

CRITICAL THINKING DISPOSITION OF MALAYSIAN SECONDARY
SCHOOL STUDENTS TOWARDS MATHEMATICS AND ITS RELATIONSHIP
WITH STUDENTS' SELF EFFICACY

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task could be accomplished if it is done one step at a time.

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ABSTRACT

Critical thinking disposition is one of the factors that 21st-century education welcomes to develop better globalisation nationwide. Especially in Mathematics, it has been a vision to create future learners who implement learning into real-life. However, international tests such as PISA and TIMSS, has shown poor results for Malaysian students, especially 15 years old students, inconsequent years despite the change in syllabus and learning aspects. Therefore, this study aims to identify the level of critical thinking disposition towards mathematics among lower secondary students from the Plentong district and establish the relationship between critical thinking dispositions and self-efficacy through quantitative research of 126 students selected through random sampling. Instruments used in this study were two questionnaires that consist of questions to evaluate the level of critical thinking disposition towards Mathematics and evaluate the self-efficacy towards Problem Solving. Both the questionnaire consists of Likert scales (1 as highest to 5 as lowest). Data were analysed using SPSS version 26. The analysis on the level of disposition among Malaysian students towards Mathematics showed a moderate scale. The Spearman Correlational test used to identify the relationship between self-efficacy and the level of Mathematics' critical thinking dispositions. The result showed no statistical significance, which proves there is no association between self-efficacy and critical thinking disposition levels. The findings of this study emphasis on problem-solving and critical thinking skills in Mathematics.

ABSTRAK

Kecenderungan pemikiran kritis adalah salah satu faktor yang disukai oleh pendidikan abad ke-21 untuk mengembangkan globalisasi yang lebih baik di seluruh negara. Terutama dalam Matematik, telah menjadi visi untuk mewujudkan pelajar masa depan yang menerapkan pembelajaran ke kehidupan nyata. Walau bagaimanapun, ujian antarabangsa seperti PISA dan TIMSS menunjukkan keputusan yang lebih rendah bagi pelajar Malaysia, terutamanya di kalangan pelajar berusia 15 tahun pada tahun-tahun yang berturut-turut walaupun terdapat perubahan dalam aspek pengajaran dan pembelajaran. Oleh itu, kajian ini bertujuan untuk mengenal pasti tahap disposisi pemikiran kritis terhadap matematik di kalangan pelajar menengah rendah dari daerah Plentong dan mewujudkan hubungan antara tahap pelupusan pemikiran kritis dengan keberkesanan diri pelajar. Kajian ini menggunakan penyelidikan kuantitatif, yang melibatkan 126 pelajar melalui persampelan rawak. Instrumen yang digunakan dalam kajian ini adalah 2 borang soal selidik yang terdiri daripada soalan yang digunakan untuk menilai tahap pemikiran kritis terhadap Matematik dan menilai keberkesanan diri terhadap Penyelesaian Masalah. Kedua-dua soal selidik terdiri daripada skala Likert (1 tertinggi hingga 5 paling rendah). Tahap disposisi pemikiran kritis di kalangan pelajar dianalisis menggunakan 20 item soalan Data dianalisis menggunakan SPSS versi 26. Analisis mengenai tahap disposisi di kalangan pelajar Malaysia terhadap Matematik menunjukkan hasil skala sederhana. Ujian Korelasi SPEARMAN digunakan untuk mengenal pasti hubungan antara keberkesanan diri dengan tahap disposisi pemikiran kritis Matematik. Hasilnya tidak menunjukkan kepentingan statistik yang membuktikan tanda tidak ada hubungan antara keberkesanan diri dengan tahap pemikiran kritis. Dapatan kajian ini dapat menunjukkan alasan untuk menanamkan kemahiran berfikir kritis dan menyelesaikan masalah di kalangan pelajar sekolah menengah.

TABLE OF CONTENTS

	TITLE	PAGE
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF APPENDICES	xiii
CHAPTER 1	INTRODUCTION	15
1.1	Introduction	15
1.2	Problem Background	17
1.3	Problem Statement	21
1.4	Research Goal	22
	1.4.1 Research Objectives	22
	1.4.2 Research Questions	23
	1.4.3 Research Hypotheses	23
1.5	Conceptual Framework	24
1.6	Operational Definitions	26
	1.6.1 Critical Thinking Disposition	26
	1.6.2 Critical Thinking among Malaysian students	26
	1.6.3 Critical Thinking in Mathematics Education	27
	1.6.4 Self-Efficacy in Mathematics	27
1.7	Purpose and Importance of Study	27
	1.7.1 Ministry of Education Malaysia	27

1.7.2	Mathematics Educators	28
1.7.3	Parents	28
1.8	Limitations	29
1.9	Summary	30
CHAPTER 2	LITERATURE REVIEW	31
2.1	Introduction	31
2.1.1	Constructivism Theory of the Critical Thinking Dispositions	31
2.1.2	Framework Model of Critical Thinking Dispositions by Paul & Elder (2004)	33
2.2	Researchers view on the Mathematical Problem Solving Skills	35
2.3	Researchers view on the Self-Efficacy Towards Mathematics	35
2.4	Critical Thinking by Norris and Ennis (1989)	36
2.5	Summary	38
CHAPTER 3	RESEARCH METHODOLOGY	39
3.1	Introduction	39
3.2	Research Design	40
3.3	Research Sample	41
3.3.1	Sampling Technique and Procedures	42
3.3.2	Research Instrument	43
3.4	Instrument Validity	45
3.5	Data Collection Procedure	46
3.6	Data Analysis Protocol	50
3.7	Summary	51
CHAPTER 4	FINDING	52
4.1	Introduction	52
4.2	Findings of the study	52
4.3	Descriptive Analysis and Hypothesis Test	53
4.3.1	Critical Thinking Dispositions among Secondary students towards Mathematics	53

4.3.2	Self-Efficacy of the students towards the Mathematical Problem Solving	58
4.3.3	Relationship between the Critical Thinking Dispositions towards Mathematics with the Self-Efficacy in the problem solving	62
4.4	Chapter Summary	66
CHAPTER 5	DISCUSSION & CONCLUSION	67
5.1	Introduction	67
5.2	Discussion of Research Findings	67
5.2.1	Levels of critical thinking dispositions among Malaysian secondary school students.	69
5.2.2	Students' self-efficacy in Mathematics Problem solving	70
5.2.3	Relationship between critical thinking dispositions and self-efficacy in Mathematics.	70
5.3	Limitations	71
5.4	Research Implications	72
5.4.1	Ministry of Education	73
5.4.2	Mathematics Teachers	73
5.4.3	Parents	
5.5	Further Research in Future	74
5.6	Conclusion	75
REFERENCES		77

LIST OF TABLES

TABLE NO.	TITLE	PAGE
Table 1.1.1	Challenges and researchers 'statement for the problem	18
Table 3.1	Instrument and Data analysis	44
Table 3.2	Elements tested through CTDI form	45
Table 3.3	Validity result	46
Table 3.4	Items in CTDI form	48
Table 3.5	Items from Self-efficacy questionnaire	49
Table 4.1	Gender of respondents	52
Table 4.2	Difference in Students' schools	53
Table 4.3	Descriptive analysis on the CTDI form result	54
Table 4.4	Frequency and Percentages for Critical Thinking Self-Confidence	54
Table 4.5	Frequency and Percentage for Inquisitiveness	55
Table 4.6	Frequency and Percentage for Cognitive Maturity	55
Table 4.7	Frequency and Percentage of Open-Mindedness	56
Table 4.8	Frequency and Percentage of Analyticity	56
Table 4.9	Frequency and Percentage of Systematicity	57
Table 4.10	Frequency and Percentage of Truth-Seeking	57
Table 4.11	Descriptive analysis for Self-efficacy form	58
Table 4.12	Frequency and Percentage of Item 1 of Self-Efficacy	59
Table 4.13	Frequency and Percentage of Item 2 of Self-Efficacy	59
Table 4.14	Frequency and Percentage of Item 3 of Self-Efficacy	60
Table 4.15	Frequency and Percentage of Item 4 of Self-Efficacy	60
Table 4.16	Frequency and Percentage of Item 5 of Self-Efficacy	61
Table 4.17	Correlation Test on CTD and Self-efficacy	65

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
Figure 1.1.1	TIMSS achievement - comparisons among Asian countries	20
Figure 1.2	Malaysia PISA result ranking with Asia countries	20
Figure 1.3	Conceptual Framework of research	24
Figure 2.1	Paul & Elder Critical Thinking Framework	34
Figure 2.2	Self-efficacy theory applied by Mathematics Teacher	36
Figure 2.3	Norris and Ennis framework for Critical Thinking dispositions	37
Figure 3.1	Methodology planned for the study	40
Figure 3.2	Flowchart of the study	41
Figure 3.3	Process of descriptive analysis	47
Figure 3.4	Procedure for Data collection	48
Figure 3.5	Flowchart for CTDI Assessment	50
Figure 3.6	Flowchart of Data Analysis	51

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Instrument Validation Form	90
Appendix B	Critical Thinking Dispositions Form	92
Appendix C	Self-efficacy Form	96
Appendix D	Jam board questions	97

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, Mathematical education has been facing various transformation that relates closely to globalisation (Yeh,2002). Mathematics learning is an essential element in the education system across the world. New styles and methods in delivering Mathematical concepts have been analysed and applied in schools to create students that mastered and confident in mathematics (English & Halford,1995).

Teaching styles and practices have been improvised along the way to support equally on the learning. Students' interest in Mathematics learning has also faced changes in response to the teaching style that improved (Davis,1984). The Ministry of education also revised the curriculum to achieve a good quality of education that caters to globalisations (Grave Meijer, 1994). PISA and TIMSS were the tests conducted on the secondary students to assess the students' ability and achievement in Problem-solving, Reading, and Science bits of knowledge. The tests worked associate with real-life problem solving (Wu, 2009). Revision of the curriculum and subject's learning and teaching had been based mainly on the outcome of these tests.

The curriculum aim and standard of the education quality revised to achieve higher-order thinking skills within students (Rindermann & Baumeister 2015). As PISA and TIMSS evaluate based on problem-solving skills and critical thinking, the curriculum aims to cultivate them in students.

According to Robert Ennis (1962), critical thinking is a process of understanding a statement and evaluating the agreement. Besides, Aydin (2000) also mentioned that critical thinking requires logical thinking to support higher-order thinking. Whereby essential dispositions of thinking is working on the tendency of

students is facing a problem. The response or reactions will allow the students' critical thinking skills (Smith-Blair & Neighbors , 2000).

In Mathematics learning, it is essential for such critical thinking dispositions. It is necessary to develop the students' critical thinking disposition through real-life problem-solving skills (Yoon, 2008). Especially for Malaysian students, this is to enhance their PISA and TIMSS results and prepare them for future globalisation. A survey conducted on the students proved that Malaysian students' problem-solving skills are lower than in other countries such as Singapore (Lee, 2009).

Malaysian Mathematics curriculum is also having changes in delivering the lessons and aims to be achieved that caters the students' development towards the globalisation. Perkins, Jay and Tishman (1993) describe critical thinking dispositions as central to right thinking. Therefore, instilling the students with critical thinking dispositions using the real-life problem as context will be supporting the nations' aim in quality education. However, researchers conducted a recent survey to analyse the critical thinking dispositions conducted on tertiary education students towards the mathematical concepts.

Based on the discussion of the secondary students in Malaysia and other countries' PISA and TIMSS outcomes in a research paper (Klieme, 2016), it was evident that secondary mathematics education will be suitable to analyse the requirements and expectations of critical thinking disposition in Malaysian Mathematics. This research will be an eye-opener for developing critical thinking dispositions, especially emphasising problem-solving skills.

1.2 Problem Background

The Sustainability and Development mission generated 17 goals, and one of them was a quality education. Quality of education has taken into concern when planning for globalization as one of the vital goals. Especially in Malaysia, the learning style implemented is slightly away from the traditional manner as a plan to improve education quality. High Order Thinking Skills (HOTS) applied as an element for assessment among secondary students to enhance quality education. It was an agreed fact that enhancement for the quality of education requires higher-order thinking skills and problem-solving that caters to the needs of globalization. Mainly in Mathematics, considering critical thinking and problem-solving skills as equal as mastering the basic concepts is essential for a future application to the real-life components.

PISA and TIMSS are the assessments conducted across the nation to determine the level of critical thinking and problem-solving skills among secondary students. Secondary students chose internationally as their Mathematics learning focusses on the higher content knowledge of the syllabus. Malaysia made several changes in the education system after these tests improve the Mathematical thinking skills among children. Critical thinking dispositions is a term that not so familiar among learners. However, this has been in concern ever since learning and teaching became less likely to be the traditional approaches. Though it requires consistent effort in developing critical thinking among students, it can increase students' performance in problem-solving. Exposed in the long term with these skills will become a routine of the students' thinking process, especially in real-life contexts.

Nations worldwide that participated in the international assessments agreed that students should be practising their critical thinking dispositions and not only critical thinking. Dispositions are to create the tendency or trigger of solving a problem critically. Even though Malaysian mathematics education has so far attempted to instil critical thinking among students, still the interest or eagerness to solve real-life problems is yet to be found. Mathematical solutions with reasoning should be encouraged in both primary and secondary to develop the ability to think critically.

International assessment results do not reflect Malaysia's students' achievement as low of problem-solving elements portrayed compared to other countries. Survey and researches conducted explained that there is a significant relationship between problem-solving and critical thinking skills. This matter should be given priority and taken into consideration as necessary thinking disposition will support applying mathematical concepts and critically solve the real-life problem, especially in the secondary Mathematical context.

A recent survey among tertiary students proved that they did not firmly apply critical thinking dispositions in their daily lives apart from the learning sessions. When we analyze further, critical thinking dispositions in Mathematics hardly triggered to both primary and secondary students during learning. Syllabus completion and summative assessments were the aims of learning where the educators intention falls on improving their basic knowledge and problem-solving methods only. Though problem-solving has a close connection with critical thinking dispositions as it one of the sub-elements of CTD, it needs challenging questions to practice as a skill. The table below explains the researchers' statements and sub-elements of the problem for this study :

Table 1.1.1 Challenges and researchers 'statement for the problem

Challenges	Researchers' statements
Mathematical Problem Solving Skills	<ul style="list-style-type: none"> <li data-bbox="775 1413 1321 1615">• According to T.Subahan (2007) , students need to practice problem solving to develop human competencies. <li data-bbox="775 1666 1321 1921">• Zahirah et. al (2003) strongly agrees that difficulty in problem solving arrives when students had difficulty in understanding the concepts and retrieving the facts.

Critical Thinking Dispositions	<ul style="list-style-type: none"> • Kuhn (1999) claims that dispositions of a learners is a factor that should be analysed over the critical thinking. • Facione (2000) states that dispositions have a driven force on a learners' behaviour and skills. • Ojewole (2013) mentioned that experience of a learner has a close impact on their critical thinking dispositions.
Self-efficacy towards Mathematics	<ul style="list-style-type: none"> • Albert Bandura (1977) refers to self-efficacy as learners' belief of their ability in completing given tasks.
Quality of Education in 21 st century	<ul style="list-style-type: none"> • Saltrick, (2011) mentioned that 21st century skills needs four important skills and one of it critical thinking.

Over the decades, lots of researches and analysis conducted on critical thinking dispositions. Researchers state that CTD in pre-service teachers is low (Bakir, 2015). This study discussed the CTD elements and elaborated the way to analyse them among the pre-service teachers. Ojewole (2013) claimed that experiences would not support critical thinking since it is basically about thought, including the seven elements. Despite having many research papers based on critical thinking dispositions, very few analysed the school-based students' critical thinking disposition involving Mathematics content. Therefore, this study is focussing on levels of critical thinking dispositions among secondary students towards Mathematics.

This study will also be analysing students' self-efficacy in solving Mathematics problem. Since PISA and TIMSS results of Malaysia have proven that critical thinking dispositions are suitable to assess among secondary children, this

study will focus on their self-efficacy based on their performance on Mathematical problem-solving. Students' performance in both PISA and TIMSS has shown below figures :

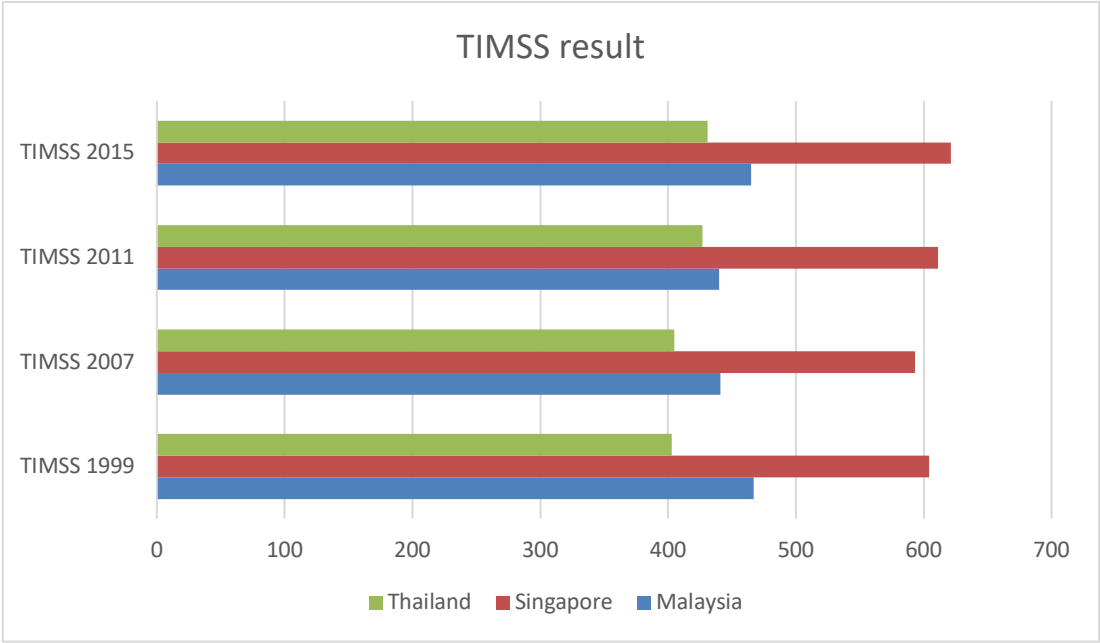


Figure 1.1.1 TIMSS achievement - comparisons among Asian countries

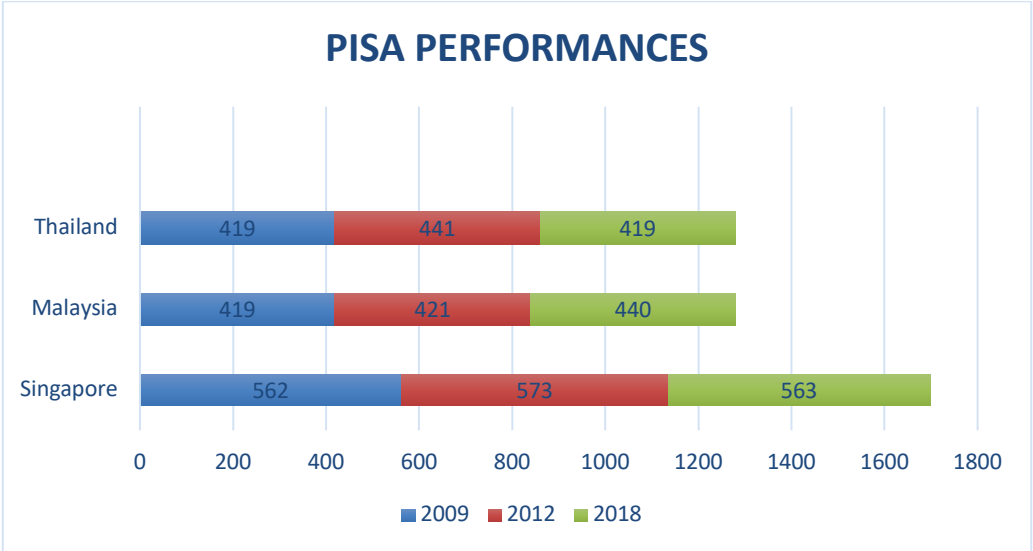


Figure 1.2 Malaysia PISA result ranking with Asia countries

Malaysian Mathematics syllabus emphasises problem-solving and reasoning for a long time. However, there was not much effort to implement solutions that could enhance students' self-efficacy and critical thinking dispositions in Mathematics. Elements that challenge the students' understanding and quality of reasoning were unimportant when evaluating attained learning outcome. According to Baykul (2003), Mathematics practices focus on logic in problem-solving, which increases students' self-efficacy towards Mathematics. Therefore, this study will be concentrating on the students' self-efficacy in Malaysian Mathematics and how it is related to critical thinking dispositions.

1.3 Problem Statement

The quality of education evaluated based on the performances that the future generation is presenting. To install 21st-century elements to the education system, educators and the ministry of education has to work together to develop students' skills into an 'out of the box' thinking process. This consideration will connect to higher-order thinking skills, which emphasize critical thinking and problem-solving. Critical thinking dispositions meant as a natural urge to solving problems. According to a recent survey, the Malaysian mathematical learning process still applies lower-order thinking skills and traditional teaching methods.

Ministry of education considered a new education system that instils students' critical thinking dispositions (Pereira & Asadullah, 2019). However, public examinations were in concern deeper than the aim of necessary thinking skills. Therefore, teachers' focus is still on the assessments and syllabus completion rather than critical thinking. It had been a significant problem in achieving 21st-century education in Malaysia.

Critical Thinking Dispositions consist of seven elements, and all of them supports problem-solving skill enhancement. Critical thinking dispositions applied through higher-order thinking skills (Aizikovitsh-Udi & Cheng, 2015). PISA and TIMSS test has encouraged Malaysian academic to look into mathematics problem-solving skills as the secondary students' performances in Mathematics problem-solving test were low.

As a result, PT3 applied as an assessment that has the criteria that support higher-order thinking skills and problem-solving. However, students self-efficacy towards learning takes a significant part in their performances. A low number of tertiary students presented critical thinking skills when attempting the Mathematics problem-solving questions in the recent survey.

As a part of 21st-century skills (2011), critical thinking is one of the key performances that intended on the students. Therefore, developing students with critical thinking dispositions will enhance the quality of knowledge and increase the innovative solutions in the future career and technology sectors. Through this study, educators and school management expected to benefit by understanding secondary students' self-efficacy on problem-solving and their critical thinking disposition towards Mathematics.

1.4 Research Goal

1.4.1 Research Objectives

The purpose of this paper is to cater to the need of the title and achieve the objectives as below :

- To investigate the levels of critical thinking dispositions among secondary school students from Plentong district.
- To analyse the self-efficacy in Mathematics Problem solving among secondary school students.
- To identify the relationship between critical thinking dispositions and self-efficacy in Mathematics.

1.4.2 Research Questions

Above mentioned objectives were derived by analysing the needs of the title and purpose of the study. Thus, research questions were planned to direct the study towards the direction where research objectives can be achieved. Questions aroused from the objectives are :

- What are the critical thinking disposition levels towards Mathematics among secondary school students?
- What are their self-efficacy in Mathematics problem solving?
- How are the critical thinking dispositions related to self-efficacy in Mathematics?

1.4.3 Research Hypotheses

Questions are the points that directs the study in order to achieve the objective of research whereby research hypotheses used in discussion and conclusion of the study. Research hypotheses that produced from the RQ 3 is as below :

H_{01} : There is a correlation between self-efficacy and critical thinking dispositions among Secondary students from Plentong district.

H_{null} : There is no correlation between self-efficacy and critical thinking dispositions among Secondary students from Plentong district.

Hypotheses and questions created supports in finalising the methodology and expected factors that were analysed in this study. Hypotheses of this study relates closely to the Malaysian Mathematics education aim and objectives.

1.5 Conceptual Framework

Figure 1.3 below shows conceptual framework of this research. Through this research study, Malaysian secondary school students' critical thinking disposition levels discussed across the seven elements listed. Students' self-efficacy on the problem solving questions were also discussed. Likert scale questionnaires provided for randomly selected students to obtain their self-efficacy results.

Correlation test conducted on the both critical thinking disposition result and self-efficacy results to analyze the relationship as mentioned in hypotheses. Students' performance scores obtained from a Jam board test given based on the PISA problem solving questions in order to discuss further on the relationship.

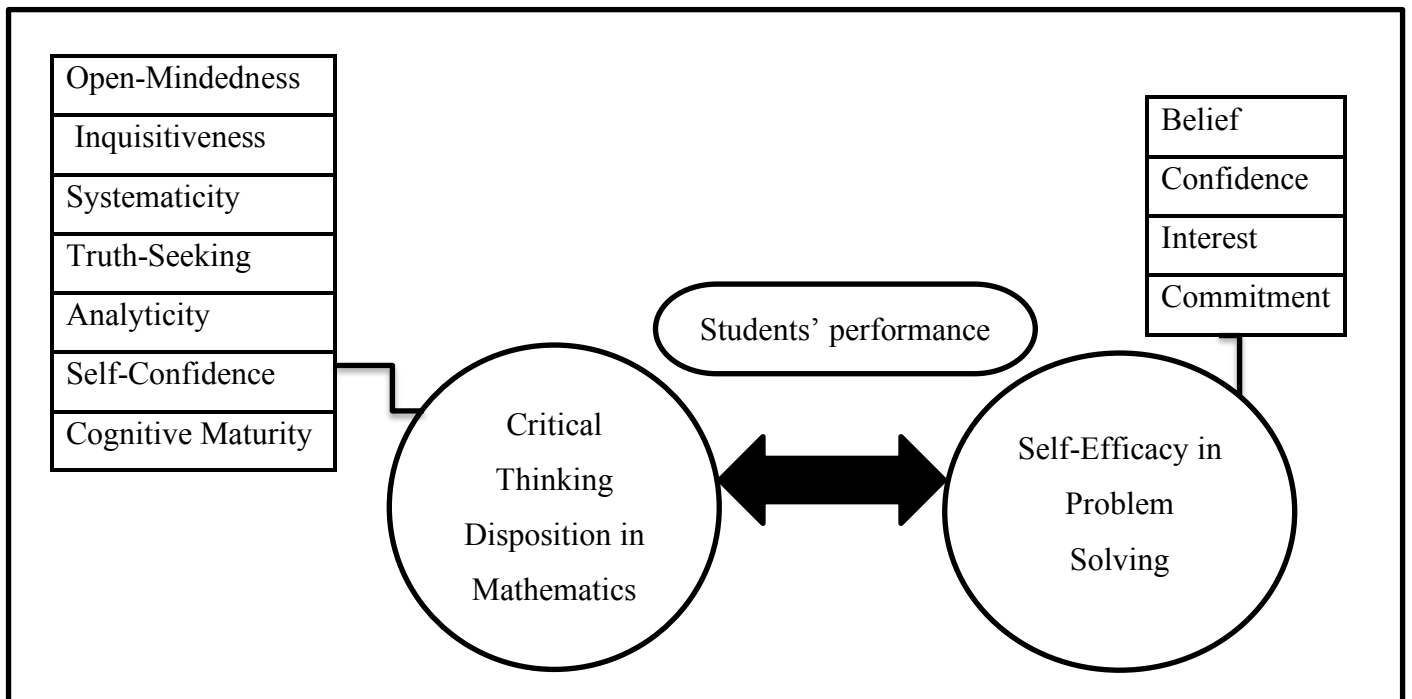


Figure 1.3 Conceptual Framework of research

The conceptual framework above created to comply the aims and objectives of this study which is to analyse the level of critical thinking disposition towards Mathematics among secondary school students. Elements in the frameworks are the expected factors that to be seen for critical thinking disposition. It was discussed by Ennis (2012) in the

study conducted for critical thinking dispositions. Based on Halpern (1999), critical thinking skills can be triggered, instilled, adapted by learners and their self-efficacy plays an important role in this matter. Thus, this study will be conducted to find out the relationship of critical thinking disposition among secondary students with their self-efficacy.

The independent variable that linked to the critical thinking disposition was self-efficacy. However, dependent variables are seven sub – dispositions that need to be achieved in prior. Elements that measured in this study explained as below :

- a. Truth-seeking: Self- interest and belief of oneself for the best knowledge
- b. Open-mindedness: Accepting the feedback and being able to correct it if needed.
- c. Inquisitiveness: Curiosity in acquiring the knowledge and understanding of the application.
- d. Analyticity: Determining the application of the knowledge with reason and evidence.
- e. Systematicity: Focus on the complexity of the problems and apply the understanding.
- f. Critical Thinking Self-confidence: Analyse skills and trust as critical thinkers.
- g. Cognitive Maturity: Making a judgement of applications and considering the solutions available for a problem.

1.6 Operational Definitions

An operational definition is made to define the terms of the concept to develop a clear understanding. Thus, this part of the chapter will clarify the terms and their meaning that suit the content of this research.

1.6.1 Critical Thinking Disposition

Critical thinking dispositions consists of 7 sub elements that used in this study to analyse students' level of CTD. Each of the elements has its own skills and characteristics that supports problem solving and decision making. Secondary school students' intended learning outcome focusses on the critical thinking elements. Therefore, seven elements were used by incorporating with Mathematics in the questionnaires to evaluate the students' level of critical thinking dispositions towards Mathematics education.

1.6.2 Critical Thinking among Malaysian students

Malaysian Ministry of Education (MOE) emphasises on the critical thinking skills as well as higher order thinking to be cultivated in learning. This study analyses Malaysian students' critical thinking as it is conducted in Malaysia and dissatisfaction on the consecutive result obtained from the international tests (PISA and TIMSS). According to Brookart (2010) students' critical thinking and higher order thinking skills are able to enhance through practice of learning and teaching. Therefore, this study focusses on Malaysian students from Plentong districts, Johor to analyse their level of critical thinking disposition towards Mathematics and its relation with their self-efficacy towards problem solving. The data collected from 5 different schools in Plentong, Johor Bahru used in this study to find out significant relation.

1.6.3 Critical Thinking in Mathematics Education

According to Baykul (2003), Mathematics courses should be aiming at developing critical thinking skills and problem-solving to prepare the students for future education. However, mathematical rules are not allowing much critical thinking as it is more firm and fixed. Elements from critical thinking disposition such as curiosity plays important part in solving the problems. Therefore, mathematical questions are suitable to practice on critical thinking. Variables from the conceptual framework should be applied in order to enhance the critical thinking in students towards the Mathematics curriculum needs and evaluate them. Therefore, this study chose to evaluate the critical thinking dispositions towards Mathematics education through CTDI form that consists of Likert scales.

1.6.4 Self-Efficacy in Mathematics

Self-efficacy in Mathematics is referring to the belief and interest of the students towards Mathematics problem solving or learning. Students will be evaluating based on their own performances and interest on the problem solving. It is important in this study as it supports the RQ 2. Therefore, Jam board test given to the secondary students participated in this research prior to the self-efficacy form given.

1.7 Purpose and Importance of Study

This study is conducted to achieve the aim and objectives stated. Based on the research objectives, this study has importance mainly for Mathematical Education in Malaysia. This study might be informative and beneficial for the parties listed below:

1.7.1 Ministry of Education Malaysia

Through this paper, I hope to see the Ministry of Education in Malaysia would visualize the issues that are discussed in a wider view. Enhancing the curriculum system and assessments can be considered to achieve the needs of mathematics education for young learners in this era. Besides that, focussing on the students'

competency and capability towards Mathematics should be considered in to improve the quality of education. Indirectly it will also develop the students' knowledge and experience for a betterment and meaningful towards Mathematics' problem solving.

1.7.2 Mathematics Educators

From this study, Mathematics educators could consider on the students' difficulty towards Mathematics' problem solving. Educators can enhance the teaching that can enhance students' self- efficacy. Perhaps, this will develop the quality of students' education which can ensure on the students' problem solving skills as well as critically thinking towards their lesson content. By analysing students' self-efficacy towards the problem solving questions in Mathematics, this study will suggest the educators on how can enhance it among future students. This is important as it helps to improve quality of education in Malaysian Mathematics nationwide.

1.7.3 Parents

Parents will be exposed to the actual need of the learning and aim of mathematical education. Parents can understand the weakness and strengths points of the students in solving mathematics word problems and thinking critically. Although students will be given enough support in learning and directed to the critical thinking dispositions by teachers, it is also important for parents to cultivate the elements start from home, especially to the Mathematics. Parents may also guide the students with real-life context-based learning for the students to develop students' critical thinking. Therefore, this study will be an eye-opener for parents to understand the importance of critical thinking dispositions in Mathematics as well as their role in how students' learning.

1.8 Limitations

According to Murnan, limitations will be there in every study and it has a specific reason for writing them along with their study paper. Thus, this study did face some limitations when collecting quantitative data for analysis.

To begin with, this research initially planned to be conducted on the secondary students from all the levels (Secondary 1 to Secondary 5). However, thinking from the perspectives of the secondary 1 and 2 who are new to the secondary syllabus and the content might not be suitable to apply the critical thinking disposition or problem solving. Apart from that, secondary 4 and 5 students were struggling with their projects and summative examinations. It was difficult and limited to assign them with questionnaires. Therefore, students from secondary 3 were selected to this study.

Besides that, teachers' support in assigning the students virtually was not easily achievable. Teachers were quite busy with their daily assigned roles. Juggling among their virtual lessons and syllabus planning did not allow them to share the physical forms to the students. However, options were given where the online forms and Google Meet platform used to assign the students.

A survey form adopting ideas from the Critical Thinking Disposition Inventory introduced in California was given to the selected group of students. This is to evaluate their level of Critical Thinking Disposition. Students' self-evaluation on critical thinking disposition levels and teaching analysed. However, due to the lockdown (COVID-19), online-based forms were generated and distributed after the explanation through video conference (Google Meet). This caused some barriers in communicating with students as not all the students were able to participate.

Besides that, there is a need for the support from teachers to guide students that were unable to evaluate themselves when completing the survey form given. Some of students might not understand the terms and therefore simpler terms applied after discussing the students' level of language with teachers. Teachers were familiar with the terms and understanding levels of the students involved. This was difficult in resolving as teachers' free time should be merging with students' availability.

1.9 Summary

Chapter 1 has explained on the mathematics education, 21st century education, problem solving difficulties among students as well as the critical thinking disposition elements. Chapter 1 also covers the background of this study, research questions that directs the analysis and also the limitations of this study. The researcher shown interest in studying the critical thinking disposition among secondary students and their self-efficacy in problem solving.

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