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The Relationship Between Learning Styles and Achievement of Solving Algebraic Problems Among Lower Secondary School Students

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Abstract

A learning style is a student's consistent way of acquiring knowledge while problem-solving is an essential skill for developing mathematical knowledge and reasoning. Studies reported that Malaysia's secondary school students' performance in solving algebraic problems was poor. Thus, this study aims to investigate the relationship between learning styles and achievement of solving algebraic problems among the lower secondary school students. For the purpose of this research, 373 lower secondary school students in the age range of 14 to 15, living in the Johor Bahru district, were randomly selected. A 12-item Kolb's learning style inventory was used to identify the students' learning styles, and a 6-item algebraic problem-solving test was used to measure the students' achievement of solving algebraic problem. The results show that the majority of the lower secondary school students preferred the assimilating and converging learning styles, and they obtained marks in the range of 70-84 percent for the algebraic problem-solving test. The study reveals a positive relationship between the students' learning styles and achievement of solving algebraic problems. Likewise, the analysis results of the correlation between learning styles and achievement of solving algebraic problems with respect to the control variable of gender also indicate a positive relationship. These findings may provide some useful ideas for the teachers to consider student-friendly learning styles in designing the lesson instructions so that the algebra teaching process as well as learning outcomes can be further improved.

Keywords: *Learning styles, algebraic problems, problem-solving, relationship.*

INTRODUCTION

The Malaysia government has placed great emphasis upon the role of education in an effort to realise the vision of becoming a developed country. Thus, very practical policies and strategic priorities have been encapsulated in the new National Education Blueprint, the implementation of which will propel the nation to attaining the desired goal and transform the national education sector into a holistic learning system. As Malaysia journeys from the developing economy to the developed status, there is much to be done in the training of its workforce; and mathematics is certainly a very crucial subject in every student's studies, which will shape his or her life and the future career (Ling, Osman, Daud, and Hussin, 2019; Sangit, Z., 2007). The Malaysian primary and secondary school curriculums provide three mathematics education programmes, namely Mathematics for the primary school students; Mathematics and Additional Mathematics for the secondary school students. The primary aim of our secondary school mathematics curriculum is to develop the students' logical thinking skills, so that they are able to use the knowledge of Mathematics and reasoning power effectively to solve problems and make informed decisions and rational conclusions (Curriculum Development Centre, 2003).

The Mathematics for the primary school students focuses on introducing numbers and arithmetic operations, and the relationship between numbers. As for the secondary level, the curriculum stresses on providing opportunities for the students to acquire mathematical knowledge and skills, develop higher order thinking skills for solving problems and making rational decisions, which will help them cope with changes as well as challenges in their daily lives (Curriculum Development Centre, 2003). Generally a typical mathematics curriculum consists of discrete areas related to counting, measurement, geometry, algebra and problem solving. According to Elizabeth Julius, (2018) algebra is one of the major branches of pure mathematics; it is concerned with the study of the rules of operation, relations, constructions, and the concepts arising from them such as polynomials, equations, and algebraic structures. It is also an aspect of mathematics which involves the use of letters and numbers (Usman and Musa, 2015). Knowledge of algebraic concepts and skills are considered prerequisites for learners to develop higher order thinking as well as problem-solving skills in real life situations (Adeleke, 2007).

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Problem solving has always been a topic of interest among the mathematics researchers and educators in Malaysia, the mastery of which will help the students in the process of finding solutions to difficult or complex issues; and this is especially relevant in solving problems involving algebra. Royani and Agustina (2019) define problem solving as a cognitive and behavioural process, in which the steps of a certain logical sequence are consciously followed. According to Albert Bandura the great Canadian psychologist, (1986) individuals whose problem-solving skills have improved are able to reach their goals easier, and carry out their jobs better. On the other hand, Royani and Agustina (2019), explain that equipping individuals with problem-solving skills should be the priority of all educational institutions. Individuals acquire knowledge in various ways based on the cognitive, linguistic motor, and social skills.

In mathematics education, many studies have been done in an attempt to identify the students' preferred learning styles (Nahil Aljaberi, 2015; Mehraj Ahmad Bhat, 2014 and Chermahini, et. al., 2013). A learning style is defined as the attitudes and behaviours which determine an individual's preferred way of acquiring knowledge (Mumford & Honey, 1996). Learning styles vary among students as every student has his or her own method of acquiring knowledge. Learning styles play a significant role in determining the success of students in their learning process. The students' choice of learning styles helps them to increase their concentration and comprehension of a certain subject. Studies conducted by researchers on learning styles show that a student who uses a combination of learning styles in the learning process, is able to produce excellent academic achievement.

Learning styles occupy a space in an individual's life (Nahil Aljaberi, 2015). The moment a person has identified his or her learning style, it will be continually and successfully practised in the learning process, which will facilitate the learning-- easier, faster, more effective, and with improved outcomes. Persons who have successfully identified their learning styles will become an effective problem solver (Mehraj Ahmad Bhat, 2014). Different variables have been examined to ascertain the relationship between each of them and learning styles; and the variables studied include gender, class level, discipline, mathematics achievement, attitudes towards mathematics courses, and mathematics anxiety (Nahil Aljaberi, 2015). Thus, this study is conducted with the aim of finding the relationship between the lower secondary school students' learning styles and their achievement of solving algebraic problems.

PROBLEM BACKGROUND

Traditionally, algebra is introduced to students after they have thoroughly understood the basic mathematics knowledge and grasped the fundamental arithmetic skills (Curriculum Development Centre, 2003). According to a study conducted by foreign mathematics researchers, the topic of algebra is the hardest to learn and understand. The problem with algebra arises because the concepts and principles are too abstract for most of the pupils, and they find difficulties in relating the subject content to everyday life (Sangit, Z., 2007). This can be seen based on the statements and quotes given by many authors, some of which are reproduced below. The misconceptions about algebra lead to difficulties among students to transit arithmetic figures into algebra (Indraswari et. al., 2018). In algebra, students are required to identify the unknowns or variables, and the relationship between them; and then express them accordingly to solve problems (Martinez, J. G. R., 2002). However, the majority of the students fail to identify the variables and the relationship between the variables. These failures of the algebra learners, ultimately affect their ability to solve algebraic problems. Solving mathematical problems becomes a daunting task for many students (Mehraj Bhat, 2014). Students' performance in completing an assignment, solving a problem, or answering a question related to mathematics, is always a critical issue. According to Tarzimah, (2005) solving mathematical problems is not a topic of learning, but an elementary process in the whole mathematics programme, which contextually helps students learn concepts and acquire skills.

According to Wee Kim Teck, (2012), the Malaysian secondary school students' performances in algebraic problem solving are poor. The study discovered that, a large number of students are unable to master the algebraic concepts and the related problem-solving skills. It was found that, most Form-2 and Form-3 students fail to understand the algebraic concepts. Interestingly, based on a literature review conducted by Zheng Zhu (2007), there are gender differences in the achievement of solving mathematical problems; by and large, male students outperform female students. Moreover a research conducted by Kusumaningseh et. al., (2018)

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discovered that male students are superior to female students in reasoning skills. On the other hand, female students are good at doing things with accuracy; for example, they can accurately choose a right problem-solving strategy. Various studies carried out by the local mathematics researchers proved that Malaysian students face problems in resolving real-life application issues and thinking critically (Hashim and Hussein, 2003). Even though solving algebraic problems is a difficult task in general, proper learning methods can play an important role in developing the students' understanding of the algebraic concepts and principles. Students acquire knowledge in several different ways, and they have their own preferences in approaching new learning content. Therefore, this study aims to identify the relationship between the lower secondary students' learning styles and their achievement of solving algebraic problems.

Four research objectives are formulated with the purpose of investigating the lower secondary school students' learning styles and their achievement of solving algebraic problems. The objectives of the study are listed as below:

1. To identify the preferred learning styles of the lower secondary school students in the Johor Bahru district.
2. To investigate the students' achievement of solving algebraic problems.
3. To determine the relationship between the Learning Styles and the Achievement of Solving Algebraic Problems.
4. To determine the relationship between the Learning Styles and the Achievement of Solving Algebraic Problems based on gender.

METHODOLOGY

This is a quantitative research study with a correlation design. The lower secondary school students' learning styles were investigated with respect to their achievement of solving algebraic problems in order to identify the relationship between the two variables based on gender. The target population in this study is the lower secondary school students from the southern region of the Peninsular Malaysia, specifically the Johor Bahru district. The whole population of this study consists of the lower secondary school students from the Form-1 to Form-3 classes; however, only the Form-2 and Form-3 students from a total of 41 government schools in the Johor Bahru district were selected to take part in this survey. The samples of this study were randomly selected from the Form-2 and Form-3 students of the government schools in the Johor Bahru region, which consist of 373 in number. Since this study aims to investigate the students' learning styles and their achievement of solving algebraic problems, only the respondents who have studied important algebraic skills such as factorisation and expansion were selected to participate in this survey.

Two types of instruments are used in this research. First, the Kolb's learning styles inventory version 3.2 was used to identify the lower secondary school students' learning styles; this instrument was adapted from that employed by (Bhat, 2018). The Kolb's Learning Style Inventory is a self-descriptive inventory which consists of 12 items, using the forced choice method with four specific response options. Respondents rate their preferred answers with "1" to "4". Number 4 is used to rank the sentence or statement that describes the best way of learning; the smaller the number, the less the preference for the stated way of learning. Hence Number 1 ranks the sentence or statement as the least preferred way of learning. Second, the test method used to assess the achievement of solving algebraic problems is adapted from research done by Sikukumwa (2017). This achievement test consists of 6 questions and all of them are designed with non-routine problems. The questions in the questionnaire are in the printed form. The 6 items are constructed with different problems based on important aspects of algebra such as factorisation, expansion, and basic arithmetic operations involving algebra, all of which are taken from the KSSM Form-2 Mathematics syllabus. The respondents are expected to deal with and answer the questions based on a step-by-step problem-solving approach, which is the Polya model as demonstrated in the mathematics textbook. All the data collected from the survey were analysed using the Statistical Package of Social Sciences (SPSS) software version 20 with descriptive and inferential statistics.

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RESULTS

The 12-item questionnaire was used to identify the students' learning modes, which are categorised according to four types of Kolb's modes of learning, namely Feeling (Concrete Experience), Watching (Reflective Observation), Thinking (Abstract Conceptualisation) and Doing (Active Experimenting). These are known as the learner's primary learning modes. A frequency distribution analysis was carried out to identify the participants' individual primary learning modes. Table 1 shows the analysis of Kolb's four learning modes.

Table 1: Kolb's Learning Modes among the participants

	N	Minimum	Maximum	Mean	Standard Deviation
Concrete Experience	373	12	42	27.77	7.120
Reflective Observation	373	12	46	30.31	6.578
Abstract Conceptualisation	373	12	46	31.62	6.508
Active Experimenting	373	12	46	30.31	6.895

Based on the summary in Table 1, The Abstract Conceptualisation mode has the highest mean value of 31.62, with a standard deviation of 6.508. The Reflective Observation mode records a mean value of 30.31, with a standard deviation of 6.578; the Active Experimenting mode also shows the same mean value of 30.31, but with a different standard deviation of 6.895. The Concrete Experience mode registers the least mean score of 27.77, with a standard deviation of 7.120. Table 2 summarises the findings of the Kolb's learning modes based on gender.

Table 2: Kolb's learning modes based on gender

	Gender	N	Mean	Standard Deviation
Concrete Experience (CE)	Female	167	29.93	6.623
	Male	206	26.02	7.041
Reflective Observation (RO)	Female	167	29.14	6.370
	Male	206	31.25	6.607
Abstract Conceptualisation (AC)	Female	167	30.62	6.672
	Male	206	32.44	6.270
Active Experimenting (AE)	Female	167	30.31	6.393
	Male	206	30.30	7.292

The Concrete Experience (CE) mode of the female students scores a mean value of 29.93 and a standard deviation of 6.623; meanwhile, the same mode of the male students shows a mean value of 26.02 and a standard deviation of 7.041. The Reflective Observation (RO) mode of the female students records a mean value of 29.14 and a standard deviation of 6.370; meanwhile the mean score for the male students shows a value of 31.25 with a standard deviation of 6.607. The Abstract Conceptualisation mode of the female students has a mean score of 30.62, with a standard deviation of 6.672; the same mode of the male students shows a higher mean score of 32.44, but with a lower standard deviation of 6.270. Finally, the Active Experimentation mode of the female students shows a mean score of 30.31 and a standard deviation of 6.393; however, the same mode of the male students shows a mean score of 30.30, with a standard deviation 7.292. Figure 1 provides a clear view of the utilisation of the Kolb's leaning modes based on gender.

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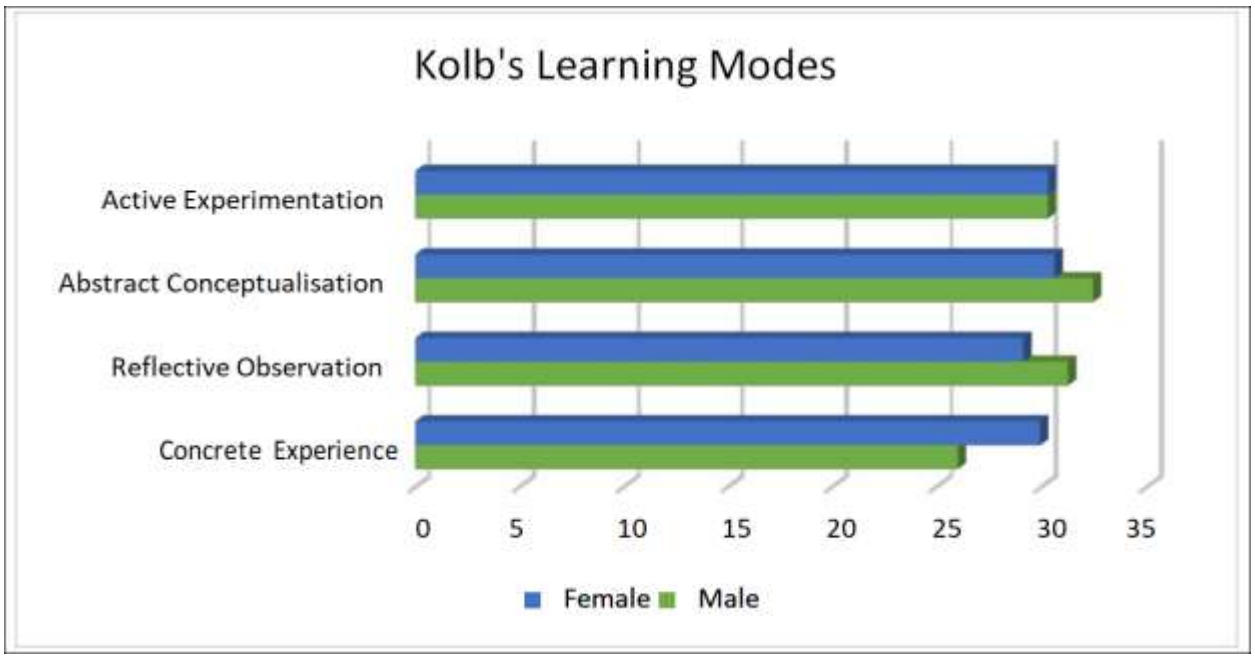

Figure 1: Mean scores of Kolb's Learning Modes

MEAN SCORE OF KOLB'S COMBINED LEARNING MODES

Table 3: Mean Scores of Kolb's Combined Learning Modes

		N	Mean	Standard Deviation
AE-RO	Male	206	-0.95	12.673
	Female	167	1.17	11.636
AC-CE	Male	206	5.97	11.760
	Female	167	0.50	12.018

Table 3 contains the mean scores and standard deviations of the Kolb's combined learning modes. The combined AE-RO mode of the male students shows a mean score of -0.95, with a standard deviation of 12.673; however, the same combined mode of the female students has a higher mean score of 1.17, but with a lower standard deviation of 11.636. Meanwhile, the mean score of the combined AC-CE mode of the male students is 5.97 and the standard deviation is 11.760; on the hand, the same combined mode of the female students has a mean score of 0.50, with a standard deviation of 12.018.

KOLB'S LEARNING STYLES

Table 4: Frequency distribution of Kolb's Learning Styles

LEARNING STYLES	N	FREQUENCY
Assimilator	127	34.0%
Converger	105	28.2%
Accommodator	74	9.8%
Diverger	66	17.7%

Based on the summary in Table 4, the assimilator learning style shows the highest frequency distribution of 34%. From the total number of 373 respondents who represent the entire population of the lower secondary school students in Johor Bahru, 127 were identified to have the assimilator learning style. The descriptive analysis of the modes also shows that the assimilator learning style is the most preferred way of acquiring knowledge. The second highest score goes to the Converger learning style, with a percentage of 28.2%, or 105 students from the total number of 373 respondents who took part in this study. The third most preferred manner

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of gaining knowledge is the accommodator learning style. Based on the frequency table above, we can see that 74 students or 19.8% of the total number of respondents are accommodators. The Diverger learning style is the least preferred way of learning among the lower secondary school students; only 66 students or 17.7% of the total number of respondents prefer this learning style. Table 5 summarises the frequency distribution of the Kolb's Learning Styles based on gender.

Table 5: Frequency distribution of Kolb's Learning Styles based on gender

		Frequency	Percentage (%)
Accommodator	Female	51	24.8
	Male	23	12.2
Assimilator	Female	31	15.2
	Male	96	46.6
Converger	Female	43	20.9
	Male	62	30.1
Diverger	Female	42	20.4
	Male	25	12.1

Table 5 reveals that 12.2% of the male students and 24.8% of the female students prefer the accommodator learning style. 15.2% of the female students and 46.6% of the male students prefer the assimilator learning style. 20.9% of the female students and 30.1% of the male students are inclined to use the Converger learning style. The Diverger learning style is adopted by 20.4% of the female students and 12.1% of the male students. Figure 2 provides a clear view of the lower secondary school students' preferred learning styles based on gender.

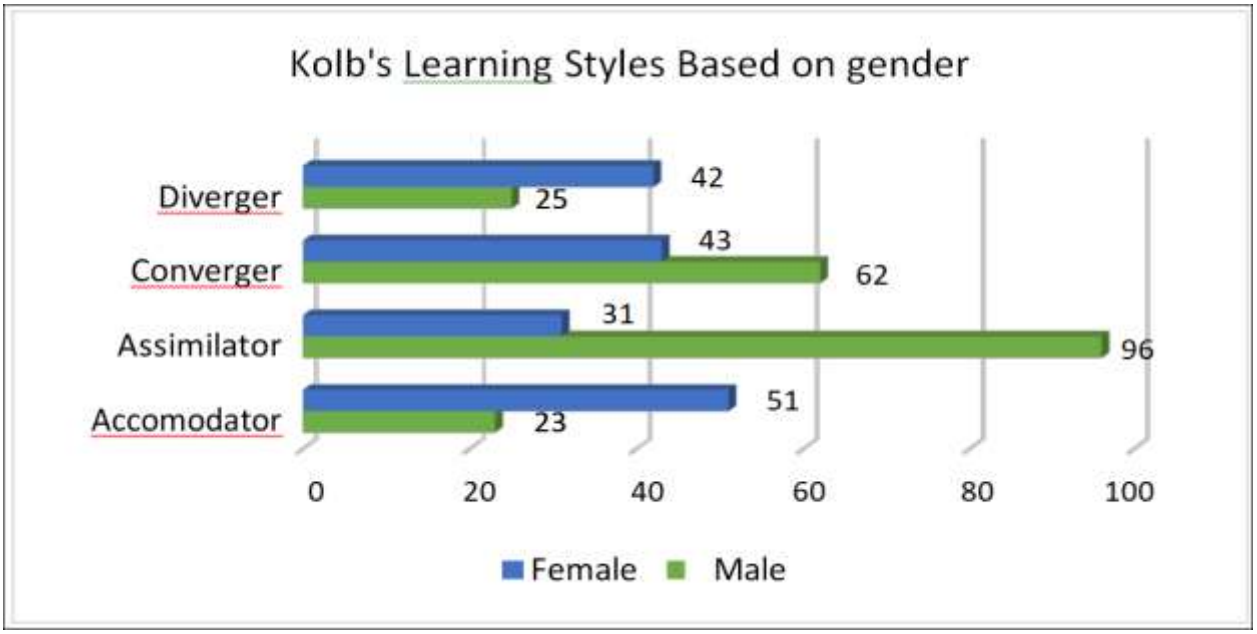

Figure 2: Kolb's Learning Styles based on gender

ACHIEVEMENT TEST OF SOLVING ALGEBRAIC PROBLEMS

This section answers Research Question 2 by testing the dependent variable of this study, which is the students' achievement in solving algebraic problems. The data gathered were analysed based on the grades obtained by all the respondents of this study. The students' test score marks are converted into grades based on the latest grade scale for the lower secondary school exam marks as shown in Table 6.

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Table 6: Grade Scale for Achievement Test of Solving Algebraic Problems

			MARKS	GRADE		
			85-100	A		
			70-84	B		
			60-69	C		
			50-59	D		
			40-49	E		
			00-39	F		

Achievement of Solving Algebraic Problems based on gender

Table 7: Achievement Test of Solving Algebraic Problems

	Grade			Frequency	Percentage (%)
	A		Male	33	16.0
			Female	19	9.2
	B		Male	79	38.3
			Female	48	23.3
	C		Male	31	15.0
			Female	27	13.1
	D		Male	28	13.6
			Female	32	15.5
	E		Male	18	8.7
			Female	25	21.1
	F		Male	17	8.3
			Female	26	7.8

Table 7 contains the summary showing the students' achievement of solving algebraic problems by gender. The table reveals that 16.0% of the male students scored grade 'A', whereas only 9.2% of the female students scored grade 'A'. 38.3% of the male students scored grade 'B', whereas only 23.3% of the female students scored grade 'B'. 15.0% of the male students scored grade 'C', whereas 13.1% of the female students scored grade 'C'. Likewise, 13.6% of the male students scored grade 'D', and 15.5% of the female students scored grade 'D'. 21.1% of the female students scored grade 'E', which is higher than the 8.7% of the male students who scored the same grade. The percentage of all the students who scored grade 'F' is the lowest with the male students recording 8.3% and the female students 7.8%. Figure 4.4 shows a clear view of the students' achievement of solving algebraic problems based on gender.

RELATIONSHIP BETWEEN LEARNING STYLES AND ACHIEVEMENT OF SOLVING ALGEBRAIC PROBLEM AMONG LOWER SECONDARY SCHOOL STUDENTS

TEST FOR INDEPENDENCE OF VARIABLES

The Chi-Square test for independence explains how two categorical variables are independent in some population when the data are gathered in the nominal and ordinal scale. The results of the test for independence are shown in Table 8.

Table 8: Chi Square Independence Test

	Value	df	Asymp. Sig. (2 tails)
Spearman Chi-square	487.117	15	0.000
N	373		

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The results of the Chi-Square independence test of statistics show a value of 487.117. The significant p-value is less than 0.001, with a freedom degree of 15. Thus, it is concluded that the Chi-Square statistics assume a non-directional hypothesis.

Correlation between Learning Styles and Achievement of Solving Algebraic Problems

Correlation measures the strength of association between two variables. The r value of correlation coefficient varies between +1 and -1. If the value of r is positive and close to 1, that means there is a strong relationship; on the other hand, if the value of the analysis is closer to -1, that means the relationship is weak. This section provides answers to Research Questions 3 and 4, the aim of which is to identify the relationship between the students' learning styles and their achievement of solving algebraic problems; the Kendall tau-b correlation analysis was employed to measure the degree of association between two variables. The results of the relation analysis are contained in Table 9.

Table 9: Correlation between Learning Styles and Achievement of Solving Algebraic Problems

		LS	ACHIEVEMENT
LS	Correlation	1	0.754*
	Sig. (2-tailed)		.000
	N	373	373
ACHIEVEMENT	Correlation	0.754*	1
	Sig. (2-tailed)	.000	
	N	373	373

*Correlation is significant at the 0.001 level (2-tailed).

The Kendall tau-b correlation analysis was used to ascertain the existence of a relationship between the independent variable of this study, i.e. Learning Styles (Assimilator, Converger, Accommodator, and Diverger) and their achievement of solving algebraic problems. The result of the correlation analysis state that r = 0.754 with a p-value of 0.000, which is below the significant level of 0.001; this means the result is significant. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted.

Correlation between Learning Styles and Achievement of Solving Algebraic Problems based on gender

This section answers Research Question 4. The gender acts as a control variable to determine the relationship between learning styles and achievement of solving algebraic problems. The Correlation analysis is used to find out if there is a relationship in the presence of gender as the control variable. The results of the analysis are as shown in Table 10.

Table 10: Relationship between Learning Styles and Achievement of Solving Algebraic Problems based on gender

Control Variable				
			LS	ACHIEVEMENT
Gender	LS	Correlation	1.000	0.492
	Sig.(2-tailed)			.001
	df			15
	ACHIEVEMENT	Correlation	0.492	
	Sig.(2-tailed)		.001	
	df		15	

The relationship between the independent variable, i.e. Learning Styles (Assimilator, Converger, Accommodator and Diverger) was tested in partial correlation with the achievement of solving algebraic problems. The result of the correlation analysis reveals r= 0.492 with a p-value of 0.001, which is below the significant level of 0.05; this means the result is significant. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted.

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DISCUSSION

The model of Kolb's learning styles consists of four learning modes, each of which describes a student's preferred way of learning, and the modes differ from one person to another in terms of managing, grouping, perceiving, and organising information. Thus, the 12-item inventory is designed to identify different modes of learning, namely Concrete Experience, Reflective Observation, Abstract Conceptualisation and Active Experimenting. The mean value of the Abstract Conceptualisation learning mode has the highest score of 31.62. This reveals that the majority of the students prefer the Abstract Conceptualisation (AC) mode as the primary way of learning algebra. Further analysis based on gender reveals that the male students record a mean score higher than that of the female students. This shows that the male students prefer to learn by thinking compared with the female students who adopt other methods of learning. Using the AC mode of studying, the students emphasise the use of thinking skills or logical analysis of ideas, and intellectual understanding in learning algebra. They prefer analysing ideas to receiving information passively. Thus, the instructors or educators can transform the algebraic learning in the classroom into a livelier and more meaningful session by switching to the students' preferred method of learning. Teachers can design the classroom instructions for algebraic learning in such a manner that will draw the students into active discussions and participation. Besides that, the teachers should encourage the students to think creatively and come out with new strategies or alternative approaches to solving a problem. Once the teacher has introduced all the related concepts and theorems of a particular learning unit, he or she can give a few complex algebraic problems which require the students to think hard, and apply the concepts learned to generate ideas for solving the given problems. This type of learning can increase the students' logical, abstract, creative, and critical thinking skills.

The mean score analysis shows that the second highest value is 30.31. The mean analysis by gender for the Reflective Observation mode reveals that the male students scored a mean value higher that of the female students. This means that more male students than female students prefer the Reflective Observation mode to learn algebra. Moreover, the male students prefer to view issues from a different point of view, and look for meanings of things. This indicates that the students expect the teachers to demonstrate a few problem-solving examples and show them the right or the best method of solving the algebraic equations in the classroom. If the students are given a question to try out, they will reflect on the teachers' demonstrated examples and act accordingly. This is commonly known as the observational learning — the process of learning through watching others or learning through others. A tremendous amount of learning happens through this process of watching and imitating others.

The Active Experimenting mode is a popular preferred learning method among the female students, registering a mean score of 30.31. However, the mean score difference is not very significant between the male and female students. This shows that both male and female students equally prefer this learning mode in studying algebra. In a practical sense, the lower secondary school students prefer more hands-on activities or learning new things by doing, in the algebra learning sessions. Generally, students who follow the Active Experimenting learning mode will keep trying to apply the theories learnt to solve problems. They are also inclined to actively experiment with the new concepts they have formed. Thus, teachers can plan out projects and case studies which will encourage the students to try out new and different approaches. The least preferred learning style among the lower secondary school students is the Concrete Experience mode with a mean score of 27.77. The male students demonstrated a mean score of 26.02, while the female students recorded a mean score of 29.93 for this mode. The results reveal that more female students prefer learning through experience, and address learning objectives through personal involvement with human agents. They learn through feelings rather than thinking through experience.

The model of Kolb's learning styles categorises the four learning methods as assimilation, accommodation, converging and diverging. All these four learning styles are formed through combinations of the Kolb's modes of learning. Assimilation is the most preferred learning style among the lower secondary school students. 34% of all the students prefer the assimilation learning style. Based on the research finding, the male students prefer the assimilation-based learning compared with the female students. The Assimilation learning style is the combination of the Reflective Observation and Abstract Conceptualisation modes. The Assimilation learners

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love to learn through watching and thinking. The Assimilation learners rely on logic, accuracy, inductive reasoning and the ability to assimilate a broad range of ideas. Assimilators are not action oriented and artistic learners. They excel in the learning that includes very organised information or instructions, testing of theories, and analysis of data. However these learners tend to be less focused on people and feelings. By understanding the general characteristic of this learning style, this study suggests to implement more problem-based tasks in teaching algebra after introducing the important concepts of the topic. This will help the students to learn and think how to apply the theorems and concepts they have learnt to solve the given problems. This kind of learning is suitable and meaningful for the algebra learners. The Assimilating learners also can be viewed as theorists. Based on the Honey and Mumford model, theorists are the students who can view things in a bigger picture, and able to adapt logical, systematic and analytic approach to solve problems.

The second most preferred method to study algebra is the converging learning style with a rate of 28.2%. The research findings reveal that more male students prefer the converging learning style compared with the female students. They prefer technical problems to interpersonal matters. Decision-making, problem solving and practical application of ideas are the most preferred activities of this type of learners. They also like to experiment new ideas and work with practical applications based on the theories they have learnt. This learning style is ideal for algebra learners who like to experiment new approaches in figuring out answers or solutions to the problems. These learners possess similar characteristics of the pragmatist in the Honey and Mumford model of learning styles. The Accommodating learning style is the third most preferred studying method among the lower secondary school students to learn algebra. The analysis of descriptive statistics reveals that, 19.8% of the students belong to the accommodating learning style. They prefer the trial-and-error approach to thinking and reflecting. They are also learners who can adopt changes, solve problems through the non-sequential information processing mode, and prefer discovery learning. These learners adopt other people's analysis and are attracted to new challenges and experiences to carry out plans. They act based on gut instinct rather than systematic logical analysis in solving problems. Generally, they rely on others to carry out their own problem analysis. The Diverging learning style is the least preferred learning method among the lower secondary school algebraic learners in the Johor Bahru region. 17.7% of the students prefer the diverging learning style. Divergers focus on innovative and imaginative approaches to perform tasks. They adopt the views of concrete situations through observations rather than by action. They connect easily with people and tend to be feeling oriented. This group of learners prefer cooperative learning and brainstorming. Deep thinking and logical analysis are not the strength of the diverging learners.

The Achievement Test of Solving Algebraic Problems was used to investigate the students' ability to solve algebraic problems. The majority of the students achieved grade B in the problem-solving test, i.e. 134 students from the total number of 373 students. 14.2 percent of the students scored grade A in the test. The achievers of these two grades successfully completed all the problems by applying the Polya problem-solving strategies as demonstrated in their textbooks. They applied all the four steps of the approach stated in the problem-solving model accordingly. Based on the Polya's problem-solving model, the first step in approaching a problem is to understand the problem. In order to select a correct plan for execution, one should understand the problem and what is required to find. Understanding is the preparation step; students need to rephrase the problem in their own words and write specific examples of the condition in the problem. After understanding the problem, the next stage is planning. Students should think of an appropriate strategy and make an attempt to solve the problem. Once planning is thought out successfully, students can move to the third stage to carry out the plan, which can lead to a solution for the problem. If the plan does not work, start over and try a new approach. The final stage is verification or checking back the potential solutions. Normally this final stage is left out by most of the students; even in this achievement test, most of the students left it out. Actually, it is an important step to check if a solution is correct or needs improvement. Overall, the students who scored A and B managed to attempt the questions with the Polya problem-solving sequence. On the other hand, 50 students scored grade C, 47 students scored grade D, 43 students scored E, and 46 students scored grade F. By and large, the students who scored grade C and D in their achievement test, were unsuccessful in their second stage of planning, and the third stage of carrying out the plan. They lost quite a lot of marks there. For those who scored grade E and grade F, basically they did not understand the problem itself when attempting some of the questions. As such, the

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students could not move forward and plan an appropriate strategy for execution to find solutions for the questions. These students have very minimal experience and exposure in attempting to solve problems given in the questions, and they are not abstract thinkers.

The relationship between Learning Styles and Achievement of Solving Algebraic Problems among the lower secondary school students located in Johor Bahru was investigated. The result of the data analysis from the previous chapter reveals that r=0.754, which means that there is a positive correlation and very strong relationship between learning styles and achievement of solving algebraic problems. The p-value is 0.001, which is lower than the pre-set alpha value of 0.05; hence, the null hypothesis is rejected and the alternative hypothesis is accepted. All these values point to one thing: there is a relationship between Learning Styles and Achievement of Solving Algebra Problem among the lower secondary school students. The variable of gender is used in this study as the controlled variable to identify the relationship between Learning Styles and Achievement of Solving Algebraic Problems. The result of the investigation shows a value of r=0.506; and this is the interpretation: there is a positive relationship between Learning Styles and Achievement of Solving Algebraic Problems by gender. This is evidence that the control variable of gender also correlates with the learning Styles and Achievement of Solving Algebraic Problems. The p-value of the result is 0.001, which is less than the alpha value of 0.05. Consequently, the null hypothesis is rejected and the alternative hypothesis is accepted, indicating that the gender has a relationship with Learning Styles and Achievement of Solving Algebraic Problems.

CONCLUSION

Based on this study, it can be concluded that recognising the students' preferred learning styles is vital for helping them realise their potential to develop skills of solving mathematical problems, especially those related to the subject of algebra. The study also reveals that the assimilator and converging learning styles (in descending order of preference) are the most preferred methods of studying among the lower secondary school students in Johor Bahru. As for the Kolb's model of learning styles, the study discovered that the Abstract Conceptualisation, Reflective Observation and Active Experimenting modes (in descending order of preference) are the most favoured way of learning among the lower secondary school students. The Abstract Conceptualisation mode scored the highest mean value among all the modes of learning in the Kolb's model. This shows that the majority of the students prefer to have more thinking elements incorporated in their algebraic classroom lessons. One of this study's aims is to find out the gender effect on the relationship between learning styles and achievement of solving algebraic problems; the research findings reveal that more male students prefer the Abstract Conceptualisation learning mode, whereas the female students prefer the Active Experimenting mode.

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