THE EFFECTS OF DEDUCTIVE AND INDUCTIVE BASED COURSEWARE ON LEARNING PERFORMANCE AND ENGAGEMENT AMONG STUDENTS WITH DIFFERENT LEVELS OF SELF-REGULATED LEARNING

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by

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LIST OF ABBREVIATION

ATID	Allesi & Trollip Instructional Design and Development
DM	Deductive Method
HOTS	Higher Order Thinking Skills
HSRL	High Self-Regulated Learning
IM	Inductive Method
IMC_{SL}	Interactive Multimedia Courseware on Straight Line
LES	Learning Engagement Scale
LSRL	Low Self-Regulated Learning
MSLQ	Motivated Strategies Learning Questionnaire
PISA	Programme for International Student Assessment
SRL	Self-Regulated Learning
TIMSS	Trends in International Mathematics and Science Study

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Conference Proceeding

Subashini, L., & Fatimah, S. (2011). Comparison between cooperative computer-assisted instruction and individual computer-assisted instruction on students' performance with different cognitive styles. Paper presented at the *International Technology, Education and Development Conference*, 7-9 March 2011 at Valencia, Spain.

Subashini, L., & Irfan, N.U. (2013). A proposed study on the effectiveness of deductive and inductive methods in learning mathematics using multimedia courseware. Paper presented at the *International Conference and Computing, Mathematics and Statistics*, 28-29 August 2013 at Bayview Beach Resort Penang, Malaysia.

KESAN KOSWER BERASASKAN DEDUKTIF DAN INDUKTIF TERHADAP PRESTASI DAN PENGLIBATAN PELAJAR YANG BERBEZA TAHAP PEMBELAJARAN PENGATURAN KENDIRI

ABSTRAK

Pelajar perlu memiliki kebolehan untuk memindahkan pengetahuan matematik yang dipelajari kepada domain atau masalah lain. Kemahiran ini akan memudahkan mereka mengendalikan masalah kehidupan sebenarnya pada masa hadapan. Berdasarkan sorotan literatur, kebolehan pelajar untuk membuat suatu kesimpulan mengenai konsep matematik yang dipelajari dapat melahirkan individu yang berupaya berfikir dan inovatif, dan seterusnya membolehkan pemindahan pembelajaran berlaku. Oleh yang demikian, satu perubahan pedagogi perlu ada di mana peralihan dari penyampaian isi kandungan matematik secara menyeluruh yang dihafal oleh pelajar kepada pembelajaran yang merangsang pemikiran mereka. Kajian ini mencadangkan satu pendekatan yang menggunakan kaedah pengajaran yang kreatif bersama multimedia interaktif untuk menggalakkan pelajar membina pengetahuan matematik. Penyelidikan ini dijalankan bagi mengkaji kesan koswer multimedia interaktif dengan dua kaedah pengajaran yang berbeza terhadap prestasi dan penglibatan pembelajaran dalam kalangan pelajar Tingkatan Empat dalam topik matematik ‘Persamaan Garis Lurus’. Koswer berasaskan kaedah deduktif dan koswer berasaskan kaedah induktif telah dibangunkan. Seramai 97 pelajar menerima kaedah deduktif manakala 94 pelajar menerima kaedah induktif. Kajian eksperimen kuasi ini menggunakan reka bentuk faktorial 2 x 2. Pembolehubah bebas melibatkan kaedah pengajaran, iaitu sama ada kaedah deduktif atau kaedah induktif, manakala pembolehubah bersandar melibatkan prestasi pelajar dalam pembelajaran pemindahan dekat, pembelajaran pemindahan jauh serta penglibatan pembelajaran

mereka. Pembolehubah moderator ialah tahap pembelajaran pengaturan kendiri pelajar iaitu tahap rendah dan tahap tinggi. Hasil kajian terhadap kesan utama kaedah pengajaran menunjukkan bahawa kumpulan rawatan induktif memperolehi skor yang lebih tinggi secara signifikan berbanding kumpulan rawatan deduktif dari aspek pemindahan dekat dan pemindahan jauh serta penglibatan pembelajaran. Bagi kesan utama tahap pembelajaran pengaturan kendiri, pelajar tahap tinggi memperolehi skor prestasi pembelajaran pemindahan jauh dan penglibatan pembelajaran yang lebih tinggi berbanding skor pelajar tahap rendah. Hasil kajian juga menggariskan kesan interaksi yang signifikan antara kaedah pengajaran dan tahap pengaturan kendiri bagi kesemua pemboleh ubah bersandar. Satu dapatan nyata daripada kajian ini ialah, pelajar tahap rendah dan tahap tinggi telah memperolehi manfaat yang setara dalam prestasi pembelajaran pemindahan dekat. Selain itu, dalam kumpulan kaedah deduktif, pelajar tahap rendah dan tinggi juga memperolehi skor yang sama bagi prestasi pembelajaran pemindahan dekat dan penglibatan pembelajaran. Secara umumnya, dapatan-dapatan ini menunjukkan kesan positif, khususnya yang dibawa oleh mod induktif terhadap prestasi dan penglibatan pelajar bagi pembelajaran topik ‘Persamaan Garis Lurus’. Lantaran itu, perekabentuk koswer, penulis buku, pegawai pendidikan dan guru harus mempertimbangkan penggunaan kaedah induktif agar pemindahan pembelajaran dalam matematik dapat dilaksanakan dengan jayanya. Selain itu koswer multimedia interaktif berdasarkan kaedah induktif boleh digunakan sebagai media yang berpotensi untuk membantu pelajar yang memiliki tahap pembelajaran pengaturan kendiri yang berlainan.

THE EFFECTS OF DEDUCTIVE AND INDUCTIVE BASED COURSEWARE ON LEARNING PERFORMANCE AND ENGAGEMENT AMONG STUDENTS WITH DIFFERENT LEVELS OF SELF- REGULATED LEARNING

ABSTRACT

Mathematical knowledge gained by the students must be successfully transferred to another domain or problem which will enable them to handle real life problems. Literature supports that designing and making one's own conclusion of the learnt concepts can produce students who are thinkers and innovators which will lead to a better transfer of learning. Therefore, pedagogical shift from delivering a whole mass of knowledge that is mostly memorized to one that enhances students' thinking skills is necessary. In this study, a combination of creative instructional method and interactive multimedia that allows students to construct their own knowledge in mathematics concepts is proposed. This study is conducted to examine the effects of interactive multimedia courseware (IMC_{SL}) with different instructional methods on Form Four students' learning performance and engagement in the mathematics topic of 'Straight Line'. Two modes of IMC_{SL} were developed, with one using the deductive method (DM) and the other using inductive method (IM) in presenting the mathematics contents. The DM was assigned to 97 students whereas the IM was assigned to 94 students. This quasi-experimental study employed a 2 x 2 factorial design. The independent variable was the instructional method namely; DM and IM incorporated in an IMC_{SL}. The dependent variables were the students' performance scores in near transfer of learning, far transfer of learning and also their learning engagement score. The students' self-regulated learning (SRL) level – either low self-regulated learning (LSRL) or high self-regulated learning (HSRL) was identified

as the moderator variable. Findings on the main effect of the treatment conditions indicated that the IM group scored significantly higher than the DM group in terms of near transfer, far transfer and learning engagement. As for the main effects of their SRL levels, the HSRL students performed significantly better than the LSRL students in far transfer performance and learning engagement. The findings also outlined significant interaction effect between treatment conditions and the students' SRL levels on near transfer, far transfer and learning engagement. One key finding that was discovered in this study was that the LSRL and HSRL students profited equally in the measures of near transfer performance. These two categories of students in the DM group also scored equally in near transfer and learning engagement. Overall, these findings support the positive effects of IMC_{SL} using IM on the learning of 'Straight Line'. Based on these positive impacts of inductive-based courseware on LSRL and HSRL students, courseware designers, book writers, education officers and teachers should consider applying the inductive examples as a transition towards transfer of learning in mathematics and also as a promising medium to accommodate the different SRL levels in students.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia's long term vision 2020 calls for establishing a scientific and progressive society that is innovative and forward-looking. The vision intends to produce a society which is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future. Vision 2020 can only be achieved by producing a critical-thinking workforce which is technology-literate and is prepared to participate fully in the global economy of the 21st century (Mahathir, 1991). A reformation in the educational system was seen as an important means to realize this vision.

The Ministry of Education Malaysia has since initiated the transformation of the nation's educational system whereby multimedia learning using information communication technology (ICT) has been the central concept. The usage of multimedia courseware in the education system obviously benefits teachers and students in the teaching and learning process (Harun & Tasir, 2003). Cognizant to this vision, the ministry has launched the Smart School project in 1997. Malaysian government began to equip schools with ICT equipment and digital learning objects such as CD-ROMS, laptops, LCD projectors and learning packages to teachers. The government is channeling a huge sum of expenditure to upgrade and improve the education system in Malaysia. However whether there has been a fair return of investment towards this end is still questionable.

Besides this, an educational reformation in mathematics and science was also seen as an important move in realizing the vision 2020. The mathematics curriculum only became standardized and official after the year of 1956 when the Razak Report suggested that there should be a formal curriculum for all government schools (Heng & Tan, 2006). The Malaysian Education Ministry has revised the mathematics syllabus several times to improve its curriculum and has introduced various movements to enhance the usage of ICT in the subject to fulfil the needs of the students in today's technology world. Technology is an essential tool for learning mathematics in the 21st century (Dede, 2000).

The recent Trends in International Mathematics and Science Study (TIMSS) shows that Malaysia's ranking in Mathematics fell from 20th in 2007 to 26th in 2011 while its ranking in Science fell by an ever greater margin, from 21st in 2007 to 32nd in 2011 (Mullis et al., 2012). The average Mathematics score fell from 474 in 2007 to 440 and the average Science score fell by an even greater degree from 471 in 2007 to 426 in 2011 (Daniel, 2013). Thus, the launch of the Preliminary Malaysia Education Blueprint 2013-2025 (*Pelan Induk Pembangunan Pendidikan*) on Sept 11, 2012 acknowledges weaknesses in the education system and seeks to produce students who will be thinkers and innovators, prepared for jobs that are yet to exist. The main aim of the blueprint is to move the Malaysian students from the bottom one-third category to the top one-third in the world.

With this, the students' interest in science and mathematics should be enhanced as these are the fundamental subjects in the usage of advanced technology. Effective teachers maximize the potential of technology to develop students' understanding, stimulate their interest, and increase their competency in mathematics. However,

many Malaysian teachers are still skeptical and lack creativity in the use of technology in teaching mathematics (Lau & Sim, 2008). Since Malaysia is committed to develop and provide world class educational system, an effective instructional medium is needed in order to transfer the knowledge learnt by the students within and to other domains. This will produce students who are able to transfer learning from one setting to another which is essential as the knowledge and job skills needed to be productive are also changing with the rapid changes in technology.

Teachers need to understand their students' potential problems and learning difficulties in order to implement effective instructional method to produce meaningful learning among students (Meese, 2001). Malaysian education system must also be in line to meet the needs of new economy which is the thrust of knowledge, innovation and technology (Najib, 2012). The Ministry of Education reiterated in its Preliminary Malaysia Education Blueprint 2013 - 2025 that it will leverage on all existing ICT initiatives such as expanding the 1 BestariNet (Wifi) for all schools by 2013 in order to scale up quality learning across Malaysia (Educational Planning and Research Division, 2012). This must be incorporated with the effective and creative instructional methods to enhance the students' learning.

It has been reported that mathematics is a subject that is difficult to understand by many students and they exhibited weakness in mastering the mathematics skills (Berch & Mazocco, 2007; Pegg, Graham, & Bellert, 2005; Seo & Bryant, 2009; Tambychik & Meerah, 2010; Tambychik et al., 2010). Hence, a pedagogical shift from delivering a whole mass of knowledge that is mostly memorized to one that is problem solving oriented is necessary. Knowledge should be delivered to enhance

students' thinking skills. Thus, this study intended to investigate the effectiveness of two different instructional methods on students' performance in the transfer of knowledge and learning engagement in learning mathematics by using an interactive multimedia courseware. The main aim of this study was to find a suitable technology-based instructional method which will enable students to transfer learning from one setting to another, thus, producing critical thinking students who will help to fulfill the main aim of the Preliminary Malaysia Education Blueprint 2013-2025.

1.2 Research Background

Technology innovations have brought tremendous changes in the Malaysian education system. In the aim to produce a technological literate society, the traditional chalk-and-talk method of teaching which has been used for decades in the Malaysian educational system has been modified and enhanced by the technological advances. The introduction of ETeMS (English for Teaching Mathematics and Science) initiative in 2003 and Smart Schools' policy in 1999 have enhanced the instructional technology environment in schools. In line with the ETeMS policy, many educational digital materials were designed and developed to aid teachers. This move was also to incorporate ICT into the teaching and learning of mathematics. It was also to take science and mathematics to international standards. New technological teaching methods were introduced and used by the teachers to improve the students' mathematical understanding. However, it was uncertain how many teachers were using the digital materials provided by the Ministry of Education.

Mathematics is a compulsory subject in all primary and secondary schools in Malaysia. It is the foundation for many fields of study such as engineering, science, medicine, business, economics and many other subjects. There have been many issues pertaining to the competency of mathematics among teachers and students. With this, the Malaysian government took many steps to raise the teachers' knowledge on pedagogy, content and technology and also the students' conceptual understanding, knowledge and skills in mathematics through the instructional technology environment.

The use of technology in conjunction with effective instructional method is emphasized in most of the delivery methods of knowledge to enhance better mathematical understanding among students. The various innovations in the Malaysian education system show a gradual paradigm shift from objectivism to constructivism learning environment. However, the educational approach is very much into teacher centered. Teachers have been encouraged to deliver an instruction mode which is more student centered where students can construct their own knowledge critically. Despite teachers attending many courses and teaching programs, there is still a lot of room for improvement in conducting a constructivist learning environment which focuses heavily on students' involvement. Students' learning is dependent on the quality of instruction that teachers provide in the classroom (Zakaria & Iksan, 2006).

With the use of computer technology and appropriate pedagogical and content knowledge, learning should not only be about mastering the information. It is more of designing and making one's own conclusion of concepts learnt that can produce students who are thinkers and innovators. As such, teachers are encouraged to use the

appropriate multimedia materials, learning method and instructional strategy to help the students experience and construct abstract ideas (Ministry of Education, 2006). Furthermore, the establishment of Smart Schools across Malaysia has activated a demand for more locally produced educational multimedia courseware. Most of the foreign educational multimedia courseware is not quite appropriate for the Malaysian educational environment and learning needs (Boon Shiong et al., 2008). Most of the courseware provided by the Malaysian Ministry of Education, Curriculum Development Centre and the commercialized CD-ROMs are based on the behaviorist and objectivist model that encourage rote learning (Vikneasvari, 2007). This is similar to teacher-centered teaching where the computer is used to replace the teachers in transferring the knowledge to the students.

The constructivist approach with the use of different instructional methods in an interactive multimedia courseware should be explicitly implemented to ensure students construct their own mathematical concepts and knowledge. This is to ensure that the mathematical knowledge gained is successfully transferred to another domain or problem which will enable them to handle real life problems. This is in par with the Preliminary Malaysia Education Blueprint (2013-2025) which focuses on key changes to bring about more effective teaching and learning in the classroom to match global standards.

Education is a main concern in Malaysia and every year, the government allocates a big percentage of the federal budget for the development expenditure in education. Many education policies have been developed and implemented to upgrade and improve the education system in Malaysia. Taking cognizance to this importance, Malaysia has allocated 21.7% of the total budget for the operational and development expenditure in year 2009 for education (SSY Partners Chartered

Accountants, 2010). This amount of allocation is huge by any standards, even for developed countries like Korea and Singapore. With the government spending such a huge sum of money in its continuous effort to upgrade and improve the education system in Malaysia, has there been a fair return of investment towards this end? To measure if there has been a fair return on this investment, an analysis on students' performance in Mathematics and Science would be a good yardstick.

Malaysia has been participating in the Trends in International Mathematics and Science Study (TIMSS) since 1999. The population of the international assessment study are students from the fourth and eighth grades. TIMSS are divided into content and cognitive domain scores with the International Benchmark of 500 points average scale score. The score is to measure and analyze the performance of each country based on their respective curriculum. Malaysian eighth graders (Secondary Form Two students) had participated in TIMSS 1999, 2003, 2007 and 2011. Therefore a comparison of mathematics achievement among these years can be made.

In the 2011 TIMSS, about 20% of Malaysian students failed to meet minimum benchmarks for both mathematics and science. Malaysia was ranked 26th in mathematics in this TIMSS 2011 assessment. (Malaysia was 20th in TIMSS 2007, 10th in TIMSS 2003 and 16th in TIMSS 1999). Based on the average scale score in both Mathematics and Science (Table 1.1), there has been a great decline in both subjects in 2011. The data obtained does not imply that the education policies and the government's effort are inefficient. There are many other factors that may have influenced the scores such as inability of students in understanding the concept, lack of critical thinking, lack of diversity in instructional strategy and learning method, poor unrealistic examples in a topic and the limited use of ICT by teachers due to time constrain.

Table 1.1 ***Malaysian Eighth-Graders (Secondary Two) Mathematics and Science Achievement of TIMSS in 1999, 2003, 2007 and 2011 [National Center for Education Statistics, Trends in International Mathematics and Science Study].***

	Average Scale Score			
Subject	1999	2003	2007	2011
Mathematics	519	508	474	440
Science	492	510	417	426

(Source: http://nces.ed.gov/timss/)

The data in Table 1.2 shows that Malaysian students were outperformed in mathematics by Singapore, Republic of Korea, Hong Kong, Chinese-Taipei and Japan.

Table 1.2 ***Eighth-Graders (Secondary Two) Mathematics Achievement of TIMSS in 1999, 2003, 2007 and 2011 [Trends in International Mathematics and Science Study (TIMSS) 2011]***

		Average	**Scale**	**Score**	
Countries	1995	1999	2003	2007	2011
Singapore	609	604	605	593	611
China Taipei	-	585	585	598	609
Korea	581	587	589	597	613
Hong Kong	569	582	586	572	586
Japan	581	579	570	570	570
Malaysia	-	519	508	474	440

(Source: http://timss.bc.edu/timss2011)

Figure 1.1. **Mathematics Achievements in TIMSS 1999 - 2011**

Figure 1.1 shows the trends in mathematics achievement of form two students in Malaysia in their participation in TIMSS 1999 – 2011. There is a great decline in the performance of mathematics in the TIMSS assessment.

Malaysia has also been participating in the Programme for International Student Assessment (PISA) arose from the Organisation for Economic Co-operation and Development (OECD) policy initiatives in the second half of the 1980s. PISA is an international study which began in the year 2000. It aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students in participating countries. Since the year 2000, over 70 countries and economies have participated in the PISA assessment. An additional 10 economies were added in 2010 under PISA 2009+ in which Malaysia is one of them. The PISA sample is drawn from the population of students aged between 15 years and 16 years (equivalent to Grade 9 or above) who attend educational institutions. PISA assesses outcomes primarily in the areas of reading literacy, mathematical literacy and scientific literacy.

Mathematical literacy assessed in PISA is an individual's capacity to identify and understand the role that mathematics plays in the world. Besides this, the assessment also sees the individuals' capacity to make well-founded judgements and to use and engage mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. Students in Malaysia attained a mean score of 421 on the mathematical literacy scale (PISA, 2012). This mean score is below the average mean score of 500 in the PISA assessment. Malaysia's mean score is also lower than all the means attained in all OECD countries. In Malaysia, only 41% of students are proficient in mathematics at least to the baseline level at

which they begin to demonstrate the kind of skills that enable them to use mathematics in ways considered fundamental for their future development**.**

Based on the data on TIMSS and PISA assessment, it is unfair to say that the education policy has failed to improve the performance of students. A more detailed emphasis should be given to the reformation of education system to enhance students' performance in mathematics. There is also a general perception among students in Malaysia that mathematics is a difficult, abstract and a boring subject (Azizi, Jamaluddin & Yusof, 2007). Students are not interested in following mathematics lessons and they lack learning engagement in this subject. They are shy to voice out their opinion since most of them are used to the supervised instruction and learn through the traditional approach. This is contrary to the essence of mathematics education where students have to gather information, think, analyze, engage in learning and apply knowledge or concepts in solving real life problems.

Malaysian mathematics teachers carry a difficult task in producing students with a world class mathematical competency. Despite numerous curricular programs organized by the Ministry of Education (MOE), students' performance in mathematics has not shown significant improvement (Sharifah, 2003). Table 1.3 shows the analysis of students' mathematical performance for the Sijil Pelajaran Malaysia (SPM) for the year 2008 - 2012.

Table 1.3 ***Analysis of Mathematics Performance in the SPM Exam 2008 – 2012.***

Percentage of student (%)							
Year	Distinction	Credit	Pass	A+ ➔ E	Fail	Number of students	GPMP
2008	26.6	22.0	29.0	77.5	22.5	381,567	5.54
2009	28.8	21.9	27.2	77.9	22.1	399,085	5.29
2010	31.1	23.6	25.9	80.6	19.4	401,558	5.05
2011	28.7	23.9	28.0	80.6	19.4	402,747	5.21
2012	32.7	23.2	25.1	81.0	19.0	406,134	4.91

(Source: Malaysian Examination Board, 2008 – 2012)

The data shows that students' performance in mathematics are equally scattered from Distinction (A+, A and A-), Credit (B+, B, C+ and C), Pass (D and E) and Fail (G). Majority of them obtained either pass or fail in 2008 (51.5% as compared to 48.5% who scored Distinction and Credit). However, there are some small changes from 2009-2012. Though it is a very minimum improvement, students are incapable to keep up with the international scene in the TIMSS and PISA exams as both assessments, require them to use the higher order thinking skills.

Algebra is one topic that is commonly viewed as a difficult topic by many students in the Malaysian secondary school. The study of algebra is essential because it has important applications to topics in basic mathematics and other subjects (Downing, 2009). The low ranking in TIMSS 2011 reflects that the eighth graders' level of algebra thinking is still far from satisfactory. Based on the 2011 mathematics TIMSS content analysis (Zabani, 2012), Malaysian eighth graders performed satisfactorily well only in the number and geometry domain. The students' performance was poor in algebra, data handling and probability questions. As for the cognitive domain, students performed well in the knowing and applying level but were weak in the reasoning level. Figure 1.2 shows part of the mathematics results of TIMSS 2011 for eighth-grade Malaysian students on content and cognitive

domains (Zabani, 2012). It is important to provide students with a strong foundation of algebra because algebra is a foundation study in fields such as science, engineering, architecture, geology and astronomy (Arcavi, 2003).

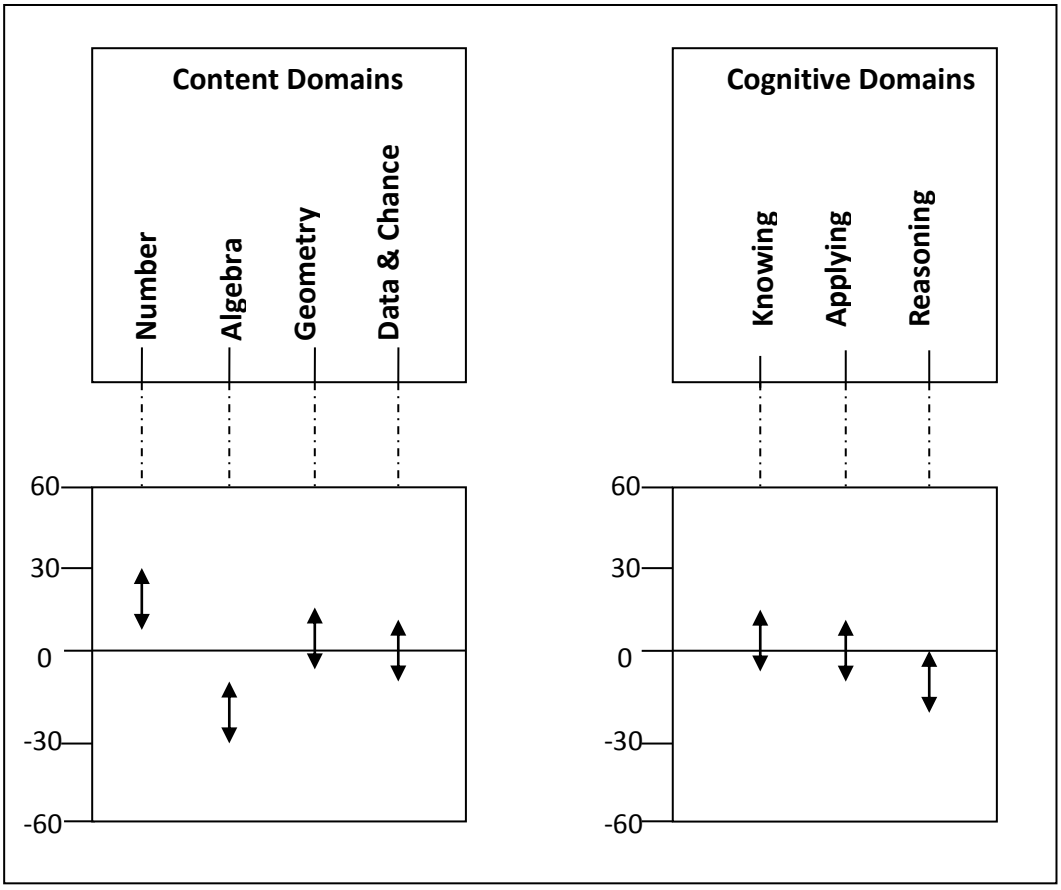

Figure 1.2 **Cognitive and Content Domains of Mathematics in TIMSS 2011 (Zabani, 2012)**

TIMSS questions basically test the thinking skills of students in the usage of mathematical concepts in real life situations. The poor performance of TIMSS (1995 – 2011) shows that Malaysian students are unable to transfer their mathematical knowledge into an unfamiliar situation or other subject domains. According to Zainal (1998), Malaysian students in schools might know how to count but they are unable to apply mathematics concept in questions that involved real life situations. Thus, transfer of learning and problem solving skills should be emphasized among students

in Malaysia. According to Posamentier and Krulik (1998), solving mathematical problems is a skill that will be carried over to everyday problem and serve a person well throughout life.

Many studies have been carried out to investigate the effectiveness of learning mathematics using various teaching strategies, learning methods and digital materials available. However, very few studies have been carried out to measure the effectiveness of using digital materials developed with different instructional methods which emphasize on higher order thinking skills (HOTS) to enhance students' performance in mathematics. Studies on the effects of other alternative instructional strategies in the teaching and learning of mathematics such as constructivism, e-learning and cooperative learning have been established in Malaysian secondary schools. However, the effects of interactive multimedia materials with deductive and inductive teaching methods on different level of self-regulated learning students' mathematical performance and learning engagement are yet to be discovered although studies on the effects of deductive and inductive approaches in the teaching of science and mathematics subjects have been reported in Malaysia. No further empirical studies has being undertaken on the present digital natives in this aspect.

The main reason that hinders the performance of Malaysian students in the two international assessment is the inability to think critically to solve HOTS questions. Thus, a suitable instructional method is important to enable students master the concept being taught. In this study, an interactive multimedia courseware which was designed and developed based on deductive method and inductive method for the Malaysian educational environment was used to see which method would help

students enhance their higher order thinking skills thus enabling the transfer of learning.

1.3 Problem Statement

Mathematics is essential to the development of science and technology. Thus, the acquisition of mathematical knowledge is important for Malaysia to achieve its vision of becoming a developed nation by year 2020. The analysis TIMMS report of mathematics ranking of Malaysia has left much to be desired. Obviously, Malaysian students' performance in mathematics needs to be improved to keep up with the international scene. As the questions in TIMSS and PISA are related to HOTS, the poor performance of Malaysian students in these international assessment can be said due to their lack of higher order thinking skills. Student are also unable to transfer the knowledge learnt to another situation. This clearly shows the lack of systematic, logical and creative thinking among the students in solving the mathematics questions.

The discovery of ideas, theorems, methods of reasoning, and problem solving by the students themselves should be the central objective of mathematics education at every grade level. The treatments given to students regarding concept learning should emphasize the "process-product" approach rather than merely providing ready-made definitions and mechanical procedures that is devoid of meaning. However, the process aspect of mathematics is neglected in most of the teaching. Students tend to memorize rather than understand the mathematical concepts that underlie due to the over emphasis on assessments and exams (Mohd, 2009).

Algebra has important application to real-life problems and is an instrumental topic in producing critical thinkers. However, the performance of Malaysian students in algebra was still unsatisfactory as shown in the recent TIMSS 2011 Report. Students will not learn algebra if they are memorizing rules for moving symbols around on paper. Moreover, the use of symbols without an understanding cannot develop students' relational understanding of algebra (Foster, 2007). The Straight Line topic is one important component of algebra which is used widely in higher education and the working world. Learning, understanding and reasoning out the Straight Line topic is not only important in understanding mathematics concept but also essential in application to real life problems.

Lecture-based instruction and teacher-centered instruction are two pedagogical limitations identified as the major shortcomings in traditional secondary mathematics education in Malaysia (Zakaria & Iksan, 2006). The main aim of teaching should not only be about transferring the mathematical knowledge but to allow students to identify and construct the mathematical concept on their own. A pedagogical innovation should take place in Malaysia where constructivist approach and student-centered learning should be the priority in order to foster meaningful learning amongst the students. Malaysian teachers must also carefully and smartly incorporate ICT in their teaching and learning process as it can enhance the students understanding and interest in the subject.

Therefore, this study was undertaken with the hope to find an appropriate instructional method that can help students successfully transfer the knowledge gained to another domain or problem which will enable them to solve real life problems. The straight line topic from the algebra component was chosen as it is the

basis for the mastery of other subjects such as Additional Mathematics, Chemistry and Physics. Two instructional methods; deductive and inductive methods were chosen to see the effects on students' performance in transfer of learning and learning engagement. Technology was incorporated in the two methods to further enhance students' understanding of the concept taught. This study intended to find the most appropriate instructional method to be used as a platform that will allow students to perform higher order thinking skills and also to move the Malaysian students in the international assessment from the bottom one-third category to the top one-third in the world thus achieving the main aim of Preliminary Malaysia Education Blueprint 2013-2025. Finally, this study hopes to add new knowledge to the limited literature of deductive and inductive study using technology in Malaysian secondary schools specifically on mathematics performance and learning engagement among high and low self-regulated learning students.

1.4 Research Objectives

This study developed and used two interactive multimedia courseware on straight line (IMC_{SL}) with different instructional methods to enhance students' transfer of learning performance. One of the IMC_{SL} used the deductive method (DM) and the other used the inductive method (IM) in presenting the mathematics contents. Both the IMC_{SL} were used in a constructivist environment which was student centered. The IMC_{SL} was used to identify the effectiveness of the two instructional methods on the students' transfer of learning performance. Two components of transfer of learning; near transfer and far transfer were used to evaluate the students' performance on conceptual understanding. Furthermore, this study investigated the students' learning engagement towards the two IMC_{SL} that applied two instructional

methods. At the same time, this study also investigated whether the students' different self-regulated learning level had an effect on the transfer of learning and learning engagement. Therefore, this study was based on the following objectives:-

a) to design and develop an interactive multimedia courseware with two treatment conditions; DM and IM
b) to investigate the effects of the DM compared to the IM in the learning of Straight Line on the students' near transfer and far transfer performance score as well as learning engagement using an IMC_{SL}.
c) to investigate the effects of DM compared to the IM in the learning of Straight Line on the students' near transfer and far transfer performance score as well as learning engagement among low self-regulated learning (LSRL) students and high self-regulated learning (HSRL) students using an IMC_{SL}.
d) to investigate the interaction effect of the treatment conditions and students' self-regulated learning levels on students' near transfer and far transfer performance score as well as learning engagement.

1.5 Research Questions

Based on the proposed objectives, several research questions were derived:

1. Is there any significant difference in the near transfer performance score between students following two instructional methods (DM and IM) using an IMC_{SL}?

2. Is there any significant difference in the near transfer performance score between LSRL students and HSRL students in both treatment conditions?

3. Is there any significant interaction effect between treatment conditions and students' self-regulated learning levels on near transfer performance score?

4. Is there any significant difference in the far transfer performance score between students following two instructional methods (DM and IM) using an IMC_{SL}?

5. Is there any significant difference in the far transfer performance score between LSRL students and HSRL students in both treatment conditions?

6. Is there any significant interaction effect between treatment conditions and students' self-regulated learning levels on far transfer performance score?

7. Is there any significant difference in the learning engagement between students following two instructional methods (DM and IM) using an IMC_{SL}?

8. Is there any significant difference in the learning engagement between LSRL and HSRL in both treatment conditions?

9. Is there any significant interaction effect between treatment conditions and students' self-regulated learning levels on learning engagement?

1.6 Research Hypotheses

The aim of this study was to investigate which mode of instructional method (DM or IM) enhanced the performance of near transfer and far transfer and also the learning engagement in learning the Straight Line using the IMC_{SL}. Most of the past studies looked into the ability of students to transfer their learning within the near and far transfer of learning using multimedia in other subjects. Intention to use the

interactive multimedia courseware in mathematics with two different instructional methods such as the deductive method and the inductive method to test the performance of transfer of learning among different level of self-regulated learners had not been emphasized. The following null hypotheses were formulated from the research questions. The probability level of 0.05 was used to test the statistical significance.

$H_0$1: There is no significant difference in terms of students' near transfer performance between students who received DM and IM using an IMC_{SL}.

$H_0$2: There is no significant difference in terms of students' near transfer performance between LSRL and HSRL students in both treatment conditions.

$H_0$3: There is no significant interaction effect between treatment conditions and students' self-regulated learning levels on near transfer performance score.

$H_0$4: There is no significant difference in terms of students' far transfer performance between students who received DM and IM using an IMC_{SL}.

$H_0$5: There is no significant difference in terms of students' far transfer performance between LSRL and HSRL students in both treatment conditions.

$H_0$6: There is no significant interaction effect between treatment conditions and students' self-regulated learning levels on far transfer performance score.

$H_0$7: There is no significant difference in terms of students' learning engagement between students who received DM and IM using an IMC_{SL}.

$H_0$8: There is no significant difference in terms of students' learning engagement between LSRL and HSRL students in both treatment conditions.

$H_0$9: There is no significant interaction effect between treatment conditions and students' self-regulated learning levels on learning engagement score.

1.7 Theoretical Framework

The theoretical framework of this study was based on Ausubel's Deductive Model, Bruner's Inductive Model, Mayer's Cognitive Theory of Multimedia Learning, Sweller's Cognitive Load Theory and Bandura's Social Learning Theory.

Mayer (2003) introduced e-learning where instruction is delivered on a computer using a CD ROM and internet. The content of e-learning is based on the learning objectives. The objective of e-learning material is to help students meet their objective and to help students build knowledge to achieve their personal goals. Mayer (2001) emphasizes a student-centered approach rather than the technology-centered approach. The importance of learning is based upon the ability to grasp the content and also to integrate the new information with prior knowledge to show a successful transfer of knowledge. Mayer's (2001) model on Cognitive Theory of Multimedia Learning is based on the Information Processing Model (shown in section 2.8). This theory was appropriate in supporting this study as the various principles used in developing the IMC_{SL} made the courseware a powerful medium in enhancing learning.

The Cognitive Load Theory (Sweller, 1999) emphasizes on the limitation of working memory capacity as an important factor in instructional design. Students should be given a structured information to avoid unnecessary overload on working

memory. The theory is based on the assumption that a person has a limited processing capacity and proper allocation of cognitive resources is important to learning. Cognitive resources for learning decrease when more resources are needed for processes which is not directly linked to learning. Learning engagement among students is also effected by overload on working memory. Thus, this theory was used carefully in designing the courseware to avoid unnecessary cognitive overload among students when they were using the IMC_{SL} to construct the knowledge and also to enhance their learning engagement.

Ausubel's deductive model (1968) shows students form and organize knowledge themselves from a structured framework. The teachers' duty is to integrate the teaching material into a meaningful schema. The teacher is responsible to expose the learning material meaningfully through the computer so that students may follow and understand the concepts taught. In this study, the deductive method was based upon this expository model.

Bruner's inductive model (1971) is used in problem solving situations where the student discovers facts and new truths based on his or her own past experience and existing knowledge. Students are likely to remember concepts and knowledge discovered on their own and this is a contrast to the traditional method. In this study, the inductive method was based upon this discovery learning model. From the presentation point of view in this study, the IMC_{SL} was presented in a constructive environment (student centered) where students solved the given problems by constructing their own concepts and knowledge.

Pintrich & Zusho (2002) and Zimmerman (2000) stresses that self-regulation operates through a set of psychological sub functions. These include self-monitoring

of one's activities, applying personal standards for judging and directing one's performances, enlisting self-reactive influences to guide and motivate one's effort and applying appropriate strategies to achieve success. Self-regulating students actively participate in learning from the metacognitive, motivational and behavioral point of view. Characteristics attributed to self-regulating persons coincide with those attributed to high-performance, high-capacity students as opposed to those with low performance. Performance of students is influenced by self-regulated learning levels especially in a student centered environment. Thus, in this study, the low and high self-regulated learning levels were used to see the effect on the performance of students. Mayer (2001) stresses multimedia learning engages active processes such as paying attention to relevant information. The above mentioned theories and models formed the theoretical framework of this study. The framework is depicted in Figure 1.3.

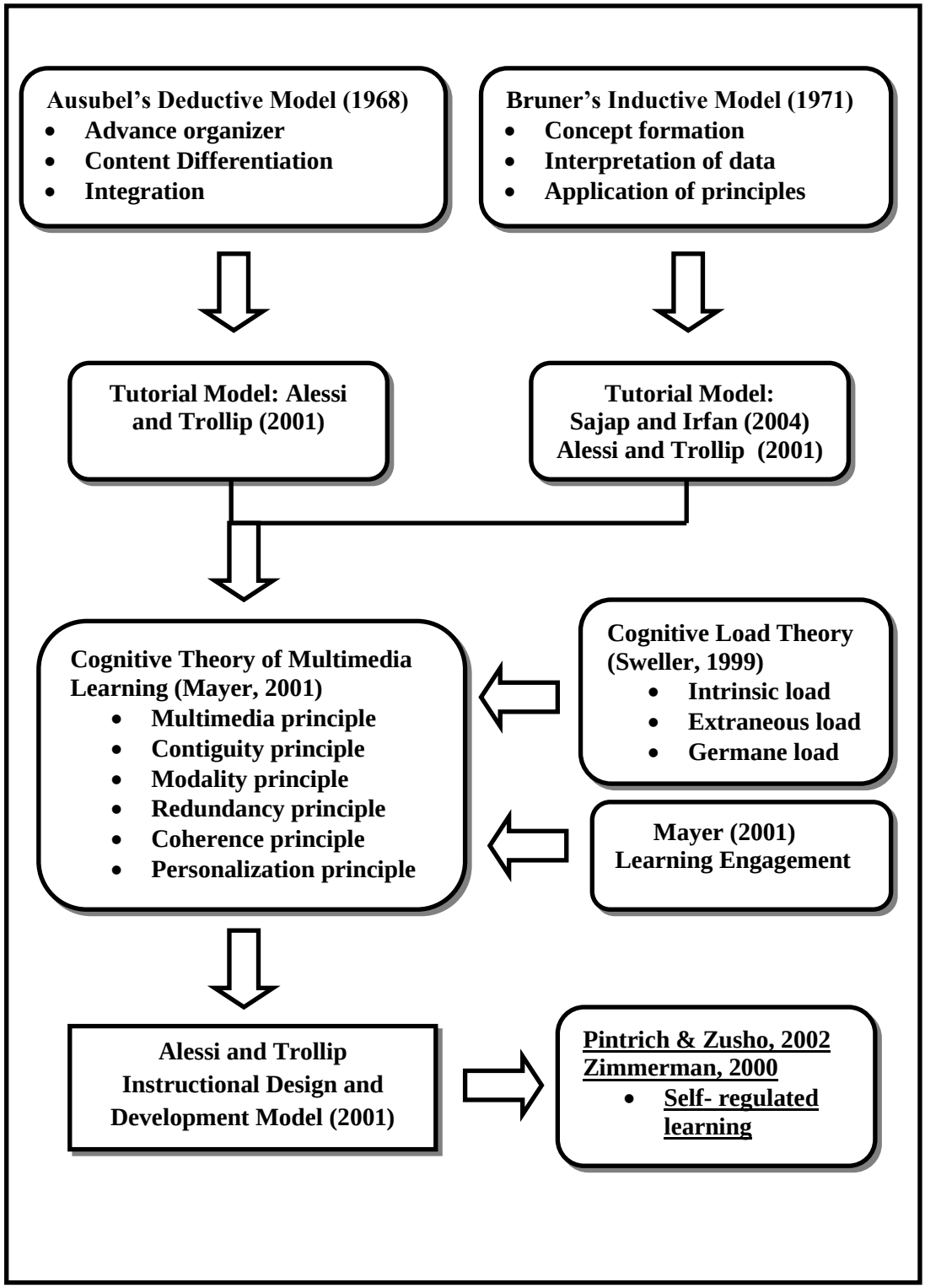

Figure 1.3 **Theoretical Framework**

1.8 Research Framework

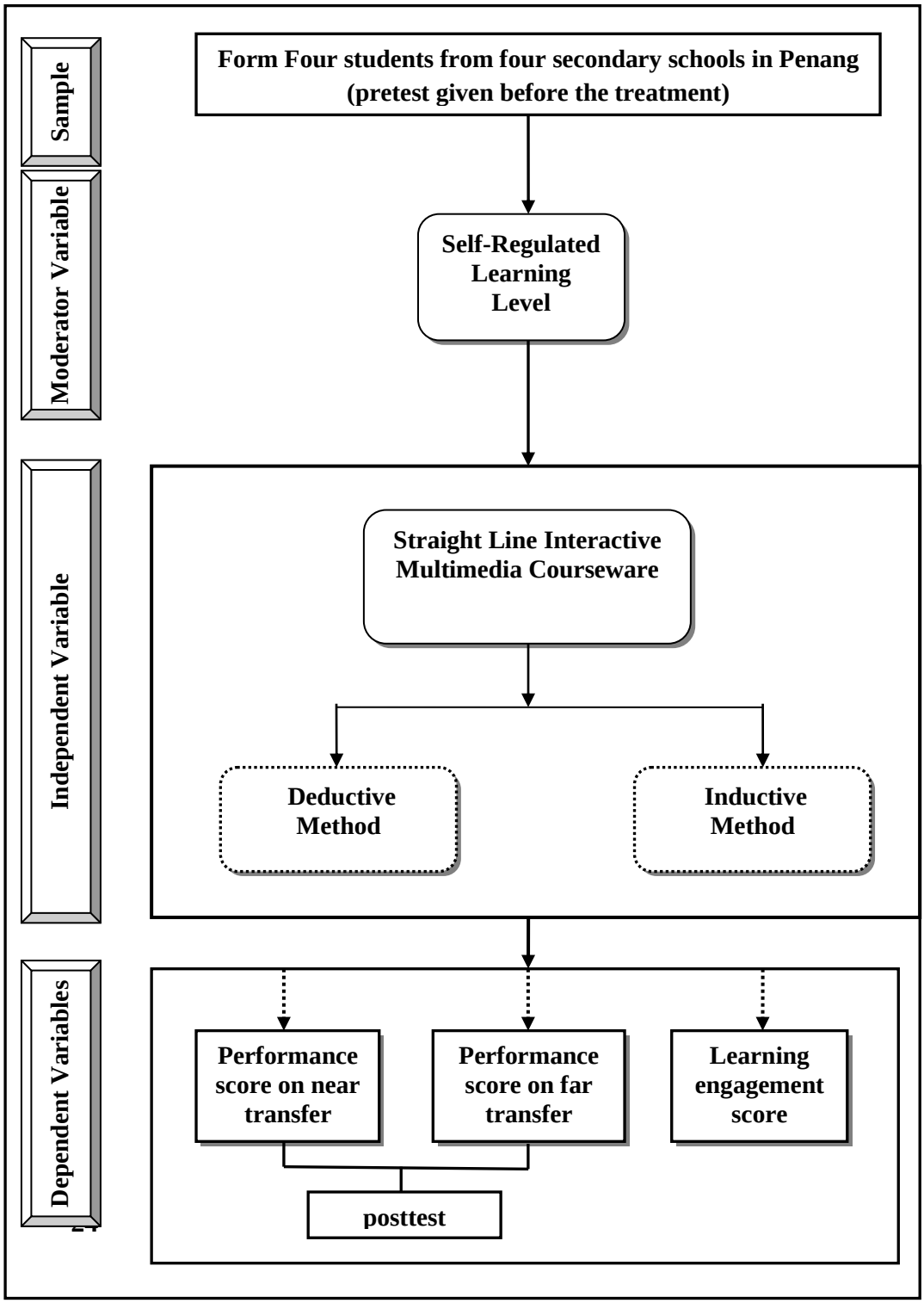

Figure 1.4 **Research Framework**