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Research Article

MANIPULATIVE KIT USED IN TEACHING AND LEARNING TOPIC ADDITION AND SUBTRACTION IN 21ST CENTURIES

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ABSTRACT

Through decades, there are large number of conventional methods have been studied and developed to help students understand topic addition and subtraction. The purpose of this article is to study the different research emphases to manipulative kit that currently use among teachers and educators in teaching addition and subtraction. The example of math manipulatives that have been used by teachers are Counters, Base Ten Block, Magnetic Coin, TuxMath and etc. Researcher suggests that manipulatives are particularly useful in helping children move from the concrete to the abstract level. Building the bridge between these levels, however, requires careful structuring of manipulatives by the teacher. Based on the findings, researcher compared each type of manipulative for ease of use and helpfulness in understanding the topic before release a paper regarding Chip Mental Arithmetic Kit which is a new manipulative kit in teaching and learning in topic addition and subtraction in 21st centuries.

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INTRODUCTION

Manipulatives refers to objects that can be touched and moved by students to introduce or reinforce a mathematical concept. The digest also speculates on some of the challenges affecting future use of manipulatives. Since the 19th century, educators have advocated the active involvement of children in learning. Study indicates that manipulatives can be effective when used properly. Issues relating to the implementation and success of manipulatives include the availability of manipulatives, the period of students' exposure to manipulatives, and teachers' experience and training.

Two influences will probably affect the use of manipulatives in the future: schools' efforts to conform to the "Curriculum and Evaluation Standards for School Mathematics" and the commitment of state resources to transform theory into practice. Some state and local initiatives have mandated implementation of manipulatives through policy, law, or curriculum documents.

There are various manipulative kit have been used for teaching and learning topic addition and subtraction. The approaches depend on the size, kit speciality, kit capabilities and etc. Every approach has their own purpose to find better performance in term of time, cost, distance and complexity (Ismail Al-

Taharwa, Sheta, & Al-Weshah, 2008). Manipulatives help students develop conceptual understanding of mathematical ideas by representing the ideas in multiple ways. Using mathematics manipulatives and models offers many benefits. Just as a picture can be worth a thousand words, manipulatives can provide visual representations of ideas, helping students to know and to understand mathematics better. Manipulatives enhance the abilities of students at all levels to reason and communicate (Shaw, 2017).

Manipulative kit is very important to enhance students in becoming more active in class by activities provided, increase their motivation towards learning and teaching thus adopt a positive attitude towards mathematics lesson. Learning through activities by using teaching manipulative gave students pleasure and increased their motivation and allowed them to learn while having fun (Hinzman, 1997).

This paper outline is as follows. Section II presents the short review on individual papers and follows by the table of comparison in Section III. Thus, the discussion about the algorithm approaches will be in Section IV. Finally, in section V the conclusion is drawn in.

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MATERIALS AND METHODS

Exploring the Use of Mathematics Manipulative Materials: Is It What We Think It Is? (Marshall and Swan, 2008)

Problem Statement

The use of mathematics manipulative materials such as counters and Base Ten Blocks is common in many Australian classrooms. Seemingly there is an unchallenged assumption that the use of manipulative materials in the teaching of mathematics is a key to learning about mathematics concepts, and this is supported by the mathematics manipulatives industry. Teachers who are time poor and under pressure are either looking for a miracle manipulative to solve all their problems with teaching a particular topic such as fractions or have abandoned the use of manipulatives in favour of textbooks.

Proposed Solution/ Methodology

This paper reports on a survey and follow-up interviews designed to explore key issues in the use of mathematics manipulative materials in the teaching of mathematics. It also reports on the collaboration between Edith Cowan University, the Independent School sector in Western Australia and R.I.C. Publications, an international publisher and supplier of mathematics manipulative materials based in Western Australia. The aim was to look into the state of play of the use of mathematics manipulative materials in primary schools in Western Australia. To this end, a survey was sent to all teachers in primary and designated middle schools in Western Australia (Pre-Primary to Year Ten; ages 4 -14), providing an initial insight into their use. Further evidence based on a comprehensive literature review, school visits, interviews and teacher workshops were used to review the current state of play as to the use of mathematics manipulative materials in classrooms and to respond to issues raised in the surveys and interviews. This paper compares the data obtained from the survey and interviews.

Result

Throughout this paper, the argument has been made that manipulatives on their own do not teach-teachers do. Children can often look very busy (active) with manipulatives but that does not necessarily mean that children are learning. Clements (1999) noted that simply using manipulatives as part of a mathematics lesson does not guarantee success. The results of the present study certainly confirm that for mathematics manipulatives to be effective, they must be part of a carefully planned mathematics program. In particular, teacher own knowledge of the mathematics, the children and the manipulatives need to be sufficient so as they can assist children to connect the use of the manipulatives to the concept being developed.

The Effect of Manipulative Materials on Mathematics Achievement of First Grade Students (Ojose and Sexton, 2009)

Problem Statement

There is a general phobia associated with learning mathematics (Ojose, 2009). It will be an understatement to say that even adults dread mathematics too. To put it in perspective, much of the problem of loathing mathematics will not be too

pronounced if students, from the onset are provided with the necessary tools that make the concepts in mathematics less abstract. That is the inherent issue here: if students are exposed to manipulative materials to help them better connect to mathematics, chances are we will have a less-phobic mathematics consumers. In addition, performance of students in mathematics, especially as it relates to high stakes tests. It should be highlighted that the students may not perform well in the tests for various reasons. One of such reason is the likelihood that they never learn the material to the level of conceptual understanding. Thus, the lack of understanding manifests in low performance. According to Ojose (2008), exposing students to hands-on materials will lead to conceptual understanding and therefore enhance cognitive development of children.

Proposed Solution/ Methodology

The design used in this study was the single group pre-test and post-test design. The 18 participants in the study made up the single group whose knowledge of number sense was determined over a 4 weeks period. The pre-test was given at the beginning of the unit to measure students' knowledge prior to instruction and the post-test was administered at the end of instruction. The students were given the pre-test before beginning the unit that incorporates the above-mentioned standards. One of the researchers then taught the lessons using magnetic coins as the manipulative materials. In the teaching episodes, instructor/researcher generally modeled how the magnetic coins are used in solving math problems with examples. After the modeling phase, the students were given one practice problem and are provided with manipulatives to aid them in working the problem. If they show understanding of the concepts, they are then given independent work to do using the manipulatives. Students are given a standing instruction to only use manipulatives even if they are able solve problems analytically or with other methods. At some point in most of the lessons, the instructor/researcher would require class participation that involves various students going to the white board to solve problems using the magnet coins. On other occasions, table groups would be given a task to buy an imagined article and the student would figure out different combinations of coins that correspond with the cost of the article. The data of scores obtained from students in the pretest and posttest were crunched and analyzed with the aid of Statistical Packages for the Social Sciences (SPSS) program.

Result

The following are the major findings associated with the study. First, it was evident that students' knowledge of composing and decomposing numbers was greatly enhanced as a result of using the magnetic coins manipulatives. In addition, using the manipulative materials positively affected the achievement of students in the number sense standards. Plus, manipulative materials have effect on all students regardless of sexual orientation, socioeconomic status, academic level and disability.

Teaching Basic Mathematics by Using TuxMath in Primary Education (Megavarnan Jagadesan, 2013)

Problem Statement

To teach mathematics in this 21st century we need ICT integration to make the students not to get bored in the classroom. In Level One, students start to learn basic mathematic operation in school. Most of the schools are using non-digital teaching aids in classroom to teach students the basic mathematic operation. This is sometimes make the 21st century students who are friendly with computers and mobile phones to be bored and uninterested. In this case, the teacher should find new digital teaching aids to teach the students.

Proposed Solution/ Methodology

Using a case study approach, this paper attempts to gain an insight on how to make easy and effective the students understanding of the basic mathematics operation in Level One. TuxMath was applied in Year One. Two and Three in early or basic mathematics operation.

The basic operations are taught to the level one students are on addition, subtraction, multiplication and division. A short program development course was given to the Level One mathematics teachers in SJK (T) Port Dickson. Then getting reflection from the mathematic teachers and solving their problems in handling TuxMath. After the program development course, the teachers applied the TuxMath in their teaching and learning process in basic mathematics operation. The teacher gave their feedback through an interview about the effective of TuxMath in basic mathematic operation in Level One students. A test paper also was given to the students who learnt basic mathematic operation by using TuxMath and without using TuxMath. The data was collected and analysed in a table.

Result

The respondents discovered that TuxMath is useful, easy to apply, and provides a best learning outcome. The teachers are confident in using the TuxMath in their class and ready to teach other mathematics teacher how to use TuxMath in their classrooms for Level One students.

Table 1 Table of Comparison

Paper	Purpose of Paper	Manipulative Kit	Finding Result	Pro & Cons
A	To look into the state of play of the use of mathematics manipulative materials in primary schools in Western Australia.	The use of Counters and Base Ten Block is common in many Australian classrooms.	The results of the present study certainly confirm that for mathematics manipulatives to be effective, they must be part of a carefully planned mathematics program. In particular, teachers own knowledge of the mathematics, the children and the manipulatives need to be sufficient so as they can assist children to connect the use of the manipulatives to the concept being developed.	Pro: Many teachers felt that the use of manipulatives helped to engage students or provided them with enjoyment or were ‘fun’. Mathematics manipulatives heighten the interest or provide motivation. The use of manipulatives can help children to grasp concepts or reinforce them. Furthermore, it also can be used to introduce concepts, help the abstract become concrete, and that it is easier to go from the concrete to the abstract, manipulative appealed to all styles of learning, encouraged oral language, improved children’s fine motor skills, provided opportunities for collaborative learning to occur, addressed multiple intelligences and all learning abilities and also allowed for peer tutoring. Cons: Teachers often do not have enough of the equipment to go around. Teachers also maintained that they had a problem having the materials ready to use, with easy access, particularly when sharing with other teachers. Plus, the cost of manipulatives made their use problematic. Children also fiddling and not listening to instructions that they were often a distraction. Plus, poor storage and organisation of the materials.
B	To investigate the effect of manipulative materials on the achievement of first grade students in mathematics.	Manipulatives material in the form of money (Magnetic Coins).	The instruction that incorporates manipulative materials in the form of money (magnetic coin) aided the achievement of students.	Pro: Manipulatives used increase students achievements. More production of manipulatives with technology interaction has started. Cons: Teachers need to attend workshops that acquaints them with how to properly use manipulatives as instructional tools.
C	To examine the usefulness of TuxMath as a teaching aid for teachers in teaching and learning process of basic mathematics in primary education.	TuxMath as teaching aid for teacher in teaching and learning process of basic mathematics.	The result showed that TuxMath had a significant positive impact among the teachers and students, and the latter preferred TuxMath rather than using the traditional method of teaching basic mathematics operation in Level One.	Pro: TuxMath is useful, easy to apply, and provides a best learning outcomes. The teachers are confident in using the TuxMath in their class and ready to teach other mathematics teacher how to use TuxMath in their classrooms for Level One students. The students also got good marks in their exam in basic mathematics operations. TuxMath is also compatible with Malaysian Mathematics Curriculum which is used by every school in Malaysia. The students also can use TuxMath in their home computer and play in their home by their self without teacher guidance. The size of TuxMath is 20.5MB and does not need a large space in the computer hard disks. Cons: Most of the schools are using non digital teaching aids in classroom to teach students in basic mathematics operation.
D	To explores the research and use of mathematics manipulatives in the teaching of mathematics today during an age of technology and standardized testing.	Virtual manipulatives, Geoboards, Pattern Blocks, Tangrams, Color Tiles, Unifix/Snap Cubes, Triman Compass, Cuisenaire Rods, Base-10 Blocks, Number Tiles, TI Explorer Plus Calc., Two-sided Counters, Judy Clock, Abacus, Scale/Balance.	The research shows that math manipulatives are a valuable tool in the instruction of mathematics in the age of technology and standardized testing.	Pro: Many new commercially math manipulatives used by students in learning basic mathematics. Cons: Many teachers are not well trained to use this math manipulatives in teaching and learning of mathematics

The students also got good marks in their exam in basic mathematics operations. TuxMath is also compatible with Malaysian Mathematics Curriculum which is used by every school in Malaysia. The students also can use TuxMath in their home computer and play in their home by their self without teacher guidance. The size of TuxMath is 20.5MB and does not need a large space in the computer hard disks.

The Importance of Using Manipulatives in Teaching Math Today (Furner and Worrell, 2017)

Problem Statement

Many new state standards, such as the Florida Math Standards, the *Common Core Math Standards* (National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO), 2010), along with the National Council for Teachers of Mathematics (NCTM, 2010) call for the usage of representational models as a significant area of practice in mathematics instruction. Representations can be interpreted in many ways, such as illustrations, virtual manipulatives, and physical hands-on manipulatives or didactics.

Among the many theorists who provide the foundational basis for using math manipulatives in instructional lessons are Piaget (1952), who believed children cannot comprehend abstract math through explanations and lectures only, and that they need experiences with models and instruments in order to grasp the mathematical concepts being taught. Brunner (1960) believed that students’ early experiences and interactions with physical objects formed the basis for later learning at the abstract level. This type of hands-on learning is often referred to as constructivism and is the basis for integrating math manipulatives into instructional math lessons. These foundation researchers provided guidance for the common use of math manipulatives in many math classrooms today.

Proposed Solution/ Methodology

This article looks at the drawbacks and cautions educators as they use math manipulatives in their instruction. This paper is the compilation of many math manipulatives in teaching and learning mathematics. It also explores some cognitive concerns as a teacher goes about teaching with math manipulatives. The paper shares many commonly used math manipulatives used in today’s classrooms and matches them up to some of the Common Core Math Standards that are taught today in classrooms in the USA and around the world.

Result

Through several paper that written in this article, what can be conclude is disabling in teaching with manipulatives during the post-test were lack of time to prepare and lack of knowledge of multiple uses of certain manipulatives. The identification of these disabling factors by teachers in the post-test might be due to the training which made them knowledgeable enough on the topic to realize the time it takes to prepare for a lesson with manipulatives, and that there may be other uses with the same manipulative. Teachers identified “difficulty with classroom management” both pre- and post-test, which could show a need for training or support in this area.

Chip Mental Arithmetic KIT

Based from the previous research, researcher found that teachers showed a high level of interest in implementing a new teaching aids in teaching and learning addition and subtraction. The result also showed that teachers acquired high level of relative advantage, compatibility and observability while very low level of complexity. There are many conventional methods have been studied and developed to help students understand topic addition and subtraction of Whole Number up till 100, but most of them less enhance than teaching aids by students. Therefore, we proposed a new teaching aids in teaching and learning topic addition and subtraction standard 1 for students in understanding the basic operation of mathematics by offering them the enjoyable experience of learning a massive innovation to education in Malaysia.

Chip Mental Arithmetic Kit is a teaching kit that is built to further enhance the interest of standard 1 student in learning addition and subtraction in topic Whole Number up till 100. A very interesting and easy-to-manage design makes this Chip Arithmetic Mental Kit easy to use by teachers and students both inside and outside of the classroom. Chip Mental Arithmetic Kit consists of 32 Chip Mental Arithmetic with variety of colours (red, blue, yellow, green, orange, purple) with numbers from 0 to 20, a number platform, which is Number Platform 10 and Operation Number Platform.

Number Platform 1(a) and Operation Number Platform 1 (b)



Figure 1 shown above is Number Platform 10 and Operation Number Platform.

This Number Platform was made by using 3D Printer with Magma Filament 1.75mm. Number Platform was designed small in size which is size of palm where it is very light to hold and easy to flip. More interesting about this Number Platform, it is so convenient and easy to carry which make learning of addition and subtraction can occur anywhere at any time. While Number Platform was built from combination of three circle that connected to one another and have triangle in middle that differentiate this two Number Platform. This unique Number Platform consists of two platforms which is Number Platform 10 (in front) and Operation Number Platform (back) as shown in Fig.1. Number Platform 10 only suitable for operation addition of three numbers that produce digit 10 in total. The combination of chip mental arithmetic kit of three numbers is restricted from 0 to 9 only. While Operation Number Platform is used for operation addition and subtraction. To identify Operation Number Platform, there are three symbols that located in the triangle, in the middle of the number platform which is plus (+), minus (-) and equal (=). All numbers from 0

to 20 of Chip Mental Arithmetic Kit can be used for this Operation Number Platform.

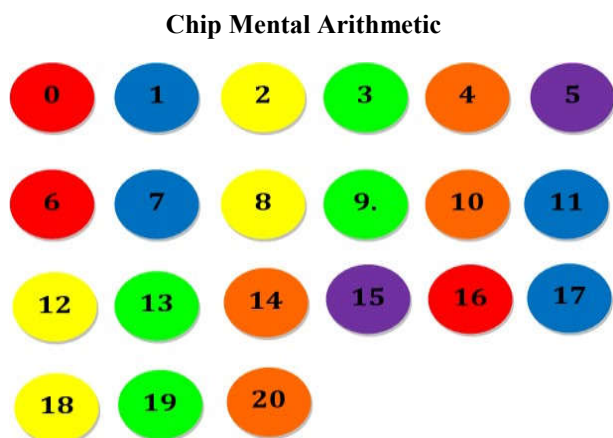


Figure 2 shown above is Chip Mental Arithmetic that was also made by using 3D-Printer with Magma Filament 1.75mm.

This 3D-Printer was used to make a set of 32 colourful pieces of Chip Mental Arithmetic which contain two sets of number from 0 to 20. This Chip Mental Arithmetic was built from geometrical same size circle and it looks like a coin. This chip is very light and the colour selected for chip is a mixture of prime, secondary and tertiary colour. This chip consists of 21 numbers with different colour which is as follows 0=red, 1=blue, 2=yellow, 3=green, 4=orange, 5=purple, 6=red, 7=blue, 8=yellow, 9=green, 10=orange, 11=blue, 12=yellow, 13=green, 14=orange, 15=purple, 16=red, 17=blue, 18=yellow, 19=green, 20=orange. Chip Mental Arithmetic can be used by both Number Platform.

User's manual for teaching and learning also provided. This user's manual consists of two parts which are, a module on how to use the Chip Mental Arithmetic Kit and a teaching manual by using Chip Mental Arithmetic Kit for addition and subtraction of topic Whole Number up till 100. Based on the user's manual on how to use, users will able to learn step by step of teaching and learning by using Chip Mental Arithmetic Kit. First, students need to identify the question. Then, start from choosing the number platform either number platform operation or number platform 10. Next, students need to select two or three number of Chip Mental Arithmetic and place the chip mental arithmetic at the number platform chosen. Students will discuss the teachers regarding the answer and this process is repeat until a lot of combination numbers form. Teaching manual was built according to the specifications of the mathematics curriculum for standard 1, which comprises one main subtopic which is to identify the combination of two or more numbers. In conclusion, this new innovation of teaching aid, may defeat the conventional method and other teaching methods since it fills the requirements of teachers needed in teaching and learning addition and subtraction.

DISCUSSION

There are so many articles of math manipulatives that have been discussed to find the best mathematics manipulatives in teaching and learning basic mathematics in 21st centuries. Survey data can disguise the real reasons behind a particular response. For example, the researchers were surprised that money was listed as the major hindrance to use manipulative materials to teach mathematics. However, recent changes to

Kindergartens in Western Australia have meant that Kindergarten budgets have been reduced. Kindergarten teachers have therefore felt financial pressure for the first time, and therefore this may have been in mind when completing the survey.

Freeman (2014) had conducted a research on a group of low performing standard 1 children in United Kingdom school over a period of 10 weeks, investigates the benefits of using the Japanese abacus. The Japanese abacus (soroban) is a tactile tool which has been adopted as part of mathematics curriculum by many primary schools in Asia in addition to being taught outside the formal school settings as part of out-of-school activities. Japanese abacus is an instrument used to do calculations based on the decimal system. The result showed that two out of the three children in the group performed very well in their computational skills.

Further studies are needed in at least four areas within the paradigm of manipulative material usage. One is that there is need to expand the research to other grades especially the upper elementary grades and the middle school grades. Second, there is the need to focus on the how of manipulative usage to gain insights into methods and practices that are replicable and can inform instruction. Third, it will be interesting to have control group(s) in the study to ensure stronger internal validity and compare such results to the finding of this study. And four, it is strongly suggested that future studies select the subjects by means other than convenient sampling. Specifically, randomized samples should be used. According to Siegel, Borasi, and Fonzi (1998), misleading learning or a delicate understanding in mathematics becomes the cause of this topic is not understand by student and higher tendency of making mistakes when dealing with this question, this attract us to further the research regarding this matter.

In addition, TuxMath also one of the best math manipulatives that use technology in teaching and learning mathematics. This modern manipulative had brought maths manipulative into the next phase. This TuxMath brings a lot of benefits to teachers and students in teaching and learning mathematics. As result, this math manipulatives increase student's achievements in basic operation of mathematics but the weakness of TuxMath is its digital devices and most of the schools are using non-digital teaching aids in classroom to teach students in basic mathematics operation.

Conventional method which is "chalk and talk" is the techniques that most of teachers and educators use for teaching and learning because this method can counter the problem of increase number of students in class and for teachers to finish the syllabus in short time (Becker and Watts, 1996). The new teaching aid had to improve the problem of teaching and learning in the increasing number of students in class. Teacher's problem of finishing syllabus in short time can be minimised because the new teaching aids make teaching and learning become more enjoyable and fun. Conventional teaching depends on teaching in the form of delivering information and elaboration of idea or verbal principle and abstract by teachers to student by one-way communication and student role as passive respondents (Mohd Aris Othman, 2007).

There are many conventional methods have been developed to help students understand topic addition and subtraction, but

most of them less enhance than teaching aids by students. Therefore, Chip Mental Arithmetic Kit was created for students in understanding the basic operation of mathematics by offering them the enjoyable experience of learning. This Chip Mental Arithmetic that easy to carry teaching aid making learning mathematics more interesting in early age.

Furthermore, teachers play an important role to make sure that teaching and learning of mathematics using manipulative kit in this 21st centuries being applied to students. A lot of aspects of the manipulative kits need to be emphasis to make sure that the new manipulative kit is a way better than manipulative kit nowadays. A pro and cons of every manipulative kit will be used by researcher to make a manipulative kit that is light and easy to use anywhere and anytime.

CONCLUSION

The information about mathematics manipulative been used nowadays are very important to determine the best manipulative kit that can be created for teaching and learning topic addition and subtraction. The best manipulative kit is when the kit is non-technology, not complicated for teachers to handle, cheap in cost and convenient. Researcher believe that using manipulatives in conjunction with other methods can deepen student's understanding of abstract concepts.

Based from the four articles that researcher emphasize in this paper, we can conclude that there are pro and cons for every teaching aid that been used by teachers, educators and students nowadays. From the information above, researcher feels that it is a must to come out with one teaching aids for teaching and learning of topic addition and subtraction.

Therefore, Chip Mental Arithmetic Kit is a teaching aids that build to help standard 1 students to solve operation of addition and subtraction in topic of Whole Number up till 100 is also suitable for low-achievement students to understand the concept of addition and subtraction better than conventional methods. Despite, student will have a clear and concrete view regarding learning addition and subtraction using this kit. In conclusion, Chip Mental Arithmetic Kit allows students to understand the concept of combination number through addition and subtraction which before this it is difficult for them to learn and to solve the problem regarding the topic. Instead of teaching and learning using conventional method, now with Chip Mental Arithmetic Kit, teachers and students be able to have new experience on interactive teaching and learning 21st century. From the articles listed, it is important in providing student with direct experiences with concrete material is supported by evidence from the classroom and an understanding of how learning takes place.

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