UNIVERSITI PUTRA MALAYSIA

INCORPORATING LESSON STUDY IN ASSESSING IMPACT OF ALGEBRAIC MASTERY LEARNING MODULE ON SECONDARY SCHOOL STUDENTS' MATHEMATICS PERFORMANCE AND ANXIETY

ELENCHOTHY D/O DAVRAJOO

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By

ELENCHOTHY D/O DAVRAJOO

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

June 2013

DEDICATION

This thesis is dedicated to my parents
Appa Davrajoo Govindan,
Amma Mariayee Murugan
Who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve,

Also, this thesis is dedicated to my beloved siblings
Elengkumaran,
Vasanthy,
Elevanil,
Elemaran,
Elevarasi,
Elengkovan,
Elevarasu,
Elenchelvan,
and
Elemathy
for the co-operation and motivation

Finally, this thesis is dedicated to all those who believe in the richness of learning.

Abstract of thesis presented to the Senate of University Putra Malaysia
in fulfillment of the requirement for the degree of Doctor of Philosopy

INCORPORATING LESSON STUDY IN ASSESSING IMPACT OF ALGEBRAIC MASTERY LEARNING MODULE ON SECONDARY SCHOOL STUDENTS' MATHEMATICS PERFORMANCE AND ANXIETY

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ELENCHOTHY A/P DAVRAJOO

June 2013

Chairman : Associate Professor Rohani Ahmad Tarmizi, PhD

Faculty : Institute for Mathematics Research

The purpose of this study was to investigate the impact of using Algebraic Mastery Learning Module with incorporation of Lesson Study on Form Four students' performance and mathematics anxiety toward mathematics learning in a national secondary school. The study utilized the true experimental design using the randomized pre-post test control group design consisting of an experimental group (n = 28) using the Algebraic Mastery Learning Module (AMaLM) teaching and a control group (n = 27) using the Algebraic Conventional Learning Module (ACoLM) teaching for four weeks of teaching and learning duration. Both groups were compared on cognitive variables (overall mathematics performance, algebraic conceptual knowledge-ACK, algebraic procedural knowledge-APK, and algebraic utility knowledge-AUK) and affective variables, (overall mathematics anxiety, mathematics class climate anxiety, mathematics inability anxiety, mathematics abstraction anxiety, mathematics test anxiety, mathematics beliefs and anxiety symptoms). Additional measures such as number of errors, type of errors made by subjects during solving test problems, students' views on AMaLM and teachers' views on using AMaLM through Lesson Study were studied.

Two instruments were used in this study, namely Algebraic Comprehension Test (ACT), Students Revised Math Anxiety Rating Scale (S-RMARS) with the use of AMaLM and ACoLM. The results of ANCOVA indicated that students from AMaLM (treatment) group performed better significantly on their overall algebraic performance (ACK, APK and AUK) (72.54; SD=8.66). Hence, there was significant impact of the different instructional approach, favouring the AMaLM for the learning of mathematics among students. Consistently the results of ANCOVA for overall mathematics anxiety (mathematics class climate anxiety, mathematics inability anxiety, mathematics abstraction anxiety, mathematics test anxiety, symptoms of mathematics anxiety) (2.39;

SD= 0.47) also showed that there were significant mean differences between the two groups, with the participants from AMaLM group showing lower mathematics anxiety compared to the ACoLM group.

ANCOVA test on the means performance of retention test also showed that participants from AMaLM group significantly performed better than the participants from ACoLM group. Further students in experimental group showed overall favourable views towards the AMaLM usage. The teachers involved expressed supportive views toward the Lesson Study technique and the content of AMaLM in developing the fundamental algebra for students. These results seem to support the contention that the use of mastery learning based instruction AMaLM with incorporation of Lesson Study reduce mathematics anxiety hence increase performance of mathematics. Overall, the results of the study suggested that there was sufficient evidence to conclude that the use of AMaLM in learning and incorporation of Lesson Study in teaching mathematics can improve students' confidence toward working on algebraic based problem solving and improve the performance.

Abstrak tesis yang dikemukakan kepada Senat of Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

GABUNGAN *LESSON STUDY* DALAM MENILAI KESAN PENGGUNAAN MODUL PEMBELAJARAN MASTERI ALGEBRA KE ATAS PRESTASI DAN KEBIMBANGAN MATEMATIK DALAM KALANGAN PELAJAR SEKOLAH MENENGAH

Oleh

ELENCHOTHY A/P DAVRAJOO

Jun 2013

Pengerusi : Profesor Madya Rohani Ahmad Tarmizi, PhD

Fakulti : Institut Penyelidikan Matematik

Tujuan kajian ini adalah untuk menyelidik impak penggunaan Modul Pembelajaran Masteri Algebra (AMaLM) dengan gabungan *Lesson Study* ke atas prestasi dan kebimbangan matematik pelajar Tingkatan Empat di sebuah sekolah menengah kebangsaan. Kajian ini menggunakan reka bentuk kumpulan kawalan-eksperimen sebenar ujian pra-pos secara rawak yang terdiri daripada kumpulan eksperimen (n = 28) dengan Modul Pembelajaran Penguasaan Algebra (AMaLM) dan kumpulan kawalan (n = 27) dengan Modul Pembelajaran Algebra Konvensional (ACoLM) selama empat minggu. Kumpulan rawatan telah mengikuti pembelajaran menggunakan AMaLM dan kumpulan kawalan telah mengikuti pembelajaran menggunakan ACoLM. Pembolehubah kognitif (pencapaian matematik keseluruhan, pengetahuan konsep algebra-ACK, pengetahuan prosedur algebra-APK dan pengetahuan penggunaan algebra-AUK) dan pembolehubah afektif (kebimbangan matematik keseluruhan, kebimbangan iklim kelas, kebimbangan ketidak upayaan, kebimbangan keabstrakan, kebimbangan ujian, pandangan pembelajaran matematik dan simptom kebimbangan) bagi kedua-dua kumpulan telah telah diperbandingkan. Pengukuran tambahan seperti bilangan kesalahan yang dilakukan, jenis kesalahan yang dilakukan semasa menyelesaikan masalah semasa ujian, pandangan pelajar mengenai penggunaan AMaLM dan pandangan guru-guru terhadap penggunaan AMaLM dengan *Lesson Study* juga telah dikaji.

Dua instrumen telah digunakan dalam kajian ini, iaitu Ujian Pencapaian Algebra (ACT), dan Skala Kebimbangan Matematik Pelajar (S-RMARS) dengan menggunakan AMaLM dan ACoLM. Keputusan ANCOVA menunjukkan pelajar daripada kumpulan AMaLM (rawatan) mempunyai pencapaian matematik keseluruhan (ACK, APK dan AUK)

(72.54; SD=8.66) yang lebih baik secara signifikan. Ini menunjukkan terdapat kesan pendekatan pengajaran yang berbeza, yang memihak kepada AMaLM bagi pembelajaran matematik dalam kalangan pelajar. Selaras dengan itu, dapatan ANCOVA untuk kebimbangan matematik keseluruhan (kebimbangan matematik iklim kelas, kebimbangan ketidakupayaan bermatematik, kebimbangan abstrak matematik, kebimbangan ujian matematik, gejala kebimbangan matematik) (2.39; SD= 0.47) juga menunjukkan bahawa terdapat perbezaan yang signifikan antara min kedua-dua kumpulan, dengan para peserta dari AMaLM menunjukkan kebimbangan matematik yang lebih rendah daripada ACoLM.

Ujian ANCOVA ujian pengekalan pencapaian menunjukkan min skor peserta dari kumpulan AMaLM lebih baik daripada min skor peserta dari kumpulan ACoLM. Selanjutnya pelajar dalam kumpulan eksperimen menunjukkan pandangan keseluruhan yang signifikan terhadap penggunaan AMaLM. Guru-guru yang terlibat juga memberikan pandangan yang menyokong terhadap teknik *Lesson Study* dan AMaLM dalam membangunkan asas algebra untuk pelajar. Hasil dapatan ini menyokong pendapat bahawa penggunaan penguasaan pembelajaran pengajaran menggunakan AMaLM dengan *Lesson Study* mengurangkan kebimbangan matematik pelajar dan meningkatkan prestasi matematik. Secara keseluruhannya, keputusan kajian ini mencadangkan bahawa terdapat bukti yang mencukupi untuk membuat kesimpulan bahawa penggunaan AMaLM dalam pembelajaran dan penggunaan Lesson Study dalam pengajaran matematik dapat meningkatkan keyakinan pelajar terhadap menyelesaikan masalah berasaskan algebra dan meningkatkan prestasi matematik.

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This thesis would not have been whole without the kind assistance from the principal, teachers and technical staff of the researched school, JPS and PPD Kuala Selangor. Finally I extend my utmost hope and gratitude to the students participating in this research they are the roots and fruits of this academic effort. Last but not least I would like to thank my editing team, colleagues, students and friends for their patience and believing in me.

I certify that a Thesis Examination Committee has met on 17 June 2013 to conduct the final examination of Elenchothy d/o Davrajoo her thesis entitled " Incorporating Lesson Study In Assessing Impavt of Algebraic Mastery Learning Module on Secondary School Students' Mathematics Performance and Anxiety" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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Date: 21 April 2014

Declarations by Graduate Student

I hereby confirm that:

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LIST OF ABBREVIATIONS

AMaLM	Algebraic Mastery Learning Module
ACoLM	Algebraic Conventional Learning Module
MAS	Mathematics Anxiety Scale
S-RMARS	Student's Revised Math Anxiety Rating Scale
ACT	Algebraic Comprehension Test
ACK	Algebraic Conceptual Knowledge
APK	Algebraic Procedural Knowledge
AUK	Algebraic Utility Knowledge
SK	Sekolah Kebangsaan
SK (C)	Sekolah Kebangsaan Cina (Chinese Primary School)
SK (T)	Sekolah Kebangsaan Tamil (Tamil Primary School)
LPM	Lembaga Peperiksaan Malaysia
KPM	Kementerian Pelajaran Malaysia
SPSS	Statistical Package For Social Science
SD	Standard Deviation
%	Percentage
Df	Degree of Freedom
P	Significant Level
F	Comparison for Value ANOVA Test
n	Number of sample

CHAPTER 1

INTRODUCTION

1.1. Background of Study

Science and technology plays a critical role in meeting Malaysia's aspiration to achieve a developed nation status. Therefore, mathematics, apart from science, is an essential tool for the workforce in the technological society. The provision of a quality mathematics education from an early age in the education process is very important to provide the fundamental knowledge for the students' future world of work especially in the fields of natural science, medicine, social sciences and many newly emerging occupational fields. Consequently, students' poor performance in mathematics will diminish their opportunities for an entry into Higher Education Institutions; and this will affect the professional human resources for our nation in 2020. For instance, Malaysia is expected to be in need of 500,000 engineers by 2020 (Mohammad & Lau, 2000) and mathematics is the gateway to engineering.
Every mathematics teacher must realize that each student has a right to acquire the need of qualification for their future. Mathematics is often labeled as a critical subject and many students face difficulties when executing mathematical activities (Arem, 2009). In the Malaysian educational system, mathematics has always been one of the core subjects in the school curriculum and students are often pressured to perform better in mathematics, more than in any other subjects (Veloo & Muhammad, 2011; Zanzali, 2011). Students, then struggle in mathematics in order to pass the exams. In the face of this, the school curriculum becomes more complex each year and learning becomes more difficult. However, most students in Malaysia have no choice but to endure the agony of learning mathematics all throughout their learning years in school (Puteh, 2012; Zakaria, Zain, Ahmad, Erlina, 2012; Zanzali, 2011; Davrajoo, Tarmizi, Nawawi, & Hassan, 2010). Vast literature and documentations have identified the many factors contributing to students' difficulties in mathematics, namely, the pedagogical, psychological mathematical innovations and learners' factors as well as the mathematical contents itself.

Generally the teachers in Malaysia's national schools have to struggle with academically At-Risk students, that is, students who are academically weak and with behavioural problems (Abu Bakar, Tarmizi, Md Nor, Wan Ali, Hamzah, Samad, Jamian, 2010). These At-Risk students are low performers and at risk of failure due to difficulties either in learning mathematics or in mentally processing mathematics or they have mathematics anxiety (Abu Bakar, Tarmizi, Mahyuddin, Elias, Wong, & Ayub, 2010). Many of these students are identified as those having certain characteristics such as poor in academic performance and having family and social problems such as low socio economic status, family in crisis, and single parents which lead to truancy and academic failure (Barley, Lauer, Arens, Apthorp, Englert, Snow, Akiba, 2002). Studies pertaining to learning needs and strategies of At-Risk students, particularly low achievers and who are placed at the lower streams are scarce. Teachers are at a loss on how to motivate them and how to make the teaching and learning process effective and interesting (Abu Bakar, et al., 2010). Effective teachers with their caring attitude and demand that the students have the capability to succeed (Brophy, 1998) may encourage At-Risk students to build confidence and motivation by developing their' basic knowledge of mathematics.

In order to achieve quality education for At-Risk students, schools must encourage students' interest and involvement in the mathematics classroom. These students need different learning tools in constructing knowledge; such as appropriate teaching approaches, methods, and effective instructional materials, which are essential for effective learning (Protheroe, 2007; Veloo, & Muhammad, 2011). Recently the Malaysian's educational system has emphasized the importance of rethinking in education for more effective teaching and learning (Lim, 2009; Zanzali, 2011). It is therefore important to align the training and knowledge of the teachers to meet the needs of low performing students in schools. In this way it may help students to attain mathematical conceptual and procedural knowledge, that is from the basic which may then lead to problem solving and at the same time motivating and changing their attitudes towards mathematics learning (Ong & May, 2008; Abu Bakar, et al., 2010; Veloo, & Muhammad, 2011).

Many researches had shown that mathematics learning has been influenced by psychological factors such as feeling of inferiority and outright fear on mathematics. Researchers in field of mathematics education had identified this situation or phenomenon as mathematics phobia or mathematics anxiety (Burns, 1998; Tobias, 1999; Jackson & Leffingwell, 1999; Hadfield & McNeil, 1999; Bower, 2001; Seligman, Walker & Rosenhan, 2001; Zaslavsky, 2001; Arem, 2009; Puteh, 2002, 2011). Their findings showed that fear of mathematics among students results in mathematics avoidance and sometimes end up with mental block towards mathematics learning. Therefore, there is generally, undeniable need for investigations about the learning and mastery of mathematics by in calculating the effect of mathematics anxiety phenomenon among secondary school students.

1.2 Mathematics Anxiety in Mathematics Learning

In Malaysian school climate, students mathematics learning gradually replaced by attempts at rote learning, as preparing them for good grades in the national examination without considering the mathematics anxiety factor. The teaching is often focused on students' performance which based on examination result (Parmjit, 2003). The inappropriate methods of teaching, as using rote memory to learn hard and fast rules to apply the knowledge results to rebellion among a part of students who do not grasp the principles of correct mathematical manipulation and thought. It is aversion or a fear of working with numbers or equations for purposes of understanding the mathematical theories behind them or simply using mathematics to solve practical problems in everyday life. Teaching students with mathematics anxiety and with mental block, is a challenging job to introduce on abstract and complex mathematical structure. Therefore it is important mathematics teachers consider psychological factors such as inferiority complex, and outright fear in mathematics during mathematics teaching besides only imparting mathematical content, (Burgess, 2001; Davrajoo, Tarmizi, Nawawi & Hassan, 2009; Zakaria,et al., 2012).

Many students develop a fear of mathematics while they are in school either in elementary or in secondary school (Tobias, 1999; Arem, 2009; Puteh, 2002, 2011). There are many factors that cause mathematics anxiety as the nature of mathematics, syllabus content, teacher factor, ineffective teaching approaches, low self esteem and aptitude towards mathematics. The nature of mathematics, is different than any other subjects, requires us to think clearly, cleanly, and often abstractly. Therefore, there is no formula for us to follow, and it is challenging in ways we could not completely prepare for (Sutton 2003). Therefore the syllabus content should be in hierarchy in order to give the understanding on mathematics learning. Students with mathematics anxiety are less willing to enrol and succeed in mathematics. According to the researchers, the higher one's mathematics anxiety level, the lower one's mathematics learning ability, mastery, motivation and beliefs (Ghanbarzadeh, 2001; Pajares, & Schunk, 2001; Kabiri, 2003; Ashcraft & Krause, 2007; Daneshamooz, Alamolhodaei, & Darvishian, 2012). Although students do have the intellectual capacity to think, they often lose their capability to understand the mathematical contents due to their anxiety.

The teachers are one of factors that would often induce mathematics anxiety indirectly when they are unable to answer the students' uncertainties, as they often reprimand the students by telling them that they would never be able to learn and understand mathematics. Thus the teachers' negative comments may hinder the student's ability and induce anxiety by giving destructive influence on the students' performance (Hadfield & McNeil, 1999; Bower, 2001; Seligman, et al., 2001; Aschcraft & Krause, 2007; Erden, & Akgul, 2010) that may lead to low self esteem and beliefs on their ability. The above beliefs end up to avoidance of mathematics learning, and produce weak and low performing students in class rooms. Woodard

(2004) and Shore (2005) states the mathematics teachers can create ways to overcome the students' mathematics anxiety by providing a safe and encouraging mathematics learning environment and build students' self confidence. With positive, relevant, and concrete instructions through effective pedagogical and psychological methods these students can be helped to achieve successful mathematical learning (Abu Bakar, et al., 2010; Davrajoo, et al., 2010; Puteh, 2012; Zakaria, et al., 2012).

Furthermore, according to Abu Bakar et al. (2010) the existing national mathematics syllabus for secondary classes in Malaysia is inappropriate for weak students. The learning objectives specified in the syllabus were also considered not clear and not catered for weak students. There is also no clear category for low achievers, whether they are low performing due lack of content factors or mathematics anxiety. If they affected by the mathematics anxiety, then emphasise must be given to the steps for overcoming the problem by manipulate the instructional practices toward less anxiety.

The review on literatures in field of mathematics education in Malaysia revealed that not many researchers focused on the phenomenon of overcoming mathematics anxiety barriers among secondary school students. Only few studies focused on secondary school students (Murshidi, 1999; Rahim, 2002; Bidin, Sharif, & Kassim, 2005; See & Lee, 2005; Davrajoo, 2007; Zakaria et al., 2012), the others focussed higher education institutions students (Yahaya, Majid, & Mukhtar, 1996; Salwani & Salleh, 2001; Puteh, 2002, Zakaria, & Nordin, 2008; Vitasaria, Herawan, Abdul Wahab, Othman, & Sinnadurai, 2010; Tang, 2009; Veloo, & Muhammad, 2011) and the mathematics anxiety measuring instruments (Kit, 1995; Kor, 1997; Liau, Kassim & Liau, 2007). According to Liau et al. (2007) it is essential to awake Malaysian mathematics teachers to be aware of mathematics anxiety phenomenon occurrence during the teaching and learning process.

The teachers' pedagogical practice either through direct classroom observation or through research lessons and case studies may help these students by identify the students' level of learning. This pedagogical practice namely Lesson Study has been propagated as an innovative and effective model of teacher professional development to further strengthen school-based teacher professional development hence improve Malaysian students' mathematics progress (Lim, White & Chiew, 2005; Chiew & Lim, 2005; Chiew, 2009). According to Chiew and Lim (2005) the Lesson Study program has manifested itself in various forms according to cultural contextual differences in Malaysia although it was originates from Japan.

1.3 Lesson Study in Mathematics Teaching

Over recent years Lesson Study (LS) has become more popular as an on-site school-based teacher development approach. LS has been used as a teacher development approach to improve teaching and learning for over a hundred years (Isoda, Stephens, Ohara & Miyakawa, 2007). It refers to collaborative research on teaching and learning processes that conducted by and for teachers to help focus on 'teaching' as well as to focus on 'learning' (Lewis, 2006; Fernandez et al., 2003; Stigler & Hiebert, 1999). Most mathematics lessons in Japan encourage students to take an active role in constructing their own mathematics by communicating with one another; students are encouraged to develop a belief in their own ability to learn and to think (Watanabe, 2002; Isoda, M. et al., 2007; Cheah, 2010).

A LS group is usually formed with at least four to six teachers (Lim & Kor, 2010). These teachers might vary in their teaching expertise, ranging from expert to the novice teachers in mathematics or any subject. Stigler and Hiebert (1999) highlighted that the practice of LS could have contributed to the high standard of mathematics teaching and achievement in Japan. These collaborative activities provide teachers with learning community opportunities to raise the level of their professional skills and the relationship with students, as well as engagement in classroom based research activities and emphasizing on "learning by doing" (Arani, 2006). It focuses upon key-school issues as they relate to the teachers' teaching processes and students learning styles. This is considered as new teaching method outside of Japan that is presently being used to improve teaching-learning processes around the world.

Countries in Asia such as Hong Kong, China Singapore and Thailand have begun to apply LS to help teachers to understand variation in students learning capacity and to change the students from being passive recipients of information to critical thinkers and learners (Lo & Pong, 2006; Goh, 2007; Lee, 2008). Even Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) showed that high performing countries such as Japan, Singapore and Finland share one common factor that places had emphasis on quality teachers who play important role in the success of these countries in the international studies (Stacey, 2009).

1.4 Related Mathematics Learning Theories

The impact of the integration of modular based approach into the existing mathematics instruction can be explained by the Social Development Theory (Vygotsky, 1978), Constructivist Theory (Piaget, 1964), Reinforcement Theory (Laird 1985, Burns 1995), Collaborative Learning (Johnson, Johnson & Holubec, 1994; Gillies, 2002) and Mastery Learning Theory (Bloom, 1968, 1976). Zimmerman and Dibenedetto (2008) suggested the incorporation of these five main learning theories by using a specifically prepared course in order to achieve successful mathematics learning. In addition, providing generative mental construction "tool kits" enabled students to master the intended learning (Jonassen, 2004). The following are the discussions on the learning theories that support and provide a framework for the incorporation mastery learning modular approach in teaching and learning of mathematics.

1.4.1 Social Development Theory

Vygotsky's theory views human development as a socio genetic process by which children gain mastery over cultural tools and signs in the course of interacting with others in their environments. The major theme of Vygotsky's theoretical framework is that social interaction is fundamental in the process of cognitive development. According to Vygotsky (1978) every function in the child's cultural development appears twice: first, on the social level, between people (inter-psychological) and later on the individual level, inside the child (intra-psychological). This is also consistent to learning through voluntary attention, to logical memory, and to the formation of concepts (Radford, 2000).

In this way, the individual's mathematical knowledge is both cognitively and socially constructed. This explains the phenomenon of mathematics anxiety, the feelings of defiance in students who could not grasp the principles of correct mathematical manipulation and thoughts. Vygotsky's theory of concept formation (1986) provides an appropriate framework to explore the issue of concept formation. The focus is on individual learning possibly with textbook or other well prepared materials written by a pedagogical expert (Radford, 2000). Thus this study integrates the modular based learning with guided examples and exercises as an instructional approaching concept formation. This may overcome students' mathematics anxiety factors caused by the inter-psychological and intra-psychological elements during the learning and teaching session.

1.4.2 Constructivism Theory

Constructivism learning theory lends support to concept formation in the process of learning. It is a combination of two major trends of constructivist perspectives: cognitive constructivism and social constructivism. It provides instructional design that aims to give generative mental construction (Jonassen, 1991) that facilitate knowledge construction by learners. The core concept of constructivism is learners are individuals of their own personal and subjective experiences and therefore knowledge could not be transferred from a mind of one to the mind of another. This theory suggests teachers should encourage students to constantly assess the activity involved to gain understanding; prepare a well planned classroom environment and act by questioning themselves and their strategies (Chiew & Lim, 2005).

The constructivist learning theory states that individuals' learning is based on previously constructed knowledge, active negotiation within the classroom, and consensus building (Shapiro, 2000). The design of constructivist learning becomes one of the most considered means to students' learning. This theory suggests that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individuals' experiences are aligned with their internal representations of the world, but may also occur as a failure to change a faulty understanding as theorized by theory of reinforcement.

1.4.3 Cooperative Learning Theory

Another theory that shaped this research is the theory of cooperative learning. Cooperative learning has its roots in the theories of social interdependence, cognitive development, and behavioural learning. Actually the cooperative learning is one strategy that rewards individuals for participation in the group's effort. A review of the literature on cooperative learning shows that students benefit academically and socially from cooperative, small-group learning (Gillies, 2002). Both Piaget and Vygotsky also had stated cooperative learning with more able peers and teachers result in better cognitive development and intellectual growth (Johnson, Johnson & Holubec, 1994).

According to Langer, Coltan and Goff (2003), cooperative learning is an efficient instructional approach in solving mathematics problems. This theory support group works in understanding and working on the tutorials in learning using module. Cooperative learning can produce positive effects on student performance (Okebukola, 1986; Cohen, 1986; Davidson, 1989; Johnson et al, 1994; Slavin, 1990, 2006; Reid, 1992). Moreover it is also suitable for both students and teachers to work in group for learning process. Therefore this study uses cooperative learning while learning during the intervention period.

1.4.5 Mastery Learning Theory

Bloom (1976) suggested that mastery learning would enhance learning in all subject areas with larger effects in mathematics and science. The basic approach reduces variation in students' final performance through instruction suited to each student's needs. This model is described as a Personalized System of Instruction (PSI) by Kulik, Kulik, and Drown (1990). It is an alternative method of teaching and learning that involves the student reaching a level of predetermined mastery on units of instruction before being allowed to progress to the next unit (Davis & Sorrell, 1995). It is a process whereby students achieve the same level of content mastery but at different time intervals.

The literature (Bloom, 1976; Guskey, 2007; Zimmerman & Dibenedetto, 2008) indicates positive effects of mastery learning on students, especially in the areas of achievement, attitudes toward learning, and the retention of content. The goal of mastery learning approaches is to have all students learn instructional material at, equivalent or near to high level. Instead of presenting information to students orally, teachers will select and create appropriate reading materials, create behavioral objectives and study questions, and prepare multiple forms of tests which measure student progress and provide feedback. Secondly, students will attempt to finish their assignments at their own pace. This principle stems from the recognition that students have many other obligations and learn at different rates. Thirdly, students must demonstrate mastery in tests or correct any inaccuracies before they move on with their work. Therefore this theory becomes the highlight of this study by implementing effective guidance by teachers and providing sufficient resources and learning task.

1.5 Problem Statement

Malaysia has made enormous steps in its education system over the past 50 years to in improving the quality of teaching and learning of mathematics (Zanzali, 2005, 2011; MOE, 2012). Consequently the mathematics curriculum had undergone significant changes through three phases from traditional based followed by modern mathematics based and then to secondary school's integrated curriculum (Kurikulum Bersepadu Sekolah Menengah -KBSM) which is holistic in nature. Yet, according to GTP Road Map (MOE, 2012) Malaysia's student learning outcomes have deteriorated compared to other countries in South East Asia such as Singapore, Hong Kong and South Korea. It has reported that about 35% of Malaysian students failed to meet the minimum TIMSS (Trends in International Mathematics and Science Study), benchmarks for Mathematics and Science in 2011, compared to 18% in 2007 and about 7% in 2003.

In addition the result of the Programme for International Student Assessment (PISA) (2009) also shows that Malaysian learners in the underperforming group when compared with 74 participating countries. Taking these international assessments into consideration and mathematics being one of the vital subjects to assess current Malaysian education system and future competitiveness, improving students' learning outcomes is crucial. This is also to avoid the risk of Malaysia being left behind by the other developing countries as well as to develop more competitive workforce as we push towards becoming a developed nation by 2020.

However improving student learning outcomes with limited resources in public day schools is not an easy job. Students from rural schools with disadvantaged socioeconomic backgrounds require more support to reach the common benchmarks. This only can only be done when the problematic at risk students gain the required basic skills for mathematics learning. For many students mathematics has always been tough or killer subject in all levels of education (Zakaria, Daud &

Mohd Meerah, 2009; Teng, 2002; Abdullah, 2004; Surif, Ibrahim & Kamaruddin, 2006; Ahmad, Zainal & Omar, 2006; Salleh, 2001; Davrajoo, 2007; Zanzali, 2011; Puteh, 2012) especially among students in the rural areas (Borneo Post, 25.03.2012).

The performance gap of mathematics between urban and rural areas in the public examination and efforts to overcome the gap often become the concern of the Ministry of Education (MOE) in recent years (mStar Online, 11.03.2009; Kosmo, 23.12.2010; 22.12.2011; News Straits Time, 21.03.2012; Borneo Post, 22.3.2013). The data in Table 1.2 specifies discrepancy in performance between rural and urban schools in recent years.

Table 1.1. Mathematics Performance in SPM of Rural and Urban Schools

Year	**2007**	**2008**	**2009**	**2010**	**2011**
Urban	78.4%	79.6	82.5	83.5	84.2
Rural	70.0%	72.8	73.5	77.5	77.1
Discrepancy	- 8.4%	- 6.8%	- 9.00%	-6.00 %	-7.1%

(Source: Malaysian Education Ministry, 2012)

The concern of this study is focussed on the public secondary schools in Kuala Selangor, Selangor. These schools are determined based on performance at the National Key Result Area (NKRA) (MOE, 2009). Table 1.3 and Table 1.4 illustrate the comparison of mathematics performance at school level to district level and national level from 2008-2012 in PMR and SPM respectively. The tables clearly show that the selected school students are underperforming and struggling with mathematics. These students need to be diagnosed on factors associated with students' fear on mathematics, beliefs by considering their knowledge in needed area of learning and instructional practices.

Table 1.2. Mathematics Performance in PMR (2008 -2012)

Year	**2008**	**2009**	**2010**	**2011**	**2012**
National	84.89	90.96	91.6	92.4	93.7
Kuala Selangor (Band Level)	84.71	88.41 (2.80)	89.55 (2.64)	90.72 (2.89)	92.48 (2.88)
SMK SAA (Band Level)	74.83	86.96 (3.62)	72.66 (3.69)	82.28 (3.54)	80.34 (3.57)

***Indicator of band**: A = 1.00; B =2.00; C = 3.00; D = 4; E; F =5.00

Table 1.3. Mathematics Performance in SPM (2007 -2012)

Year	2008	2009	2010	2011	2012
National (Band Level)	76.2 (5.51)	77.8 (5.34)	80.5 (5.19)	77.1 (5.04)	80.90 (5.08)
Kuala Selangor (Band Level)	73.36 (5.50)	74.43 (5.48)	76.06 (5.30)	77.13 (5.36)	78.36 (5.05)
SMK SAA (Band Level)	57.56 (7.37)	57.66 (6.35)	63.20 (6.29)	56.56 (6.69)	65.24 (6.55)

***Indicator of band:** (A^+ = 0.00; A=1.00; A^- =2.00; B^+= 3.00; B = 4.00; C^+ = 5.00; .C=6.00; D =7.00; E=8.00; F=9.00)

(Source: Kuala Selangor District Education Department, 2012)

In Malaysia 58% of class time is dominated by three activities of 'explaining - practicing- working on practices' in mathematics; the rest goes for reviewing homework, re-teaching and clarifying content, taking tests and quizzes and participating in classroom management tasks that are not related to the lesson content (Idris, & Salleh, 2010). They found that most of the time in class room spent on listening what the teacher is saying and it's normal for students see the teacher solve the problems on board or sometimes there are teachers who engage students to complete the mathematical tasks for class. According to Zanzali (2011), The Malaysian mathematics teachers only focus on "product of mathematical thinking" and less emphasize on outcomes of learning as a "process of mathematical thinking" (Mullis, Martin, & Foy, 2008). It has shown that the traditional method of teaching still exist and will continue to exist in the teaching of the mathematics in the Malaysian classroom The traditional method practices emphasis on memorisation rather than understanding. Thus teaching happens in activities of transmitting and absorbing information by students. They are trained to regurgitate in the form similar to what that has been absorbed (Zanzali, 2011). Therefore these students' panicked helplessness or were mentally disorganised when they could not recall the rules required in solving a mathematical problem.

This state experienced by the students is known as mathematics anxiety and is one of the causes for mathematics inability and mathematics avoidance (Ashcraft & Kirk, 2001; Arem 2009; Puteh, 2012). Students start to lose confidence and strengthened by the beliefs that mathematics is really hard and hence affecting their approach to this subject (Kloosterman & Cougan 1994; Ahmad, et al., 2006; Radzali, 2007). Moreover an analysis on teaching aid for instructional purpose showed that in 64% of Malaysian mathematics teachers depend primarily on textbook when teaching mathematics (Zanzali, 2005, 2011). The contribution of textbook towards students' progress is still debatable. Research had shown that teacher-centered teaching that depends on textbooks and the board to teach procedural knowledge in mathematics is related to students' mathematics underperformance (Lim, 2007; Zanzali, 2005, 2011; Bayat, 2012). Again traditional teaching of mathematics is insufficient to increase the learner's performance.

The focus of study is on the teaching of algebra since TIMSS report (2007) indicated that the Malaysian mathematics curriculum of has less emphasis on algebra as compared to Singapore and Japan. It has been proven that algebraic knowledge is essential in mathematics to improve the mathematics performance and competency among students (NCTM, 2008). Moreover, researches showed that students find difficulties in working on the unknown such as '*a'*, '*n'*, '*x'* and '*y* that represent the abstraction of mathematics that often lead to the poor performance (Hee, 2004; Arem, 2009; Davrajoo et al., 2009; Puteh, 2012). The abstractness makes them clueless on what they are learning and that leads by mathematics anxiety (Puteh, 2002, 2012).

The low performing students often get confused with very basic terms such as 'unknown', co-efficient expression and equation (Davrajoo et al., 2009). The report of *Lembaga Peperiksaan Malaysia* (LPM – Malaysian Examination Board) (MOE, 2007) found most of low achievers gave answers either without providing working steps providing incomplete and disorderly working steps; some even applied wrong formulae or substituted the wrong value in their selected formulae for problem solving. The Ministry of Education (2009) has suggested that mathematics teachers in rural areas have to assess children's prior knowledge and experiences to get better understanding of the children prior to teaching and learning in order to overcome the existing constraints and limitations. With appropriate aids in teaching, it may enhance students' understanding of mathematics (Idris & Salleh, 2010). With these factors established, this study examined the utilization of the mathematical instructional module named Algebraic Mastery Learning Module (AMaLM) for low performing students learning in place of textbook to enhance the problem solving performance in algebra. Emphasis is given on the understanding of basic concepts to increase problem solving performance as well as develop positive values, attitude towards mathematics based on theories of constructivism, mastery learning and cooperative learning as recommended by Curriculum Development Centre (2003).

1.6 Purpose of the study

The purpose of this study is to assess the effect of the Algebraic Mastery Learning Module (AMaLM) on mathematics performance and mathematics anxiety. Consequently, two types of instructional strategies; the conventional instruction using Algebraic Conventional Learning Module (ACoLM) a traditional based approach, and mastery learning based instruction using Algebraic Mastery Learning Module (AMaLM) which incorporates mastery, constructivist and cooperative were compared. Both instructional strategies were different with respect to its delivery method in which the compilation of past year questions used as the module of ACoLM whilst specifically designed with mathematical scaffolds and guidance module for the AMaLM. The teachers who were involved in both AMaLM and ACOLM groups were also interviewed about their experience of teaching incorporating the Lesson Study.

1.6.1 Objectives of the Study

The objectives of the study are to compare two instructional approaches namely, the modular approach (using the module named, AMaLM) and the conventional approach (ACoLM) to assess their effect on algebraic performance and mathematics anxiety. Specifically the objectives of the study are:

1. To compare the effect of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' overall mathematics performance;

2. To compare the effect of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' performance related to algebraic conceptual knowledge;

3. To compare the effect of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' performance related to algebraic procedural knowledge;

4. To compare the effect of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' performance related to algebraic utility knowledge;

5. To compare the effect of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' mathematics anxiety;

6. To compare the effect of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' mathematics anxiety subscales (class climate, inability, abstraction, test, beliefs and symptoms);

7. To examine the common problem solving strategy utilized by students during algebraic problem solving when undergoing the modular instruction (AMaLM) and conventional instruction (ACoLM) students;

8. To compare the retention effects of modular instruction (AMaLM) and conventional instruction (ACoLM) on students' algebraic performance;

9. To examine the common errors committed by students during algebraic problem solving when undergoing the modular instruction (AMaLM) and conventional instruction (ACoLM) students;

10. To investigate the effect of the mastery learning activities for AMaLM group based on the respondents' opinions on the teaching and learning approach;

11. To gather the opinion of teachers' involvements on the Lesson Study practice in teaching.

1.6.2 Research Hypotheses

It was hypothesized that the use of the modular teaching approach (using AMaLM) may have an impact on the students' algebraic performance and mathematics anxiety. The specific research hypotheses are as follows:

H_{a1} There is a significant difference in the mean overall algebraic performance between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a2} There is a significant difference in the mean performance on algebraic conceptual knowledge between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a3} There is a significant difference in the mean performance on algebraic procedural knowledge between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a4} There is a significant difference in the mean performance on algebraic utility knowledge between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a5} There is a significant difference in the mean mathematics anxiety between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a6} There is a significant difference in the mean of class climate anxiety between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a7} There is a significant difference in the mean of mathematics inability anxiety between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a8} There is a significant difference in the mean of mathematics abstraction anxiety between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a9} There is a significant difference in the mean of mathematics test anxiety between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a10} There is a significant difference in the mean of mathematics beliefs anxiety between the modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a11} There is a significant difference in the mean of mathematics anxiety symptoms between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a12} There is a significant difference in the problem solving strategy utilized during algebraic problem solving among the modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

H_{a13} There is a significant difference in the mean of performance in ACT Retention Test between the mastery learning modular instruction (AMaLM) and conventional instruction (ACoLM) groups.

1.7 Significance of the Study

The emphasis of mathematics anxiety in mathematics learning and teaching is still new in Malaysia. There were not much researches has done on the level of mathematics anxiety and steps to overcome through instructional practice (Davrajoo et al., 2009). This study is an effort and a paradigm shift towards mathematics for all, overcoming the misconception that only some students who are skilled at mathematics perform well. This study is also aimed in developing students' ability to think mathematically. Hence this study has taken the low performing students as an effort to show that mathematics performance among students can be improved if the teacher is able to overcome the mathematics anxiety state when it has been a hindrance for mathematics learning. It is hoped that through gradual conceptual construction for topics involving abstractness mathematics performance will improve.

The purpose of a research is to contribute new theories to the body of knowledge. Theoretically, this research complements innovations in learning and teaching of algebraic concepts. Algebraic concepts are fundamental for problem solving that relates various topics of mathematics. Without the proper conceptual knowledge and procedural knowledge, students cannot and will not learn mathematics. This study has merged three interrelated pieces of knowledge or 'inputs' needed for performance as the 'output' of learning.

In theory, this research is suggesting policy makers to instill the psychological knowledge content on mathematics anxiety into teaching and learning other than pedagogical content knowledge, and subject-content knowledge. This study has utilized the learning theories of concept formation (social development), mastery learning, and constructivism learning in developing a module for the learning of algebra and to improve students' performance by reducing mathematics anxiety. Students' learning depends on the selection of sequence in the curriculum that moves one stage to another using appropriate pedagogical approach, and is assisted by a psychological approach that varies according to the group of children the teacher or instructor is working with. If the learning did not meet the needs of learner there is little room for successive teaching.

The instrument Student's Revised Mathematics Anxiety Rating Scale (S-RMARS) is a useful tool to diagnose mathematics anxiety, which is very real among the secondary school students especially in upper secondary (Davrajoo, 2007). It seems that all learners have some degree of mathematics anxiety related to previous mathematics learning experience. Researchers have shown that this phenomenon will make the students miss mathematics class which in turn results in poor performance and difficulty to proceed to a higher level of learning and in achieving a science and technology based career. Therefore S-RMARS can help identify factors of mathematics anxiety phenomenon such as mathematical climate, abstraction, inability, and test, beliefs based on value, confidence, enjoyment and symptoms.

Generally, findings of this study could guide mathematics teachers in reducing the causes of mathematics anxiety. Likewise the diagnose module Algebraic Comprehension Test (ACT) can be useful to assess the understanding on concepts and use of algebraic learning in mathematics. Previous studies have shown that most students faced problems in algebraic due to its nature or characteristics involving symbols, variables and formula. It is very hard for them to relate these symbols or variables in real life problem solving. Therefore, ACT as a diagnose module can be applied to assess the algebraic conceptual knowledge (ACK), Algebraic, Procedural Knowledge (APK), and Algebraic Utility Knowledge (AUK) based on value of learning algebra in mathematics. It will provide comprehensive information to teachers as well as researchers on factors that predict poor mathematics performance among students in rural areas, specifically. This information may help to generate more research concerning mathematics teaching.

The AMaLM is designed to convey successfully the algebraic knowledge to low achievers of public secondary schools particularly in rural areas hence improving their mathematics performance. It can help to improve mathematics performance in mathematics among At Risk students by developing the ACK and APK gradually from the bottom of basic to problem solving. It can be used for both lower and upper secondary class students who are lacking the basic knowledge in algebra especially in topics of algebraic expressions, linear equations, quadratic equations, simultaneous equations, in equalities and application of these knowledge in various problems such as Perimeters, Areas of Circle, and Volumes of Solid Geometry and so on that involved the area of algebra. In addition this modular learning also gives emphasis on the AUK to increase the students' interest towards learning mathematics in real-life situation. For teachers, either the module or the findings of this study will help them to conduct remedial classes or improve the performance of low achievers. It is a guide for them to take into consideration the pedagogical and psychological aspects when planning their teaching materials, learning processes and learning tasks.

This research is a pioneer effort in treating such a situation in Malaysian secondary schools. Teaching mathematics is not just to reinforce the use of numbers, symbols and formula, but teachers must also provide a safe and encouraging environment for their students through pedagogical methods by positive, relevant, and concrete instructions. As well as the instruments and outcomes of this study are a practical resource for planning and implementing quality teaching and learning of mathematics.

Moreover these findings are very useful for teacher-training institutions pre-service teachers and material development panel. It is useful in the preparation of modules geared towards helping the students to appreciate mathematics and gain confidence in school mathematics. Modular based learning in mathematics is not popular comparatively to science discipline such as biology, chemistry and physics. The existing modules in secondary schools are the compilation of past-year examination questions. This study has provided an adapted curriculum for mathematics learning in the area of algebra. Meanwhile the incorporation of Lesson Study encourages mathematics teachers to explore opportunities allowing creativity so that students would remain interested, focused, and enthusiastic throughout their mathematics course and at the same time improve their positive attitude and confidence in mathematics. For future researchers this study can be used as a foundation to be developed to other areas of mathematics field such as Geometry and Trigonometry as mathematics foundation courses.

1.8 Limitations of the study

This study is limited to a targeted group for the purpose of identifying the psychological and pedagogical aspects in mathematics performance. The targeted group is the Form Four at risk students who are affected by mathematics anxiety. The curriculum is on algebraic learning, which was identified as the basis for problem solving. Therefore, the study is specifically on students performance (ACT) based on algebraic learning in the lower secondary (Form 1, Form 2, and Form 3) schools which is foundation for mathematics learning in Form 4.

The psychological approach was used to find out the mathematics anxiety and to measure the dimensions of mathematics classroom climate, inability in solving problems, abstraction of mathematics, test, beliefs and symptoms in a mathematical situation. The students' beliefs on mathematics learning score were measured on three dimensions, confidence, enjoyment and value in mathematical learning. Therefore, the findings are limited to those anxious students with negative beliefs on usage of mathematics in their daily lives even after their school years.

The pedagogical aspects were only based on constructivism learning, mastery learning and collaborative learning and Vygotsky social learning. The course was an adapted curriculum on Algebra that was arranged in units progressing from the simple to complex concepts leading towards the application of algebra in problem solving. The treatment was done over four weeks of teaching sessions (four hours per week). Hence the results can be generalized to courses of similar contents and level. In this study mortality was a threat. Some participants dropped out of the course. However participants from both groups (AMaLM and ACoLM) were homogenous based on pre-performance test and pre test. Hence, all the findings on performance were only those obtained score in ACT that are related to AMaLM.

1.9 Definitions of Terms

The following are the definitions of terms (conceptual and operational) which are used in this study. They are as follows:

Learning Module

Conceptually, module is an instructional package dealing with single conceptual unit of subject matter. Researches that based on self-instructional package (Aquino, 1998; Acelajado, 2006; Harris, 2005; Rohrer & Taylor, 2007; Selimi & Veliu, 2010; Aquino, Hagos, Evangelista, Lim & Reyes, 2011) shows that teaching modules as a tool to build- up skills and knowledge in discrete units with self-paced learning according to the students' need and ability. It can be used by individuals or small groups of learners in various situations.

Algebraic Mastery Learning Module

Algebraic Mastery Learning Module (AMaLM) is a module used in this study consisting of a set of selected topics of algebra based on Malaysian's secondary school mathematics curriculum. It is a tutoring guidebook to help students in mastering the concepts of algebra that incorporates the theory of mastery learning and constructivism learning. AMaLM was designed in such a way to help struggling students comprehend the concepts before receiving new concepts.

It comprises of algebraic teaching and learning curriculum with the objectives, steps, examples, exercises and evaluations on Algebraic Expressions, Simultaneous Algebraic Equations, Quadratic Equations, Algebraic Inequalities, and Application of Algebra that planned for 16 hours of teaching and learning. In the Application of Algebra unit the students will be expected to apply the gained algebraic knowledge and to solve problems from various topics of The Straight Lines, Solid Geometry, and also Area and Perimeter.

In this study the term AMaLM is an instructional module to help At-Risk students in mathematics learning. In this approach students will be guided to construct the ideas in algebra gradually starting from the introduction on variables to the circumstances of using formulae in problem solving. It incorporates the learning theories: constructivism, mastery and collaborative (CDC, 2004; MOE, 2009). It is a student-centric method emphasizing on active learning and developing positive attitude towards mathematics by inculcating confidence, enjoyment and the value of algebra. Students are required to master the lessons of each unit before proceeding to next unit (refer the sample in Appendix A 1).

Algebraic Conventional Learning Module

Conceptually, in Malaysian schools the term of module used for a set of questions of subject matter (mathematics question banking system) to drill students towards examination. In this study the term Algebraic Conventional Learning Module ACoLM refers modular instructional approach for the low performing students. It is a compilation of past years questions from Mathematics for *Sijil Pelajaran Malaysia* (SPM-upper secondary level achievement examination). It is compilation of drills and procedures on problem solving that incorporates the conventional instructional approach (Idris, & Salleh, 2010). It comprises curriculum with practices of algebraic teaching and learning on Simultaneous Equations, Quadratic Equation, Inequalities, The Straight Line, Solid Geometry and also the Perimeter and Area that planned for 16 hours.

The teaching and learning sessions conducted by providing exercises, explanations and drilling. Students are taught to learn concepts via the conventional instructional approach usually the problem solving is exam oriented. In this study it refers to a long established traditional teaching that society has deemed appropriate. It is a teacher-centric method focussing on rote learning and memorization emphasising on verbal answers. It is a whole-class instruction with three main activities of 'explaining -practicing- working on practices' with little discussion at the end of in mathematics lessons (refer sample of the ACoLM is in Appendix A 2).

<u>Mathematically At-Risk Students</u>

Conceptually mathematically At-Risk students are students with difficulties either in learning mathematics or in processing mathematics, memory and sequencing and having mathematics anxiety. They have visual spatial confusions related to mathematics and also unusual anxiety in learning mathematics ((Abu Bakar et al., 2010).

In this study At-Risk students refer to academically weak students and requiring remedial teaching in basic skills and have behavioural problems. They are the ones who are at risk of failure (scoring below 40 in mid-year examination) based on school records (Refer Appendix B).

<u>The Algebraic Performance</u>

Performance is defined as a cognitive perspective in which learners learning and understanding are evaluated (Eggen & Kauchak, 2004). The performance on algebraic knowledge is determined on the understanding of algebraic content in the mathematics syllabus covering the field of Shapes and Relations (MOE, 2004; Zanzali, 2005, 2011). The understanding include the 'unknowns', 'co-efficient', 'expressions' and 'equations' and related problems especially in algebra (Ryan, 2000; Davrajoo, 2007). It measures the basic topics of Algebraic Expressions, Linear Equations, Quadratic Equations, Linear Inequalities, Solid Geometry, Perimeter and Area of Circle

This study focused on effect of some treatment. Therefore two measurements of algebraic performance on Algebraic Comprehension Test (ACT) were taken. The first is ACT-Diagnostics Test (Refer Appendix C 1) that was administered before the treatment. It was based on the lower secondary syllabus (Mathematics for PMR). ACT-Diagnostic Test scores were used as covariates in statistics analysis. The second test is ACT-Post (Refer Appendix C 2) which were conducted and at the end of intervention. It is based on the upper secondary syllabus as required in upper secondary syllabus (Mathematics SPM). Both are similar in terms of structure of algebraic test. These tests based on the Algebraic Conceptual Knowledge (ACK), Algebraic Procedural Knowledge (APK) and Algebraic Utility Knowledge (AUK) as discussed below. It consists of ten subjective questions with the total score of 40 and 20 multiple-choice questions based on the students understanding of algebraic with a total score of 60. For the first ten questions students were required to solve algebraic problems using appropriate concepts and procedures. These items measured students' ACK and APK. Meanwhile the next 20 items measured students' AUK

Algebraic Conceptual Knowledge (ACK)

Hiebert and Lefeyre (1986) (in Maciejewski, Mgombelo & Savard, 2007) and Bayat, (2012) defined conceptual knowledge as relationship between pieces of information and it is achieved by the creation of the relationship between existing knowledge and new information. ACK refers to knowledge of recognizing the symbols (like terms and unlike terms), skills of converting word problems in or carrying out an operation, by understanding the function of the equation and how to solve the equations (Booth, Koedinger & Siegler, 2007). It refers to the understanding of ideas and generalizations that connect mathematical constructs (Ashlock, 2006) and is rich in relationships.

In this study the ACK refers to the ability to answer correctly by understanding the meaning and making sense of algebraic equations and solve the problem. It measures errors based on equal sign-related errors and performed operations, omitting the equals sign from the equation, and combined-like terms, or unlike terms in the 10 problems solving of ACT I. Hence, answers to the ACT I items were coded as correct or incorrect, and the scores computed in the percentage of problems answered correctly by each student.

Algebraic Procedural Knowledge (APK)

According to Hiebert and Lefevre (1986) (in Maciejewski, Mgombelo & Savard, 2007) procedural knowledge is a familiarity with the symbols that consists of rules or procedures for solving mathematical problems. Many of the procedures that students possess probably are chains of prescriptions for manipulating symbols. Algebraic procedural knowledge is defined as the knowledge of formal language in terms of symbolic representations using rules, algorithms, and procedures while working on problem solving. It is considered as the competency of carrying out a mathematical task, the knowledge of how to solve or to carry out specific mathematical tasks quickly and efficiently.

In this study the APK is measured through the correct procedures used while solving the problems involving transfer errors (e.g., previously using the wrong solution), and non-systematic errors (e.g., arithmetic errors, omission errors, and carelessly carried forward mistakes). The composite scores are used to indicate the number of procedural errors of students made while working on the problems in ACT I.

Algebraic Utility Knowledge (AUK)

In this study AUK refers to the knowledge of the students on the use or value of algebraic measured by the items on Part II of ACT. It consists of 20 items with multiple-choice answer. Each answer carries a different score that determines a student understanding on algebraic real-life situations with the total score of 60. The items measure the understanding of students about algebraic learning and the usage of mastering algebra for problem solving. It comprises of six components namely: learning of algebra, the terminologies used in algebra, the variables and constants in algebra, algebraic expressions, and properties of addition and multiplication and combining like-terms in an expression.

Mathematics Anxiety

Mathematics anxiety is defined as feelings of tension and worry that interfere with the manipulation of mathematics problems (Richardson & Suinn, 1972; Morris, 2007). Tobias and Weissbrod (1980) defined mathematics anxiety as “the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem”. According to Luo, Wang, and Luo, (2009) mathematics anxiety is an unhealthy mood response which occurs when mathematics problems cause panic and losing one’s head, depressed and helpless, nervous and fearful; at the same time, it is accompanied by some physiological reactions, such as perspiration of the palms, holding tight the fists, being sick, vomiting, dry lips, and pale face. Students experience a feeling of self-threat in mathematics learning, resulting in the loss of interest in mathematics and the loss of confidence in mathematics learning. Mathematics anxiety is defined as an adverse emotional reaction to mathematics or the prospect of doing mathematics (Preis & Biggs, 2001; McKee, 2002; Maloney & Beilock, 2012).

In this study, it is refers to the total scores measured using students' collective scores of the frequent anxious experiences with the underlying dimensions of mathematics class climate, inability, abstraction, test, beliefs and symptoms as measured by the Students'-Revised Mathematics Rating Scale, S-RMARS (Davrajoo, 2007). The items in S-RMARS (Refer as Appendix D) measure the frequent occurrences of experiencing situations using the Likert scale ranging from never (1) to always (5). The following discusses each of the five dimensions in assessing mathematics anxiety.

Class Climate Anxiety

Class climate is defined as the affective nature of the space and relationships comprising a learning environment; this includes the aesthetics, comfort, and appropriateness of the learning space and the levels of mutual respect, personal sharing, resource access, inclusion of alternate viewpoints, support and encouragement, risk and reward, and the placement of decision making in the environment (Sutter, 2006). It allows students to feel secure enough to take risks, honestly expressing their views, and share and explore their knowledge, attitudes, and behaviours (Holley & Steiner, 2005).

In this study class climate is referred to the total score of twelve items that measure student teacher-students' interaction in the mathematics classroom involving the practices, the pedagogical approach and psychological approach (Refer to Appendix D-Part II: Items 1-12).

Abstraction Anxiety

Ferguson, (1985) defined abstraction anxiety as "a factor of math anxiety that reflects a qualitative difference from the type of anxiety illustrated by the items that loaded heavily on Numerical Anxiety. Students often express this difference with a statement like "I understand 2 and 3, but I don't understand x and y". Abstraction anxiety is the anxiety caused by mathematics features such as the use of numbers; algebraic concepts nature as the formulae, symbols, notation (Orton, Orton & Frobisher, 1996; Schwartz, 2000); the rigidity of the logic laws, axioms and theorems (Bessant, 1995).

In this study abstraction anxiety refers to total score of twelve items on students' perceptions or thinking of their anxiety related to learning or working on mathematical task involving the unknowns, equation and formulae (Refer to Appendix D-Part II: Items 13-24).

Mathematics Inability Anxiety

Mathematics inability anxiety is defined as feelings of tension and worry when confronted by the inability to handle frustration, inability to manipulate numbers in a variety of situations, inability to concentrate and inability to hear teacher instructions (Jain & Dowson, 2009) and to cope with quantification, in mathematics (Anderson, 2007). This anxiety caused by low self-esteem, lack of capability, lack of confidence, pessimism, frustration, flailing efforts in deriving the correct answer and their indifferent attitude in seeking for help (Jones, 2001) when involved in problem solving. It also results in an inability to attend to more than one task at a time or to organize thoughts and plans effectively. Low levels of anxiety may temporarily increase a person's ability to do a simple task, because of the greater vigilance and narrowing of attention associated with anxiety.

In this study mathematics inability anxiety refers to the total score of ten items measuring on how student utilizes social interactions with peers to achieve their goal. Peer learning includes group discussion or group work to overcome the inability of working on the given sums (Refer to Appendix D-Part II: Items 25-35).

Test Anxiety

Spielberger and Vagg (1995) defined test anxiety as a situation-specific anxiety trait or disorder that involve excessive amount of concern, worry and fear about assessment. Students with high test anxiety feel more threatened in evaluative situations and are more likely to exhibit higher state anxiety. Test anxiety arises during the evaluation such as quizzes, monthly tests, and examinations that will set off stress due to time constraint (Spielberger & Vagg, 1995). Test anxiety is an interfering agent (Cassady & Johnson, 2001; Jain & Dowson, 2009) resulting in mental emptiness or incapable in thinking clearly (Hembree, 1990; Sarason, 1984; Wine, 1982). High test anxiety has difficulty in retrieving known information and strategies (Jain & Dawson, 2009).

In this study the test anxiety refers to the total score on the 10 items that measure anxiety due to time management and self-initiated effort to organize the learning context in order to answer during evaluations on students' mathematics performance (Refer to Appendix D-Part II: Items 36-45).

Mathematical Beliefs

Beliefs refer to student's perceptions regarding mathematics learning such as confidence, (Goolsby, 1988; Linn & Hyde, 1989; Randhwa, Beamer, & Lundberg, 1993), enjoyment (Ma & Kishor 1997; Thorndihe-Christ, 1991), and value (Fennema-Sherman, 1976). Schoenfeld, (2006) stated that consequential pessimistic beliefs in mathematics among students may be causing them the anxiety syndrome. The beliefs include cognitive feelings relating to the nature of mathematics, opinions on their self-esteem the teacher's role and the social context where mathematics is taught (Smith, 2005).

In this study beliefs refer to the multidimensional construct consisting of the total score on the twelve items that measure the perceptions on the dimensions of value, confidence and enjoyment in mathematical learning (Refer to Appendix D-Part III A: Items 1-12).

Value

The value of mathematics is defined as the ability to utilize mathematics skills in real-life problem solving (Fennema-Sherman, 1976). Wigfield and Meece, (1999), suggested that the value students attach to mathematics depends on whether they have low perceptions of their math abilities and consequently then do not value mathematics and then may not report as much mathematics anxiety compared to students who have low perceptions of their mathematics abilities but think it is important to do well in mathematics.

In this study the value refers to the total score on the three items as a subscale of beliefs on the use of mathematics in daily life (Refer to Appendix D-Part III A: Items 1-3).

Confidence

The mathematics anxiety phenomenon exists in many forms, degrees and at many levels arising from the lack of confidence. It is the feelings continuum in the psychological domain, with its extremes being confidence and anxiety. The degree of mathematics anxiety continuum is reduced when the confidence in problem solving increases. The transition from confidence to anxiety had been hypothesized to be the result of unpleasant experiences associated with learning or doing mathematics (Byrd, 1982; Kogelman & Barbara, 1986; Tobias, 1978, 1999). According to Dodd (1992), the lack of confidence is probably the math-anxious learner's greatest obstacle.

In this study confidence refers to students' perception or thinking of their confidence while working on mathematical task. Altogether four items are used to measure the level of confidence for the beliefs subscale (Refer to Appendix D-Part III A: Items 4-7).

Enjoyment

The dimension of enjoyment defined as the convenience on mathematics learning, self-efficacy and trusting their intuition and relying on memorizing instead of understanding the concepts (Le, 2003). In this study enjoyment refers to the students' perception or thinking of their enjoyment related to learning or working on mathematical task. Altogether there are five items response to measure the level of enjoyment for the beliefs subscale (Refer to Appendix D-Part III A: Items 7-12).

Symptoms

Physical symptoms are stressful feelings of "powerless, out of control, lacking in self-esteem" caused physical experience that may involve rapid or pounding heartbeat, difficulty breathing, tremulousness, sweating, dry mouth, tightness in the chest, sweaty palms, dizziness, weakness, nausea, diarrhea, cramps, insomnia, fatigue, headache, loss of appetite, and sexual disturbances (Fotoples, 2000; Anderson, 2007).

In this study symptoms such as getting the students' experiencing physical and/or mental symptoms in getting nervous, shivering, dizzy, vomiting, stomach churning, panic, wet palm, rapid breathing. Altogether there are ten items of S-RMARS (Davrajoo, 2007) to measure the occurrence of mathematics anxiety while working on mathematical task (Refer to Appendix D-Part III B).

1.10 Summary

This chapter presented perspective on teaching and learning of mathematics, for At-Risks students at the secondary school level. The objectives of the research and the hypothesis are presented. A problem statement is derived based on the existence of mathematics anxiety and low mathematics performance among At-Risks students. The supporting theories on the use of mastery learning module for learning are also discussed. The purpose and significance of this study in improving the existing mathematical performance among At-Risks students are highlighted. Also discussed are the limitations of this study and the conceptual and operational definitions of the key terms utilised

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