	6 (10.5)	23 (40.4)	24 (42.1)	4 (7.0)
I have interesting methods in solving algebra questions	2.21 (0.647)	6 (10.5)	34 (59.6)	16 (28.1)	1 (1.8)
I can relate Algebra with my daily life problems	2.09 (0.606)	8 (14.0)	36 (63.2)	13 (22.8)	0

Table 4 presents the result for the students' understanding and interest in mathematics after taking MAT037 course. Most of the average score from all statements are more than 3 which indicates that they agree with the statements. After taking MAT037, students' interest towards mathematics are better as compared to before taking this course. Most of them, which is 48 (84.2%) are now more interested in mathematics. After taking MAT037, students are exposed to some techniques in order to solve the algebra questions specifically. The result shows 35 (61.4%) of them know how to use the Rabbit Method in expanding algebraic expressions. Meanwhile only 25 (43.8%) say that the Rabbit method is easier than the other techniques. Apart from that, 57 (91.6%) of the students agree that TSA method is easier than other techniques in solving linear equations and they clearly understand how to use that method to solve the problems. Besides, 48 (84.2%) students agree that learning mathematics is easier when describing it using illustrations in everyday life. 49 (86%) of them also agree to have the easy-to-remember words such as "Salam", "Tembak", "Hiding Log" and "Hiding Base" used in describing mathematics problems. Lastly, 49 (86%) students with a mean score of

3.19 agree that using TSA Method, Rabbit Method" and other techniques help them perform better in examinations.

Table 4 Distribution of students' understanding and interest after taking MAT037 course

After taking MAT037 course.	Mean (SD)	Frequency (%)			
		Strongly Disagree	Disagree	Agree	Strongly Agree
I am interested in Mathematics	3.21 (0.7)	0	9 (15.8)	27 (47.4)	21 (36.8)
I am good at solving Mathematical questions	2.96 (0.626)	0	12 (21.1)	35 (61.4)	10 (17.5)
I am interested in Algebra topic	2.95 (0.610)	0	12 (21.1)	36 (63.2)	9 (15.8)
I know how to use the Rabbit Method in expanding algebraic expressions	2.68 (0.659)	1 (1.8)	21 (36.8)	30 (52.6)	5 (8.8)
Rabbit Method is much easier than other techniques in expanding the expressions	2.47 (0.684)	2 (3.5)	30 (52.6)	21 (36.8)	4 (7.0)
I know how to use the TSA technique in solving the linear equations	3.16 (0.591)	0	6 (10.5)	36 (63.2)	15 (26.3)
The TSA technique is easier than other techniques in solving linear equations	3.18 (0.571)	0	5 (8.8)	37 (64.9)	15 (26.3)
Mathematics can be understood if it is explained in English	2.53 (0.658)	2 (3.5)	26 (45.6)	26 (45.6)	3 (5.3)
Mathematics is easier when described using illustrations in everyday life	3.11 (0.658)	0	9 (15.8)	33 (57.9)	15 (26.3)
Mathematics is easier when described with easy-to-remember words such as "Salam", "Tembak", "Hiding Log", "Hiding Base" and others	3.25 (0.689)	0	8 (14.0)	27 (47.4)	22 (38.6)
Using TSA, Rabbit Method and other techniques helps me answer questions better in examinations	3.19 (0.667)	0	8 (14.0)	30 (52.6)	19 (33.3)

The test of equality of variances (Levene's test) was analyzed to check the assumption of equal variance. The result shows that the variance for both situations before and after taking MAT037 for male and female students are equal. Therefore, the t-test value from equal variance assumed is tabulated. The mean difference between gender for both mean score of students' understanding and interest towards mathematics either before and after taking MAT037 have been checked as in **Table 5**. The mean score for both situations does not have significant difference between different gender (t = 0.340, *P*-value = 0.735) and (t = 0.601, *P*-value = 0.550). This indicates that their understanding and interest level remains the same between male and female students.

Table 5 Mean difference and T-tests for Comparisons between Genders

	Gender, Mean(SD)		t-statistics	*P*-value
	Male	**Female**		
Before taking MAT037	2.365(0.575)	2.423(0.584)	0.340	0.735
After taking MAT037	2.916(0.319)	2.993(0.482)	0.601	0.550

Conclusion

Using attractive techniques in solving mathematical questions is helpful for students who facedifficulties in mathematics. The introduced methods such as Rabbit Method, Salam Method, TSA Method, Hiding Method and others have helped students improve their understanding and interest in learning algebra. Majority of them agree that these methods are easy to understand and contribute in their performance in examinations. Hence, these methods are applicable to be employed by the lecturer or teachers when teaching the topic for future students. As the world has revolved with the advancement of technology, the teaching methods among educators should be more creative and attractive, as long as the fundamental knowledge on the topic is not changed.

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Conflict of interests

The authors declare that there is no conflict of interest.

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