UNIVERSITI PUTRA MALAYSIA

FACTORS INFLUENCING MATHEMATICAL PROBLEM SOLVING PERFORMANCE AMONG MALAYSIAN MATRICULATION STUDENTS

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By

SURIATI ABU BAKAR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

May 2019

DEDICATION

This thesis is dedicated to

My lovely family and friends:

With love, respect and a bunch of memories
Indeed, we belong to Allah and indeed to Him we will return.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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May 2019

Chairman : Associate Professor Ahmad Fauzi Mohd Ayub, PhD
Faculty : Institute for Mathematical Research

This research was conducted to identify the relationship between mathematics beliefs, mathematics attitude, mathematics self-efficacy, metacognitive skills and mathematical problem solving performance among Malaysian matriculation students. For this purpose, a total of 312 matriculation students from three matriculation colleges were selected as respondents. The data were analysed by using IBM SPSS. All the independent variables were measured using a questionnaire while mathematical problem solving performance was measured using a mathematical test. A descriptive analysis was carried out to obtain both the mean and standard deviation of the variables. The findings showed that students had more positive beliefs and positive attitude in mathematical problem solving. Besides, students also had shown increase in mathematics self-efficacy and metacognitive skills in mathematical problem solving. Based on the analysis of the mathematical problem solving test, it was revealed that majority of the students performance in solving non-routine problems is still at unsatisfactory level. The outcomes of this research showed that their ability to understand problem, to plan a solution and execute correct answer are low.

There was a significant positive correlation between mathematics beliefs (r=0.386**, p=0.000), attitude towards mathematics (r=0.489**, p=0.000), mathematics self-efficacy (r=0.484**, p=0.000) and metacognitive skills (r=0.455**, p=0.000) towards mathematical problem solving performance. Further statistical tests to determine factors influencing mathematical problem solving performance revealed that among these variables, mathematics self-efficacy does not contribute significantly to mathematical problem solving performance. Results showed that metacognitive skills (β=0.284, p=0.000) has the biggest contribution followed by mathematics attitude (β=0.251, p=0.000) and mathematics beliefs (β=0.132, p=0.022). This result identified that the final three predictors model explained 31.1% of the variation in mathematical

problem solving performance. As a result, from these findings, it is suggested that problem solving must be included as part of mathematics matriculation syllabus so that students will have the opportunity to improve their problem solving abilities.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

FAKTOR YANG MEMPENGARUHI PENCAPAIAN PENYELESAIAN MASALAH MATEMATIK DALAM KALANGAN PELAJAR MATRIKULASI

Oleh

SURIATI ABU BAKAR

Mei 2019

Pengerusi : Prof. Madya Ahmad Fauzi Mohd Ayub, PhD
Fakulti : Institut Penyelidikan Matematik

Kajian ini bertujuan untuk mengenal pasti hubungan antara kepercayaan matematik, sikap terhadap matematik, efikasi swadiri matematik, kemahiran metakognitif dan pencapaian penyelesaian masalah matematik dalam kalangan pelajar matrikulasi di Malaysia. Untuk tujuan ini, sejumlah 312 pelajar matrikulasi dari tiga buah kolej matrikulasi telah dipilih sebagai responden. Data kajian dianalisa menggunakan perisian IBM SPSS. Semua pembolehubah tidak bersandar diukur menggunakan soal selidik sementara pencapaian penyelesaian masalah matematik diukur menggunakan ujian matematik. Analisis deskriptif digunakan untuk mendapatkan nilai min dan sisihan piawai pemboleh ubah. Dapatan kajian menunjukkan bahawa pelajar mempunyai kepercayaan matematik dan sikap yang positif terhadap penyelesaian masalah matematik. Selain itu, pelajar juga menunjukkan efikasi swadiri matematik dan kemahiran metakognitif yang tinggi terhadap penyelesaian masalah matematik. Berdasarkan analisis ujian penyelesaian masalah matematik menunjukkan bahawa majoriti pencapaian pelajar dalam menyelesaikan masalah bukan rutin masih di tahap tidak memuaskan. Hasil kajian ini menunjukkan bahawa keupayaan mereka untuk memahami masalah, merancang penyelesaian dan mendapatkan jawapan yang betul adalah rendah.

Terdapat hubungan positif yang signifikan antara kepercayaan matematik (r=0.386**, *p*=0.000), sikap terhadap matematik (r=0.489**, *p*=0.000), efikasi swadiri matematik (r=0.484**, *p*=0.000) dan kemahiran metakognitif (r=0.455**, *p*=0.000) terhadap pencapaian penyelesaian masalah matematik. Selanjutnya, ujian statistik untuk menentukan faktor-faktor yang mempengaruhi pencapaian penyelesaian masalah matematik menunjukkan bahawa antara kesemua pemboleh ubah dalam kajian ini, efikasi swadiri matematik tidak mempunyai hubungan yang signifikan terhadap pencapaian penyelesaian masalah matematik. Dapatan kajian menunjukkan

kemahiran metakognitif (β=0.284, *p*=0.000) memberikan sumbangan paling besar diikuti sikap matematik (β=0.251, *p*=0.000) dan kepercayaan matematik (β=0.132, *p*=0.022). Dapatan kajian ini mengenal pasti bahawa kombinasi tiga peramal menerangkan 31.1% variasi dalam pencapaian penyelesaian masalah matematik. Hasil penemuan kajian ini mencadangkan bahawa penyelesaian masalah harus dimasukkan ke dalam sukatan pelajaran matematik matrikulasi supaya pelajar mempunyai peluang untuk memperbaiki kebolehan menyelesaikan masalah mereka.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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I hereby confirm that:

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) were adhered to.

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LIST OF ABBREVIATIONS

EPRD	Educational Planning and Research Division
HOTS	Higher Order Thinking Skills
MOE	Ministry of Education
KBSM	*Kurikulum Bersepadu Sekolah Menengah*
KSSM	*Kurikulum Standard Sekolah Menengah*
MMP	Modern Mathematics Program
NCTM	National Council of Teachers of Mathematics
OECD	Organization for Economic Cooperation and Development
PISA	Programme for International Students Assessment
PLS-SEM	Partial Least Squares Structural Equation Modeling
PSPM1	*Peperiksaan Semester Program Matrikulasi 1*
UPSR	*Ujian Pencapaian Sekolah Rendah*
SEM	Structural Equation Modeling
SPM	*Sijil Pelajaran Malaysia*
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
TVET	Technical and Vocational Education and Training

CHAPTER 1

INTRODUCTION

1.1 Background

Vision 2020 was launched in 1991 to be a source of aspiration for Malaysians towards achieving a fully developed country in our own mould. The nation's human capital quality is deemed as the most critical aspect in the achievement of the national mission. The government came to the realisation that in order for Malaysia to achieve the Vision 2020 successfully, the main focus should be placed on developing the human capital (Ninth Malaysia Plan, 2006). This development of human capital will require world class workers just for the purpose of collaboration with one another, but also to have the competency to manage as well as to solve more complex problems in their everyday work lives (Mansor & Tengku Kasim, 2008).

Human capital development is a crucial enabler that drives as well as sustains Malaysia's economic growth and also supports all economic sectors' transition towards knowledge-intensive activities, drive labour productivity gains and attract investment into Malaysia. In the 10th Malaysia Plan, 2011-2015, a range of measures was introduced by the government in order to enhance the labour market and transform its education system by increasing the enrolment across all levels, from preschool to tertiary education (Eleventh Malaysia Plan, 2015).

Moving towards 2020, in the 11th Malaysia Plan, 2016-2020, the measures were further developed to push the economic agenda of forming human capital equipped with the right knowledge, skills, and attitudes in order to thrive in a globalised economy (Eleventh Malaysia Plan, 2015). Malaysia is expected to create 1.5 million jobs to increase labour productivity and reduce the dependency on low-skilled foreign workers. The government will focus on enhancing the labour market efficiency, transforming Technical and Vocational Education and Training (TVET), strengthening lifelong learning for skill enhancement and increasing the education system quality.

Later, the Ministry of Education implemented an education transformation plan through the Malaysia Education Blueprint 2013-2025 to equip our human capital with the 21st century knowledge as well as skills in order to be one of the top global players (Ministry of Education Malaysia, 2016). It is the government's aim to develop Malaysia's children with the knowledge, leadership skills, language proficiency, ethics and spirituality, critical thinking skills, and national identity to succeed in the 21st century. The skills students will need to succeed in the 21st century era include communication, creativity and innovation, collaboration, critical thinking and problem solving (Beers, 2011).

The Malaysia Education Blueprint 2013-2025 (Shift 1) focuses on the aim to provide equal access in Malaysian education standard to be at par with the international standard. The Ministry hopes that standards for student outcomes as well as learning practices would be benchmarked and aligned with that of the high-performing education systems so that Malaysia produces the students who are globally competitive. Thus, the Blueprint identifies a number of reforms that needs to be implemented with the introduction of the Secondary School Standard Curriculum or *Kurikulum Standard Sekolah Menengah* (KSSM) and revised the Primary School Standard Curriculum or *Kurikulum Standard Sekolah Rendah* (KSSR) in 2017 by placing larger emphasis to promote knowledge and skills like innovation, creative thinking, problem-solving and leadership. The new curriculum is designed based on international benchmarks to ensure that children who enter the school system in the country have the necessary skills to compete globally (Ministry of Education Malaysia, 2013). The Ministry will make sure that students do not only excel in subject but are able to provide reasoning, extrapolate, and creatively apply their knowledge in unfamiliar and novel settings. Thus, the ministry will gradually improve the percentage of questions that testing the higher-order thinking that comprises at least 40% of questions in *Ujian Pencapaian Sekolah Rendah* (UPSR) and 50% in *Sijil Pelajaran Malaysia* (SPM). The changes in examination design will train students to improve their critically thinking and apply knowledge in different settings.

It is the government's vision that in the near future, children will learn ways to further acquiring knowledge all through their lives, to connect various pieces of knowledge and form new knowledge (Ministry of Education Malaysia, 2013). The transformation of the education system and improvement of the teaching and learning process hopefully will produce students that can master a range of important cognitive skills, which is inclusive of critical thinking, creative thinking, reasoning, and innovation. One of the most important 21st century skills students need is problem solving because there are many advantages someone with good problem solving skill can benefit from in life and in the workplace (Khalid, 2017).

1.2 Mathematics Education in Malaysia

Mathematics as a compulsory subject has a strategic role in establishing formal knowledge characters for students from preschool until the higher education stage (Rahman & Ahmar, 2016). Thus, the Malaysian secondary school mathematics curriculum aims to develop individuals with the ability to think and apply mathematical knowledge effectively and responsibly in solving problems and making decisions to cope with daily life challenges (Ministry of Education Malaysia, 2006). One of roles the mathematics in education is the intention to develop students' mathematics-related powers capabilities of practical and work-related knowledge and skills, functional numeracy, and advanced specialist knowledge of mathematics that can be used in life beyond school (Ernest, 2015).

The mathematics curriculum in Malaysia has undergone two major reforms since 1970, whereby the Modern Mathematics Program (MMP) was introduced, and in the mid 1980s, the mathematics curriculum was further revised with the introduction of the national integrated curriculum for both the primary and secondary school which has undergone a few minor changes periodically (Nik Azis, 2008). The syllabus content does not have significant differences from the MMP, but emphasizes on achieving the balance between understanding concepts and computational skills, and also on the importance of context in problem solving (Ahmad Zanzali, 2011).

The latest mathematics syllabus in Malaysia has been designed to incorporate Higher Order Thinking Skills (HOTS) such as problem solving to improve the quality of education (Ministry of Education Malaysia, 2016). In general, the perspective on mathematics learning has shifted from mathematical learning as a set of facts as well as procedures to mathematical learning as a set of intellectual tools to understand the circumstances involving mathematics (Nik Azis, 2008). HOTS was widely introduced in the year 2013, which has in a way to trained students the ability to apply methods or knowledge to solve problems innovatively, creatively, and consequently students have the ability of creating a new dimension based on the knowledge that has been learnt (Ministry of Education Malaysia, 2013). The implementation of HOTS in the teaching and learning of mathematics can attract students to foster their interest in mathematics and change the society's stigma pertaining to the difficulty related to mathematics (Abdullah et al., 2017).

The introduction of the Thinking map (i-Think) program starting from the year 2012 helps stimulate students' HOTS and prepared them with the knowledge and skills so that they can handle problem solving in daily life (Hassan, Rosli, & Zakaria, 2016). Besides that, teachers can promote the use of HOTS by applying various strategies, such as questioning techniques, problem solving activities, project-based learning, thinking tools, simulations, discussions, role play and gradual increment of the level of difficulties of tasks (Sulaiman et al., 2017). Through mathematical problem solving activities in class, students could apply conceptual understanding of mathematics to solve problems and be more confident when they come across new or complex situations (Ministry of Education Malaysia, 2006). Thus, mathematics education in Malaysia should be able to produce Science, Technology, Engineering and Mathematics (STEM) graduate work force that is creative and has the innovative problem solving skill with a drive to create jobs, rather than only seeking jobs.

Mathematics Education in Matriculation Programme

Matriculation programme is a one or two-year pre-university preparatory programme being provided by the Ministry of Education to prepare students for professional sectors in higher learning sectors (Ministry of Education Malaysia, 2013). Mathematics is a compulsory core subject that must be learned within two or four semester. Since matriculation is a preparatory programme for qualified SPM students to pursue tertiary education, the curriculum contains topics that are required to

strengthen and broaden their knowledge and skill in mathematics for the respective courses.

As problem solving is the primary focus when it comes to teaching and learning of mathematics, the emphasis must not be placed at the secondary level only but also at post-secondary level as well. The Ministry of Education provides a wide range of post-secondary education including Matriculation, which is recognised as a credible foundation programme that meets the entrance requirements of undergraduate programmes in institutions of higher learning in Malaysia and several overseas universities (Ministry of Education Malaysia, 2016). Hence, matriculation mathematics syllabus was designed by taking into consideration the topics covered in secondary schools to strengthen and broaden their knowledge and skill in Mathematics so students are equipped with a complete and strong foundation when pursuing courses in science, technology, social science and management (Matriculation Division, 2006).

The mathematics syllabus for matriculation programme was designed with the aim towards developing students' understanding of mathematical concept and applications, and skills when interpreting and solving the problem so that they have a complete and strong foundation to undergo programmes at tertiary level. In the first semester, the syllabus contains 10 chapters for Science stream and nine chapters for Accounting stream. Meanwhile, for the second semester, mathematics for Science comprises of 10 chapters and 11 chapters for Accounting. The objectives of the syllabus are to enable matriculation students to formulate problems in mathematical forms and to solve them; analyse, interpret and make mathematical decisions, and also apply algebra, calculus, and statistics in the field of science, technology, social science, accounting and management (Matriculation Division, 2006).

1.3 Problem Solving in Mathematics Teaching and Learning

Problem solving is the primary focus of teaching and learning of mathematics process which must include the skills that are comprehensive which cover the whole curriculum (Ministry of Education Malaysia, 2006). Mathematics curriculum for secondary schools adopt the problem solving strategy from Polya (1957) and the further strengthening of the strategies was carried out in the process of teaching and learning of Additional Mathematics subject (Ministry of Education Malaysia, 2006). This curriculum places heavy emphasize on relationship between mathematics and real life problems through problem solving and it could aid students to appreciate mathematics (Ahmad Zanzali, 2000).

Teaching topics in mathematics through problem solving focused on problem-solving contexts and enquiry-oriented environments (Khalid, 2017). A problem solving activity can help students experience the power of mathematics by understanding the mathematical content and encourage them to apply the knowledge in the real world problems (Ahmad Tarmizi, Kargar, & Saadati, 2015). However, most students further

their study at the university level and become rote learners without appreciating the usefulness of mathematics in daily life (Abdullah, Halim, & Zakaria, 2014).

Integration is included in the first topic and is made to be covered in the second semester of the One-Year Programme in matriculation mathematics syllabus. One of the main concepts in Calculus is that important for students to master is the definite integral concept and this concept is learned not only in Mathematics classes, but also in Physics, Chemistry and Engineering classes at university level (Serhan, 2015). However, a research on engineering students in the application of integration topic found that majority of them had difficulty in understanding the concepts (Janier, Shafie, & Wan Ahmad, 2010).

A vast amount of researches were conducted to research on students' characteristics towards their mathematics performance. This includes a study on difficulties that students' face during mathematics problem solving (Ayop & Ahmad Tarmizi, 2015). A number of studies revealed that affective factors such as mathematics beliefs (Abedalaziz & Akmar, 2012; Kamalimoghaddam, Ahmad Tarmizi, Mohd Ayub, & Wan Jaafar, 2016), mathematics attitude, metacognitive and mathematics self-efficacy are influential in problem solving (Wan Jaafar & Mohd Ayub, 2010; Guven & Cabakcor, 2013).

At matriculation level, students need assorted strategies when planning to solve mathematics problems that involve more than one solution (Zakaria & Yusoff, 2009). Students' beliefs on mathematics could determine how they approach a problem, which strategies to be employed or avoided and how long they persevere when solving mathematics problems (Schoenfeld, 1985). Previous researchers had reported that students' beliefs on mathematical problem solving within classroom activities could predict mathematics achievement (Mason, 2003). Students who constructed more advanced and productive beliefs about mathematics can help them in improving their problem solving strategies and solve mathematics problems correctly (Mason & Scrivani, 2004). Besides, beliefs in problem solving can enhance students mathematics ability to successfully solve mathematics problems (Ishida, 2002).

Many researchers reported that positive mathematics attitude and beliefs will increase mathematics achievement. Students can perform and obtain better grades when they show good attitudes towards mathematics by spending more time to solve the problems (Lim & Chapman, 2013). However, students with negative mathematics attitudes are more reluctant to solve mathematics problems and lack the perseverance in solving it (Zakaria & Yusoff, 2009). Pyzdrowski et al. (2013) recommended that incorporating metacognitive skills and attitudes towards mathematics, especially self-confidence, influences the mathematics achievement. Students who lack metacognitive skills tend to face problems in problem solving (Idris, Abdullah & Sembak, 2015). In order for problem solving to become an integral part of students' experience from primary to tertiary levels, all aspects of the human psychology such as cognition, affect, metacognition and behaviour must be involved (Mason, 2016).

Kamalimoghaddam et al. (2016) suggested that students who held strong mathematics beliefs had higher mathematics self-efficacy and will perform better in mathematics. Problem solving that requires students perseverance and confidence to solve problems, thus, mathematics beliefs and self-efficacy are particularly very important (Ozturk & Guven, 2016). Students having low self-efficacy tend to give up and will avoid solving challenging mathematics problems (Hassan, Alasmari & Ahmed, 2015).

Thus, this research is aimed to identify the relationships between mathematics beliefs, mathematics attitude and metacognitive skills with mathematics problem solving performance particularly in the integration topic of matriculation students. Moreover, students affective factors and metacognitive skills on mathematics performance were used to evaluate prediction of factors that influence mathematical problem solving.

1.4 Problem Statement

The unsatisfactory performance of Malaysian students in TIMSS and PISA assessment where their performance was far from satisfaction raises the concerns of many people (Ismail, Salleh, & Aris, 2017). Although Malaysia recorded an increase in Mathematics score for TIMSS 2015 with a score of 465, Malaysia is still in the intermediate rank in international benchmarks (Bahagian Perancangan dan Penyelidikan Dasar Pendidikan, 2016). Falling in this benchmark implies that most of the students could only apply basic mathematical knowledge in straightforward situations. Since problem solving emphasizes on applications that allow students to relate mathematics to their real life situations, there is a need to evaluate students' level of performance in mathematical problem solving.

The mathematics curriculum in matriculation programme was designed to develop students' understanding of mathematical concepts and applications, and skills to interpret and solve problems so that they are equipped with a complete and strong foundation in mathematics to pursue tertiary education level in the field of science, technology, and accounting (Matriculation Division, 2006). However, universities are having concerns regarding the declining level of mathematics ability among pre-university students as it can cause difficulties to enrol undergraduate students for engineering course (Ahmad Fuaad, Mohd Nopiah, Chik, Md. Shafie, & Awaluddin, 2016). Furthermore, a study conducted by Kamal, Arsad, Husain and Nopiah (2015) concluded that pre-university education is associated with students' performance in engineering subjects when they are pursuing education at the university level. Hence, this study is necessary to be conducted among matriculation students since matriculation is a pre-university preparatory programme.

As highlighted by Ong and Lim (2014), although most of matriculation students have good grades in mathematics subject at secondary level but they are still having difficulties in mathematical problem solving. Zakaria and Nordin (2008) stated that matriculation students can perform well during mathematics class and assignment but still fail to do well in examination. A study on attitudes and problem solving skills by

Zakaria and Yusoff (2009) showed that algebra problem solving skills among Malaysian matriculation students were at the average level. They also found that students were not able to solve problems correctly at the stage of solution planning and monitoring. Matriculation students also had difficulties to understand the mathematical symbols, which affects their confidence in solving mathematics problems (Ong & Lim, 2014). Therefore, students' problem solving skills when solving mathematical word problems need to be further investigated.

Students who have strong mathematics beliefs had a higher mathematics self-efficacy and therefore perform better in mathematics (Kamalimoghaddam et al., 2016). Mathematic beliefs on problem solving is particularly crucial among students mathematics learning environment since it influences students involvement in the learning activities and their mathematics performance (Abedalaziz & Akmar, 2012). Thus, in order to improve students' performance in problem solving, students' beliefs on mathematical problem solving are required to be determined and identified.

Similarly, Norton and Irvin (2007) suggested that students with poor mathematics attitudes can cause them to view mathematics as a dull subject, which only involves calculation. Besides, students with negative mathematics attitudes are more reluctant to solve mathematics problems and lack perseverance in solving it (Zakaria & Yusoff, 2009). Thus, students' mathematics attitude when solving problems must be taken into consideration to prevent students from giving up easily when attempting to solve problem solving in mathematics.

Hassan, Alasmari and Ahmed (2015) claimed that students with low self-efficacy tend to give up and will avoid solving challenging mathematics problems. They believe that their effort and ability to solve problems is deficient (Chen, Lee, & Hsu, 2015). Meanwhile, a high of self-efficacy level would motivate students to put in more effort, whereby they would persist longer and complete the problems (Loo & Choy, 2013). In order to prevent students from giving up easily while solving unfamiliar problems, their self-efficacy in mathematical problem solving must be taken into consideration.

Idris, Abdullah and Sembak (2015) suggested that students who lack metacognitive skills tend to face problems when attempting problem solving. Most of teaching and learning strategies in the classroom only focus on the content knowledge and ignore the necessary skills needed to learn effectively (Rahman, Yasin, Ariffin, Hayati, & Yusoff, 2010). Metacognitive skills have a crucial role in mathematical problem solving in order for students to become efficient learners (Ahmad Maulana & Mohd Idrus, 2013). Thus, students' metacognitive skills when solving mathematics problems are required to be determined.

Most studies involving matriculation students have been done on carried out to study the relationship of mathematics anxiety with motivation and achievement (Zakaria & Nordin, 2008), metacognitive skills and achievement in mathematical problem solving (Zakaria, Yazid, & Ahmad, 2009), conceptual knowledge of mathematics and

mathematics achievement (Zakaria, Yaakob, Maat, & Adnan, 2010) and students' points of view on problem solving difficulties (Ayop & Ahmad Tarmizi, 2015). However, to date, there are no researches made on matriculation students investigating the combined mathematics beliefs, mathematics attitude, mathematics self-efficacy and metacognitive skills with mathematical problem solving, particularly the non-routine problems. Therefore, in this study, the influence of these four factors were studied to determine students' mathematical problem solving performance among matriculation students.

In conclusion, matriculation students have difficulties in mathematical problem solving. Students are lacking in mathematical problem solving skills and mathematics skills and these impede the development of problem solving in mathematics learning. Therefore, this research was carried out to identify the relationships between mathematics beliefs, mathematics attitude, mathematics self-efficacy and metacognitive skills with performance in problem solving. In this research, the prediction of mathematical problem solving performance was carried out using mathematics beliefs, mathematics attitude and metacognitive skills as predictors.

1.5 Research Objectives

The objectives of this research are as below:

1. To determine students' mathematics beliefs, mathematics attitudes, mathematics self-efficacy, metacognitive skills and mathematical problem solving performance among Malaysian matriculation students.
2. To determine the relationship of mathematics beliefs, mathematics attitudes, mathematics self-efficacy and metacognitive skills with performance in problem solving among Malaysian matriculation students.
3. To predict factors that influence mathematical problem solving performance among Malaysian matriculation students.

1.6 Research Questions

The research questions based on objective 1 are as follows:

RQ_1 : What are students' mathematics beliefs in mathematical problem solving?
RQ_2 : What are students' mathematics attitudes in mathematical problem solving?
RQ_3 : What are students' mathematics self-efficacy in mathematical problem solving?
RQ_4 : What are students' metacognitive skills in mathematical problem solving?
RQ_5 : What are the levels of mathematical problem solving performance among Malaysian matriculation students?

1.7 Research Hypotheses

The following hypotheses that will be tested based on objective 2 and 3 are as follows:

H_1 : There is a significant relationship between students' mathematics beliefs with performance in problem solving among Malaysian matriculation students.

H_2 : There is a significant relationship between students' mathematics attitudes with performance in problem solving among Malaysian matriculation students.

H_3 : There is a significant relationship between students' mathematics self-efficacy with performance in problem solving among Malaysian matriculation students.

H_4 : There is a significant relationship between students' metacognitive skills with performance in problem solving among Malaysian matriculation students.

H_5 : There is a significant factor that influence students' mathematical problem solving performance among Malaysian matriculation students.

1.8 Significance of the Study

There are a few rationales and crucial reasons why this research needs to be conducted. This study's research would add to the growing body of knowledge about problem solving in mathematics as it proposes to investigate the factors influencing mathematical problem solving performance among Malaysian matriculation students. Although there are previous studies carried out on the relationship between mathematical problem solving achievement, students' mathematics attitudes, mathematics self-efficacy, and mathematics beliefs but very few studies were made on post-secondary education such matriculation students. Post-secondary level education in Malaysia, especially the Matriculation Programme, has not been researched extensively as compared to primary, secondary and tertiary education levels.

This present study aims to determine students mathematics beliefs, mathematics attitude, metacognitive skills and mathematics self-efficacy to explain mathematical problem solving performance. This study focused on mathematical problem solving performance based on understanding, planning and answer. Analysing the factors that may influence the mathematical problem solving performance will provide an enriched information in improving mathematics education. Mathematics lecturers need to know how to enhance students' optimal potential in mathematical problem solving by identifying what factor affects students' performance the most. This indirectly requires lecturers to change their teaching approaches, strategies, and practices in the teaching process. Lecturers can consider individual differences when teaching the subjects and design learning environments based on these differences. In order to discover the hidden factors of effective teaching and learning process, an investigation of factors influencing students' mathematical problem solving performance for Malaysian students, especially in pre-university level is deemed necessary. Thus, this study aims to investigate and will ascertain the factors influencing students' mathematical problem solving performance. The findings from

this research can provide researchers and lecturers with insights into how beliefs, attitudes, metacognitive and self-efficacy influence the way knowledge is transferred to students.

In addition, the wealth of literature materials and findings in this research will serve as a source of information for mathematics educators, as well as for policy makers and curriculum planners in Matriculation Division to improve mathematical problem solving performance. This research will provide an opportunity for Matriculation Division to prepare mathematics syllabus, which is in line with enhancing the level of students' mathematical problem solving.

Finally, this research will provide information for further researches to researchers in the mathematics education and beyond. It also can be used as a guide for researchers to make improvement with regards to the studies on problem solving at the doctoral level later.

1.9 Limitations of the Study

There are a few limitations identified in this research. The study will only be limited and focused on students of the Matriculation Division, under the Ministry of Education Malaysia. Students' mathematical problem solving in matriculation colleges may not relate to other subjects, and levels such as primary and tertiary education. Therefore, the generalization of results obtained may be limited to the A-Level programme, pre-university programme in public and private universities, and Form Six students.

As it is a survey study, the self-reported data are gathered by means of questionnaires and tests set. Therefore, the outcomes are based on respondents' self-reports and this is clearly a limitation of the research. Moreover, the present study only investigates students' mathematics beliefs, mathematics attitudes, metacognitive skills and mathematics self-efficacy on students' mathematical problem solving performance. There are other factors that might influence students' mathematical problem solving performance such as gender, parents' education, and socio economic status. Finally, the content of knowledge that is focused in this study is only on the Integration topics for post-secondary education level, mainly from the mathematics matriculation syllabus.

1.10 Definitions of Terms

The following terms were employed and clearly defined in the study in order to obtain a proper understanding and to refrain any confusion on the usage of terminologies. They are as following:

1.10.1 Mathematical Problem Solving Performance

Mathematical problem solving refers to mathematics problems that have the potential to contribute intellectual challenges for strengthening students' mathematical conceptual understanding and development (NCTM, 2010). Polya (1957) defined mathematical problem solving like finding a strategy around a hardship and to get a solution to unfamiliar problem, while Stylianides and Stylianides (2014) referred to mathematical problem solving as the activity of finding a solution to a mathematics problem that relates the data with the unknown. In this research, mathematical problem solving performance referred to students' achievement to find a solution for the mathematical problem solving test. The Mathematical Problem Solving Test (MPST) comprises of five self-developed non-routine mathematics problems to assess student's problem solving performance. The problems were based on matriculation mathematics curriculum which cover the topic on Integration.

1.10.2 Mathematics Beliefs

Mathematics belief is defined as an individual beliefs about mathematics that encourage him/her to make decisions regarding actions they will attempt (Kloosterman, Raymond, & Emenaker, 1996). Mathematics beliefs has also been defined as students' conceptions about mathematics that they hold to be true either implicitly or explicitly, and can influence them in mathematics learning and mathematical problem solving (Op't Eynde & De Corte, 2003). In this study mathematics beliefs is defined as students' beliefs about mathematical problem solving and their approaches in mathematics learning, and this consist of five dimensions. Kloosterman and Stage (1992) suggested these five dimensions to be difficult problems, steps, understanding, word problems and effort.

1.10.2.1 Difficult Problems

Kloosterman and Stage (1992) refers to difficult problems which requires perceived ability in solving time-consuming mathematics problems, while Abedalaziz and Akmar (2012) stated that difficult problems involves confidence to solve mathematics problems that need a long space of time. Difficult problems in this study refers to students' beliefs to solve time-consuming mathematics problems.

1.10.2.2 Steps

Kloosterman and Stage (1992) referred to steps as students' level of belief about the existence of mathematics rules. Mason (2003) stated that step-by-step procedures cannot solve all of the mathematics problems. Steps in this study refers to students' belief that there are mathematics word problems that cannot be solved by following procedural method.

1.10.2.3 Understanding

Prendergast et al. (2018) refers to whether or not it is necessary for students to understand how to get solutions when solving mathematics problems. Bal (2015) indicated that understanding mathematics problems is important to find solutions. Understanding in this study refers to students' beliefs about the importance to understand why a particular procedure is correct rather than to get the right answer.

1.10.2.4 Word Problems

Kloosterman and Stage (1992) refer to word problems as students' view that solving word problems is crucial which will motivate them to become successful problem solvers besides just having computational skills. Abedalaziz and Akmar (2012) refer to word problems as an essential element of mathematics which deals with mathematics discipline. Word problems in this study refers to students' perceptions of the importance of solving word problems rather than computational skills.

1.10.2.5 Effort

Effort refers to the students' believe that their attempt to study can improve their mathematics ability and increase their problem solving skills (Kloosterman & Stage, 1992). Similarly, Prendergast et al. (2018) highlighted that students who beliefs that the effort they put can motivate them to successfully solving mathematics problems. Effort in this study refers to students' beliefs that efforts can strengthen their mathematics ability and thus make them smarter in mathematics.

1.10.3 Mathematics Attitudes

Mathematics attitude is defined as a positive or negative attitude on emotional disposition towards mathematics (Zan & Di Martino, 2007). Mathematics attitude is also defined as individual's emotional response towards mathematics, beliefs in mathematics and their behaviour towards mathematics (Hart, 1989). In this study mathematics attitudes is defined as students' attitude towards mathematics during learning process in the classroom, and this consists of four dimensions. Tapia and Marsh (2004) suggested that these four dimensions are self-confidence, value, enjoyment, and motivation.

1.10.3.1 Self-confidence

Majeed, Darmawan and Lynch (2013) indicated self-confidence as students' sense of dread, anxiety and hatred of hearing the word mathematics. Self-confidence will influence students effort and perseverance to keep trying to find a solution in solving mathematics problems (Jonassen, 2000). In this study, self-confidence refers to students' confidence and self-concept of their mathematical problem solving performance.

1.10.3.2 Value

Value refers to the usefulness and relatedness of learning mathematics to students lives (Tapia & Marsh, 2004). Meanwhile, Hannula (2002) refers to value as students' understanding of the importance of mathematics to achieve their goals. In this study, value refers to students' feeling on the relevance, usefulness and importance of mathematics in their life situation.

1.10.3.3 Enjoyment

Tapia and Marsh (2004) defined enjoyment as students' satisfaction when solving mathematics problems in the classroom. Majeed et al. (2013) refers to enjoyment as students' feeling of pleasure in solving challenging mathematics problems, willingness to participate in mathematics discussion and their excitement in mathematics classroom. In this study, enjoyment refers to students' pleasure in learning mathematics in classroom.

1.10.3.4 Motivation

Motivation refers to students' enthusiasm to continue learning mathematics beyond what is required for them to learn (Majeed et al., 2013). Similarly, Ajisuksmo and Saputri (2017) stated that motivation involved students' interest in learning mathematics and willingness to further their knowledge in mathematics. In this study, motivation determines the extent to which students are interested in learning mathematics and their intends to further studies beyond the college level.

1.10.4 Mathematics Self-efficacy

Mathematics self-efficacy refers to individual's beliefs or perceptions that he/she has the ability to perform a specific task or solving mathematics problems (Bandura, 1997). Mathematics self-efficacy is defined as students' beliefs about their capabilities to carry out tasks needed for learning (Joët, Usher, & Bressoux, 2011). In this study mathematics self-efficacy is defined as students' confidence of their abilities to complete a variety of tasks, from understanding concepts to solving problems in mathematics. Mathematics self-efficacy were measured with four subscales, namely mastery experience, vicarious experience, social persuasions and physiological states (Usher & Pajares, 2006).

1.10.4.1 Mastery Experience

Mastery experience refers to how students view and assess previous achievement, and judgements of competence are amended according to these views (Doménech-Betoret, Abellán-Roselló, & Gómez-Artiga, 2017). Goldin et al. (2016) defined mastery experience as students' capabilities that develop from previous success and in contrast, failure undermines this capability. In this study, mastery experience refers to students' interpretation of their current and previous mathematics performance.

1.10.4.2 Vicarious Experience

Usher and Pajares (2009) refers to vicarious experience as how students feel about the academic skills of peer or adult models in the subject of interest. Vicarious experience can established students' judgements of capabilities by assessing their competence with regards to their friends and teachers' performance (Usher & Pajares, 2009). In this study, vicarious experience refers to students making judgments about their own capabilities when observing their mathematics lecturers and peers solving mathematics problems successfully.

1.10.4.3 Social Persuasions

Usher and Pajares (2006) defined social persuasions as the encouraging messages students get from teachers, parents, and closed friends that can empower their confidence in academic capabilities. In this study, social persuasions refers to the extent to which students receive encouraging feedback for their mathematics capabilities from families and peers.

1.10.4.4 Physiological States

Yurt (2014) defined physiological states as someone's emotional condition. Pysiological states refer to students' interpretation about their feeling of anxiety due to lack of academic capabilities when entering the classroom (Usher & Pajares, 2009). Physiological states in this study refers to respondents' anxiety when solving mathematics problems.

1.10.5 Metacognitive Skills

Metacognitive skill was defined as individual's ability to reflect and this skill is used to understand, planning and evaluate learning activities (Schraw & Dennison, 1994). Metacognitive can also be expressed as individual's awareness to periodically monitor whether he/she attained the goal and carry out different strategies after selecting them if they were necessary (O'Neil & Abedi, 1996). In this study context, metacognitive skills have been defined as students' awareness of mathematical problem solving process. As suggested by O'Neil and Abedi (1996), metacognitive skills consisted of four dimensions, which are planning, self-checking, cognitive strategy and awareness.

1.10.5.1 Planning

O'Neil and Abedi (1996) refers to planning as individuals' goal that is coupled with strategy to reach it. Planning is related to the learning strategy, goal setting and focusing on materials (Rahman, Yasin, Ariffin, Hayati, & Yusoff, 2010). In this study, planning refers to students' plan to solve mathematical problem solving questions.

1.10.5.2 Self-checking

Self-checking or monitoring is defined as the self-analysis process when monitoring goal achievement (O'Neil & Abedi, 1996). Desoete (2008) defined self-checking as students' ongoing control on their learning process to determine problems and to change strategy when needed. In this study, self-checking refers to students self-monitoring ability to monitor their solution when answering mathematical problem solving questions.

1.10.5.3 Cognitive Strategy

O'Neil and Abedi (1996) refers cognitive strategy as an individual cognitive or affective strategy that is required when monitoring learning activities. In this study, cognitive strategy refers to students' cognitive or affective strategy to find the main idea before attempting to solve mathematical problem solving questions.

1.10.5.4 Awareness

O'Neil and Abedi (1996) defined awareness as a process that someone is fully aware of. In this study, awareness relates to students' conscious with the process of answering mathematical problem solving questions.

1.11 Conclusion

This chapter discussed the background of the study, problem statement, research objectives, questions and hypotheses, significance and limitations of the study, and definition of terms used in this study. The following chapter will discuss the literature related to students' mathematical problem solving and theories involved in mathematical problem solving.

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