COMPARING MATHEMATICAL PROBLEM SOLVING ABILITY OF PUPILS WHO LEARN ABACUS MENTAL ARITHMETIC AND PUPILS WHO DO NOT LEARN ABACUS MENTAL ARITHMETIC

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Abstract: The main objective of this study was to compare the mathematical problem solving ability between pupils who learn abacus-mental arithmetic and pupils who do not learn abacus mental arithmetic. A sample of 69 Standard One primary school pupils in the State of Penang were involved in this study. Two instruments, Mathematics Test for Standard One pupils and Mental Arithmetic test were used to collect the data to make the comparison. T-test was used to compare the problem solving ability between these two groups of pupils. Pearson Product-Moment correlation coefficient was computed to determine the relationship between abacus-mental arithmetic achievement and ability to solve mathematic problems. The results indicated that there was significant difference (p<0.05) for ability in solving symbolic items and also achievement in mental arithmetic between pupils who learn abacus-mental arithmetic and pupils who do not learn abacus-mental arithmetic. Mean score for pupils who learn abacus-mental arithmetic was higher than those who did not learn abacus mental arithmetic. However, there was no significant difference (p<0.05) in achievement for solving mathematical word problems between these two groups of pupils.

Introduction

Mathematical problem solving abilities refers to the capabilities of pupils to solve mathematical routine problems and non-routine problems. According to Aziz (2002), if pupils solve problems by merely applying the algorithm, the problem is known as routine problems. However, if pupils need to use advance level of mathematical concept to solve the problem given, it is then classified as non-routine problem. Mathematical problems in the primary school curriculum are of the routine problems which are in symbolic format or mathematical word problems (Ong, 2003).

Noor Azlan (1995) reviewed the development of mathematical education in Malaysia and pointed out that the mathematics curriculum has experienced major changes since the country gain independent till now. The Malaysian Ministry of Education emphasized on good quality teaching and learning in the Mathematics classroom. This is evident from the many efforts that had been carried out to improve the standards of teaching and learning mathematics. Various creative and innovative approaches have been introduced in the in-service programs for teachers as well as in training programs for pre-service teachers. One of these is the introduction of the use of abacus or mental arithmetic in the teaching and learning of primary schools mathematics. The use of abacus-mental arithmetic is believed to be able to help pupils to perform computation and to solve mathematical problems (Ministry of Education, Malaysia, 1994).

The method of abacus-mental arithmetic in learning mathematics involved manipulation of beads on the abacus which produces sound and psycho-motor abilities with the movement of fingers on the abacus. As a result pupils are actively involved in the learning process both mentally and physically. This help to generate mental images which aid in ability to solve mathematical problems.

From the year 2005, abacus-mental arithmetic is included in the primary school mathematics curriculum. The issue of effective implementation of this program will be a concern for mathematics educators as well as parents. So far research on the use of abacus-mental arithmetic in
the teaching and learning of mathematics in Malaysia is not explore and information regarding this will be useful in providing direction as to how it can be carried out effectively.

**Problem Statement**

The New Primary Schools Curriculum (KBSR) was implemented in 1983 with the aim of developing pupils’ overall individual development in aspects such as intellect, spiritual, physical, emotion, talent, character, aesthetic values and social. This curriculum emphasizes on mastery of the three basic skills (3R), which are reading, writing and arithmetic. For mathematics, the focus was on mastering numbers and its basic operations (addition, subtraction, multiplication and division) at level one which include year one, year two and year three pupils.

A study carried out by the Inspectorates of schools (1993) reported that mastery of basic mathematical skills for primary schools pupils at level one was found to be not satisfactory. This will pose serious problems when the pupils proceed automatically to level two of the primary school education. The mathematical skill and concepts will be more complex. Base on the findings, it was recommended that methods of mathematics teaching need to be varied example using aids like abacus-mental arithmetic which was successfully used in countries like China, Japan and Korea (Stigler & Perry, 1988; TIMSS, 1996; Kim 2003).

Hope (1987) reviewed a study conducted in Cockcroft Report on mental arithmetic in England. He pointed out that many adults and children were unable to perform simple calculation mentally. As an example, 45% of the sample, aged 17 years were not able to multiply 90 with 70 mentally. Similar finding was also revealed in the study conducted by the National Assessment of Education (NAEP).

Base on the experience of teaching mathematics for fourteen years, the researcher found that primary school pupils as well as many secondary school students are weak and slow in mental calculation. A personal contact with a group of primary school pupils who learnt abacus-mental arithmetic was shown to perform mental computation much faster and accurate. The question arises whether mental-abacus arithmetic will help students in the learning of mathematics.

**Purpose of Research**

The purpose of this research is to provide information on mathematical problems solving abilities for pupils who learn abacus-mental arithmetic compare to pupils who do not learn abacus-mental arithmetic. Besides, this study also compare abilities in solving the different mathematical problems, that is, symbolic item and word problems item. The relationship between ability to solve mathematical problems and achievement in abacus-mental arithmetic was also determine.

**Research Questions**

This research attempts to answer the following questions:

1.5.1 Is there any significant difference in the mathematical problem solving abilities between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students?

1.5.2 Is there any significant difference in mental arithmetic achievement between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students?

1.5.3 Is there any significant difference in the ability to solve mathematical symbolic items between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students?
1.5.4 Is there any significant difference in the ability to solve mathematical word problems items between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students?

1.5.5 Is there a correlation between mental arithmetic achievement and the mathematical problem solving abilities?

Research Hypothesis

Ho1: There is no significant difference in the mathematical problem solving abilities between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students.

Ho2: There is no significant difference in mental arithmetic achievement between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students.

Ho3: There is no significant difference in the ability to solve mathematical symbolic items between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students.

Ho4: There is no significant difference in the ability to solve mathematical word problems items between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students.

Ho5: There is no significant correlation between mental arithmetic achievement and the mathematical problem solving abilities.

Significance of the Study

This research hopes to provide information about role of learning abacus-mental arithmetic in the learning of mathematic among primary school pupils. It is hoped that the result of this study will provide guidelines on implementing abacus-mental arithmetic more effectively in primary schools.

Cognitive Development Theory

This study is based on the cognitive developmental theory researched by Piaget (1969), Bruner (1964) and Vygotsky (1978). Teaching aids like abacus plays an important role in explaining numerical concept effectively. Several researcher, Stigler (1986), Hayashi & Kawano (2000) demonstrated that the use of abacus at an early stages for children seem to provide concrete experience in helping them to solve mathematical problems and reinforce understanding of concept on numbers. Abacus was found to encourage and involve children in an active and fun way to learn arithmetic concepts.

According to the study of Hishitani (1975), Hatano et al (1977), Stigler (1986) and Kawano (2000), students who are good at using abacus form a mental image by visualizing the abacus beads in their heads. This has enable student to think symbolically or in a language of that symbolic level to solve mathematical problem. This implied that mastering abacus skills in mental representation aid in cognitive development of a student.

Mathematical Problem Solving Abilities

Schoenfeld (1985) perceives mathematical understanding of a student as the mathematical problem solving abilities. He has identified four categories of knowledge which influenced this problem solving ability. The first was known as resources; that is, student’s basic mathematical knowledge. Secondly, student needs heuristics which are a set of broad problem solving techniques. The third
one is control over the resources; that is, whether the student is able to select the necessary resources. Lastly, the belief systems of the student in the problem situation.

**Methodology**

*Research Design*

The research is of the Causal-Comparative design. Two types of pupils, those who learn abacus-mental arithmetic and those who do not learn abacus-mental arithmetic. The variable understudy are their ability to solve mathematical problem and their mental arithmetic ability.

<table>
<thead>
<tr>
<th>Table 3.1</th>
<th>The Variables</th>
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<tr>
<td>Independent Variable</td>
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<td>Group 1</td>
<td>Group 2</td>
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<td>Mathematical problem solving ability</td>
<td>Mental arithmetic ability</td>
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Group 1: Learning abacus-mental arithmetic pupils
Group 2: Non-learning abacus-mental arithmetic pupils

*Sample*

A primary school SJK (C) in the district of Georgetown, Penang was selected to conduct this study. The school was selected base on information from a private institution that conducted mental-abacus arithmetic. Students enrolled in this institution were from eight nearby primary schools. 39 pupils, that is the biggest number obtained was from the above primary school. This group of students, who has learnt mental-abacus arithmetic at the said private institution was known as Group 1 pupils in this study.

As the school does not stream the students according to ability, one class of primary one pupils who has not learnt mental-abacus arithmetic was selected at random from the total of nine primary one classes. There were altogether 30 of them and is known as group 2 in this study.

*Instruments*

Two instruments were used in this study. The Standard One Mathematics Test and the Mental Arithmetic Test. The Standard One Mathematics Test was prepared based on the Table of Specification using the primary one mathematic curriculum. This help in ensuring the validity of contents for the items. The format of the test was in accordance with the format in the School Based Evaluation Progress (PKBS) test which was conducted in the school under study during 2003 and 2004. The test items cover only arithmetic for addition and subtraction of positive numbers less than 100 with the inclusion topic on money. Items in the mathematical tests consisted of two types, that is, symbolic items and word problem items. The mathematical test consisted of 30 subjective items.

Similarly the mental arithmetic test was constructed based on the Table of Specification using syllabus from mental-arithmetic textbooks of the UCMAS Academy. The syllabus of UCMAS Academy was used as the Curriculum Development Center (2001) appointed UCMAS for the implementation and training of teachers for abacus mental-arithmetic in Malaysia since 1998. The mental arithmetic test consisted of 30 subjective items.
Data Analysis and Results

The data analysis was done using the computer program of Statistical Package for Social Sciences (SPSS) version 11.5.

1. The t-test used to test null Hypothesis 1 (Ho1) where the mean score of mathematics test for learning abacus-mental arithmetic students compared with the mean score for mathemetic test of non-learning abacus-mental arithmetic students.

The result of the analysis shows that there is a significant difference in the achievement of Standard One mathematics between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students (t = 2.79, p = 0.008).

2. The t-test used to test null Hypothesis 2 (Ho2) where the mean score of mental arithmetic test for learning abacus-mental arithmetic students compared with the mean score for mental arithmetic test of non-learning abacus-mental arithmetic students.

The result of the analysis shows that there is a significant difference in the achievement of mental arithmetic between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students (t = 3.44, p = 0.001).

3. The t-test used to test null Hypothesis 3 (Ho3) where the mean score of mathematic symbolic items for learning abacus-mental arithmetic students compared with the mean score of mathematic symbolic items for non-learning abacus-mental arithmetic students.

The result of the analysis shows that there is a significant difference in the achievement of mathematic symbolic items between learning abacus-mental arithmetic students and non-learning abacus-mental arithmetic students (t = 3.20, p = 0.003).

4. The t-test used to test null Hypothesis 4 (Ho4) where the mean score of mathematic word problem items for learning abacus-mental arithmetic students compared with the mean score of mathematic word problem items for non-learning abacus-mental arithmetic students.

The result of the t-test (t = 0.87, p = 0.39) shows that there is no significant difference in the achievement of mathematic word problem items between pupils who learn abacus-mental arithmetic and pupils who do not learn abacus-mental arithmetic.

5. For null Hypothesis 5 (Ho5), the Pearson r correlation used to determine the relationship between the mental arithmetic achievement score and mathematics achievement score.
   a) The correlation between mental arithmetic achievement and Standard One mathematics achievement is significant among pupils who learn abacus-mental arithmetic.
   b) Likewise, the correlation between mental arithmetic achievement and Standard One mathematics achievement is significant among pupils who do not learn abacus-mental arithmetic.

Discussion

The result of this study shows that the mathematical problem solving abilities among pupils who learn abacus-mental arithmetic is higher compared to pupils who do not learn abacus-mental arithmetic. This suggested that pupils with background knowledge of abacus mental-arithmetic seem to have a good foundation in numerical concept that helps in solving mathematical problems.
Students who have learnt abacus mental-arithmetic seem to have advantage and able to calculate one and two digit numbers accurately up to five rows, compared to students who have not learnt abacus mental-arithmetic.

Nevertheless, this study showed that students from both groups did not differ significantly for ability to solve mathematical word problems. Higher computation ability among pupils who have learnt abacus-mental arithmetic did not help in solving mathematical word problems. It has been shown by other researches that ability to solve word problems require other ability like language and comprehension.

The positive and significant correlation between achievement in mental arithmetic and Standard One mathematics achievement imply that pupils who showed higher achievement in mental arithmetic will probably perform better in the Standard One mathematics achievement test. This seems to provide evidence that abacus-mental arithmetic is an important basic skill for doing primary school mathematics. Mental arithmetic skills not only help pupils compute for correct answers but also enable them to check whether answers are correct. This is also supported by studies conducted by Rey (1994) and Nohda (1994) in Taiwan and Japan respectively.

Implication of Findings

The positive and significant correlation between achievement in mental arithmetic and achievement in the mathematics test for Standard One imply that abacus-mental arithmetic skills is important in solving mathematical problems, especially the symbolic items. The Ministry of Education should then extend the learning of abacus-mental arithmetic to all students in Malaysia. Further, in-service as well as pre-service training should be conducted for all Mathematics teachers in the teaching of abacus-mental arithmetic to ensure effective implementation of the program.

Activities to encourage the mastery of abacus-mental arithmetic should be organized both by the private sectors as well as the Ministry of Education. The abacus-mental arithmetic competition for teachers’ training colleges in Malaysia conducted by the Teachers’ Education Department and Ministry of Education, Malaysia, should also be extended to primary and secondary schools.

Conclusion And Proposal for Further Study

Pupils who learn abacus-mental arithmetic performed better in solving mathematical problem compare to those who do not learn abacus-mental arithmetic. Correlation between achievement in mental arithmetic and achievement in Mathematics test showed that abacus- mental arithmetic has an effect on performance in primary school mathematics. Hopefully, mastery of abacus-mental arithmetic is able to give pupils confidence in the learning of primary school mathematics.

Further research can be done to investigate the learning of abacus-mental arithmetic to all students in Malaysia. Besides, issues regarding implementation of the abacus mental- arithmetic should be investigated to ensure the program benefited all pupils.

Studies on the effect of learning abacus-mental arithmetic on other variables such as thinking ability, computing skills and accuracy of answers will be useful in affecting the teaching and learning of Mathematics.
References


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Indian Abacus ABACUS EDUCATION—WILL IT CONFLICT WITH SCHOOL METHOD OF TEACHING MATHEMATICS? Few people have in their mind an apprehension that the child at their young age gets confused with the method of teaching of mathematics at school and abacus training. However, resolving a mathematical problem quickly and accurately is not always accomplished by every child, under normal method of learning of mathematics. Evidence shows that those who have taken the Abacus program will have the following advantages: Abacus presents multi-digit numeric relationships in a concrete slider/bead based system. If a child starts the Abacus program prior to or concurrent with traditional methods, there is minimal conflict and the child will easily work with both systems.

Abstract: Mental abacus (MA) is a technique for performing fast and accurate arithmetic using a mental image of a physical abacus. Expert users exhibit astonishing calculation abilities. Although previous studies have documented impressive abilities in MA experts, they do not shed light on whether MA training can produce benefits for a broad range of students in a standard classroom setting. The present study tested this, and asked whether MA expertise. Most previous studies of MA have investigated experts who have elected to receive extensive training outside of school, raising the possibility that expertise is possible only in individuals who have particular mathematical talents or interests. Similarly, studies that have tested MA. Mental Abacus 5.