UNIVERSITI PUTRA MALAYSIA

EFFECTS OF MATAS HOPSCOTCH TECHNIQUE IN THE LEARNING OF SUBTRACTION OF FRACTION AMONG YEAR 5 PUPILS

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By

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

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EFFECTS OF MATAS HOPSCOTCH TECHNIQUE IN THE LEARNING OF SUBTRACTION OF FRACTION AMONG YEAR 5 PUPILS

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Chairperson : Professor Kamariah bt Abu Bakar, PhD

Faculty : Institute For Mathematical Research

MATAS Hopscotch technique was created to solve the subtraction of fractions. The study involved 56 pupils from two Year 5 classes. A quasi-experimental, nonrandomized control group, pre-test-post-test delayed post-test was conducted to test the effectiveness of the *MATAS Hopscotch* technique.

The findings indicated the control group showed improvement in pupils' scores after the implementation of the traditional method with gain scores 9.46. The findings also indicated the experimental group showed improvement in pupils' scores after the implementation of the *MATAS Hopscotch* technique with gain scores 15.57. The Analysis of Covariance (ANCOVA) revealed the pupils who were exposed to the use of *MATAS Hopscotch* achieved significantly better scores as compared with those who were taught using the traditional method. The Two-way ANOVA also showed there were interactions between pupils with different ability. The study also revealed the treatment maintained gains after 8 weeks.

The study described types of error made by the pupils in solving the subtraction of fractions. The findings in the pre-test showed both groups made whole number concept errors, directions errors and careless errors. However, in the post-test, the experimental group made only careless errors while the control group made whole number concept errors, directions errors and careless errors. The average and low abilities pupils in the experimental group made only careless errors. The average ability pupils in the control group made directions errors and careless errors while the low ability pupils in the control group made whole number concept errors, directions errors and careless errors. Further, pupils in the experimental group showed a positive

attitude towards the *MATAS Hopscotch* technique. Both the average ability and low ability pupils in the experimental group also showed a positive attitude towards the technique. Hence, we can conclude that *MATAS Hopscotch* technique was effective in improving pupils' performances.

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

KESAN TEKNIK MATAS HOPSCOTCH DALAM PEMBELAJARAN PENOLAKAN PECAHAN DALAM KALANGAN MURID-MURID TAHUN 5

Oleh

DEVAKI A/P PERIASAMY

November 2014

Pengerusi: Professor Kamariah bt Abu Bakar, PhD

Fakulti: Institut Penyelidikan Matematik

Teknik MATAS Hopscotch telah dibina untuk menyelesaikan masalah penolakan pecahan. Kajian ini melibatkan 56 orang murid Tahun 5 dari dua kelas. Reka bentuk eksperimen-quasi, kumpulan kawalan tanpa rawak, pra-ujian-pos-ujian dan pos-ujian dilewatkan, dijalankan untuk menguji keberkesanan *teknik MATAS Hopscotch.*

Dapatan menunjukkan pencapaian murid meningkat dalam kumpulan kawalan selepas pelaksanaan kaedah tradisional dengan nilai skor tambah 9.46. Dapatan juga menunjukkan pencapaian murid dalam kumpulan eksperimen meningkat selepas pelaksanaan *teknik MATAS Hopscotch* dengan nilai skor tambah 15.57. Analysis of Covariance (ANCOVA) menunjukkan terdapat perbezaan signifikan antara kedua-dua kumpulan. ANOVA dua-hala juga menunjukkan terdapat interaksi antara murid-murid pelbagai kebolehan. Kajian juga menunjukkan kumpulan eksperimen mengekalkan skor tambah selepas lapan minggu.

Kajian ini juga memperihalkan jenis kesilapan yang dilakukan oleh murid dalam menyelesaikan masalah penolakan pecahan. Dapatan pra-ujian menunujukkan kedua-dua kumpulan melakukan kesilapan konsep nombor bulat, kesilapan arah dan kesilapan disebabkan oleh kecuaian.

Walaubagaimanapun, dalam pos-ujian, kumpulan eksperimen hanya menunjukkan kesilapan disebabkan oleh kecuaian sahaja manakala kumpulan kawalan menunjukkan kesilapan konsep nombor bulat, kesilapan

arah dan kesilapan disebabkan oleh kecuaian. Kumpulan murid sederhana dan lemah dalam kumpulan ekspeimen hanya melakukan kesilapan disebabkan oleh kecuaian. Kumpulan murid sederhana dalam kumpulan kawalan melakukan kesilapan arah dan kesilapan disebabkan oleh kecuaian, manakala murid lemah dalam kumpulan kawalan melakukan kesilapan konsep nombor bulat, kesilapan arah dan kesilapan disebabkan oleh kecuaian. Tambahan, murid dalam kumpulan eksperimen menunjukkan sikap positif terhadap *teknik MATAS Hopscotch.* Murid sederhana dan lemah dalam kumpulan eksperimen juga menunjukkan sikap positif terhadap teknik itu. Justeru kita boleh rumuskan *teknik MATAS Hopscotch adalah* berkesan dalam meningkatkan prestasi murid-murid.

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Last but not least, I would like to thank my parents, Periasamy A/L Sellamuthu and Rajambal A/P Muthu for giving me full support in completing my research.

I certify that a Thesis Examination Committee has met on 24 November 2014 to conduct the final examination of Devaki a/p Periasamy on her thesis entitled "Effects of Matas Hopscotch Technique in the Learning of Subtraction of Fraction among Year 5 Pupils" 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 Master of Science.

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

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I hereby confirm that:

- this thesis is my original work;
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- the research conducted and the writing of this thesis was under our supervision;
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INTRODUCTION

1.1 Research Background

The Malaysian education system has undergone tremendous transformation after gaining independence from the British colonial rule in 1957. Since then, the school curriculum has seen a few major reforms to achieve Vision 2020. According to the Curriculum Development Centre (2006), our nation's vision can be achieved through a society that is educated and competent in the application of mathematical knowledge.

Thus, the teaching and learning of Mathematics in English which was implemented in 2003 starting with Year One, Form One and Lower Form Six by Malaysian Educational Ministry, 2002 was changed. The teaching and learning of Mathematics in Bahasa Melayu was implemented in 2011 starting with Year One, Form One and Lower Form Six which progressively moved to all other levels and to be completed in 2016 (Educational Planning and Research Development, 2012).

In mathematics curriculum, fraction is an important topic (Curriculum Development Centre, 2006). The application of fractions can be found in all current branches of mathematics and science in general. According to the National Mathematics Advisory Panel (2008) fraction is one of the important topics that pupils need to successfully learn before they proceed to algebra. The report of the National Mathematics Advisory Panel (2008) did indicate at least 40 percent of middle school students experienced difficulty with fractions, and nearly 50 percent of middle and high school students struggled with elementary level fraction content. This finding poses a problem as fractions are considered an essential foundational skill for future success in mathematics (National Mathematics Advisory Panel, 2008).

This indicates, changes in the mathematics curriculum are to promote the learning of mathematics. Learning of fractions seems to be an important topic pupils need to master.

1.2 Teaching and Learning of Fractions among the Primary and Secondary school Students

The conceptions on teaching and learning refer to the beliefs held by teachers about their preferred ways of teaching and learning (Chan & Elliot, 2004). These include the meaning of teaching and learning and the roles of teacher and pupils. There are two main opposite conceptions in teaching and learning (traditional and constructivist). The traditional conception in teaching utilizes teacher-centered teaching strategies. This conception sees the teacher as the source of knowledge and the student as the passive receiver of knowledge. On the other hand, the constructivist conception uses student-centered teaching strategies because this type of learning helps students develop critical thinking and collaboration skills and learning takes place in environments where students are able to participate actively (Johnson, 2009, Chan & Elliot, 2004; Cheng, Chan, Tang, & Cheng, 2009).

In addition, according to Jennison, Beswick, and Mathematics Education Research Group of Australasia (2010), the students identified practical, hands-on activities and group work as impacting positively on their understanding and their confidence in relation to fractions. Meanwhile, a survey done by Fontana, Scruggs and Mastropieri (2007) revealed that a majority of students preferred mnemonic instruction for they felt they learned more.

However, a report by the Malaysian Examination Panel (2004) revealed the overall pupils' performances in subtraction of fractions were weak. Another report given by the Malaysian Examination Panel (2005) stated pupils had not mastered the skill in simplifying the fractions. This was consistent with the report given by the Malaysian Examination Panel (2007) which also revealed pupils' performances in subtraction of fractions as weak. Besides, another report given by the Malaysian Examination Panel (2008) revealed pupils' performances in writing the fraction in word form were weak. In addition, a recent report given by the Malaysian Examination Panel (2010) also revealed pupils had not mastered the division of fractions.

These facts were again highlighted in a case study conducted by Tengku Zainal Mustapha and Habib (2009) who found pupils made mistakes in comparing fractions due to the lack of understanding in the fraction concept. They also found that pupils were unable to differentiate between whole numbers and fractions; and these problems occurred at the early stages of learning fractions.

The problems in fractions do not occur only in primary schools but also in secondary schools. A majority of the lower secondary students are having problems in the process of learning fractions (Tee, 2005). He revealed students were confused on shading, did not practise equal parts and found difficulty in comparing fractions with different denominators. In addition, a report by the Malaysian Examination Panel (2008) found most of the Form Three students were unable to look for the same denominator correctly and to simplify it into a single fraction in its simplest form. This was consistent with the research done by Abdol Razak, Noordin, Alias and Dollah (2012) who revealed 13 year old students in Malaysia were not showing a very good conceptual understanding of comparing proper fractions. They also identified students who were not quite able to compare two fractions with the same numerator but different denominators and had more problems when asked to compare more than two fractions. They also revealed students were found to have difficulties identifying equivalent pictorial representations of fractions. They found the students were not able to identify the equivalent pictorial representation of the same fraction and also not able to name fractions when both equal and equivalent partitions occur in the same pictorial representation of a fraction(Noordin, Abdol Razak, Dollah & Alias, 2012). This phenomenon was also mentioned by Chick and Mathematics Education Research Group of Australasia (2010) and Sprute and Temple, (2011) that fractions were difficult to learn.

These indicated difficulties in the learning of fractions still exist among the primary school pupils and even students in secondary schools. Constructivist learning gives a positive impact among the pupils. However, a majority of the pupils preferred using mnemonic.

1.3 Mnemonic Strategy

A mnemonic strategy is defined “as a word, sentence, or picture device or technique for improving or strengthening memory” (Mastropieri & Scruggs, 1998). These strategies enhance student learning and memory by explicitly connecting new information with prior knowledge by means of visual and acoustic cues.

Students who have difficulty with academics often benefit from learning mnemonic strategies which provide a step-by-step process to accomplish a task (Dunn, 2012). Besides, mnemonic has the potential to assist the learning process because mnemonic devices can accelerate the rate at which new information are acquired and improve formal reasoning (Laing, 2010). Individuals using keyword mnemonics recalled more concrete than abstract words both immediately after learning and after a one-day time interval (De Graff, Verhoeven, Bosman & Hasselman, 2007).

This indicates that mnemonic strategies can help pupils who are having difficulties in the learning process. They enhance the pupils’ learning and memory. By increasing the pupils’ memory their errors in mathematics can be reduced.

1.4 Errors in the Learning of Fractions

Errors are referred as mistakes made by learners as a result of carelessness, misinterpretation of symbols and texts, lack of relevant experience or knowledge related to a Mathematical topic, learning objective or concept, lack of awareness, or inability to check the answer given (Hansen, 2006).

A research done by Hodes and Nolting (1998) proposed four types of errors. The errors were concept errors, directions errors, application errors and careless errors. They explained concept errors were mistakes made when the learner did not understand the properties or principles covered in the textbook and lectures. Directions errors were errors that occurred when learners skipped directions or misunderstood directions, but answered the question or the problem anyway. They also stated application errors were mistakes learners made when they knew the concept but could not apply it to a specific situation or question. Careless errors were mistakes made which could not be caught automatically upon reviewing ones' own work.

The error analysis revealed an overall lack of experience with basic fractions (Brown & Quinn, 2006). Based on the report by Malaysian Examination Panel (2004), pupils made mistakes in the subtractions of mixed numbers involving the same denominator need to be looked into seriously. They found that pupils did directions errors. They also found that some pupils also made concept errors. Another mistake they found was pupils tended to do careless errors. This was consistent with the report by Malaysian Examination Panel (2005) where pupils made mistakes in simplifying the fractions. Similar report was given by Malaysian Examination Panel (2007) which revealed that pupils were still facing problems in the subtractions of mixed numbers involving the same denominator as mentioned in an earlier report by the Malaysian Examination Panel (2004). They found pupils made careless errors. They also found pupils made concept errors in solving the subtractions of mixed numbers involving the same denominator and they also made errors in directions. These errors were consistent with the findings in a case study conducted by Tengku Zainal, et al., (2009) when identifying the common misconceptions of fractions among primary school pupils. In particular, they revealed pupils tended to make concept errors in fractions.

These were also supported by a research done by Raduan (2010) to identify errors by the 374 Year Five primary school pupils in solving the mathematical word problems for the 'Fraction' topic. He revealed 52.91% of the mistakes made were due to comprehension, 22.37% transformation skills, 15.55% process skills, 8.84% encoding and 0.34% reading.

A recent research done by Idris and Narayanan (2011) among eighty Form Two students from a national secondary school in Selangor was to discuss the types of errors and the pattern of systematic errors often made by students in the operation of additions and subtractions of fractions. They indicated errors in the addition operations were 29.8% careless errors, 26.3% negligence errors and 11.1 % systematic random errors. They also found there were 26.4% systematic errors, 10.3% careless errors, and 2.5% random errors in the subtractions of fractions. They identified 47.9% of students faced problems in the process of understanding systematic errors.

In addition, a study was recently conducted by Isiksal and Cakiroglu (2011) among the prospective mathematics teachers' knowledge on the common conceptions and misconceptions by the sixth and seventh grade students regarding the multiplication of fractions. The prospective teachers stated students' lack of formal knowledge and rote memorization of the algorithms caused difficulties among them.

These indicate errors still exist among the primary pupils and secondary school students. More efforts need to done to reduce the errors to improve pupils' attitudes in the learning of fractions.

1.5 Pupils' Attitudes

Attitude is referred as a point of view that can either be positive, negative, hostile or indifferent, which one holds towards a person, object, task or idea (Ifamuyiwa & Akinsola, 2008). Positive attitude facilitates learning while negative attitude hinders learning (Sparrow & Hurst, 2010).

A qualitative research done by Test and Ellis (2005) found 100% of pupils indicated mnemonic used was easy to learn. It was also revealed 83% of the pupils thought fractions were easier and liked working using mnemonic.

This indicates positive attitudes improve the pupils' learning process. By increasing the pupils' positive attitudes, their errors in mathematics can be reduced.

1.6 Mathematics Performance in UPSR

Table 1.1 gives an analysis of the results of the Primary School Evaluation Test or Ujian Pencapaian Sekolah Rendah (UPSR), for the Mathematics subject, based on the performance reports from 2007 to 2011 (Malaysian Examination Panel, 2012). Results for the UPSR mathematics performance throughout the five consecutive years from the year 2007 to the year 2011, showed 82.6% - 86.6% of students obtained grades A, B and C. The results indicate despite years of educational development, it seems more need to be done to improve the mathematics performances among the Malaysian primary school pupils. New techniques or instructional methods should be introduced if improvements are to be forthcoming.

Table 1.1 Mathematics Performances in the Primary School Evaluation Test (2007- 2011)

Year	Percentages						
	A	B	C	ABC	D	E	DE
2007	35.7	20.6	29.0	85.3	6.9	7.8	14.7
2008	31.1	18.7	32.9	82.7	7.5	9.8	17.3
2009	35.3	18.8	30.8	84.9	7.7	7.4	15.1
2010	37.2	19.3	29.3	85.9	7.4	6.8	14.1
2011	36.9	19.4	30.4	86.6	7.2	6.2	13.4

(Source: Malaysian Examination Panel. 2012)

1.7 The Remedial Process of the Teaching and Learning Fractions

Remedial is a process to increase students' mastery of basic maths (National Mathematics Advisory Panel, 2008). A qualitative research was done by Test and Ellis (2005) among six eighth-grade students special education math classroom to evaluate the effectiveness of a mnemonic strategy called LAP Fractions to add and subtract fractions. The letter "L" referred to look at the sign and denominator. The letter "A" referred as ask yourself the question; "Will the smallest denominator divide into the largest denominator an even number of times?". The letter "P" referred as pick your fraction type. They identified five out of six students were able to achieve mastery in solving addition and subtraction of unlike fractions. They also found all six students maintained gains over a period of six weeks.

In another qualitative research conducted by Haris and Sivasubramaniam (2010) among five Year 5 pupils, the researchers examined the effectiveness of the Formula Method that they created. They found the Formula Method was effective in reducing confusion in subtractions of mixed numbers among the five low ability pupils. However, they stated that the Method was unable to overcome related knowledge such as multiplication facts, simplifying fractions and converting improper fractions to proper fractions.

This indicates pupils' mastery in learning of fractions has increased. In schools pupils are categorized into three groups; high, average and low. Thus, mnemonic is appropriate for low and average proficiency pupils.

1.8 Problem Statement

One paramount problem in mathematics education is many pupils are not able to grasp the concepts of basic fractions and hence are not able to solve fraction problems. Thus, in order to improve mathematics learning especially the topic on fractions, attempts must be made to find an effective instructional practice to teach fractions among the Year 5 pupils in Malaysia.

Fraction is a problematic area among the primary school pupils and even secondary school students. The problems occurred at the early stages of learning fractions (Tengku Zainal et al., 2009). Pupils have difficulties in solving the problems till completion, implementing the operations that had been planned, solving the problems based on the information given and using formula to solve problems (Raduan, 2010). Pupils also made mistakes when writing the answers in the spaces provided, when simplifying the answers and recalculating the problems (Raduan 2010). Pupils have difficulties in differentiating between whole numbers and fractions (Tengku Zainal et al., 2009).

Pupils' performances in fractions were weak (Malaysian Examination Panel, 2004; 2007; 2010). Pupils have not mastered the skill in simplifying fractions (Malaysian Examination Panel, 2005). Pupils have difficulties in writing the fractions in the word form (Malaysian Examination Panel, 2008). Lack of understanding the fraction concepts were clearly shown (Tengku Zainal et al., 2009). These problems also occurred among secondary school students. Most of the students were unable to look for the same denominator correctly and simplified it to single fraction in its simplest form (Malaysian Examination Panel, 2008). Students having difficulties in terms of confusion on shading (Tee, 2005) and not showing a very good conceptual understanding of comparing proper fractions (Abdol Razak et al., 2012). It was clear students also had difficulties in identifying equivalent pictorial representations of fractions (Noordin et al., 2012).

Many researchers agreed learning fraction is difficult (Chick & Mathematics Education Research Group of Australasia, 2010; Sprute & Temple, 2011; Calhoon, Emerson, Flores & Houchins, 2007). Traditional teaching had limited effectiveness to fulfil the learners' need (Chan & Elliot, 2004). Teachers used symbols and abstract terms to teach fractions (Tengku Zainal et al., 2009). Teacher centered teaching seemed to show lower performance among the students (Tengku Zainal et al., 2009). Pupils had difficulties in terms of identifying which operation to be used, identifying the steps of problem solving, identifying the strategies to be used and relating the information identified with the information needed (Raduan, 2010). Thus, teachers teaching need to be varied to improve students' performances in fractions.

Researchers have shown that students made errors in fraction topic. Despite the improvement in the UPSR result in Malaysia, most pupils still showed errors in fractions (Malaysian Examination Panel, 2007). Difficulties were found among the pupils although the fraction topic was introduced since Year Three (Yee Ling, 2006). Disjointed understanding of fraction concepts and operations caused errors among the students (Brown & Quinn, 2006). Lack of formal knowledge and rote memorization of the algorithms also stemmed difficulties among the students (Isiksal & Çakiroglu, 2011). High errors were due to lack of understanding among the primary school pupils (Raduan, 2010). Students memorising algorithm provided them with only one way to solve the computational problem (Idris & Narayanan, 2011).

Thus, teachers need to be concerned over errors made by the students. These early difficulties can lead to a restless situation which subsequently causes lack of interest in learning Mathematics. Identification and analysis of students' errors have the potential to improve instructional planning and ultimately, student performance.

Mnemonic improved pupils' memory and accelerated the rate at which new information was acquired and improved formal reasoning (Laing, 2010). Students recalled more concrete than abstract words both immediately after learning and after a one-day time interval using keywords mnemonic (De Graff, Verhoeven, Bosman & Hasselman, 2007). Students benefited from learning mnemonic strategies which provided a step-by-step process to accomplish a task (Dunn, 2012). Despite of the improvement shown by using mnemonic technique, only two studies were done among students with mild disabilities to teach fractions (Test & Ellis, 2005).

Educators are moving towards conceptual understanding rather than procedural. Practical, hands-on activities and group work were giving positive impact (Jennison, Beswick & Mathematics Education Research Group of Australasia, 2010). However, analysis of errors clearly showed that the students still had difficulties in learning of fractions (Tengku Zainal et al., 2009; Raduan, 2010; Idris & Narayanan, 2011). Meanwhile, mnemonic method was preferred by a majority of students, felt they learned more (Fontana, Scruggs & Mastropieri, 2007). Mnemonic improved students with mild disabilities to add and subtract fractions (Test & Ellis, 2005). Error analysis of low and average achievers among primary and secondary students after the usage of learning materials in the learning of fractions need to be conducted (Idris & Narayanan, 2011).

For these above reasons, an experimental research was conducted and error analysis of low and average abilities among the Year 5 pupils before and after the use of mnemonic technique in the learning of fractions was investigated to fill in the gap.

1.9 Aim of Research

The focus of this research is on the subtraction of fractions in Year 5. The purpose of this research is to investigate the application on pupil-centred teaching, the effectiveness of mnemonic technique for remedial process learning for Year 5 Mathematics and the errors found after mnemonic technique is introduced among the Year 5 pupils.

1.10 Objectives of Research

Specifically, the objectives of this research are as below:

a) To compare the performances of pupils in solving the subtractions of fractions between the control and experimental groups.
b) To compare performances of pupils with different ability in solving the subtractions of fractions between the control and experimental groups.
c) To investigate the differences between the post and delayed post-test scores in solving the subtractions of fractions for the experimental group.
d) To investigate the types of error made by the control and the experimental groups in the subtractions of fractions.
e) To investigate the types of error made by the pupils with different ability in solving the subtractions of fractions between the control and experimental groups.
f) To investigate the pupils' attitude towards the technique used in the experimental group.

1.11 Research Questions

There are 7 research questions.

RQ. 1 Are there significant differences between the pre and post-test scores in solving the subtractions of fractions in the control group?
RQ. 2 Are there significant differences between the pre and post-test scores in solving the subtractions of fractions in the experimental group?
RQ. 3 Are there any significant differences between the control and experimental groups in solving the subtractions of fractions in the post-test scores?
RQ. 4 Is there an interaction effect between the use of MATAS Hopscotch technique and pupils with different ability on the post-test scores?
RQ. 5 Are there significant differences between the post and delayed post-test scores in solving the subtractions of fractions among the pupils in the experimental group?
RQ.6 What are the types of error made by Year 5 pupils in the control and experimental groups in solving the subtractions of fractions in the pre and post-test performances?
RQ.7 What are the pupils' attitudes in the experimental group towards MATAS Hopscotch technique in solving the subtractions of fractions?

1.12 Research Hypotheses

There are 5 hypotheses in this research.

H_{01} There are no significant differences between the pre and post-test scores in solving the subtractions of fractions in the control group.

H_{02} There are no significant differences between the pre and post-test scores in solving the subtractions of fractions in the experimental group.

H_{03} There is no significant difference between the control and experimental groups in solving the subtractions of fractions in the post-test scores.

H_{04} There is no interaction between the use of MATAS Hopscotch technique and pupils with different ability on the post-test scores.

H_{05} There are no significant differences between the post-test and delayed post-test scores in solving the subtractions of fractions in the experimental group.

1.13 Significance of Study

The findings of this research will contribute towards improving the strategies of teaching and learning on the topic of fractions. This investigation is an effort to reduce the errors in fractions. Pupils and teachers will benefit from the findings of this research.

The findings of this study could provide evidence for the mnemonic technique as another alternative teaching technique for the teachers to improve the pupils' understanding on fractions. Teachers can apply this technique especially to the pupils who are having difficulties in mathematics. Besides, this technique helps to reduce errors made by the pupils when solving mathematical problems like fractions and subsequently their mathematical performances can be enhanced. In addition, the teaching and learning of mathematics can be changed from the traditional to constructivist style of teaching, thus meeting the goal of the Malaysian mathematics curriculum.

The findings of this study too may provide evidence that learning of mathematics through the mnemonic technique will enhance pupils' memory especially the low ability pupils. This technique is consistent with the primary school mathematics curriculum.

Finally, the results of this study will also provide additional information to the many researches and studies done on the mnemonic technique. The applicability of mnemonics in mathematics among primary school pupils in the Malaysian classroom has yet to be discovered. The outcome of this study will hopefully encourage other researchers to study other different classroom levels besides Year 5. This will enrich the mnemonic literature in the educational field.

1.14 Limitation of Research

This research is limited to Year 5 pupils of a rural school in the district of Sepang, Selangor. The pupils were able to read, understand instructions and communicate in basic English. Hence the findings could not be generalised to the population of all Year 5 pupils in Malaysia. However, it may be applicable to pupils of the same background in this study.

The mathematics topic involved in this study is fractions and is the second topic in the Year 5 syllabus. Therefore it may not be applicable to other topics in the syllabus. The results are applicable only to three types of subtraction of fractions involving the same denominator. It would not apply to other mathematical concepts learnt before. The technique used in this is mnemonics only. It is also not applicable to addition, multiplication and division of fractions.

1.15 Operational Definition

The key terms used in this study are defined conceptually and operationally in order to give a clear understanding and direction in conducting this study.

1.15.1 Effectiveness

Effectiveness can be described as a capability of producing desired results (impact) in students' academic, physical, social emotional, and behavioural well-being. For teachers in the classrooms, it is the effective professional learning which is the single most powerful pathway to promote continuous improvement in teaching (Killion & Hirsh, 2010). In this research, effectiveness is the impact of the technique developed which is measured through the pupils' performance in their pre-test, post-test and delayed post-test.

1.14.2 Teaching method

Methods of teaching can be described as the appropriate ways to improve efficiency of teaching (Entwistle, 1988). In this study, the teaching method is the mnemonic technique called *MATAS Hopscotch* technique which will be compared with traditional method.

1.15.3 Performances

Performance is defined as a cognitive perspective in which learning and understanding are evaluated (Eggen & Kauchak, 2004). In this study performance is based on the pre-test scores which were collected before the experiment, post-test scores collected after 840 minutes of experiment and delayed post-test scores collected after 8 weeks.

1.15.4 Performance Abilities

Students' academic performances are considered as an indicator of ability (Bohlin, Durwin & Reese-Weber, 2009). In this study, a grading system was used to categorize the pupils according to their abilities. The pupils with scores above 80% were classified as "high ability", 60% to 79% classified as "average ability". Those with scores less than 59% were classified as "low ability". Based on the grading system, the pupils in this study were categorized into two; average ability and low ability.

1.15.5 Errors

Errors performed refer to the discrepancy between the learners' solution set and the correct solution scheme (Tarmizi & Sweller, 1988). In this study, both the control and experiment groups made errors in the pre and post-test. Hodes and Notling (1998) proposed four types of errors which were concept errors, directions error, application errors and careless errors. According to them, concept errors refer to mistakes made when the learner does not understand the properties or principles covered in the textbook and lecture while directions errors occur when learners skip directions or misunderstand directions, but answer the question or the problem anyway. Application errors refer to errors made when they know the concept but cannot apply it to a specific situation or question while careless errors refer to errors made which can be seen automatically upon reviewing one's own work.

In this study, whole number concept errors referred to errors made when the pupils used whole number concept. Directions errors referred to errors made when the pupils performed subtraction from right to left. Application errors referred to errors made when the pupils were unable to apply the concept correctly. Careless errors referred to errors when the pupils subtracted wrongly or left answers without simplifying the fractions. If no error term added, it indicated pupils did not make any errors in the subtraction of fractions. The pre-test and post-test papers were randomly selected from both groups and were scanned. The types of error were described clearly for both the control and experiment groups.

1.15.6 Attitudes

Attitude refers to as a positive or negative response towards mathematics that is relatively stable, similar to what some might call dispositions (Hemmings, Grootenboer & Kay, 2011). In this study, attitude refers to the pupils' views towards the mnemonic technique. The items used were adopted and adapted from Aiken (1974). Ten (10) items were used to measure the pupils' attitudes. Pupils indicated whether they enjoyed learning the mnemonic technique based on a five point Likert scale, 5 for "strongly agree", 4 for "agree", 3 for "undecided", 2 for "disagree" and 1 for "strongly disagree".

1.15.7 Remedial

Remedial is a process to increase students' mastery of basic maths such as simple addition, subtraction, multiplication, and division (National Mathematics Advisory Panel, 2008). In this research, remedial is a process to help increase pupils' mastery in subtraction of fractions with the help of the mnemonic technique. The remedial process was conducted for four weeks.

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