THE EFFECTIVENESS OF VISUAL-SPATIAL INTELLIGENCE TEACHING COURSEWARE ON EQUIVALENT FRACTIONS FOR WEAK STUDENTS

YUHAIDA BINTI YUSOF

DISERTATION IS SUBMITTED TO FULFILL CONDITION TO RECEIVE MASTER IN EDUCATION

FAKULTY OF ART, COMPUTING AND CREATIVE INDUSTRY
UNIVERSITI PENDIDIKAN SULTAN IDRIS

2011

DECLARATION

I hereby declare that the work in this dissertation is my own except for quotation and summaries which have duly acknowledged.

Date 24 APRIL 2011

Signature
Name: Yuhaida Binti Yusof
Registration no: M20072000708

APPRECIATION

First and foremost, I am thankful to the Ministry of Education for granting me a full time scholarship to pursue the master degree in Multimedia at Universiti Pendidikan Sultan Idris.

Heartiest thanks to my advisor, Prof. Dr. Mohamad Bin Ibrahim. Your pursuance for quality had enriched me in so many ways. May Allah bless you and give you good health to continue guiding students to perform their best.

My gratitude to Tn. Hj. Mohd Nazri bin Md Saad, director of ICT center, who had helped me to produce my Visual-Spatial Teaching Courseware for Weak Students in his MTM 6063 course. It was his idea to embark on this research topic. He encouraged me to take part in convention and thus I have presented my paper in The Third Asia Pacific Educational Research Association Conference 2010 in Putra World Trade Center on 24th November 2010.

To all staff and lecturers the Faculty of Art, Computing and Creative Industry, I truly appreciate your assistance and advice.

My special appreciation to my husband Mohd Masri Bin Jamaat, who always encourage me right from the start. Your care and concern had given me the strength to continue in my struggle to balance between study and family. Thank you to all my kids, Ahmad Ilman, Ahmad Ariff, Ahmad Aqil, Hany Liyana, and Ahmad Aiman for understanding my busy schedule. I hope to have set good example in term of perseverance and dedication to all of you.

I am most grateful to Mrs. Loh Peh Choo, Mathematics Excellent Teacher from SMK Bandar Baru Sungai Buluh who is willing to share her expertise with me. Your selflessness and devotion into teaching had motivated me to keep going in my career.

My thanks go to my fellow comrades who have walked this incredible journey together with me, especially Norhayati Mahadi and Lee Hooi Ching. Thank you for giving strength to each other in times of hardship. Hope the strong bond among us will last forever.

The last but the most important person, my mom, dad, and mother in law, thank you for always being there for me. I love all of you.

Abstract

The objective of this research is to test the effectiveness of visual-spatial intelligence teaching courseware to teach "equivalent fraction" topic for form 1 weak students. This courseware uses visual-spatial intelligence which is one of the eight multiple intelligences in multiple intelligence theory by Howard Gardner. The design of this research is pretest and posttest nonequivalent groups design. The sample for this research is fifty seven students from form 1, comprising of twenty nine for the treatment group and twenty eight for the control group. This research also tests whether the use of the courseware can increase visual-spatial intelligence in the Multiple Intelligence (MI) test. Students' perspective towards the courseware in terms courseware objectives, courseware content, interface design, motivation, and assistance in learning the topic is measured using questionnaire. ANCOVA test, $F(1,55)=5.29$, $p=.03$, had shown that there was a significant effect of the visual-spatial teaching courseware on learning performance compared to KPM courseware after controlling for the effect of pretest (non-homogenous groups). There was a significant increase in the Visual-Spatial Intelligence score in the Multiple Intelligence test from pretest ($M=12.48$, $SD=2.50$) to posttest ($M=13.28$, $SD=2.40$), $t(28)=-2.19$, $p=.04$. Students have positive perception of the courseware in term of courseware objectives ($M=2.98$, $SD=.52$), courseware content ($M=2.90$, $SD=.49$), interface design ($M=3.06$, $SD=.50$), motivation ($M=3.08$, $SD=.52$), and assistance in learning topic of equivalent fractions ($M=3.10$, $SD=.52$). Based on the findings, teachers are recommended to use visual representations (visual-spatial intelligence) as much as possible and use less words (linguistic and mathematical intelligence). Teacher should also use one or a few intelligences in each lesson to increase reading in that particular intelligence in the MI test.

Abstrak

Penyelidikan ini ialah untuk menguji keberkesanan koswer kecerdasan visual-ruang untuk mengajar topik "pecahan setara" untuk murid-murid tingkatan 1 yang lemah. Koswer ini menggunakan kecerdasan visual-ruang iaitu salah satu kecerdasan dalam Teori Kecerdasan Pelbagai oleh Howard Gardner. Reka bentuk penyelidikan ini ialah separa eksperimental ujian pra dan ujian pos bagi kumpulan-kumpulan yang tidak setara. Sampel penyelidikan ini ialah lima puluh tujuh orang pelajar dari tingkatan 1, iaitu dua puluh sembilan dalam kumpulan eksperimental dan dua puluh lapan dari kumpulan kawalan. Penyelidikan ini juga bertujuan untuk menguji samada kecerdasan visual-ruang dalam ujian kecerdasan pelbagai akan meningkat. Persepsi pelajar terhadap koswer dari segi objektif koswer, isi kandungan, rekabentuk antaramuka, motivasi, dan bantuan untuk mempelajari topik Pecahan Setara diukur menggunakan soal selidik. Ujian ANCOVA, Sig $F(1,55) = 5.29$, $p = .03$, menunjukkan ada kesan yang sinifikan pada pretasi pembelajaran berbanding koswer KPM selepas mengawal kesan pra ujian (kumpulan tidak setara). Ada peningkatan yang sinifikan dalam skor kecerdasan Visual-Ruang dalam ujian Kecerdasan Pelbagai dari ujian pra (*M*=12.48, *SD*=2.50) kepada ujian pos (*M*=13.28, *SD*=2.40), $t(28)=-2.19$, $p=.04$. Pelajar mempunyai persepsi yang positif terhadap koswer dari aspek objektif koswer (*M*=2.98, *SD*=.52), isi kandungan koswer (*M*=2.90, *SD*=.49), rekabentuk antaramuka (*M*=3.06, *SD*=.50), motivasi (*M*=3.08, *SD*=.52), dan bantuan untuk mempelajari topik Pecahan Setara (*M*=3.10, *SD*=.52). Berdasarkan dapatan kajian ini, implikasi kepada pedagogi juga dibincangkan. Guru juga disarankan untuk menggunakan grafik (kecerdasan visual-ruang) and mengurangkan penggunaan perkataan (kecerdasan bahasa dan matematik). Guru perlu menggunakan satu atau beberapa kecerdasan dalam setiap kelas untuk meningkatkan bacaan dalam kecerdasan pelbagai tersebut.

TABLE OF CONTENTS

APENDICES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND OVERVIEW OF THE RESEARCH

1.1 INTRODUCTION

In a class, the main role of a teacher is to impart knowledge. According to El Naga (2009), how much students learn depends upon their abilities, backgrounds, and match between their learning styles and teaching styles. We cannot change students' abilities, background, and learning styles but we can work on our teaching methods.

The usage of technology has increasingly becomes an integral part of our modern life. In education, the integration of ICT is inevitable in the process of preparing the k-workers for the future. In 2003, the schools in Malaysia changed the medium of instruction in the teaching and learning of Mathematics and Science from Bahasa Malaysia to English. The learning of Mathematics and Science in English was introduced to enhance fluency in English and facilitate proficiency in Mathematics and Science. It was felt expedient to teach these subjects in English in order to equip the students with necessary knowledge and skills in accelerated access to and mastery of these fields of knowledge in order to compete effectively in the international arena (Ministry of Education, 2002). The Ministry decided that teaching and learning in the classroom would be supported by the use of ICT. In the national budget for 2003, the Prime Minister announced that RM5 billion would be allocated between 2002-2008 for implementing the policy of teaching Mathematics and Science in English. All the teachers teaching these two subjects and English from national schools would be given a laptop. In addition to this, each school was given a launching grant of RM 5,000 to RM 15,000 to acquire additional reference resources and materials. This represented a massive investment of resources by the Malaysian government and helped to kick-start the use of ICT in the classroom (Rahimi Md Saad, Noraini Idris, Loh Sau Cheong, Ahmad Zabidi Abdul Razak, & Norjoharuddeen Mohd Nor, 2007).

However we must be careful in the usage of visual representations as our teaching aids. According to Centre for Teaching Excellent, University of Waterloo (2011), there are effective and ineffective ways to use visual aids in presentations.

1.2 Background of research

According to Rao (1991) when software is developed, a lot of emphasis is given to the commercial value so much so that the quality is assessed based on the quality of media used and not on the quality of teaching and learning and expected change in students' behavior. Evidently, teachers must always keep in mind that, claim of software publishers are made to get rid of their products. While they are probably not blatantly intending to mislead, the product developers are unfamiliar with the students' particular levels or needs. Any one piece of software may or may not be helpful to a certain group of students in accomplishing their individual goals in the manner that best works for them. As a professional, the teacher must always ensure that any instructional tool, software included, is the best way to teach a particular concept to a particular student or group of students. Software will never replace teachers - the professional, human, decision-making abilities of caring teachers will always be required to guide student learning (Rahimi Md Saad et al., 2007).

In Malaysia, there are a few groups that have developed Multiple Intelligence (MI) educational courseware. The first one is developed by Baharuddin Aris, Jamaluddin Harun, and Zaidatul Tasir (2003) from UTM on Statistics form 2. Intan Salwani Mohamed, Faris Zuhairi Mohamed, Norzaidi Mohd Daud, and Normah Omar (2008) from UiTM, developed courseware on chemistry, specially designed for Smart Schools. Another group led by Rio Sumarni Shariffudin and Lee Ming Foong (2003) from UTM on science and mathematics. Bushro Ali and Halimah Badioze Zaman (2008) from UKM developed courseware on trigonometry form 4. No courseware has been tested for weak students to test its effectiveness in the teaching and learning process for weak students. As a teacher, I would like to contribute to this neglected market by testing this courseware that I have previously developed for MTM 6063 class to find out its effectiveness for teaching weak students.

The concept of intelligence as a single entity was first put forth by an English psychologist named Charles Spearman in the early 20th century. Spearman (1904) coined the term 'General Intelligence' or 'g' that was based on measure of people's performance across a variety of mental tests. This single intelligence was believed to enable humans to undertake common mental tasks and believed to correspond to a specific region of the brain. Recent research has supported this with a part of the brain called the 'lateral prefrontal cortex' being shown to the only area, which has increased blood flow when test patients tackle complicated puzzles. However, many have also questioned Spearman's theories, in particular the simplistic nature of the 'g' concept and whether intelligence can really be treated as a single entity. Others have debated the dependence of intelligence on our biological make-up, citing the importance of socio-economic factors such as education (Cohen, 2010).

IQ is the acronym for intelligent quotient, and refers to a score given for several standardized intelligence tests. French psychologist, Alfred Binet, developed the first of these in 1905. He constructed the IQ test, as it would later be called, to determine which children might need additional help in scholarly pursuits. Today, the IQ test is commonly based on some model of the Stanford Binet Intelligence scale (Ellis-Christensen, 2008).

IQ is a score derived from one of several different standardized tests attempting to measure intelligence. The term "IQ," a calque of the German *Intelligenz-Quotient*, was coined by the German psychologist William Stern in 1912 as a proposed method of scoring early modern children's intelligence tests such as those developed by Alfred Binet and Theodore Simon in the early 20th Century.

Although the term "IQ" is still in common use, the scoring of modern IQ tests such as the Wechsler Adult Intelligence Scale is now based on a projection of the subject's measured rank on the Gaussian bell curve with a center value (average IQ) of 100, and a standard deviation of 15, although different tests may have different standard deviations (Cohen, 2010).

The traditional view of intelligence is that it is a uniform cognitive capacity people are born with. The short-answer test will tell us how smart we are and we cannot change it. An unfortunate use of Intelligence Quotient IQ tests in schools is that it often results in labeling students. The theory of Multiple Intelligences (MI) challenges this view. MI arose as a critique of this standard view of intelligence. Students have several types of intelligences and only two of it (verbal and mathematical skills) are measured in IQ test. Another two types of intelligence, interpersonal and intrapersonal skills, are described as Emotional Quotients (EQ) (Gan, 1995).

Research by Gardner (1983) of Harvard University suggests that we all have several intelligences. He has so far identified nine distinct types of intelligences that we all posses to some degree, namely linguistic intelligence, logical-mathematical intelligence, visual-spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence, intrapersonal intelligence, naturalist intelligence, and existential intelligence. We do not have the same strength in each intelligent and we do not have the same combination of intelligences. The idea is that our intelligence is just distinct and individual as our personalities. According to McKenzie (1999) everyone has all the intelligences and we can strengthen each intelligent. Given enough stimuli, each type of intelligence can be strengthened. Studies also found that learners can strengthen their learning preferences, and at the same time, strengthen their weaker skill areas (Seay, 2004).

Since Howard Gardner proposed the seven multiple intelligences in his book *Frames of Minds* in 1983, and later on added the eight and ninth intelligent i.e. naturalistic and existential intelligences, it has gain popularity among educators especially in USA. Teachers around the world are rethinking lessons and units and their entire teaching approach based on his research. MI is a student centered approach where educators begin with looking at how the student learns and then developed instructions based on this information. MI theory has evolved and been embraced widely. After publication of *Frame of Minds*, Gardner (1983) became a celebrity among many teachers and school administrators. In addition to writing many more books and articles on MI theory, Gardner has served as a consultant to a variety of schools districts. The MI movement now includes publishers, symposiums, web sites, "how-to" manuals, educational consultants who consider themselves "MI specialists", as well as a number of critics.

In my experience as a counselor and an educational examiner, I have observed that many children with learning disabilities appear to have significant strengths in visual-spatial intelligence (Keith, 2008). This implies that to teach weak students teachers should capitalize on visual-spatial intelligence by using a lot of pictures, diagrams, courseware rich with graphics, videos, printed materials full of graphics, et cetera.

1.3 Statements of the problem

The issue of the effectiveness of the teaching and learning process has been debated since Aristotle era. Many learning theories have been developed to give an insight into the problem. The major learning theories are Behaviorist, Cognitive and Constructive. Apart from that there are also other learning theories such as Experiential Learning (Colb, 1983), Multiple Intelligence (Gardner, 1999), Surface and Deep Learning (Biggs, 1999), Conditions of Learning (Gagne, 1992), Adult Learning (Knowles, 1970), Popular Education (Freire, 1970), and many more.

Following the widespread use of ICT in education, an abundance of educational software is available. Schwars and Lewis (1989) found that teachers are still not satisfied with the quality of the design and presentation strategies used in educational software. The teachers are aware that simply putting instructional routines on the computer does not assure that the courseware will support the learning process. According to Chen and Chung (1989), many educational software products in the market are of poor quality in presentation and do not follow the theories of learning. Similarly, Abtar Kaur (2000) gave a critical review of educational software produced by private companies, suggesting that they are attractive in graphical presentation but lack pedagogical value. Azman pointed out that most of the educational software still employ traditional instructional methods and only emphasize fact recall and trial and practice (as cited in Rahimi et al., 2007, p. 48).

In Malaysia, the Mathematics and Science courseware is designed and developed by the Educational Technology Department (ETD) to support the implementation of teaching Mathematics and Science in English. This courseware serves as model for pronunciation of scientific terms and acts as teaching instruction especially for teachers who lack competency in English. Before distribution to schools the software was pre- screened for content and pedagogy by experts and the development committee (Rahimi Md Saad et al., 2007).

According to Robyler and Edwards (2000) courseware should not be used simply because it is supplied by government. Teachers should evaluate the courseware provided even after the experts and committee had pre-screened the courseware to determine whether the courseware fitted the planned teaching strategies in order to produce the intended outcome. On the other hand, some researchers suggested that the learners or students should serve as the evaluator in order to improve the evaluation process (Schwarz & Lewis, 1989).

However, no courseware using visual-spatial intelligences on Fractions for Mathematics form one, was tested for the weaker classes or students. From researcher's experience, many Mathematics teachers complaints that weaker students do not understand the concepts of Fraction even though they have learn it since Year 3 in primary school. The courseware being tested in this research (which was previously developed by researcher using visual-spatial intelligence for weak students) can help students to grasp the concept of Equivalent Fractions.

Another issue that researcher wants to highlight in this research is the problem of teaching fractions, particularly teaching equivalent fractions. The concept of equivalent fractions is a very important concept that students must master before they can understand higher concepts such as the addition, subtraction, multiplication and division of fractions. In the curriculum Specifications set by Curriculum Development Centre (Ministry of Education Malaysia, 2002), there are seven learning objectives for the chapter of fractions:

1. Understand and use the knowledge of fractions as part of a whole.
2. Understand and use the knowledge of equivalent fractions.
3. Understand the concepts of mixed numbers and their representations.
4. Understand the concepts of proper fractions to solve problems.
5. Understand the concepts of addition and subtraction of fractions to solve problems.
6. Understand the concepts of multiplication and division of fractions to solve problems.
7. Perform computations involving combined operations of addition, subtraction, multiplication and division of fractions to solve problems.

For the second objective above, there are five learning outcomes for Equivalent Fractions, to:

1. find equivalent fractions for a given fraction,
2. determine whether two given fractions are equivalent,
3. compare the values of two given fractions,
4. arrange fractions in order, and
5. simplify fractions to the lowest terms.

Researcher chooses the second objective above to be covered in the courseware because of two major reasons. First, this subtopic is suitable for visual-spatial intelligence because it is very difficult for weak students to 'see' and understand the concept of equivalent fractions if it is not presented visually. According to Moss and Case (1999), many students have problems in learning the concepts of fractions because they cannot establish part/whole relationship and as a result mathematics educators realize that an alternative form of visual representation must be used to represent proportional quantity and standard numerical representation. Second, from my experience as a mathematics teacher for fourteen years, even though students have learn about equivalent fractions since Year 4 in primary school, many students still fail to grasp the concept and do not have the correct mental picture of the concept when they enter secondary school.

Spatial learners tend to process information more slowly and their high level of internal mental activity may be interpreted as intentional off-task behavior (Mann, 1995; West, 1995). In reality, spatial learners may have to consider the entire concept and reflect on how individual pieces fit into the main scheme of information as they are holistic in their approach to learning (Silverman & Freed, 2007); they may have difficulty attending to details that are presented in isolation. They often display an ability to grasp complex relationships between systems, are aware of physical properties and patterns and understand how the pieces fit together. This holistic preference for acquiring knowledge may result in a weakness to plan sequentially (Mann, 1995).

As a summary, there are three main problems, (a) lack of quality courseware for weak students, (b) problems that students have in learning fractions, particularly equivalent fractions, and (c) graphic visualization (visual-spatial intelligence) is not fully utilized in the teaching and learning strategy for weak students.

1.4 Research Objectives

Teachers today are encouraged to use technology-driven teaching and learning aids to enhance students learning. They need to ensure that, the software used as part of their classroom instruction is appropriate and effective in producing the intended outcome and achieving educational goals (Robyler & Edwards, 2000).

The objectives of this study are to:

1. examine the effectiveness of the usage of the visual-spatial intelligence teaching courseware for weak students on equivalent fractions, in the teaching and learning process as compared to KPM courseware.
2. find out whether using the visual-spatial teaching courseware can increase the score on visual-spatial intelligence in MI test, and
3. find out students' evaluation of the teaching courseware from the aspect of content, learning objectives, interface design, motivation and assistance to learning Equivalent Fractions.

The second objective is set because Gardner (1983) wrote in his book *Frames of Minds,* intelligences can be nurtured and strengthened, or ignored and weakened. In another book *Multiple Intelligence: The Theory In Practice* Gardner (1993) stresses that it is of the utmost importance that we recognize and nurture all of the varied human intelligences, and all the combinations of intelligences. According to

McKenzie (1999) everyone has all the intelligences and we can strengthen each intelligent. Given enough stimuli, each type of intelligence can be strengthened. Studies also found that learners can strengthen their learning preferences, and at the same time, strengthen their weaker skill areas (Seay, 2004). The second objective is set to test this idea.

1.5 Research questions

Based on the purposes above, the research will answer the questions below:

1. Does the usage of the visual-spatial intelligence teaching courseware for weak students on equivalent fractions increase the students' achievement in the proficiency test as compared to KPM courseware?
2. Does the use of visual-spatial intelligence courseware increase the score of visual-spatial intelligence in MI test?
3. What are students' evaluation of the visual-spatial intelligence teaching courseware from the aspect of content, learning objectives, interface design, motivation, and assistance to learning Equivalent Fractions?

1.6 Hypothesis

Research hypothesis 1:

The mean score of the proficiency test of the group that uses the visual-spatial intelligence teaching courseware is significantly greater than the mean score of the group that uses KPM courseware.

Statistical hypothesis 1:

H_{O1}: There is no significant difference in the mean score of proficiency test between the group that uses visual-spatial intelligence teaching courseware and the group that uses KPM courseware.

H_{A1}: The mean score of the proficiency test of the group that uses the visual-spatial intelligence teaching courseware is significantly greater than the mean score of the group that uses KPM courseware.

Research hypothesis 2:

There is significant increase in the mean score of visual-spatial intelligence in the MI test after students use the visual-spatial teaching courseware.

Statistical hypothesis 2:

H_{O2}: There is no significant increase in the mean score of visual-spatial intelligence score in the MI test after students use the visual-spatial teaching courseware.

H_{A2}: There is significant increase in the mean score of visual-spatial intelligence in the MI test after students use the visual-spatial teaching courseware.

The independent variables are courseware supplied by KPM and visual-spatial intelligence courseware previously developed by researcher. The dependent variables are the scores of Equivalent Fraction proficiency test of the controlled and experimental groups and the score of visual-spatial intelligence in the MI test for the experimental group.

1.7 Significant of the study

This study is significant and justifiable because:

1. No courseware using visual-spatial intelligence for equivalent fractions, Mathematics form 1, has been tested for weak students in Malaysia.
2. To popularize the usage of visual-spatial intelligence in the teaching and learning process for weak students.
3. To move away from highly linguistic mathematical approach in the teaching and learning process especially for weak students.

In Malaysia, MI courseware developed by Baharuddin Aris, Jamalludin Harun, and Zaidatul Tasir (2003) uses eight types of intelligences. Intan Salwani Mohamed, Norzaidi Mohd Daud, and Normah Omar (2008) from UiTM use eight intelligences and their courseware is designed for smart school. Courseware developed by a group led by Rio Sumarni Shariffudin (2003) from UTM uses nine types of intelligences. Bushro Ali and Halimah Badiozaman (2008) from UKM use three types of intelligences. There is no courseware that uses only one type of intelligence (visual-spatial intelligence) and no courseware has been tested specifically for weak students.

Literature review in chapter two has shown that using visual-spatial intelligence in the teaching and learning process is effective (Hoerr, 2002), especially for weak students. This research is significant to test this idea in Malaysian context.

1.8 Conceptual framework

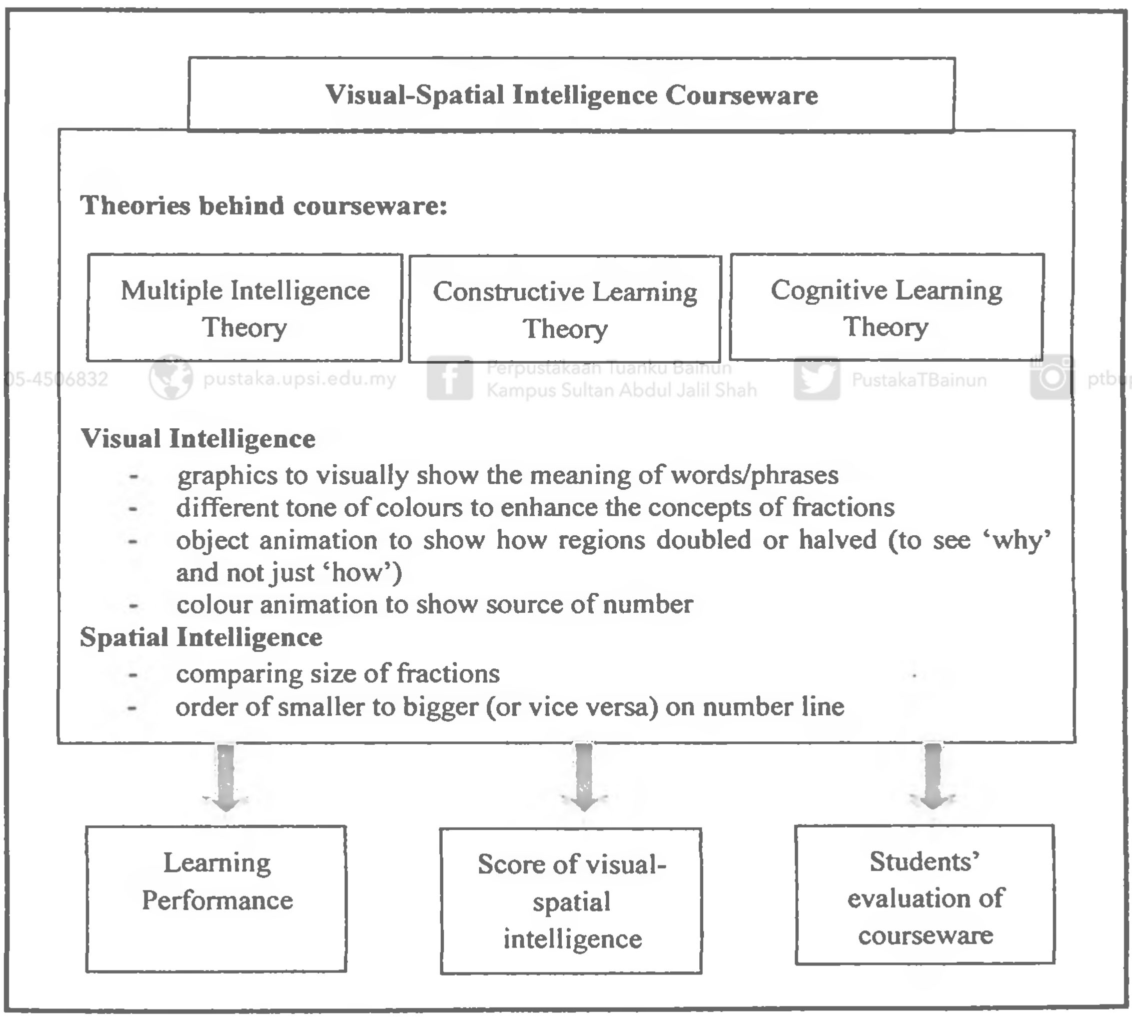

Figure 1.1: Conceptual framework

The visual-spatial intelligence courseware previously developed by the researcher is based mainly on MI theory that stresses the many types of intelligence that we possess. Research has shown that weak students are generally weak in logical-mathematical and verbal-linguistic intelligences (which are tested in IQ test) but strong in visual-spatial intelligence.

The visual intelligence (figure 1.1) is used in several ways. First, graphics are used to visually show the meaning of words/phrases. For example, the term 'equivalent fractions' is also shown using diagrams. Students may not understand English language (verbal linguistic intelligence) but they will understand the diagrams. Secondly, different tone of colours is used to show the concept of fractions. For example for diagram of 3/4, the three parts use a darker green than the fourth part. Third, object animation is used to show how the denominator of the fraction doubled or halved. For example, a diagram of 2/3 is animated to move below the original diagram before the process of doubling the denominators to produce a new fraction of 4/6. In this way, students will see that diagram 4/6 originally comes from diagram 2/3 and therefore are equivalent in size. Lastly, colour animation is used to show source of number. For example, to calculate the Lowest Common Multiplication (LCM) for fraction 1/2 and 3/4, when the number '2' are put inside the division box, the '2' in the fractions at the question changes colour to show that '2' came from the denominator of fraction 1/2.

On the other hand, there are two ways spatial intelligence is used in this courseware (figure 1.1). First, it is used to compare size of fraction. For example to compare which fractions is bigger between 2/3 and 3/4. Secondly students use spatial intelligence to see the order from smaller to bigger (or vice versa) on the number line.

In addition to MI theory, the courseware uses constructive learning theory (figure 1.1) by providing scaffolding in the form of visuals to help weak students to understand the mathematics concepts. Another form of scaffolding provided by the courseware is it is not a self-access courseware but a teaching courseware. The teacher will help weak students in the teaching and learning process by providing all the explanations and help needed by them to understand the mathematics concepts.

Scaffolding allows students to perform tasks that would normally be slightly beyond their ability without that assistance and guidance from the teacher. Appropriate teacher supports can allow students to function at the cutting edge of their individual development. Scaffolding is therefore an important characteristic of constructivist learning and teaching (Murphy, 1997). The courseware uses the concept of scaffolding in constructive learning theory by providing helps to students using a lot of graphics. The graphics help students to visualize and understand the mathematics concepts.

The visual-spatial teaching courseware also incorporate cognitive learning theory (figure 1.1) that stresses the different ways each one of us thinks (diversity). This diversity, when understood and appreciated, provides a great source of strength. The courseware recognizes the different way weak students process data. They can process data better with the help of visual representations.

The visual-spatial intelligence courseware is tested against KPM courseware (for the first hypothesis) to compare which one is more effective. The experimental group is taught using the visual-spatial intelligence courseware while the control group uses KPM courseware. Then both groups are given the proficiency test and data are analyzed using ANCOVA.

On the other hand, for the second hypothesis students' score (in the experimental group) in MI test prior and after the experiment are analyzed using paired-sample t-test to see if there is any significant increase in the score of the visual-spatial intelligence (figure 1.1).

Lastly to see students' evaluation of the courseware in term of content, learning objectives, interface design, motivation, and assistance to learning Equivalent Fractions, questionnaire is used (figure 1.1).

1.9 Limitations of the study

There are a few limitations to this research:

1. This research is confined to the student population of SMK Bandar Tasik Puteri and therefore cannot be generalized to the whole population of weak students.
2. This research does not control a few variables such as students' learning styles, socio- economic status and a few other variables that might affect the study.

1.10 Operational definitons

Effectiveness: Mean score of Equivalent Fractions Proficiency Test.

Weak students: Students from Form 1 of SMK Bandar Tasik Puteri, Rawang, Selangor, chosen from the weaker classes that got C, D or E for Mathematics in Ujian Penilaian Sekolah Rendah (UPSR).

Equivalent Fractions: One subtopic from Fraction chapter in the Curriculum Specifications for Mathematics Form 1. This subtopic has five learning outcomes.

Equivalent Fractions Proficiency Test: Test on Equivalent Fractions developed by researcher and verified by *Guru Pakar Matematik*, Mrs. Loh Peh Choo, from SMK Bandar Baru Sungai Buluh.

Multiple Intelligences: A learning theory proposed by Howard Gardner (1983) that breaks intelligences into nine types, instead of just two (verbal-linguistic and logical-mathematics) tested in IQ test. In this research, only visual-spatial intelligence score is used.

Multiple Intelligence Test: A test developed by Chislett and Chapman (2006) based on Gardner's MI Model. The test chosen is young people's version. It is available freely from www.businessballs.com.

Visual-spatial teaching courseware: The courseware previously developed by researcher in MTM 6066 class to be tested in this research. The courseware is a package consisting of the courseware itself, paper and pencil exercises given after each learning objectives, and an A4 paper consisting of rows of boxes for students to draw lines inside the boxes to visualize the fractions.

Visual representations: Graphics/visuals/diagrams/illustrations used in the courseware to represent ideas and to teach mathematical concepts. Visual representations help students to form the correct mental pictures.

1.11 Summary

This research is to test the effectiveness of the visual-spatial intelligence courseware (previously developed by researcher) in the teaching and learning of equivalent fractions for form one students who are weak at mathematics (scoring C, D or E in mathematics in UPSR) as compared to KPM courseware. The second objective is to test whether the use of the courseware can increase the score of visual-spatial intelligence in MI test, given the entire graphical and spatial stimulus in it. The third objective is to find out students' evaluation of the courseware in term of content, learning objectives, interface design, motivation and assistance to learning equivalent fractions.