EFFECTIVENESS OF USING SCRATCH® IN ENHANCING WORD PROBLEM SOLVING ACHIEVEMENT IN BASIC ARITHMETIC AMONG YEAR TWO PUPILS

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DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER IN MATHEMATICS EDUCATION WITH INFORMATION COMMUNICATION TECHNOLOGY

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ABSTRACT

Teaching and learning of primary and secondary Mathematics in Malaysia wields problem solving as the central theme and fundamental emphasis in the curriculum content. However, problem solving which allows pupils to think critically, analytically and logically often viewed as complex mathematics area since it obliges knowledge of number sense and basic arithmetic operations and language skill. The purpose of this study is to determine the effect of using Scratch in enhancing word problem solving achievement in basic arithmetic among year two pupils. A total of 60 year two mixed ability pupils from a government primary school in Bangsar district were chosen as respondent of this quasi experimental study by convenience sampling. The experimental group (N=30) was subjected to lessons designed with Scratch while the control group (N=30) was subjected to lessons using the traditional method without Scratch. To answer the research questions, this study implemented a quantitative data collection method namely pre-test and post-test. Pupils' achievement in solving word problems in basic arithmetic is analysed inferentially. Significant difference between pre-test and post-test of the experimental group year two pupils' achievement in solving word problems in basic arithmetic is measured using paired samples t-test while significant difference in year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group before and after the intervention is measured using independent samples t-test. Results of the paired samples t-test (M = -30.80, SD = 9.77), t (29) = -17.27, $p < .001$ revealed that there is a significant increase in the achievement of experimental group in solving word problems in basic arithmetic. Moreover, results of independent sample t-test (M =27.092), t (59) = 6.32, $p < .05$ indicated that there is a significant difference in post-test between the experimental and control group. These findings point out that the use

of Scratch enhanced the pupils' achievement in solving word problems in basic arithmetic.

KEBERKESANAN PENGAJARAN MENGGUNAKAN SCRATCH DALAM MENGUKUHKAN PENCAPAIAN PENYELESAIAN MASALAH DALAM ARITMETIK ASAS DALAM KALANGAN MURID TAHUN DUA

ABSTRAK

Pengajaran dan pembelajaran Matematik rendah dan menengah di Malaysia menggunakan penyelesaian masalah sebagai tema utama dan penekanan asas dalam kandungan kurikulum. Walaubagaimanapun, penyelesaian masalah yang membolehkan murid untuk berfikir secara kritis, analitikal dan logik sering dipandang sukar kerana ia mewajibkan pengetahuan nombor dan operasi aritmetik asas serta kemahiran bahasa. Kajian ini betujuan untuk mengenalpasti keberkesanan penggunaan Scratch dalam meningkatkan pencapaian penyelesaian masalah dalam aritmetik asas dalam kalangan murid tahun dua. Sejumlah 60 murid tahun dua sekolah rendah kerajaan di daerah bangsar yang terdiri daripada berkebolehan pelbagai telah dipilh sebagai responden bagi kajian kuasi experimen ini melalui pensampelan secara kebetulan. Kumpulan eksperimen (N=30) mengikuti pembelajaran yang direka dengan Scratch manakala kumpulan kawalan (N=30) mengikuti pembelajaran menggunakan kaedah tradisional tanpa Scratch. Untuk menjawab soalan kajian, kajian ini melaksanakan kaedah pengumpulan data kuantitatif iaitu ujian pra dan ujian pos. Pencapaian murid dalam penyelesaian masalah dalam aritmetik asas dianalisis secara inferens. Perbezaan signifikan dalam pencapaian penyelesaian masalah dalam aritmetik asas antara ujian pra dan ujian pos kumpulan eksperimen diukur dengan ujian-t berpasangan manakala perbezaan signifikan dalam pencapaian penyelesaian masalah dalam aritmetik asas dalam pasca ujian antara kumpulan eksperimen dan kumpulan kawalan diukur dengan ujian-t tak bersandar. Keputusan ujian- t berpasangan (M = -30.80, SD = 9.77), t (29) = -17.27, p < .001 menunjukkan terdapat

peningkatan signifikan dalam pencapaian kumpulan eksperimen dalam penyelesaian masalah dalam aritmetik asas. Selain itu, keputusan ujian-t independent (M =27.092), t (59) = 6.32, $p < .05$ menunjukkan terdapat perbezaan signifikan dalam pasca ujian antara kumpulan eksperimen dan kumpulan kawalan. Penemuan ini menunjukkan bahawa penggunaan Scratch mengukuhkan pencapaian murid dalam penyelesaian masalah dalam aritmetik asas.

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LIST OF ABBREVIATIONS

MIT	:	Massachusetts Institute of Technology
UCLA	:	University of California Los Angeles
TIMMS	:	Trends in International Mathematics and Science Study
PISA	:	Program for International Student Assessment
OECD	:	Organization for Economic Co-operation and Development
UPSR	:	Ujian Pencapaian Sekolah Rendah
ICT	:	Information Communication Technology
MSC	:	Multimedia Super Corridor
PCK	:	Pedagogical Content Learning
TPCK	:	Technological Pedagogical Content Knowledge
MI	:	Multiple Intelligences
LCD		Liquid-Crystal Display
KSSR	:	Kurikulum Standard Sekolah Rendah
DLP	:	Dual Language Programme
SPSS	:	Statistical Package for Social Sciences

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CHAPTER ONE

INTRODUCTION

1.1 Background of Research

Problem solving is the most vital cognitive activity in everyday as well as professional contexts (Jonassen, 2000). The skill of solving problems comprises the process of identifying and understanding a particular problem that occurs, emerging a plan to solve the problem, carrying out the suitable course of action and finally checking and expanding the solution (Polya, 1954). Problem solving ability is the fundamental dexterity in daily lives. Schoenfeld (2013) stated that problem solving was defined as an effort to accomplish some outcome, when there was no explicit method to solve it. For example, in the situation of necessity to go to the store however it is raining, there are many possible solutions to overcome it. Some choose to walk with an umbrella while some may call a peer for a ride. There is no apparent way to solve it because different people have different way of solving. Since problems vary in content, type or procedure, problem solving is considered as a non-uniform activity (Jonassen, 2000).

Baroody and Coslick (1998) stated that problem solving skills are able to effectuate individuals who are able to think critically, analytically and logically about complex issues besides conceive solutions and communicate them clearly and convincingly to others. Problem solving is the main focus in the teaching and learning of Mathematics and has been established as the central theme of primary and secondary levels Mathematics curriculum content in Malaysia (MOE, 2013). Problem solving is not only a goal of learning Mathematics but also a major means of doing so (National Council of Teachers of Mathematics, 2000). Problem solving mainly concentrates the most effective strategy for developing and emphasizing students' understanding of mathematical concepts at the primary level. Problem solving is the fundamental key in learning Mathematics (Schoenfeld, 2010).

Mathematical problem solving is crucial for every Mathematics student. The problem solving skills need to be given proper accent so that pupils are able to solve various problems in their daily efficiently. The current Mathematics education prepares students who benefit from opportunities to engage in any problem in real world that is complex, unfamiliar, challenging or demanding, even it may take time to solve (National Council of Teachers of Mathematics, 2014). Pupils can develop practical and creative thinking as well as portray independency by learning Mathematical problem solving as to prepare themselves to cope with current globalisation era. Brown, Watson, Wright, and Skalicky (2011) acknowledged that problems solving in Mathematics also let pupils to explore abstract and disconnected concepts in meaningful and significant way.

Solving word problems has been a challenge for many pupils and educators at primary level. Problem solving considered as a complex Mathematics area because it needs knowledge of number sense and basic arithmetic operations and language skill (Jimenez Fernandez, 2016). Skills of interpreting information, planning and working methodically, checking results and trying alternative ways are required in problem solving (Muir, Beswick, & Williamson, 2008). The basis of Mathematical problem solving which determine the success or failure of a problem solver are knowledge, problem solving strategies, metacognition and beliefs (Schoenfeld, 1985).

The unsatisfactory performance in Mathematics problem solving caused by many possible factors. Windschitl (1999) stated that pupils struggle in constructing mathematical knowledge and understanding through representing, reasoning and application of problem solving. Pupils tend to copy from the teachers instead of exploring the solution by themselves. This may lead to passive learning and soon Mathematics turn out to be meaningless beyond the classroom (Rolle, 2012). Difficulty in solving mathematical problem affirmed to be the key factor for poor performance in Mathematics problem solving (Geist, 2010). Pupils did not learn to use the problem solving strategies, which require wide range of heuristics effectively (Schoenfeld, 2015). Moreover, Mathematics teachers fail to realize that improving problem solving is mainly emphasis on teaching the strategies that help a student to improve problem solving competencies, not a matter of doing more practical exercises (Jimenez Fernandez, 2016). Teacher factors such as lack of teachers' mathematical knowledge, restriction in instructional time and limitation in opportunity for professional development related to innovative teaching styles are also contributing to Mathematics problem solving intricacy (Silver, Ghousseini, Gosen, Charalambous, & Strawhun, 2005).

Thus, teaching and learning need to involve problem solving skills comprehensively and across the whole curriculum. Teaching of problem solving should prompt pupils' engagement, thinking and making of cognitive connection (Sullivan, Mousley, & Jorgensen, 2009). A deep understanding of mathematical concepts should be developed by engaging them to create, conjecture, explore, test and verify. The use of technology in teaching and learning of Mathematics is now widespread and provides a rich learning environment (Forster, 2006).

Scratch is a new media-rich programming language and environment established by the Lifelong Kindergarten group at the MIT Media Lab with the UCLA Graduate School of Education and Information Studies (Rizvi, Humphries, Major, Jones, & Lauzun, 2011). Scratch mainly designed to assist primary school pupils to develop their imagination, improve common sense, problem solving skills as well as to interact with computers. Scratch also stimulate conducive learning environment along with enhancing problem solving skills. Calder (2010) stated that this software provides an engaging and relatively easy-to-use space for problem solving to explore mathematical concepts. Additionally, it proved to be an effective medium for encouraging communication and collaboration among the pupils in order to create a meaningful learning environment.

21st century learning requires pupils to think creatively and reason systematically. Scratch is a software that enables pupils to program interactive stories, games, animation and share their projects in the online community (Kalelioglu & Gulbahar, 2014). Scratch could also benefit educator to plan a meaningful and engaging lessons by designing creative, entertaining and interdisciplinary materials that unbridle pupils' imagination (Lee, 2011). Adapting Scratch in the teaching and learning enhance problem solving skills and ability. By allowing pupils to use Scratch, teachers can bring word problems to life. The use of Scratch is closely related to intensifying the learning of problem solving because by using Scratch programs were easily composed and modified, hence it improves pupils' critical, metacognition and reflective skills (Calder, 2010).

When pupils make a link between their input and the actions that occur on the screen, it evoke relational and mathematical thinking which lead to creative problem solving skills and the development of logic and reasoning. Moreover, according the study done by Harvey (2010) learning problem solving with Scratch is effective as it cater both advanced and intermediate pupils. Game development and game based learning is an effective approach for intrinsically motivating pupils to learn. Scratch also stimulate thinking by collaborative learning where pupils share their work in a sharing forum and help each other.

1.2 Problem Statement

Problem solving has been recognized as one of the hallmarks of Mathematics and the major concern in Mathematics education. The utmost goal of Mathematics education is to have pupils who are good problem solvers and become increasingly able and willing to engage with and solve problems. Few critical issues had been identified in this research.

The first critical issue is the difficulties faced by pupils in solving word problems in Mathematics. Pupils tend to face failure in solving word problems although they can perform well in normal arithmetic calculations. Pupils are lacking in ability to think and analyse the problem especially non-routine problem and identify the sub goal leading toward the solution and decide the strategy to use. The most problematic task for a student in Mathematics is solving problems especially for those with Mathematics learning difficulty (Bryant, Bryant, & Hammill, 2000). Many pupils find word problem solving challenging. Based on the analysis on 6^{th} grade pupils errors when solving word problems, five possible stumbling were identified namely reading ability, comprehension, transformation, process skills and encoding (Newman as cited in Hansen, Drews, Dudgeon, Lawton & Surtees, 2017). Moreover, pupils encounter complications in word problem solving when the idea of utilising daily life experiences in order to solve the problem at hand because diverse experience of pupils (Hansen et al., 2017).

One of the critical concerns in solving word problems is the problem solving language, both written and spoken (Schwieger, 2003). Solving word problems requires complex process because the words and phrases given in the problems may lead to misconception. Lamb (2010) indicated that pupils with reading disability struggle in Mathematics. Walker, Zhang, and Surber (2008) similarly supported this statement by stating that students' performance in Mathematics effected and lowered significantly as a consequence of the reading difficulty of Mathematics questions and how the questions are written. Complication in reading a problem, comprehending the sentences, identifying the key words and overlooking extraneous information given are also identified to be the factors of problem solving difficulties (Mancl, 2011).

Application and integration of mathematical skills and concepts are utmost obligation in the process of decision making and problem solving. Based on few studies, Tambychik and Meerah (2010) mentioned few mathematical skills needed as a foundation in word problem solving, number fact skills, arithmetic skills, information skills, language skills and visual spatial skills. Word problem solving difficulties are mainly ingrained by lack of mastery of number facts, computational weakness, inability in connecting conceptual aspects of math, inadequacy in transferring the knowledge, failure in making meaningful association among information, inability to transform the information mathematically, incomplete mastery of mathematical terms and understanding of mathematical language as well as difficulty in comprehending and visualising mathematical concept (Nathan, Sarah, Adam, & Nathan, 2002).

Various errors and confusion in word problem solving mainly initiated by dearth of conceptual understanding and procedural knowledge. All the above mentioned signifying that word problem solving requires reading comprehension skill, computational skill and mathematical skill.

The second critical issue is the performance of Malaysian students' problem solving is still unsatisfactory as highlighted in TIMMS and PISA and achievement in UPSR examination. One of the Mathematics international assessment that Malaysia takes part in Trends in International Mathematics and Science Study (TIMMS). TIMSS is a valuable tool to increase the level of Mathematics instruction and teach students to achieve global standard of excellence (Nelson, 2002). Malaysia's performance was seen to be inconsistent since its involvement in 1999 (A. Abdullah, Sin Yee, & Jieh Tze, 2017).

In TIMSS, Malaysia score 519 in the year of 1999, 508 in the year of 2003, 474 in the year of 2007, 440 in the year of 2011 and 465 in the year of 2015. The score is declined from the year 1999 to 2011 and slightly improved in 2015 with a significant improvement of 25 point. This improvement is still not satisfactory. Based on the international benchmark, the percentage of students in advanced group was decreased from 10 in the 1999 to 2 in 2011. Same scenario happen for high group and intermediate group where, the percentage of students in high group was decreased from 36 in the 1999 to 12 in 2011 and the percentage of students in intermediate group was decreased from 70 in the 1999 to 36 in 2011. Malaysia is also one of the countries which decreases in all four content domains which are number and fraction, algebra, geometry and data and had lower achievement in all three cognitive domains which are knowing, applying and reasoning from TIMSS 1999 to 2011 (A. Abdullah et al., 2017).

Similarly, Malaysia's performance in PISA showing poor performance in Mathematics. Program for International Student Assessment (PISA) is an international assessment conducted in accordance with operational and guidelines of OECD which Malaysia started participating in 2009. In PISA 2009, Malaysia is ranked 57th among

74 countries with an average score of 404 meanwhile in PISA 2012, Malaysia is ranked 52nd among 65 countries with an average score of 421 (A. Abdullah, Surif, & Ibrahim, 2014). In PISA 2015, Malaysia is ranked 55th among 72 countries with an average score of 446. Though there is a significant improvement of 25 points, the score is below the international average score which is 490. 13.8 percentage of students are in below level 1, 23.7 percentage of students are in level 1, 29.5 percentage of students are in level 2 and 21.9 percentage of students are in level 3. On the other hand, 9.1 percentage of students are in level 4, 1.8 percentage of students are in level 5 and 0.2 percentage of students are in level 6. This indicates achievement of Malaysian students in Mathematics is mostly at level 2 (KPM, 2016).

This research also refers to the report of primary school assessment which shows an unsatisfactory achievement in Mathematics in UPSR examination. 18.6 percentage of students fail to score minimum mastery level in UPSR 2017 (KPM, 2017). In addition, a performance analysis report for Mathematics indicated weak candidates could not answer problem solving and application questions

The third critical issue is the lack of technology use in teaching and learning of Mathematics in the classroom. The use of technology in mathematic teaching highlights rich learning outcome is something which could not be denied. However, integration of technology in the classroom is rely on attitude and personality of a teacher and the environment. One of the main issues in Mathematics education is to prepare in-service and pre-service teachers for the appropriate use of technology in their teaching of Mathematics (Kokol Voljc, 2007). Monaghan (2004) affirmed that there is a division in perception of those who view technology as something that makes the teachers to be less didactic and problematic when perceiving the change in their practices in mathematic classes. Ertmer, Paul, Molly, Eva, and Denise (1999) mentioned that implementation of technology is hampered by external and internal barriers.

Internal barriers include being extrinsic to teachers, limited access to technology, lack of time to prepare teaching integrating technology and derisory support from administration. On the other hand, external barriers comprise attitude and beliefs about teaching with computers, traditional classroom practices and instruction as well as reluctance to change. Tough many new teachers are aware of inculcating Mathematics with ICT, deploying particular software like data capture devices is still being a strong need among the teachers because learning Mathematics aided by the technology is more essential than being fluent with the operation of the software (Pimm & Johnston Wilder, 2004). Nevertheless, making substantial changes in teaching using technology requires support and commitment from school administration (Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

Niess (2005) stated that it is essential for teachers to develop and overarching concept of the subject which is the content knowledge with respect to technology which is the technological knowledge and teaching with the technology which is the technological pedagogical knowledge. Based on the study done, Bozkurt (2016) mentioned implementation of technology in teaching by the teachers affected by limited access to ICT amenities including quantitative and qualitative issues, lack of guidance and support from mentors concerning the use of ICT, time constraint to evaluate a software due to workload issue and lack of links in the scheme of work.

Mathematics teachers agree that the use of ICT is beneficial in teaching Mathematics and could produce a positive result in their pupils' learning of Mathematics. Despite, most of them still indicating low self-confidence when using

ICT in their classroom. Abdullah, Mokhtar, Kiong, Ali, Ibrahim and Surif (2016) affirmed that the reason for the teachers to have a low self-confidence is the fear of problematic technical issue which might occur during the teaching process. It worsens the situation when it happens in front of the students who expect their teacher to be adequate to solve such problem. These manifest mathematic teachers are dearth of professional training and supports related to the effective integration of ICT in teaching.

In a nutshell, based on the past researches, there are some issues in difficulties faced by pupils in solving word problems in Mathematics, the performance of Malaysian students problem solving is still unsatisfactory as highlighted in TIMMS and PISA and achievement in UPSR examination and lack of technology use in teaching and learning of Mathematics in the classroom. Therefore, this study intended to examine the effect of Scratch in enhancing word problem solving achievement in basic arithmetic among year two pupils.

1.3 Theoretical Framework

This research is conducted based on Polya's Problem Solving model. This model identified four basic principles of problem solving (Polya, 1954). To solve a word problem, pupils must first understand the problem and the information given. Next, it is essential to determine a strategy to solve the problem and should determine whether the solution makes sense and reasonable once arrive at a solution to the particular problem. Polya's Problem Solving model is useful to conduct the research as all the principles and criteria of the model leading towards enhancing solving word problems.

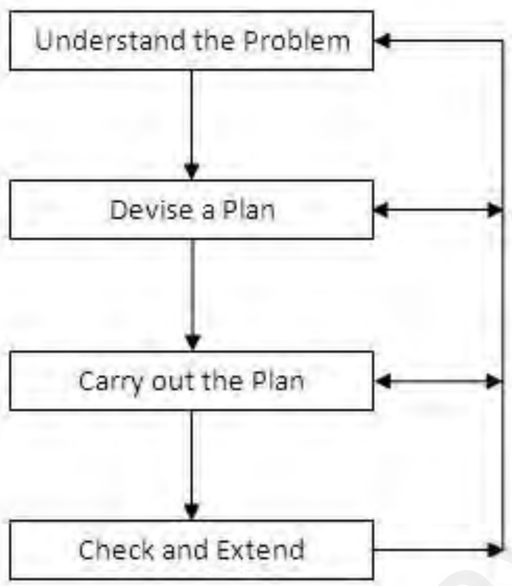


Figure 1.1. Polya's Problem Solving Model

Understand the problem is the preparation stage where pupils need to learn the necessary underlying mathematical concept and consider the terminology or notation used in the given problem. This stage requires reading the question slowly and carefully to understand the information given. Drawing simple diagram or picture, rephrase the problem in own words and write specific examples of the condition given in the problem are the strategies that can be used in the stage of understanding the problem.

Devise a plan is the second stage where pupils need to think for a reasonable way to solve the problem. Pupils need to think about the information that they know, the information that they are looking for and relate the pieces of information in order to devise a plan. Looking for a pattern, eliminating the possibilities, making an orderly list and using formulas can be useful in the stage of devising a plan.

Carry out the plan is the insight to solve the problem. This stage is simpler than devise a plan. Pupils should persist with the plan that have been chosen. The devised plan should be modified or changes if it does not work. Immediate action to find for a new idea to try or new perspective on how to approach solving the problem is needed. In this stage, common sense and natural thinking abilities found to be powerful tools.

Look back is last stage of solving problems which considered as the verification process where students need to examine the solution obtained. This is very crucial because it helps in identifying the mistakes and enables to predict the strategy to be used to solve problems in the future.

Polya's Problem Solving Model is chosen to be used in this study rather than other problem solving model because Polya's Problem Solving Model is best to be implemented to solve mathematical problems both at primary and secondary levels. This model is competent in problem solving because it directs the students to make steps in order to solve a problem and complete the outcome by reflecting it back (In'am, 2014). Polya's Problem Solving model has the best formulated theory and view of what a mathematical problem solving needs. This model has a specific views and criteria as to what establish a problem and the reason. This model also comprise four key cognitive activities during problem solving which are mobilization, organization, isolation and combination (Carifio, 2015). Mobilization is the process of retrieving relevant elements from memory, organization is the process of grouping the unconnected facts together to adapt to the problem, isolation is the process of focusing on a single detail by isolating it from the problem and combination is the process of grouping details together in a new way. Above mentioned statements prove that Polya's Problem Solving Model guides the students to solve a mathematical problem in an effective way on top of building cognitive abilities.

This study is aimed to enhance word problem solving achievement in basic arithmetic among year two pupils using an ICT tool, which is Scratch. In this regard, effect of using Scratch in enhancing word problem solving achievement in basic arithmetic research carried out by a number of assumptions as follows.

1. Problem solving skills built by pupils based on their own experience.
2. Lower primary pupils are active and neutral in problem solving.
3. The concept of problem solving involves the skills of collecting information, processing the information, saving the information, recalling and using information to solve the problem.
4. The participants of the study have not been using technological tool in learning problem solving before this study was conducted.
5. *Scratch* is a relevant software to teach problem solving in basic arithmetic and the teacher is competent in teaching Mathematics using dynamic software.
6. The participants of the research have learned problem solving in basic arithmetic before the study is conducted.
7. The participant will be actively solving the problems given during the intervention.
8. Pupils' achievement in solving word problems in basic arithmetic can be measured by using instructional activities and post-test given.
9. Item sets in the post-test is adequate representation of content of basic arithmetic topics of lower primary.

These assumptions would help the researcher to carry out this study smoothly and can facilitate the research process. Apart from that, the assumptions narrow the scope of the study. Last but not least, the assumptions made in this study would make the data collection and data analysis processes to be done easily. The outcome of the study would be assessed based on the assumptions made.

1.4 Purpose and research questions

This study aimed to determine the effect of using Scratch in enhancing word problem solving achievement in basic arithmetic among year two pupils. The objectives of this study are :

1. To determine the difference in solving word problems in basic arithmetic in pre-test between experimental group and control group.
2. To determine the difference in solving word problems in basic arithmetic in post-test between experimental group and control group.
3. To determine whether there is any improvement between pre-test and post-test score of the experimental group in solving word problems in basic arithmetic.

In accordance with the objectives of the study, four research questions are formed as follows:

1. Is there any significant difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention?
2. Is there any significant difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention?
3. Is there a significant increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention?

Based on the research questions, two hypotheses are formed

1. H_0 : There is no difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention.

H_1 : There is a difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention.

2. H_0 : There is no difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention.

   H_1 : There is a difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention.

3. H_0 : There is no increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention.

   H_1 : There is an increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention.

1.5 Definition of Terms

This study used a set of definitions of terms. Six of them are problem solving, basic arithmetic, word problem solving, Scratch, teaching of problem solving with Scratch, teaching of problem solving without Scratch and achievement in word problem solving. The definitions of the terms are as follow

Problem Solving

Problem solving can be defined as an attempt to find a solution of a particular problem by carrying out a series of actions to reach the solution (Muir et al., 2008). Problem solving skills are the fundamental part of finding way of solving problems. Problem solving in mathematical concept is the connection between the knowledge gained and the application process using cognitive and affective factors (Rohmah & Sutiarso, 2017). Polya (2004) stated that problems solving involves a range of skills comprising understanding the problem, devising a plan, carrying out the plan and looking back

Basic Arithmetic

Basic arithmetic is an important branch of Mathematics that revolves around study of numbers and their operations. The four basic arithmetic includes addition, subtraction, multiplication and division. The computation of basic arithmetic is the ultimate functional skill in Mathematics and fundamental aspect in the lower levels of school Mathematics (Throndsen, 2011).

Word Problem Solving

Word Problem solving is a verbal description of a daily life problem which requires application of mathematical operations to solve. Process of solving word problems includes extracting the numbers and operations from the problem, operating on them to obtain a result, make a generalization about the result obtained and reinserting the result into the scenario of the problem (Lave, 1992). Mathematical principles often illustrated in word problem solving.

Scratch

Scratch is a networked and media-rich programming digital software which designed to enhance the development of technological fluency (Maloney, Burd, Kafai, Rusk, Silverman, Resnick., 2004). Scratch is a tool that lets a student to create games, animation and interactive art by simple programming (Malan & Leitner, 2007).

Teaching of Problem Solving With Scratch

Teaching of problem solving with Scratch is a teaching and learning process where pupils will be taught of solving word problems aided by a technological tool which is Scratch. Teaching of problem solving supported by Scratch will provide an engaging and relatively easy-to-use learning platform for problem solving as well as exploring mathematical concepts (Calder, 2010).

Teaching of Problem Solving Without Scratch

Teaching of problem solving without Scratch is a teaching and learning process where pupils will be taught of solving word problems without any technological support. Pupils learn to solve word problems in a traditional classroom with conventional method where the teacher plays a dominant role. With an emphasis on teaching, much attention will be given to the mechanical memorization of mathematical facts (Zorica, Cindric, & Destovic, 2012).

Achievement in Word Problem Solving

Achievement in word problem solving is the ability of a pupil to understand a word problem and derive a correct solution for the problem. Achievement in solving word problems also reflects the understanding of pupils based on their ability of describing the correct arithmetic procedure (Huang, Liu, & Chang, 2012). This is measured by the total score of the word problem solving achievement test.

1.6 Limitations and Delimitations

This research contains several limitations and delimitations. Four of the limitations are related to research design, data collection method, sampling method and theoretical framework while three of the delimitations are related to critical issue, research topic, data collection instruments and setting.

The first limitation of this research related to the research design. The research design is quantitative and namely quasi experimental. Threat to internal validity is the weakness for quasi experimental design. This research design rarely has randomization though manipulation of the independent variable or control of the study setting can be found (Thompson & Panacek, 2006). This limitation can be handled by using random or purposive sampling with the aim of decreases the potential for low internal validity.

The second limitation of this research related to the data collection method. The data collection method of this research is quantitative data collection method merely pre-test and post-test. These data collection method can cause bias and data collected is responded from students is subjective. Furthermore, pre-test and post-test are more sensitive to internal validity due to interaction between such factors as selection and maturation, selection and history and selection and pretesting. The difference in post-test between control and experimental groups may be even attributable to characteristic differences between groups rather than to the intervention (Dimitrov & D Rumrill, 2003). In order to reduce this limitation, the researcher should avoid selecting respondents based on extreme performances and maintain consistency in the questions, test administration and method of administration.

The third limitation of this research related to the sampling method. A non-probability sampling, convenience sampling was used as sampling method. The sample of the study was not randomly selected from a population and it is selected based on the criteria to fulfil the purpose of the study. The nature convenience sampling method contains certain degrees of biasness. To reduce this limitation, the researcher should make naturalistic generalization.

The fourth limitation related to the theoretical framework used in this research. Polya's problem solving theory does not fulfil the promise of general heuristics. General heuristics have been found grim to teach and transfer. To reduce this limitation, researcher should focus on the metacognitive skills where pupils are able to recognize the fruitful solution by inculcating problem solving skills with the assistance of technology in the teaching and learning process.

The first delimitation of this study related to critical issue, namely difficulty in solving word problems in basic arithmetic. This study focused on enhancing word problem solving in basic arithmetic among year two pupils' because it is the root for a better performance and achievement in this topic. This delimitation was handled by providing enough researches which support this critical issue. More studies can prove that this is the critical issue that need to be investigated.

The second delimitation related to the research topic selected for this study which is problem solving in basic arithmetic. Problem solving in basic arithmetic is considered as the core learning area in Mathematics which pupils started to learn from year one. Therefore, this topic required more attention in order to increase pupils' understanding and skills. In order to handle this delimitation, the researcher had explained the justification and rationale for selecting this topic clearly. Problems faced by the pupils in this topic explained in details to show that this topic need to be studied as it is a new learning field for primary school pupils.

The third delimitation related to data collection instruments, namely pre-test and post-test. These data collection instruments offer ease of data analysis and allow comparability. This delimitation was controlled by stating the research design and type of data needed for this study. Research design and the type of data needed for the study can justify the selection of data collection tool because it depends on these two aspects.

The fourth delimitation related to setting. Year two pupils from Bangsar district were selected as the sample for this study. This study focused on year two pupils because they are at the lower primary level. Additionally, they had learnt problem solving in basic arithmetic for one year and thus they had sophisticated mathematical knowledge. With the intention of reducing the delimitation, the researcher clearly explained certain qualifications of the sample of this study. The researcher excluded other pupils in primary school since they did not meet the qualification related to the research topic.

1.7 Significance of Research

This study is beneficial for several stakeholders in Mathematics education such as Mathematics education lecturers, Mathematics curriculum planner and primary Mathematics teachers.

First of all, this study will be significant to Mathematics education lecturers to gain information regarding the different concept of knowledge acquisition from Polya's problem solving perspective. This information not only enrich their knowledge in delivering lectures about learning theories but also can be a guide to conduct research related to problem solving from the perspective of Polya model. As a result, they can contribute to the body of literature involving problem solving.

Second, this study will give benefit to Mathematics curriculum planners to utilize the data to create new policies and instructional transformation in education. Mathematics curriculum is an important document in teaching of Mathematics.

Previously, the content of Mathematics curriculum formed based on behaviourism. In conjunction with changes in education systems, finding of this study could help the curriculum planners to customize the existing curriculum to be more student centered so that students' thinking to be a part of Mathematics curriculum.

Thirdly, this research also benefits primary Mathematics teacher to create a transformation in teaching of Mathematics in classroom. Findings from this study allow Mathematics teachers to incorporate information communication technology in their teaching process. Apart from that, this study also permits teachers to see understanding through pupils' lens rather than hypothesizing how pupils should perceive understanding. Teachers could encourage the pupils to learn according to their styles and abilities to cultivate student centered learning environment through information communication technology.

1.8 Summary

First chapter is the base for this study. It outlines the background of the study and identifies several critical issues which related to this study. Then, a critical issue was selected and described and justification for selecting the critical issue was made. Then description about theoretical framework, purpose and research questions were given. Finally, definition of terms was stated, limitation and delimitation of the research were described and significance of the study was discussed. This research moves forward to describe the literature review in detail in chapter two, methodology in chapter three, data analysis and findings in chapter four and discussion, conclusion and implication in chapter five. Then, all the references are listed while all the appendixes are attached.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Chapter Two is divided into eleven main sections which are introduction, Polya's theory, concept of problem solving, problem solving in basic arithmetic, problems encountered by pupils in learning problem solving, technology in teaching and learning Mathematics in primary schools, scratch software, scratch in teaching problem solving, past research findings, conceptual framework and summary. This chapter revolves around the general ideas that make up the concept of problem solving in the context of Mathematics beginning with a fresh review of Polya's ideas towards the specific focus of the research which is the usage of 'Scrat bch' in developing problem solving skills among lower primary schools. It threads closely with the aspirations of the 21st century learning skills and teaching techniques which have become a centre of today's education especially in Malaysia. This chapter shows how the varieties in researches from the past have been useful for the current study in helping the researcher shape a firm grasp over the concepts studied.

2.2 Polya's Theory

Problem solving has an uncommon significance in the investigation of Mathematics. An essential objective of Mathematics teaching and learning is to build up the capacity to settle a wide assortment of complex Mathematics problems. Stanic and Kilpatrick in Schoenfeld (2016) followed the part of problem solving in school Mathematics and represented a rich history of the subject. To numerous scientifically literate individuals, Mathematics is synonymous with solving problems doing word problems, making patterns, deciphering figures, creating geometric developments, demonstrating hypotheses, and so forth. Then again, people not excited with Mathematics may depict any Mathematics action as problem solving. Problem solving is deeply rooted to the thinking processes humans possess and they can be replicated via technology such as the use of certain software which have been developed over time. 'Scratch' is one that does the replication in a way that it models the thinking processes outlined by Polya especially in this context of study.

The basis for most Mathematics problem solving look into for secondary school students in the previous 31 years can be found in the works of Polya (Voskoglou, 2011), the field of psychological brain research and particularly in intellectual science. Subjective analysts and psychological researchers look to develop or validate speculations of human learning Gok (2010) while Mathematics instructors look to see how their students communicate with Mathematics. The territory of intellectual science has especially depended on computerized recreations of critical thinking (Polya as cited in Gok and Sylay, 2010). In the event that a computer program generates a grouping of practices like the arrangement for human subjects, at that point that program is a model or hypothesis of the conduct. Newell and Simon as cited in Fiore, Rosen, Smith-Jentsch, Salas, Letsky & Warner (2010) have provided simulations of mathematical critical thinking. These simulations might be utilized to better comprehend arithmetic critical thinking.

Polya has extremely specific views and criteria about what constitutes a mathematical problem and why and it is for this reason that we have instituted the term "Polya Problem" to recognize such issues from different sorts of issues that are commonly utilized in studies of mathematical and non-mathematical issues explaining (Carifio, 2015). The majority of the issues utilized in numerous investigations of mathematical critical thinking would not meet Polya's definition and criteria of what a mathematical problem is. The special case to this last point, in any case, is work that has been finished on, badly characterized problems (Fessakis, Gouli, & Mavroudi, 2013) and issue solving where there are different incomplete or imperfect arrangements, which is a class of problem and critical thinking not normally associated with normal and joined rather than additional "intriguing" Mathematics. Characterizing problems or classifying problems is important in the context of creating processes for each type of problem and the computation can be significant especially when it involves software programming (Swanson, 2011).

Polya's theory commonly involves a set of processes or stages which will guide an individual towards the discovery of the solution to a problem, a mathematical problem. In general, the Polya's processes are divided into four steps which gradually helps one to devise methods that can produce the results. Polya's first step of a problem-solving hierarchy is to understand a problem which a combination of skills in are collecting data or information (Kotsopoulos & Lee, 2012) based on the problems at hand. As mentioned earlier, problem solving is a critical thinking process and it must involve multiple skills like identifying a problem and characterizing the elements in the problem to get a clearer view of what the problem may be. As stated before, when secondary school students were studied over three decades, most of the steps in solving mathematical problems involved in-depth brain processes. In the first step, Polya maintains that there must be good communication between the students and the problems and it involves careful observation and meticulous analysis (Siswono, 2010). However, identifying what a problem is and understanding the problem are two different stages and they must be done one after the other in order to properly solve a problem.

Next, Polya emphasizes on the need to devise a plan and this plan needs to be in accordance to the information analysed and identified in the previous level which was understanding the problem. Devising a plan as mentioned prior to this involved deciphering (Silver, 2013a) different elements which are presented through the problems and identified in the previous stages. However, this is where computational skills play important roles as students attempt to strategize and form a set of successful steps to uncover the solution of the problem. Devising such plans include identification of sequences (Ertmer & Newby, 2013) and formulation of systematic models that can help in solving a larger problem part by part. The importance of this step definitely outweighs the other stages as it is the core of problem solution when a student manages to map different elements of a problem to identify the best way to uncover the answers. This level will be followed by carrying out the plan and in this stage, every devised and confirmed stage will be implemented. It involves the use of operational skills and as mentioned earlier it is a matter of reasoning through cognitive thinking skills which will allow one to operate through this stage.

The last stage is the stage where Polya emphasizes on the ability to look back or check back. This includes reversing the previously implemented steps and it is also part of a complicated cognitive ability because for one to be able to reverse the entire process back to the initial unsolved problem one must be able to scientifically understand each operation frontward and backward. According to Yimer and Ellerton (2010), these computational skills are skills which are accumulated over time as children learn to combine multiple operations in problems which are developed from time to time. Back-referencing gives the students the necessary confirmation of their devised plans for the specific problem and if the plan had worked, checking will allow them to categorize the devised plan as suitable for such problems in the future. The key is to identify how each operation or level of solution is related to the other and how each level functions.

Looking back might be the most essential piece of problem solving. It is the arrangement of exercise that provides the primary opportunity for understudies to gain from the issue. The stage was identified by Polya (Stein & Kim, 2011) with admonitions to inspect the arrangement by such exercises as checking the result, checking the argument, determining the outcome in an unexpected way, utilizing the result, or the method, for some other problem, reinterpreting the problem, interpreting the result, or expressing another issue to solve. Educators and scientists report, in any case, that building up the disposition to look back is hard to achieve with students. Kantowski (as cited in Cobb and Steffe, 2010) discovered little proof among understudies of thinking back despite the fact that the direction had focused on it. Wilson (as cited in Stein & Kim, 2011) directed a year-long in-service Mathematics critical thinking course for secondary teachers in which every member created materials to execute some part of critical thinking in their on-going instructing task. In the study, many teachers agreed that it was becoming increasingly tough to convince students to check back because students were only engrossed in solving the problem one way and not interested in reversing the processes for confirmation.

Late research has been considerably more express in taking care of this part of problem solving and the learning of Mathematics. The field of metacognition concerns thinking about one's own particular cognition. Metacognition hypothesis holds that such idea can screen, direct, and control one's cognitive forms. Bauersfeld (2012) depicted and exhibited an official or monitor component to his problem solving hypothesis. His problem-solving courses included unequivocal regard for an arrangement of rules for reflecting about the problem-solving exercises in which the students were locked in. Unmistakably, powerful problem-solving instruction must give the students a chance to reflect amid problem solving exercises in an orderly and useful way. In conclusion, Polya put together the four steps to address the complicated cognitive elements that come in the concept of problem solving in Mathematics. The question of technology as an aid or as the replacement of thought processing is a question that remains unanswered. The current study seeks to explain how a software can be a platform for thinking skills pertinent to problem solving and not merely an aid that helps in the four processes. Technology development claims that the four processes can be computed within algorithms on programming and be completed without interference from the human mind.

2.3 Problem Solving

According to Aljaberi and Gheith (2016), problem solving as a technique for educating might be utilized to achieve the instructional objectives of learning essential facts, concepts, and procedures, and also objectives for problem solving inside problem settings. For instance, if students investigate the areas of all triangles having a settled perimeter of 60 units, the problem-solving exercises ought to give sufficient practice in computational skills and utilization of formulas and strategies, as well as open doors for the applied improvement of the connections between zones also, edge. The "problem" may be to discover the triangle with the most zone, the regions of triangles with integer sides, or a triangle with territory numerically equivalent to the edge. Subsequently problem solving as a method of teaching can be utilized to present ideas (Surya, Sabandar, Kusumah, & Darhim, 2013) through exercises including investigation and disclosure. The production of an algorithm and its refinement, is likewise a perplexing problem solving assignment which can be expert through the problem way to deal with instructing. Open finished problem solving regularly utilizes problem settings, where a succession of related problems may be investigated. For instance, the problems in the edges developed from considering greenhouses of various shapes that could be encased with 100 yards of fencing.

According to Rahman and Ahmar (2016), problem solving is a complex mental process, including visualization, imagination, abstraction, and association of information. According to Anderson and Krathwohl (as cited in Rahman and Ahmar, 2016) in this manner, problem solving through Mathematics learning process can enable understudies to increment and build up their capacities in the part of application, analysis, synthesis, and evaluation. The process of problem solving is a complex psychological process. Further, Arsyad, Rahman, and Ahmar (2017) state that in the term of data handling, one is said to have issue, when he has objective, in any case, there has not yet an "instrument" to accomplish the objective. In the ongoing decades, numerous specialists have been developing model of issue comprehending process, particularly in Mathematics education.

The advancement depends on a presumption that problem solving skill is abstract and can be transferred in critical thinking with various context. One of the cases of general critical thinking model was created by Bransford and Stein (as cited in Budayasa and Juniati, 2018) comprising of identifying problem, defining issue through reasoning procedure about the issue and choosing important data, exploring conceivable arrangement and doing confirmation from a few points of view, actualizing the choice systems and inspecting and evaluating the result acquired from the procedure implementation. Polya in Zahner and Corter (2010), characterized critical thinking as an exertion in discovering arrangement of a problem to accomplish a goal that appears difficult to pick up. As indicated by Polya (Guberman & Leikin, 2013), issue solving in arithmetic incorporates 4 stages, in particular understanding problems, arranging the ventures in taking care of the issues, implementing the systems to take care of the issues and doing verification. The level of the trouble and the capacity in a procedure of issue solving is dictated by several factors. As indicated by Guberman and Leikin (2013), there are a few factors that can influence the level of difficulty of an issue, to be specific problem understanding, mental representation, the scope of issue and problem imbalance.

In comparison to Polya the historical review of problem solving by Schoenfeld (2016) in the Journal of Education provided a deeper view of how problem solving is viewed through a mathematical perspective. Stanic and Kilpatrick (as cited in Schoenfeld, 2016) recognize three primary themes with respect to its use. In the main topic, which they call problem solving as context, problems are utilized as vehicles in the administration of other curricular goals. They distinguish five such parts that problems play:

a) **As a justification for teaching Mathematics.**

   Generally, problem solving has been incorporated into the Mathematics educational modules to some extent in light of the fact that the problems give legitimization for teaching Mathematics by any means. Probably, in any event a few problems related somehow to genuine world experiences were incorporated into the educational programs to persuade students and teachers of the estimation of Mathematics.

b) **To provide particular motivation for subject topics.**

   Problems are regularly used to introduce themes with the implicit or explicit understanding that "when you have learned the exercise that tails, you will have the capacity to tackle problems of this sort."

c) **As recreation.**

Recreational problems are proposed to be motivational, in a more extensive sense. They demonstrate that math can be fun and that there are engaging employments of the aptitudes understudies have aced.

d) **As a method for developing new skills.**

Precisely sequenced problems can acquaint understudies with new subject matter, and provide a context for discussions of topic techniques.

e) **As practice.**

Milne's exercises, and most by far of school Mathematics errands, fall into this class. Students are demonstrated a technique, and after that given problems to hone on, until the point that they have aced the procedure.

In every one of the five of these parts, problems are viewed as rather common substances and are utilized as a way to one of the closures recorded previously. That is, problem solving isn't typically observed as an objective in itself, however solving problems is seen as encouraging the accomplishment of different objectives. "Problem solving" has an insignificant translation: working the errands that have been set before you.

2.4 Problem Solving in Basic Arithmetic

Problem solving in the sense of basic arithmetic is a broad aspect as it encompasses rote memorization which opposes Polya's ideas at some point. For example, most students at the lower level only face with exercises that require them to repeat actions (Hastuti, Nusantara, & Susanto, 2016) which can be done even without understanding. A problem to Polya and in this manner a "Polya Problem" must be comprised of a few elements that need to be connected together, require several steps to get an answer, have a few different potential solution ways and require information to be furnished from outside of the problem articulation to create a solution. A "problem" that had a couple of elements that required one stage to solve.

Polya's model of problems and problem solving is not about the problem solving of pre-formal or early solid tasks for children, albeit a large number of the proto-components of his model might be both seen in and instructed to such children to all the more likely set them up for their next formative levels (Surya et al., 2013). It addresses the thinking levels proposed by Bloom whereby understanding is the foundation of the entire taxonomy but in Polya’s views understanding is set at a point where children have the cognitive abilities to extract and categorise information accordingly (Barabe & Proulx, 2015). Such segmentation requires additional skills and hence, as mentioned prior to this there must be a proper scope to define basic arithmetic in the context of problem solving. Polya's model is a model of problems and problem solving of young adult to adult problem solvers, which is a critical point about Polya and his model, as the two sorts of problem solvers are to a great degree (Aljaberi & Gheith, 2016) and subjectively not quite the same as each other. Polya's model is not about rudimentary problems and problem solving, but instead it is about more modern problems and problem solving that are more complex and related to real-world situations in character and the level of the subjective improvement of the problem solver is a basic and constraining element in his model and with utilizing it.

Polya considers mobilization and organization to be complementary exercises in the manner in which they work together. Essentially, isolation and combination are reciprocal exercises. In continuing towards an answer, the tasks of mobilization, organization, isolation and combination may happen over and again and in any succession. Advancement might be moderate and may occur in imperceptible steps. In the event that the means lead down a deadlock way, the problem solver must repeat the assembly and association tasks before assist disengagement and blend exercises can happen (Karatas & Baki, 2017). Understanding that one is perceiving and dispensing with useless arrangements ways which in itself is a positive advance along the way and process towards an answer, especially on the off chance that one is doing this sensibly rapidly, would be the meta-discernment of an "idealistic" instead of a "sceptical" problem solver. Therefore, basic arithmetic must be treated as complicated combination of smaller issues that can be segmented by a student by implementing a variety of skills. This is crucial because basic arithmetic is not a problem until it is incorporated to intimidate children to use the different skills that they have.

Empowering, teaching, and rewarding problem solving hopefulness would be the favoured advantage in Polya's model instead of the opposite. Additionally, Polya is very clear about failure in problem solving containing supportive and conceivably positive data in respect to solve the problem and being a stage along the way to problem solving success and not a flag for terminating additional endeavours to tackle the problem or endeavours at future such problems, which is regularly the "teaching message" in numerous zones and ways to deal with teaching Mathematics, problem solving and mathematical problem solving. According to Ayllon, Gomez, and Ballesta Claver (2016), Polya pushed post-mortems of problem solving disappointments to gain from the disappointments and find the accommodating and conceivably positive data with respect to solve the problem. The idea of post-mortem or looking back is still considered crucial even in the event of completing basic arithmetic problems. Understanding the deeper issues in inculcating the methods of Polya in problem solving among younger learners needs to be addressed and the usage of technology in the teaching and learning Mathematics might be a solution to these problems.

However, the focus of the current study would be grounded to problem solving within the areas of basic arithmetic skills like addition, subtraction, division and multiplication which often makes up most of the syllabus at the lower primary level of students in Malaysia. Using Polya's model of problematizing a situation has always been related to the implementation of these skills whether individually or combined. The use of the model has helped in creating problems with the sole purpose to guide students to be aware of the use of those skills. For example, we can view addition or subtraction as skills that can be merely fed through rote memorization into the minds of the children. The challenge is to ensure that a child does not learn addition and subtraction through memorization but rather a deeper understanding through properly meted out problems. Doing basic arithmetic would not be problem solving to Polya (Shaanan & Gordon, 2016), not simply because this execution could be just be executed in a rote manner propensity or calculation, yet in addition in light of the fact that Polya's model implicitly assumes that the problem solver is at the upper concrete operations level to formal thinking level of subjective improvement. However, basic arithmetic can be viewed from Polya's perspective when the problems are formulated to truly test the students' thinking skills. Therefore now, even operations like addition are introduced through problems which empower learners to be more responsible of their learning.

2.5 Problems Encountered by Pupils in Learning Problem Solving

Mathematics is a living subject which tries to understand patterns that permeate both our general surroundings and the psyche inside us. In spite of the fact that the language of Mathematics depends on decides that must be educated, it is critical for motivation that students move past guidelines to have the capacity to express things in the language of Mathematics. This transformation recommends changes both in curricular content and instructional style (Schiff & Vakil, 2015). It includes recharged push to centre around:

- Seeking arrangements, not simply memorizing methods (Fessakis et al., 2013);
- Exploring patterns, not simply memorizing formulas;
- Formulating conjectures, not simply doing exercises.

The problems encountered by pupils in learning problem solving is to grasp the true purpose of learning the ideologies of problem-solving learning. It revolves around how children perceive the use of these problems as a way to learn different metacognitive skills. As teaching starts to reflect these accentuations, understudies will have opportunities to examine Mathematics as an exploratory, dynamic, evolving teach as opposed to as an unbending, total, shut assortment of laws to be remembered (Wilson as cited in Stein and Kim, 2011). They will be urged to consider Mathematics to be a science, not as a group, and to recognize that Mathematics is extremely about patterns and not just about numbers. Students are generally unaware of the processes engaged with problem solving and that tending to this issue inside problem solving instruction might be important.

To wind up a decent problem solver in Mathematics, one must develop a base of Mathematics information. How successful one is in organizing that knowledge moreover adds to fruitful problem solving. Kantowski (as cited in Begolli and Richland, 2016) found that those students with a good knowledge base were most ready to utilize the heuristics in geometry direction. Schoenfeld and Herrmann (in Mason and Davis, 2013) found that young learners took care of surface highlights of problems while specialists categorized problems based on the central standards included. Silver (2013) found that successful problem solvers will probably categorize math problems based on their fundamental similarities in mathematical structure which is a problem in learning problem solving when children cannot notice similarities in structures and sequences. Silver (2013) also found that general heuristics had its uses in a more practical form of problem solving. The assignment particular heuristics were frequently particular to the problem domain, for example, the tactic most students create in working with trigonometric identities to convert all expressions to elements of sine and cosine and do algebraic simplification.

Based on Stanic and Kilpatrick (as cited in Schoenfeld, 2016), heuristics are sorts of information, accessible to students in settling on choices amid problem solving, that are helps to the age of an answer, conceivable in nature rather than prescriptive, only here and there giving infallible guidance, and variable in results. To some degree synonymous terms are strategies, techniques, and rules-of-thumb. For instance according to Bishaw (2010), reprimands to disentangle an algebraic expression by expelling parentheses, to make a table to restate the problem in your own words, or to attract a figure to recommend the line of contention for a proof are heuristic in nature. The problem faced by most primary school learners is when they only, outside of any relevant connection to the subject at hand, they have no specific esteem, yet incorporated into circumstances of doing Mathematics they can be very intense. Blomberg, Renkl, Sherin, Borko, and Seidel (2013) explained that children even when presented with information are not aware of its uses in completing mathematical problems which in return makes Mathematics very tough for them.

Theories of Mathematics problem solving (Vukovic, Kieffer, Bailey, & Harari, 2013) have put a noteworthy spotlight on the role of heuristics. Most likely it appears that providing explicit instruction on the advancement also, utilization of heuristics ought to enhance problem solving performance; yet it is not that straightforward.

Schoenfeld (2016) has called attention to the limitations of such a simplistic examination. Theories must be augmented to incorporate classroom settings, past knowledge and experience, and beliefs. The problem is when children are not taught how problem solving in Mathematics is a sequential set of processes which combines different theories. What Polya portrays in 'How to Solve It' is significantly more complex than any speculations we have grown up until now. Mathematics direction focusing on heuristic processes has been the focal point of a few ponders. Kantowski (as cited in Junsay, 2016) utilized heuristic instruction to improve the geometry problem solving execution of auxiliary school understudies. Wilson and Smith (as cited in Nicol, Archibald, & Baker, 2010) inspected complexities of general and assignment specific heuristics. These examinations uncovered that assignment particular heuristic guideline was more compelling than general heuristic direction. Schoenfeld (2016) utilized the heuristic of sub-goal generation to empower students to form problem solving designs. He utilized thinking aloud, peer interaction, playing the role of teacher, and direct direction to build up understudies' capacities to produce sub-goals. The challenge to make children understand mathematical problems gives way to more technological assistance in the area.

2.6 Technology in Teaching and Learning Mathematics in Primary Schools

Educational technology is regularly considered, wrongly, as synonymous with instructional innovation (Bray & Tangney, 2013). Technology, by definition, applies current knowledge for some valuable purpose. Along these lines, technology utilizes evolving knowledge whether about a kitchen or a classroom to adjust and enhance the framework to which the learning applies, for example, a kitchen's microwave oven or educational processing. Conversely, advancements speak to change for change purpose. Given this refinement, it is simple to contend that educators are right to resist simple innovation (Nyerere, J. A., Gravenir, F. Q., & Mse, G. S., 2012), yet they ought to welcome educational technology. Tragically, the historical backdrop of educational technology does not bolster this theory (Hooper and Rieber as cited in Bray and Tangney, 2013). In spite of the fact that education has witnessed a multitude of both technology and innovation in the course of recent years (Reiser as cited in Bray and Tangney, 2013), the educational system has barely changed amid that time. Krumsvik (2014) stated that classroom teaching is a demanding work. The vast majority outside education most likely think teachers invest the vast majority of their energy teaching, however instructors are responsible for numerous tasks (Khan, 2012; Stobaugh, 2011) that have little to do with classroom instruction. Past planning and actualizing instruction (Polly, 2011), educators are additionally expected to be managers, psychologists, counsellors, caretakers, and network "ministers," also entertainers (Nyerere et al, 2012). On the off chance that instructing sounds like a nonsensical, relatively unimaginable, work, maybe it is. It is straightforward how a teacher may move toward becoming frustrated and disillusioned (Jung, 2014; Keengwe, 2010). Most educators enter the profession expecting to start the delight of learning in their students.

Tun Dr. Mahathir Mohamad during the MSC Malaysia Launch in 1996 said that, “We are examining our education system to create a curriculum where people learn how to learn so they can continue their education throughout the rest of their lives. The measure of success in 2020 will be the number and quality of our people who can add value to information.” Technology in teaching and learning generally in Malaysia has taken a greater leap since the launch of the Vision 2020 with the nation gearing towards forming a more advanced community ahead of all the countries in the region to be competent in many things including technology aspects (Othman and

Mohamad, 2014). It was followed by numerous initiatives like the proclamation of Cyberjaya as a tech-city (Ibrahim, M. S., Razak, A. Z. A., & Kenayathulla, H. B., 2013) with boosts given to start-ups and more technology-based companies. However, the core of the initiative remained within the education sector with the ministry continuously putting efforts into integrating technology in education. One of such efforts was the creation of the SMART schools in Malaysia.

In Malaysia, the idea of smart schools was proposed in 1997 and moved toward becoming operational in 1999 (Ibrahim et al, 2013). Seventy-eight million dollars were apportioned to the project, the biggest portion of which - thirty-eight percent- - was spent on obtaining educational material (Soltani, 2012). Designed on the Malaysian model, the smart school project in Iran was propelled in 2004. At the pilot arrange, the Iranian Ministry of Education actualized the project in four high schools in the capital city of Tehran. Following the publication of "The Road Map of Iranian Smart Schools" (Attaran, and Saedah Siraj, 2010). In 2011, the project was stretched out to other educational districts. The primary concentration at the present stage has been equipping the smart schools with computers, smart boards, network facilities et cetera. In the same way as other different nations, an implicit assumption is by all accounts dominant in the venture: that by equipping schools with computer hardware, ICT integration will transform into a mainstream incline (Ming, T., Hall, C., Azman, H., & Joyes, G., 2010).

Learning Mathematics can be a battle for a few students and the strategies that educators use in the classroom can make a gigantic impact on the level of understanding for the student. Instructors perceive the requirement for diverse methods, strategies, curricula, and professional training that might be important to help address the issue in the pedagogy of students in science. Educators need to take a gander at conceivable territories of improvement of the pedagogy of Mathematics to a higher-arrange suspecting that can help motivate and inspire students to learn the elements and aspects of Mathematics, as well as to see the practical employments of Mathematics in the genuine world. One of these territories of change that can be utilized in the secondary school science classroom is the utilization of technology by not just the educator in the delivery of the content, yet additionally by the understudies in the learning process. It is hypothesized that the utilization of technology in the high school classroom can positively affect the engagement of the student, and consequently enhancing Mathematics understanding and test scores.

Emergence into the 21st century highlights tools that are extraordinary, communication that is unique, information that is unique, and work that is different. Given this move, education must move to incorporate PC based, electronic technologies coordinating learning with these technologies inside the setting of the scholarly branches of knowledge. Notwithstanding, how teachers took in their subject matter is not really the way their students should be taught in the 21st century. Learning subject matter with technology is not the same as learning to teach that topic with technology. The challenge for instructor preparation programs is to prepare their possibility to instruct from an integrated knowledge structure of educating their particular topic—the intersection of knowledge of the topic with information of teaching and learning, or pedagogical content learning (PCK) portrayed by Shulman (1986). Technology integration has been viewed as merely an act of adding the power plug to the traditional classroom when there is more that can be done. Pedagogical content learning in this context can be traced to how we introduce basic arithmetic operations to children. For example, how is a problem on division projected through a short film. There are many elements that can be used as information that can induce students to figure out the operation of division. Similarly, when teachers use a wide array of technology in order to give children a chance at problematizing a basic operation like multiplication. Technology helps them to make the problem more realistic and more practical, thus making critical thinking more relevant to our needs.

In any case, for technology to end up an integral component or device for learning, science and Mathematics pre-service instructors should likewise create a general origination of their subject matter concerning technology and what it implies to instruct with technology—an innovation PCK (TPCK). TPCK requires a consideration of multiple domains of knowledge. Pre-service educators require a very much created knowledge base in their subject. This topic knowledge is frequently created over numerous years with a focus on personal learning what's more, construction of how that subject is known. With the newness of the investment of technology in a few trains, the improvement of knowledge of the branch of knowledge might be integrated with the advancement of their insight into technology. As students start the teacher preparation program, a portion of the advancement of their insight into the topic perhaps coordinated with the development of their knowledge of teaching and learning.

Be that as it may, pre-service educator understudies learn much about technology outside both the development of their knowledge of topic and the development of their knowledge of teaching and learning. So also, they find out about learning and educating outside both the subject matter and technology. In reality, pre-service educators frequently find out about instructing what's more, learning with technology in a more non-specific way detached with the development of their information of the subject matter. The current study using the software Scratch will be a field for generating useful knowledge for Mathematics teachers in Malaysia to create more learning opportunities and training sessions that are vital to enhance their teaching skills. Eventually, this research is more pertinent to the educators as one of the many ways to gain vital information about technology related elements which can be used in the 21st century classroom.

2.7 Scratch Software

Scratch is a media-rich digital environment that utilises a building block command structure to manipulate graphic, audio, and video aspects (Fadjo, C. L., Hong, J., Chang, C. H., Geist, E., Lee, J. H., & Black, J. B., 2010). It joins components of Logo including 'tinker ability' in the programming procedure (Calder, 2010). This allows children to join the programming building blocks now and again incorporating measurements and to immediately observe the result of that programming. The blocks can be dismantled furthermore, recombined as the children develop the wanted movements and effects. In Scratch understudies utilize geometric and measurement ideas, for example, coordinates, edge and length measurements. Also, it facilitates creative problem solving, logical reasoning, what's more, empowers collaboration.

Scratch is a new and innovative program that is fun and simple to utilize. It has energizing potential to help pupils develop computer programming skills and thinking aptitudes. The program can be utilized in numerous different ways, with the distinctive subjects and territories of the key stage three curriculum. It is designed and laid out in a way that it will capture the attention and interest of the children. At the point when Scratch is opened it will display a blank project with a cartoon cat, in this blank project the cat is the 'sprite'. A sprite is a question in Scratch which can move, there can be more than one. Sprites can be drawn, taken from the sprites envelope or imported from my reports. The back ground or 'stage' of the sprite is settled can likewise be drawn, taken from the samples or imported. This is an appealing part of the program as students can have a ton of fun adding and creating sprites and backgrounds. The blocks for motion, looks, sound, pen, control, sensing, operators, variables can drag and move into the script area. To create a content, you simply snap together graphical blocks, similarly as you would for magnetic Lego Blocks. These blocks replace the frequently muddled and monotonous method of composing in directions in more seasoned projects, for example, LOGO. The blocks must be connected in a way that makes sense, if the script does not make sense the program will not permit the blocks to stick e.g. motion and operator squares cannot interface effectively. This strategy is more suitable and appealing for kids with little or no programming experience.

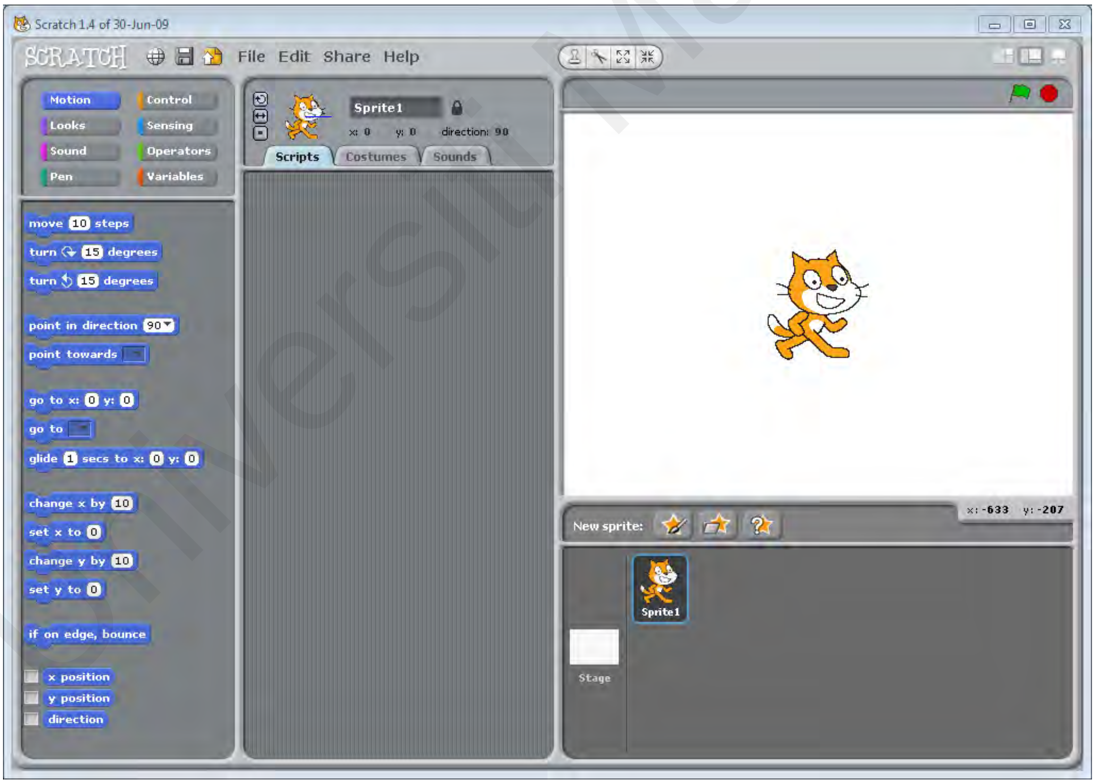


Figure 2.1. Scratch Basic user Interface

Scratch software proved to be engaging also, moderately simple to-utilize space for problem solving, which in the meantime gave a beneficial and motivating programming environment to investigate mathematical concepts. Many studies on its utilization have been published over the years. For example, Calder (2010) in a study found that it ended up being an effective medium for encouraging correspondence and coordinated effort (Otrelcass, Forret, and Taylor, 2009 as cited in Calder,2010). The challenge of creating a mathematical activity or game for more youthful students overtly positioned the program in Mathematics, while certainly, it simultaneously requested that mathematical thoughts be utilised to build up their game. The children were rapidly ready to get to and understand the programming capabilities what's more, utilized mathematical thinking in their way to deal with problem solving. It demonstrated to be a medium whereby programs were effortlessly composed and modified, in this manner empowering the utilization of critical, meta-cognitive and reflective skills.

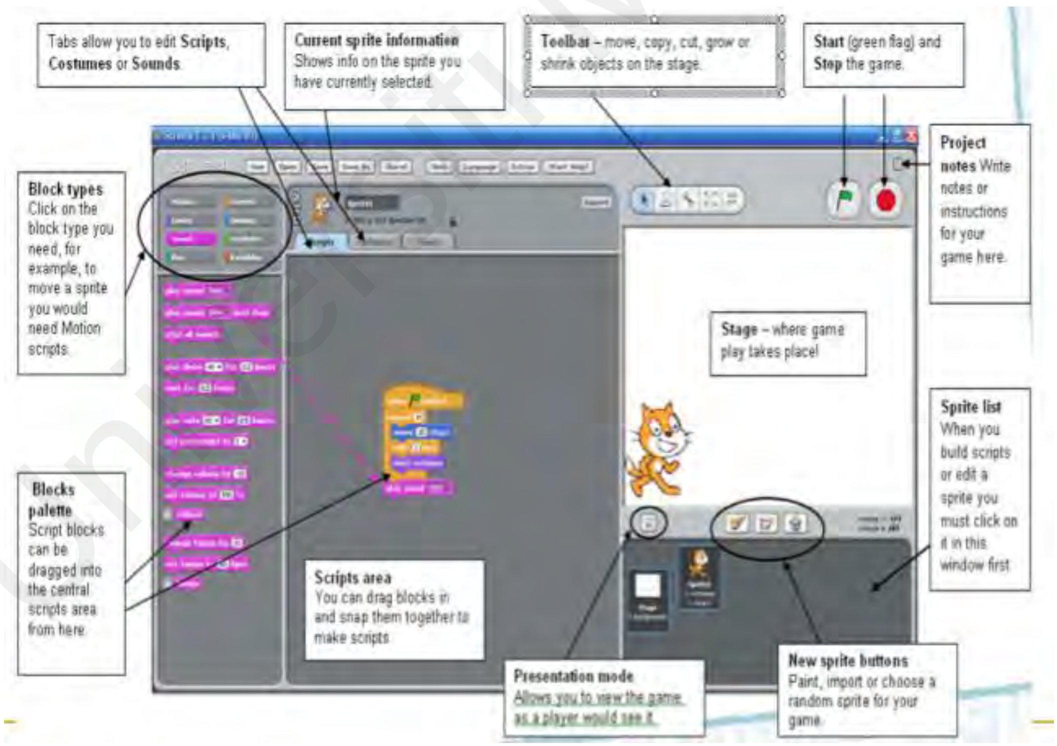


Figure 2.2. Scratch Activity Board

Scratch was additionally inherently persuading. The sharing sessions were pivotal in that they gave a forum to displaying work, what's more, as a method for all things considered helping each other to tackle programming problems. Scratch subsequently, gave a chance for pupils to build up their thinking (Lye and Koh, 2014). The facilitation of logical thinking from beginning experimental concepts, as understudies test thoughts in reaction to feedback, and the influence of program feedback in the evolution of students' geometric ideas has been accounted for somewhere else. C. M. Lewis (2011) used Scratch to plan learning environments and evaluated person work with pair work by contrasting two profoundly collaborative learning situations with isolate parts of pair programming that are noteworthy for supporting students' understanding, attitudes and interest in software engineering, and pace. The analyst finished up that there are obvious benefits of combine programming over environments without support and collaboration. It very well may be inferred that Scratch has some benefits for teens and this condition can be a powerful source for youngsters. The potential of the Scratch environment is likewise underlined by Lee (2011), where the scientist finished up that educators can benefit from Scratch by creating creative, entertaining, interdisciplinary curriculum materials, and along these lines students can release their imagination in a more meaningful and engaging way.

Although not composed particularly to facilitate conceptual thinking in a particular mathematical territory, there were clear indications the children drew in with mathematical ideas. The child's spatial awareness, comprehension of edge and time measurements, and feeling of position using coordinates (Reisa, 2010), were all drawn in to varying degrees. There was too evidence of relational thinking as the children made links between their information, the activities that happened on screen, and the effect of specific variations of size and occurrence of single or repeated procedures. Be that as it may, the process the participants undertook too facilitated mathematical thinking by inspiring creative problem-solving processes and the advancement of logic and reasoning as they reacted to the various types of input. Most programming assignments in the Scratch condition included the development of mathematical concepts (Kobsiripat, 2015). The current study will be using Scratch with a younger target group and it is important to know if the usage of the software is relevant for a lower age group, defying the stigma that such applications can only be used among skilful programmers.

Harvey and Monig (2010) discussed in their paper regardless of whether Scratch can serve for two different target gatherings, to be specific for kids and advanced programmers. The scientists called attention to the growing trend among colleges for implementing Scratch in computer science courses for novices. Truth be told, the Scratch software is serving the two gatherings since there are numerous inquiries about managing distinctive age groups who are likewise beginners in programming. Reisa (2010) likewise specified the utilization of Scratch from a wide of scope of educational institutions from K– 12 schools to colleges as an initial step into programming. Analysts say effective usage for early adapters yet accentuate the need to give better instructive help to more extensive utilization. They additionally underline the importance of a move in recognitions about programming, what's more, about PCs when all is said in done. They reasoned that they have to grow the idea of 'digital fluency' to incorporate outlining and making, not simply perusing and connecting. At exactly that point will initiatives like Scratch have an opportunity to satisfy their maximum capacity to cultivate the interest of programming devices for kids furthermore, youth is that they help more youthful clients develop 21st century abilities, for example, problem solving, collaboration, and creativity.

2.8 Scratch in Teaching Problem Solving

One of the most recent trends in the educational landscape is the presentation of computer programming in the K-12 classroom to create computational thinking in pupils (Calao, Moreno Leon, Correa, & Robles, 2015). As computational thinking is not a skill solely identified with computer science, it is expected – however not yet logically demonstrated – that the problem-solving process might be summed up furthermore, transferred to a wide assortment of problems. The educational utilization of programming is not something new to the world of education. Harking back to the 1960s Seymour Papert built up the Logo programming language expecting to allow children to utilize computers to create games, composing music or painting recursive illustrations. Notwithstanding, following a couple of long periods of success, programming vanished from the K12 educational landscape in view of the problems that students and educators confronted attempting to learn the language syntax, among different reasons (Resnick, 2013).

In any case, in the most recent years new visual programming dialects, for example, Alice, Kodu and particularly Scratch (Resnick, 2013), have reawakened the interest of the educational community in coding, not as an end in itself, but rather as a tool to develop other skills and to improve learning outcomes and motivation in understudies, as Mitchel Resnick, maker of Scratch, argues in Learn to code, code to learn (Resnick, 2013). As to convenience of programming with Scratch as a tool to move forward student learning, there is research literature that has an extremely promising outlook, as coding has been successfully utilized in subjects like Mathematics, science, arts, writing or English as a second language, among others. Concentrating on Mathematics, Lewis and Shah (2012) detect correlation between programming tests furthermore, math tests grades, Ke (2014) clarifies that students demonstrated essentially more inspirational disposition towards this discipline after the study, while L. A. Zavala, Gallardo, and García-Ruíz (2013), watch improvements in the identification and examination of numbers, albeit no gain in relation to the spatial location was recognized. Be that as it may, the vast majority of the investigations looked into did not take after essential suggestions to create inquire about in education (Lai and Yang, 2011), and in this way, there is a need to do empirical studies utilizing control gatherings and giving quantitative information to demonstrate the capability of computer programming with Scratch as an educational device to enhance academic outcomes.

A good Scratch project must encompass certain criteria such as the usability and the relevance of each project to the topic or unit that a teacher wishes to conduct with the children. Students need to know what they are learning because often Scratch just becomes a pacifying tool that makes the teacher more popular. In this case, it must by all means address the issues of basic arithmetic. Scratch allows teachers to be more creative in problematizing by including the use of basic arithmetic operations for students especially young learners. As the modern world evolved, various examinations have experienced to clarify the potential benefits of games-based learning in training. Learning Mathematics required the understanding of certainties and acquisition of skills, where student figure out how to solve problems as per methods and relate it to genuine world problems. Since Mathematics is difficult to learn, instructors and guardians need captivating techniques to handle student's interests at their initial age. Kids will probably demonstrate interests in games, where games can make ideal environments for honing abilities particularly where Mathematics required bunches of training in learning the procedure. Concentrates likewise found that in spite of the fact that games do not completely enhanced the skills in Mathematics, games may enhance the attitudes towards Mathematics contrasted with the utilized of traditional method in learning process (Perrotta, C., Featherstone, G., Aston, H., & Houghton, E., 2013). Likewise, numerous games have been integrated with mobile devices, in this way games can be upgraded all the more, for example, can be utilized anyplace and whenever and the availability of games source are increased (Epper, Derryberry & Jackson, 2012).

According to a study by Calao et al. (2015), they found that the Scratch program increased the use of the skills in Mathematics and one particular skill emphasized in it was the skill of reasoning. Mathematical reasoning has become the core basic arithmetic in Malaysia even more than before with the revisions of curriculum based on the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) performances we have attained over the years. One principle point of the Malaysian arithmetic educational modules was to create person who can figure numerically and who can apply scientific information viably and capably in tackling issues and deciding (Ministry of Education Malaysia, 2003 as cited by Ismail, Yusof & Pappu, 2013). This shows the critical accentuation of scientific reasoning in the expected educational modules. Scientific reasoning is significantly increased over the course of using Scratch when the pupils are allowed to go through problems. For example, when students are introduced to the concepts of subtraction, they use Scratch as a useful platform to conceptualise the underlying principles of the process of subtracting. Problems conveyed through Scratch are conveying more vital information ample for pupils to deduce that a process of subtraction must take place. Now, Scratch programs as we know allows one to problematize situations and when a problem is presented in a way that allows the learner to actively take part (Calao et al., 2015) in it, they see the problem from different perspectives which eventually helps them construct process knowledge on basic arithmetic skills like subtraction. It is similar for addition, division and multiplication.

Scratch also allows teachers to focus on different scopes and levels of basic arithmetic skills. For instance, the problems created can be segmented or differentiated based on learners' abilities by simply editing the details in it and it is also simple. If a teacher creates a single game where students need to add up the money given to a character for lunch, the numbers can be altered, and multiple projects can be produced and distributed to children of different levels. Differentiated learning strategies are one of the emphasis of today's education and it is significant because it gives learners the independence to progress on their own paces. Teachers can increase or reduce the number of information they provide on the project platform. For example, pictures can be used in problems involving addition to guide low achievers meanwhile higher achievers can be encouraged to draw objects to show understanding of the process of addition. The idea of Scratch itself is to create content for a larger audience and address the issue of learner differences as different children learn differently.

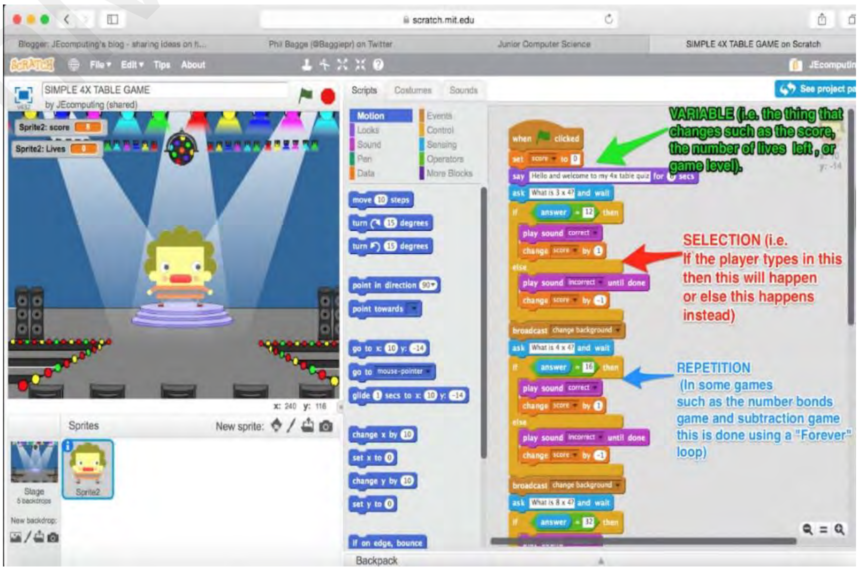


Figure 2.3. Scratch Activity for High Achievers

Figure 2.3 shows a game for multiplication game is built via Scratch to cater to high achievers and it inculcates deeper problem-solving skills by incorporating the elements of problems solving in each level. The game itself comes in different level proving to be engaging and challenging for learners to develop their thinking skills. Multiplication is a basic arithmetic skill that can be taught to learners as young as seven years old and sometimes even younger. By providing them with ample opportunities to explore multiplication in a fun and interactive manner, Scratch addresses differences in learning styles as proposed by Gardner. The theory of multiple intelligences, created by psychologist Howard Gardner in the late 1970s and mid-1980s, posits that individuals have at least eight moderately autonomous intelligences. People draw on these insights, exclusively and corporately, to make items and solve problems that are relevant to the social orders in which they live. The eight recognized insights incorporate linguistic intelligence, consistent mathematical intelligence, spatial intelligence, musical intelligence, substantial kinaesthetic knowledge, naturalistic intelligence, interpersonal intelligence, and intrapersonal intelligence (Gardner, 2018). As per Gardner's investigation, just two insights – linguistic and legitimate scientific – have been esteemed and tried for in present day secular schools; it is helpful to think about that dialect rationale blend as "scholastic" or "academic knowledge." In imagining knowledge as different as opposed to unitary in nature, the hypothesis of numerous insights – henceforth MI hypothesis – speaks to a take-off from conventional originations of insight initially defined in the mid twentieth century, estimated today by IQ tests, and concentrated in incredible detail by Piaget and other subjectively situated therapists.

2.9 Past Research Findings

Based on Rohmah and Sutiarso (2017), the research paper describes that the core of Mathematics is problem solving and mathematical problem solving is the resolution of a situation. This qualitative research paper explains that mathematic problem solving requires interaction between knowledge and application process which requires deep cognitive skills which are the ability to understand the problem, carry out appropriate method of solving the problem and build mental abstract models. The research paper is linked to this study because it encourages to do further investigation on students' common errors when comes to solving word problems in Mathematics.

Santos-Trigo and Reyes-Martínez (2019) implemented a recent study using the digital technologies that enhance the ways of reasoning that prospective high school Mathematics teachers to exhibit in a problem-solving scenario. This study has showed that virtual learning spaces encourage pupils to share ideas, discuss and extend mathematical discussion beyond classroom which support more structured problem solving approach. The findings of the study indicate high school Mathematics teachers rely on technological tools to formulate, explore and recognize properties to support mathematical conjectures. The research encourages this study because it recognizes the importance of digital tools to represent mathematical concepts as well as problem solving approaches.

A case study carried out Fessakis et al., 2013 proved that computer programming envorinment has given positive impact on 5-6 years kindergarden children in problem solving. The study was carried out on ten kindergarden children. The results of the study indicate that reasoning and problem solving ability in Mathematics have been facilitated through computer programming based learning environment. This learning environment is also appropriate and beneficial since it promotes mathematical and orientation skills. The study provides an idea of appropriate programming software which can be used in mathematic problem solving.

Gunbas (2020) conducted recent research on the application of animated-cartoons to enhance students' Mathematics word problem solving. 76 fourth grade students from public school participated in this research. The results of the pretest posttest experimental design shows that students in the animated-cartoon story group have a significant improvement in their word problem-solving achievement. It is clear that animated-cartoons can support and develop students' Mathematics word problem-solving performances. The research paper is linked to this study because it provides a clear anchored instruction framework on developing word problem-solving achievement.

Yang, Hyun, Kim, Kim & Kim (2013) conducted a research on application of Scratch in creativity enhancement. Based on their findings, Scratch is a powerful tool which gives a positive influence in effectiveness and satisfaction with respect to the Mathematics area of learning especially problem solving. Scratch enhances creativity among pupils and has great impact in their leaning effect. Besides, different types of programming software such as LOGO can be used as the technological tool as well to promote Mathematics problem solving.

According to Calao, Moreno Leon et al. (2015), computational thinking skills have been developed through the use of Scratch visual programming environment. This quantitative, quasi-experimental study observes that pupils' problem solving achievement increased with the use of programming in the teaching and learning. The mean value of the experimental group pupils aided by Scratch is significantly higher than control group pupils who used the traditional approach. The study boosts this research as well because the study is on developing on students' problem solving achievement and using Scratch programming software

2.10 Conceptual Framework

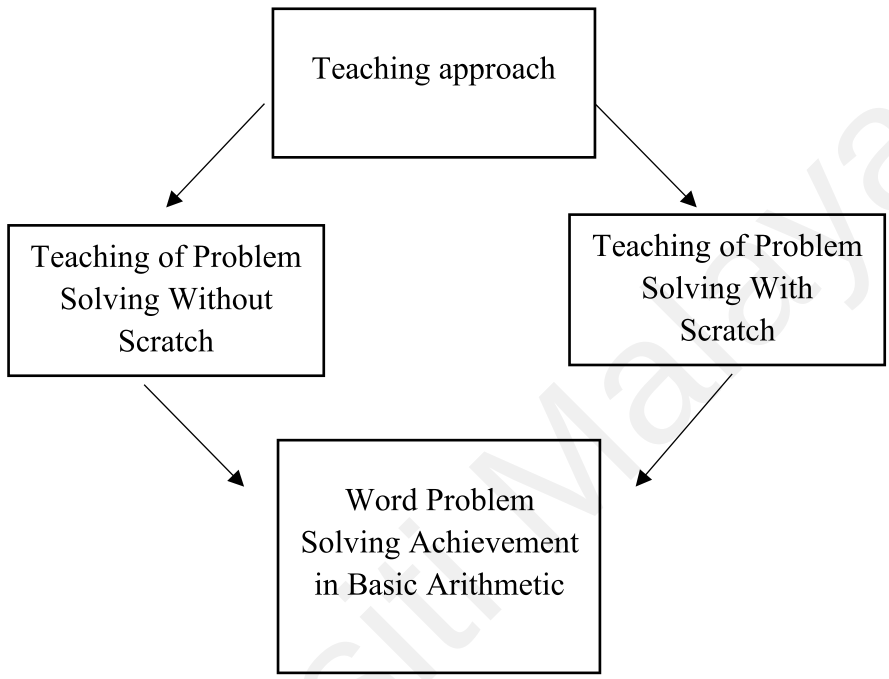


Figure 2.4. Conceptual Framework

Figure 2.4 illustrates the conceptual framework of the study which indicates the correlation between the variables that leads toward the results of the study. Independent variable of this study is the teaching approach meanwhile the dependent variable is the word problem solving achievement in basic arithmetic. These two varibales are interrelated and correlated with each other.

Based on the Figure 2.4, two teaching approaches were practiced. The control group will undergo teaching of problem solving without Scratch where their learning process will be based on teacher-centred and aided by text books, activity books and white board. Teaching of problem solving without is lecturing and demonstration methods which the teacher used. The experimental group will endure the teaching of problem solving with Scratch, the digital tool in a student oriented classroom where they explore and ascertain their own learning. Pupils in the experimental group wield Scratch in twelve lessons in the process of learning word problem solving in basic arithmetic.

According to Figure 2.4, the dependent variable of this study is the word problem solving achievement in basic arithmetic. After the intervention, word problem solving achievement in basic arithmetic for both the groups, experiment and control groups tested in post-test.

2.11 Summary

The four main processes in Mathematics which are addition, subtraction, division and multiplication are the underlying basis of our primary school system and as we move towards a more 21st century teaching and learning environment there is need to acknowledge higher order thinking skills. Using Scratch will eventually guide teachers to tap into those thinking components by largely introducing problem solving via problematized Mathematical activities. The idea is to steer away from rote memorization and allow pupils to exercise their thinking abilities in solving problems. Scratch offers a platform for educators to be creative in problematizing so that these skills can be further instilled among young learners. Mathematical literacy is a serious issue in Malaysia as every year screening detects how pupils lack of mathematical literacy exist in all parts of the country. Scratch can be a solution to the never-ending issues of mathematical skills.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter Three is divided into eight main sections which are introduction, research design, population and sample, data collection method, instrumentation, validity and reliability of instruments, data analysis method and summary. First section described the important contents of chapter three while research design and justification for selecting the research design described in section two. Then, population, location, sample and sampling method were discussed in section three. Forth section briefed about data collection method used in this study while fifth section briefed about types of instrumentation used, objective and content of the instrumentation. Next, validity and reliability of instruments were explained in sixth section. Finally, data analysis method was described in section seven and summary of chapter three was stated in section eight.

3.2 Research Design

This study implements a quantitative research methodology. Quantitative research methodology concerned with discovering facts about social phenomena and assumes a fixed and measurable reality. Quantitative research methodology gathers data in numerical form and can be interpreted with statistical analysis. Basias and Pollalis (2018) mentioned that since the quantitative methodology provides data in numerical form, considering and representing research and facts would not be influenced by researcher’s personal feelings or opinion. Moreover, quantitative research simplifies the processing of large amount data and allows easier comparison of data.

Quantitative research methodology was chosen for this study because this method can examine the relationship between two variables. The independent variable of this study is the teaching approach while the dependent variable of the study is word problem solving achievement in basic arithmetic. Quantitative data gathered from the instruments need to be analysed to verify the hypotheses and the theory used in this study. These quantitative data ease to highlight the changes and differences. Qualitative research methodology is not appropriate for this study because it analyse behaviours, experiences and relations without the use of statistics and processing of numerical data (Merriam, 2002).

A quasi experimental design is used in this study to collect and analyze data to answer the research questions. The purpose of the quasi experimental design is to evaluate the impact of a treatment (Reichardt, 2009). Quasi experimental design is suitable for this study compare to other quantitative design since this study investigates the effectiveness of the intervention in an empirical phenomenon. Non-equivalent group design was used where the control group is assigned from the same population as the experimental group to receive different treatment and the effectiveness of the treatment is assessed by comparing the post-test results (Campbell & Riecken, 1968). Cook, Campbell, and Shadish (2002) stated that in a quasi experimental design, the treatment which is the cause is manipulable and happens before the impact is assessed. Thus, this study uses quasi experimental research design.

Both the experimental and control groups will be given a pre-test before the intervention take place. After the pre-test, the experimental group will undergo the intervention where they learn word problem solving in basic arithmetic using Scratch whereas the control group will be learning using traditional approach. Traditional approach refers to the teacher centred strategy to teach a particular topic. As a final point, both groups will be assigned to do a post-test to measure their achievement in word problems solving in basic arithmetic.

Experimental Group	O_1	X_1	O_2
Control Group	O_1	X_2	O_2

O_1 represents the pre-test
O_2 represents the post-test
X_1 represents the students learning word problem solving in basic arithmetic with Scratch
X_2 represents the students learning word problem solving in basic arithmetic without Scratch

Figure 3.1. Research Design

There are few reasons for selecting quasi experimental as the research design instead of other research designs for this study. First, in quasi experimental, the focal matter which is being studied is the hypothesis testing and correlation between cause and effect. Pa (2014) stated that quasi experimental design aimed to make generalization which contributes to the theory that enables researchers to make predictions, explanations and understand certain phenomena. Quasi experimental is chosen because the improvement in students' problem solving skill using Scratch can be done between groups which are with or without intervention for the experiment group only. Furthermore, quasi experimental is also not context dependent and uses deductive reasoning. Lastly, the results of study obtained from pre-test and post-test can be statistically generalized. Therefore, quasi experimental design is suitable to investigate and explain the effectiveness of using Scratch in developing problem solving skills in basic arithmetic among lower primary pupils.

Quasi experimental design has some strengths. First and foremost, this research design is easy to be implemented compared to the true experimental design where the randomization is impractical and extensively used in social science studies. Shuttleworth (2008) mentioned that quasi experimental reduces the time and resources because extensive pre-screening and randomization is not required. It a relatively low cost approach which develop empirical generalizations and the best for ethical reasons. Dutra and dos Reis (2016) highlighted that the strength of quasi experimental design is mainly on its applicability where it does not require a rigor. However, this type of research design has some limitations as well. The results obtained through quasi experimental design have less validity because susceptible to bias and confounding. Though this research design has the element of manipulation and control, but lack of randomization (Thompson & Panacek, 2006). Besides, Dutra and dos Reis (2016) mentioned that causal relationship between the variables could not be made since potential of wide spreading is less and less conclusive results are obtained. Quasi experimental design sometimes can be relatively costly and challenging when the follow up periods prolonged if there is a necessity.

There are few ways to reduce the impact of the limitations of quasi experimental design. Alternative explanations which are plausible and logic should be enumerated to ensure it helps in limiting the weaknesses of the research design. Multiple pre-tests can be given to the control and experimental groups before the treatment to facilitate maturational trend. Control group should be included with more low performing pupils to keep them in the hypothesized direction with the intention of explaining the effect of the treatment given (Cook et al., 2002). Analyzing the data using change score and analysis of covariance are the statistical strategies to detect and amend the effect of selection differences (Reichardt, 2009). Moreover, the researcher seeks advice and idea from experienced lecturers and professors in order to make sure the process of case study goes smoothly. The quasi experimental research design can be intellectually demanding when plausible alternative explanations increases.

3.3 Population and Sample

Year two pupils from Bangsar district were selected as the population of this study. The school chosen has computer facilities with smart board, speaker and Liquid-Crystal Display (LCD) Projector. Pupils can access the computer individually because the computer lab is equipped with 40 computers with strong connection of Internet. The respondents of this study were 30 pupils from two different achievement levels in Mathematics namely high and average achievement and there were male and female pupils. The socio economic status of the respondents is varied. They started to learn the problem solving in basic arithmetic in year one under Kurikulum Standard Sekolah Rendah (KSSR) and Mathematics is taught in English under Dual Language Programme (DLP).

Respondents of this study were chosen by convenience sampling. This sampling method was chosen because the respondents of the study are the individuals who meet the criteria that set by the researcher in conjunction with purpose of the study (Pa, 2014). Respondents of the study were chosen using convenience sampling based on several reasons. First of all, the study was intended to generalize the findings to the population, thus probability sampling should not be used (Merriam, 2002). Second, respondents and location of the study were chosen according to need of the research. According to Etikan, Musa, and Alkassim (2016) convenience sampling is suitable to choose sample of a study who require specific criteria and those selected have the needed information to fulfil the purpose of the study. Third, convenience sampling was based on assumption that the researcher can explore, understand and concentrate in depth on specific cases (Merriam, 2002). However, this sampling method has its limitation. Convenience sampling method the foremost being variability and bias cannot be measured or controlled (Acharya, Prakash, Saxena, & Nigam, 2013). Additionally, results from the data obtained cannot be generalised beyond the sample. These limitations can be handled by providing judgements that are based on clear criteria such as the theoretical framework (Acharya et al., 2013). Moreover, the limitation can be undertaken because common problem notified among lower primary pupils. On that purpose, Year two pupils are chosen and they represent other lower primary pupils with similar characteristics.

The respondents of the study were lower primary school pupils. 61 pupils from Year two were selected from two mixed ability classes namely high and average achievement. All the pupils are Malaysian Indians. The participants consist of male and female pupils. These pupils assigned into control group and experimental group. 30 pupils will be in experimental group meanwhile 31 will be in control group. They have learnt the topic problem solving in basic arithmetic since Year one and they are not involved in public examination. Location of the study was a primary vernacular school on Bangsar district in Kuala Lumpur.

Table 3.1

Gender and Mathematics Performance of the Participants

Group	**Gender**		**Performance**		**Total**
	M	**F**	**H**	**A**	
Control Group	16	14	17	13	30
Experimental Group	14	16	18	12	30
Total					**60**

3.4 Data Collection Method

The data collected from this study is a quantitative data. Quantitative data are in the form of numbers or statistics rather than divergent reasoning and gathered using structured instruments. Results that are easy to generalize and summarize are produced through quantitative data collection methods. There are few quantitative data collection methods such as tests, questionnaires and survey. According to Johnson and Turner (2003), quantitative data are deductive, structured, confirmatory and closed-ended. Quantitative data collection is essential to provide broad comparability of answers, speed of data collection and the power of numbers (Salhin, Kyiu, Taheri, Porter, Valantasis Kanellos & Konig, 2016).

This study used a quantitative data collection method namely pre-test and post-test. According to Johnson and Turner (2003), tests are commonly used in quantitative research design to measure the performance of the participants. Pre-test and post-test were chosen as the data collection tool for this study based on several reasons. First of all, these tests are possible to be administered with string psychometric properties. These tests also offer ease of data analysis and allow comparability.

Table 3.2

Research Procedures

Research Procedures	
Experimental Group	**Control Group**
Pre-test	
Introducing the word Problem solving in basic arithmetic with Scratch. • Lesson 1 - 3: Problem Solving in addition.	Introducing the word Problem solving in basic arithmetic without Scratch. • Lesson 1 - 3: Problem Solving in addition.

Table 3.2 continued

Research Procedures	
Experimental Group	**Control Group**
Pre-test	
• Lesson 4 - 6: Problem Solving in subtraction. • Lesson 7 - 9: Problem Solving in multiplication. • Lesson 10 - 12: Problem Solving in division.	• Lesson 4 - 6: Problem Solving in subtraction. • Lesson 7 - 9: Problem Solving in multiplication. • Lesson 10 - 12: Problem Solving in division.
Post-test	Post-test

Table 3.2 shows the research procedures of the study. As the beginning process, a pre-test will be administered to the control and experimental groups. After the pre-test, the experimental group will undergo the treatment where they learn word problem solving in basic arithmetic using Scratch. The intervention for the experimental group will be given for six weeks. Twelve lessons are planned and each lesson will be conducted for an hour. For the first week, pupils will be exposed to the Scratch for the topic of addition. The following week, pupils will be learning the topic of subtraction using Scratch followed by the topic of multiplication and division. Pupils need to play games in Scratch with different levels of difficulties starting from easy to difficult. Pupils at advanced level may proceed to the difficult level of game after finishing the beginner stage. Meanwhile pupils at starting and intermediate level can try the game again and again unlimitedly till they progress from easy to difficult level. Pupils will be facilitated and motivated by the researcher, who is the teacher throughout this process.

Meanwhile, after the pre-test, the control group will learn word problem solving in basic arithmetic without Scratch. Even though, there is no application of technological tool for the control group, pupils in the control group will be learning word problem solving in basic arithmetic in 21st century learning approach where there will be discussion, idea sharing, collaborative activities, assessment process and integration of other resources such as songs and pictures. These methods help the researcher to handle the issue of researcher bias. Table below shows the instructional activities for the intervention. The instructional activities for the inventions are also attached in Appendix A.

Table 3.3

Instructional Activities for the Intervention

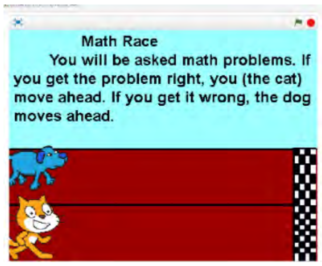
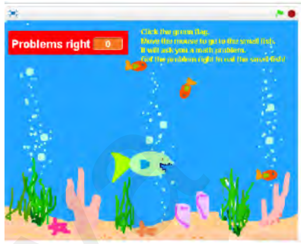
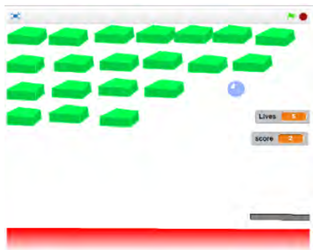
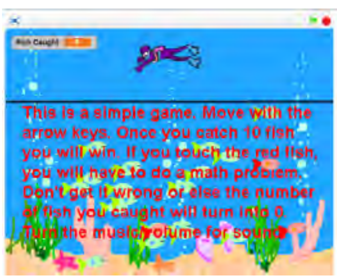
LEARNING OBJECTIVE	TEACHER ACTIVITIES	STUDENT ACTIVITIES
Lesson 1, 2 & 3 Learning Objective: I can solve daily life problems involving addition up to two numbers in Scratch.	1. Teacher to ask pupils to solve addition word problems using Polya's four steps. 2. Teacher to introduce the Scratch Software. 3. Teacher to ask pupils to play addition word problem games in Scratch (Addition Race) with different levels of difficulties starting from easy to difficult.	1. Pupils solve the given addition word problem in Polya's four steps. a) Understand the problem b) Devise a plan c) Carry out the plan d) Check and expand 2. Students to play Addition Race in Scratch. 
Lesson 4, 5 & 6 Learning Objective: I can solve daily life problems involving subtraction up to	1. Teacher to ask pupils to solve subtraction word problems using Polya's four steps. 2. Teacher to ask pupils to play subtraction word problem games in Scratch (Catch the	1. Pupils solve the given subtraction word problem in Polya's four steps. a) Understand the problem b) Devise a plan c) Carry out the plan d) Check and expand

Table 3.3 continued

LEARNING OBJECTIVE	TEACHER ACTIVITIES	STUDENT ACTIVITIES
two numbers in Scratch.	Fish) with different levels of difficulties starting from easy to difficult.	2. Students to play Catch the Fish in Scratch. 
Lesson 7, 8 & 9 Learning Objective: I can solve daily life problems involving multiplication up to two numbers in Scratch.	1. Teacher to ask pupils to solve multiplication word problems using Polya's four steps. 2. Teacher to ask pupils to play multiplication word problem games in Scratch (Bounce the Ball) with different levels of difficulties starting from easy to difficult.	1. Pupils solve the given multiplication word problem in Polya's four steps. a) Understand the problem b) Devise a plan c) Carry out the plan d) Check and expand 2. Students to play Bounce the Ball in Scratch. 
Lesson 10, 11 & 12 Learning Objective: I can solve daily life problems involving division up to two numbers in Scratch.	1. Teacher to ask pupils to solve division word problems using Polya's four steps. 2. Teacher to ask pupils to play division word problem games in Scratch (Smart Diver) with different levels of difficulties starting from easy to difficult.	1. Pupils solve the given division word problem in Polya's four steps. a) Understand the problem b) Devise a plan c) Carry out the plan d) Check and expand 2. Students to play Smart Diver in Scratch. 

Pupils in control group will be taught using traditional approach without any intervention or treatment. Traditional approach refers to the teacher centred strategy where the teacher just uses text book, notebook and work book. After the instruction on word problem solving in basic arithmetic given by the teacher, pupils in control group will be given exercises and drilling practise to reinforce their understanding. Lastly, both control and experimental group will be assessed via post-test.

3.5 Instrumentation

3.5.1 Word Problem Solving in Basic Arithmetic Achievement Pre-test and Post-test

Word Problem Solving in Basic Arithmetic Achievement Pre-test and post-test were used as instruments to measure the word problem solving achievement of pupils in basic arithmetic. These tests consist of 12 subjective questions of problem solving in basic arithmetic which are addition, subtraction, multiplication and division. It used a paper and pencil procedure and pupils are given 60 minutes to complete it. Three of the problems required the use of addition, three of the problems required the use of subtraction, three of the problems required the use of multiplication and three of the problems required the use of division. The pre-test and post-test are identical to provide an accurate measure of improvement in word problem solving. Pre-test and post-test will be administered to pupils in both control and experimental groups.

Pre-test is used to measure the existing word problem solving ability that pupils have and identify the root problems which lead to misconception. Post-test is used to measure the effectiveness of the intervention towards word problem solving. These tests are adapted from TIMSS 2011 and 2015 grade four released items. Pre-test will be given before the intervention to determine the difference in word problem solving between the control and experimental group. Post-test will be given after the intervention to examine the impact of the intervention on the word problem solving of the experimental group. Score 4 is given for the correct answer for each step whilst score 0 is given for the incorrect answer obtained. Total score is 48 and the score will be converted into percentage. Table 3.2 depicts the distribution of the items in the pre and post-test. The complete pre-test and post-test is attached in Appendix B.

Table 3.4

Distribution of the Items in the Pre and Post-Test

Question	Concept	Question Type	Adapted From
1, 5, 9	Addition	Find the total of two numbers	
2, 6, 10	Subtraction	Find the difference of two numbers	TIMSS 2011
3, 7, 11	Multiplication	Find the product of two numbers	TIMSS 2015
4, 8, 12	Division	Find the quotient	

3.6 Validity and Reliability of Instruments

Validity is vital to measure whether or not the instrument used is valid and accurate in measuring what it supposed to. In determining the validity of the pre-test and post-test, content validity and pilot test were done. To accomplish the content validity, the Pre-test and Post-test was given to two extensive experts to evaluate and validate the content. The experts are two lecturers from Faculty of Education, Mathematics and Science Department. One of the experts is a professor University of Science, Malaysia and the other expert is a lecturer from Flindres University, Australia.

The first expert stated that Question 4 contains an inappropriate word. The word ‘boxed’ had spelled wrongly due to typing error and had been changed into ‘boxes’. Secondly, he asked to remove the word ‘in desk’ from Question 6 to avoid any confusion. Lastly, he mentioned that Question 8 and 9 should be corrected grammatically. The second expert notified that Question 4 could mislead understanding where pupils might add instead of multiply. He also mentioned that Question 10 was problematic because there are too many ways for pupils to interpret the situation of the question.

Internal and external validity reflects the trustworthiness of the results of the study. By controlling inessential variables, the internal validity of this study was enhanced. There are no missing values in both pre-test and post-test since all the pupils were fully participated in the research. The Pearson correlation test results for the group of subjects (n=30), the test-retest correlation values for pre-test and post-test are 0.65 at the significance of $p<.05$. It shows that this instrument is appropriate for obtaining reliable results from other subjects in the same population. This research was done in a natural setting in order to improve the external validity. There were no any changes been made in the classroom setting in order to avoid any bias. External validity ascertains by using convenience sampling in the study instead of random sampling. The results can be represented and limited to the lower primary schools with similar curriculum.

The reliability of the pre-test and post-test assessed through a pilot test given to 30 lower primary pupils. Pilot study was carried out prior to the real data collection. Conducting a pilot study is very important because well designed pilot study leads the researcher to conduct a research well and know the likely outcomes. The pilot study was conducted on Year Three class from the same school. Year Three pupils were chosen as the respondents of the pilot study as both Year Two classes of the school are involved the sample of the study. Moreover, these pupils represented the respondents of the study very closely. Pilot study was done for several reasons. First, pilot study determined the validity and reliability of the instrument. Second, pilot study is essential to get the researcher to handle the limitations of the research design and data collection method. Researcher determined the validity of the instrument with the help of an experienced university lecturer. Some problems which were identified during the pilot study were refined with the assistance from the supervisor. Reliability analysis was conducted on the pre-test and post-test. A sample of 30 pupils were chosen to answer the instrument. The consistency of the test was calculated using Cronbach's alpha coefficient. The reliability of the pre-test and post-test is accepted because the values are > 0.7.

3.7 Data Analysis Method

Data analysis is a process to organize the data in a meaningful way and represent it in a compact way. Inferential and descriptive data analysis will be used to analyse the data obtained. Results from pre-test and post-test will be analysed inferentially. Participants' responses for pre-test and post-test will be checked based on the rubric set. Researcher will key in the mark obtained for each question in Statistical Package for Social Sciences (SPSS) version 26. The data will be analysed based on the research question.

Table 3.5

Data Analysis Method of Each Research Question

Research Questions	Statistical Analysis
1. Is there any significant difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention?	Two Tailed Independent Samples T-Test
2. Is there any significant difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention?	Two Tailed Independent Samples T-Test
3. Is there a significant increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention?	One Tailed Paired Samples T-Test

To answer research question one and two, two tailed Independent Samples T-test was chosen as it fulfilled the assumptions. Independent Samples T-test is used to find out is there any significant difference in year two pupils' achievement in solving word problems in basic arithmetic in pre-test between the experimental and control group before the intervention and to find out is there any significant difference in year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group after the intervention. Independent Samples T-test was chosen as the mean scores of pre-test and post-test of control group and experimental group are compared which independent observations are involved. The assumptions of the Independent Samples T-test are there is no correlation between the observations in each group, there is no significant outliers in the two groups, the variance of the outcome variable is equal in each group and the data for each group is normally distributed. Normality of the data was checked using Shapiro-Wilks test.

To answer research question three, one tailed paired Samples T-test was chosen as it met the assumptions. Paired Samples T-test is used to find out whether the achievement in word problem solving post-test scores of the experimental group significantly higher than pre-test scores. The sample of the study will be examined twice before and after the intervention with pre-test and post-test which are the same instrument. The dependent variable which is the scores of the pre-test and post-test are interval scale. The sample was randomly chosen from the population of Year 2 primary school. Lastly, since the sample is below 50, Shapiro-Wilks test was used to check the normality of the data.

3.8 Summary

Chapter three discussed about few important ideas which are research design, population and sample, data collection method, instrumentation, validity and reliability of instruments and data analysis method. This research used quasi experimental design to identify the effect of using Scratch in enhancing word problem solving achievement in basic arithmetic among year two pupils. Pre-test and post-test were used as data collection tool in this study to observe, question and evaluate the pupils' responses. Inferential and descriptive analysis were employed as the data analysis tool. The actual analysis and findings of the study without interpretation and discussion were presented in chapter four. Interpretation of the data, conclusion, discussion and implication were presented in chapter five.

CHAPTER FOUR

FINDINGS

4.1 Introduction

Chapter Four is divided into three main sections which are introduction, results of analysis for research questions and summary. First section described the important contents of chapter four while findings for research question one, research question two and research question three described and explained in section two. The data obtained is analysed using inferential and descriptive data analysis. Independent t-test was used to answer research question one and two where pre-test and post-test of control group and experimental group analysed separately. Meanwhile paired t-test was used to answer research question three because the sample of this study was measured twice with pre-test and post-test before and after the intervention. Statistical Package for Social Sciences (SPSS) software used as the tool to analyse the findings of this study. Finally, summary of chapter four was enlightened in section three

4.2 Inferential and Descriptive Analysis of Research Questions

4.2.1 Data analysis of Research Question One

First research question is, “Is there any significant difference in the mean score of year two pupils’ achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention?” Based on this research question a hypothesis is formed.

H_0 : There is no difference in the mean score of year two pupils’ achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention.

H_1 : There is a difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention.

Table 4.1

Descriptive Statistics of RQ1

	N	Mean	Std. Deviation
Experimental Group	30	50.07	17.850
Control Group	31	44.45	21.352

Table 4.1 shows the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention. The experimental has mean score (M = 50.07, SD = 17.850) and the control group has mean score (M = 44.45, SD = 21.352).

Inferential data analysis namely independent samples t-test was used to test the research hypothesis. A test of normality was carried out to satisfy the assumptions of independent samples t-test. Shapiro-Wilks test was chosen since the sample size is less than 50 (Ahad, Yin, Othman, & Yaacob, 2011). Table 4.2 shows the results of normality test as evaluated by Shapiro-Wilk test.

Table 4.2

Test of Normality of Pre-test

	Shapiro-Wilk		
	Statistics	df	Sig.
Experimental Group	.963	30	.363

Table 4.2 continued

	Shapiro-Wilk		
	Statistics	df	Sig.
Control Group	.937	30	.076

The p value of experimental group is *p*=.36 and the p value of control Group is *p*=.08. The results of both tests are insignificant where the p value is more than the alpha level .05. Thus, the data is normally distributed.

Table 4.3

Levene's Test of Equality of Error Variances

F	df1	df2	Sig.
1.522	1	59	.222

According to Levene's test in Table 4.3, the homogeneity of variance assumption is satisfied $F (1, 59) = 1.52, p>.05$. Thus, the null hypothesis is failed to be rejected. In conclusion, it indicates that the assumption of homogeneity of variance is met.

Difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic in pre-test between the experimental and control group before the intervention was measured using independent samples t-test. Table 4.3 shows the results of independent samples t-test for pre-test between the experimental and control group.

Table 4.4

Independent Samples Test for Pre Test Score

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pre Test Score	Equal variances assumed	1.52	.22	1.11	59	.27	5.62	5.05	-4.49	15.72
	Equal variances not assumed			1.11	57.8	.27	5.62	5.03	-4.46	15.70

Levene's test showed that the variances for pre test scores for both groups were equal, F(1,59) = 1.52, p=.22. Table 4.4 shows that *t* (59) = 1.11, p=.27. The null hypothesis is failed to be rejected because there is a no significant difference in year two pupils' achievement in solving word problems in basic arithmetic in pre-test between the experimental and control group before the intervention (*M*=5.62, 95% CI [-4.49, 15.72]). If the difference between the samples' mean score values is small and falls outside the null hypothesis rejection area, the null hypothesis will not be rejected (Chua, 2012). As a conclusion, these results proved that both experimental group and control group pupils performed equally before the intervention.

4.2.2 Data analysis of Research Question Two

Second research question is, "Is there any significant difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention?" Based on this research question a hypothesis is formed.

H_0 : There is no difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention.

H_1 : There is a difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention.

Table 4.5

Descriptive Statistics of RQ2

	N	Mean	Std. Deviation
Experimental Group	30	80.87	12.650
Control Group	31	53.77	20.104

Table 4.5 shows the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention. The experimental group has higher mean (M = 80.87, SD = 12.650) than the control group (M = 53.77, SD = 20.104).

Independent samples t-test was used to test the research hypothesis. The results of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group before the intervention shows no significant difference. Therefore, independent samples t-test is used to identify the difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic between the experimental and control group after the intervention. Shapiro-Wilks test was chosen as the test of normality as to satisfy the assumptions of independent sample t-test. Table 4.5 shows the results of normality test as evaluated

Table 4.6

Test of Normality of Post-test

	Shapiro-Wilk		
	Statistics	df	Sig.
Experimental Group	.955	30	.226
Control Group	.938	30	.074

The results of both tests are insignificant where the p value is more than the alpha level .05. The p value of experimental group is *p*=.22 and the p value of control Group is *p*=.07. This shows that the data is normally distributed.

Table 4.7

Levene's Test of Equality of Error Variances

F	df1	df2	Sig.
10.152	1	59	.002

According to Levene's test in Table 4.7, the homogeneity of variance assumption is satisfied F (1, 59) = 10.15, p=.002. Thus, the null hypothesis rejected. In conclusion, it indicates that the assumption of homogeneity of variance is not met. Hence, the equal variances not assumed values for the post test scores were taken.

Difference in the mean score of year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group after the intervention was measured using independent samples t-test. Table 4.8 shows the results of independent samples t-test for post-test between the experimental and control group.

Table 4.8

Independent Samples Test for Post Test Score

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post Test Score	Equal variances assumed	10.15	.00	6.28	59	.00	27.09	4.31	18.45	35.73
	Equal variances not assumed			6.32	50.79	.00	27.09	4.29	18.48	35.70

Based on Table 4.8, the result is significant t (59) = 6.32, $p < .001$. The null hypothesis is rejected because there is a significant difference in year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group after the intervention (M=27.09, 95% CI [18.48, 35.70]) with effect size of 1.61. It was calculated based on the formula, $d = (M_2 - M_1) / SD_{pooled}$, where d refers to Cohen's size, M_2 refers to the treatment condition and M_1 refers to the comparison condition and SD refers to standard deviation. According to Cohen's (1988) interpretation, this is interpreted as a large effect. There is nearly one standard deviation unit of difference between the means of the pre-test and post-test scores. The effect size shows that use of Scratch has stimulated experimental group pupils' achievement in solving word problems in basic arithmetic. The mean score of post-test of experimental group pupils is *M*=80.87 and the mean score of post-test of control group pupils is *M*=53.77. As a conclusion, these results prove that solving word problems in basic arithmetic achievement of experimental group pupils who utilized Scratch is different compared to control group pupils.

4.2.3 Data analysis of Research Question Three

Third research question is, "Is there a significant increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention?" Based on this research question a hypothesis is formed.

H_0 : There is no increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention.

H_1 : There is an increase in the mean score in year two pupils' achievement in solving word problems in basic arithmetic before and after the intervention.

Table 4.9

Descriptive Statistics of RQ3

	N	Mean	Std. Deviation
Pre test	30	50.07	17.850
Pre test	30	80.87	12.650

Table 4.9 shows the mean score of experimental group year two pupils' achievement in solving word problems in basic arithmetic before and after the

intervention. The experimental group has higher mean after the intervention (M = 80.87, SD = 12.650) than before the intervention (M = 50.07, SD = 17.850).

Inferential data analysis namely paired samples t-test was used to test the research hypothesis. A test of normality was carried out to satisfy the assumptions of paired sample t-test. Table 4.8 shows the results of normality test as evaluated by Shapiro-Wilk test.

Table 4.10

Test of Normality of Experimental Group

	Shapiro-Wilk		
	Statistics	df	Sig.
Pre test	.963	30	.363
Post test	.955	30	.226

The p value of pre-test is *p*=.363 and the p value of post-test is *p*=.226. The results of both tests are insignificant where the p value is more than the alpha level .05. Thus, the data is normally distributed.

Mean score increase in achievement between pre-test and post-test of the experimental group year two pupils' achievement in solving word problems in basic arithmetic after the intervention was measured using paired sample t-test. Table 4.6 shows the results of paired samples test for experimental group

Table 4.11

Paired Samples Test for Experimental Group

		Paired Difference							
		Mean	SD	Std Error	95% Confidence Interval of the Difference Lower	Upper	*t*	df	Sig.
Experimental Group	Pre-test Post-test	-30.80	9.77	1.78	-34.45	-27.15	-17.27	29	.000

Table 4.11 shows that the result is significant t (29) = -17.27, $p < .001$. The null hypothesis is rejected because there is a significant difference between pre-test and post-test of the experimental group year two pupils' achievement in solving word problems in basic arithmetic after the intervention (M=-30.80, 95% CI [-34.45, -27.15], SD = 9.77) with effect size of 1.99. It was calculated based on the formula, $d = (M_2 - M_1) / SD_{pooled}$, where d refers to Cohen's size, M_2 refers to the treatment condition and M_1 refers to the comparison condition and SD refers to standard deviation. According to Cohen's (1988) interpretation, this is interpreted as a large effect. There is nearly one standard deviation unit of difference between the means of the pre-test and post-test scores. The effect size shows that use of Scratch has stimulated pupils' achievement in solving word problems in basic arithmetic. As a conclusion, these results prove the achievement in word problem solving post-test scores of the experimental group significantly higher than pre-test scores.

4.3 Summary

Chapter four interpreted the analysis and findings of the study. The paired samples t-test shows that there was a significant difference between pre-test and post-test of experimental group. This proves that achievement in word problem solving post-test scores of the experimental group higher than pre-test scores. The independent samples t-test shows that there was a significant difference in post-test between experimental and control group. This ascertains that experimental group had higher score in solving word problems in basic arithmetic after the intervention compared to control group. Interpretation of the data, conclusion, discussion and implication will be deliberated in chapter five.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 Introduction

Chapter Five is divided into six main sections which are introduction, summary of the findings, discussions, implications, contribution of the study and conclusion. First section described the important contents of chapter five while summary of the research is evaluated in section two. Then, discussions on the effectiveness of using Scratch in enhancing word problem solving in basic arithmetic and pupils' attitude towards learning problem solving were discussed in section three. Forth section directed about implications in teaching and learning of problem solving in basic arithmetic and recommendation for further studies while fifth section explained about contributions of the study in different perspectives. Finally, conclusion of the study was stated in section eight.

5.2 Summary of the Study

The objective of this study is determining the effect of using Scratch in enhancing word problem solving achievement in basic arithmetic among year two pupils. This quasi experimental research involving 60 pupils, where 30 pupils in experimental group while 30 pupils in control group. Convenience sampling was used as the sampling method. A pre-test was given to both the experimental and control groups before the intervention take place. After the pre-test, the experimental group will undergo the intervention where they learn word problem solving in basic arithmetic using Scratch whereas the control group will be learning using traditional approach without Scratch. After the intervention, both groups will be assigned to do a post-test. The pre-test and post-test were adapted from TIMSS 2011 and 2015 grade four released items. Data were collected quantitatively and analysed statistically using independent sample t-test and paired samples t-test.

5.3 Summary of the Findings

Research Question 1: Is there any significant difference in year two pupils' achievement in solving word problems in basic arithmetic in pre-test between the experimental and control group before the intervention??

The first research question aimed at investigating whether there is any difference in year two pupils' achievement in solving word problems in basic arithmetic in pre-test between the experimental and control group before the intervention. The independent samples t-test proved that there is no significant difference in year two pupils' achievement in solving word problems in basic arithmetic in pre-test between the experimental and control group before the intervention (M=5.62), t (59) = 1.11, $p > .05$. This means both experimental and control group showed equal achievement in solving word problems in basic arithmetic before any intervention was done.

Research Question 2: Is there any significant difference in year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group after the intervention?

The second research question intended to determine whether there is any difference in year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group after the intervention. The independent samples t-test proved that there is a significant difference in year two pupils' achievement in solving word problems in basic arithmetic in post-test between the experimental and control group after the intervention (M =27.09), t (59) = 6.32, $p < .05$. The mean difference value of 27.092 shows that mean of post-test of experimental group pupils (M=80.87) is higher than mean of post-test of control group pupils (M=53.77). This is a breakthrough in the current research as it provides a concrete evidence of the effectiveness of using the Scratch software in solving word problems in basic arithmetic. This analysis proves that the experimental group who went through the intervention with the Scratch software have significantly higher scores in the post-test. The effectiveness of using Scratch to teach year two pupils mathematical problem solving is ultimately demonstrated here.

Research Question 3: Is the achievement in word problem solving post-test scores of the experimental group significantly higher than pre-test scores

The data analysis reflected that the achievement in word problem solving post-test scores of the experimental group significantly higher than pre-test scores because of the use of the intervention which is the proposed use of Scratch. The results of paired samples t-test shows that there was a significant difference between pre-test and post-test of the experimental group year two pupils' achievement in solving word problems in basic arithmetic after the intervention (M = -30.80, SD = 9.77), t (29) = -17.27, $p < .001$. The researcher confirmed that using Scratch did cause pupils' to be able to solve word problems in basic arithmetic and score more. As mentioned earlier, it corroborates to the findings of Lye (2014) who discovered that pupils did experience enhanced thinking abilities when they interacted using the software. The mathematical concepts that are developed via the Scratch software as mentioned by Kobsiripat (2015) facilitates users' understanding of mathematical problems. This is key to the current study because the paired samples t-test analysis for the experimental group reflected that the pupils involved experienced a better understanding of the word problems in basic arithmetic when they used the software. This can be attributed to the findings of both Lye (2014) and Kobsiripat (2015) who also found that the software helped learners gain more understanding of mathematical concepts.

5.4 Discussions

This discussion section encompasses the major perspective which is the effectiveness of using Scratch in enhancing word problem solving achievement in basic arithmetic. As summarised earlier, the post-test scores of the experimental group projected a remarkable increase compared to the controlled group because of the use of Scratch. The discussions have further analysed these findings in relation to past studies and findings by other researchers.

5.4.1 Word Problem Solving Achievement in Basic Arithmetic

As mentioned prior to this, the data analysis has already proven that using Scratch has had positive impact in the way the pupils in the experimental group solve word problems in basic arithmetic. Although this has been proven ultimately, the fact that post-test scores of the controlled group pupils which showed an increase also supports to the claims that problem solving does not have one specific solution or method (Schoenfeld, 2013). The key idea here is the concept of computational thinking. Barr, Harrison, and Conery (2011) admitted that human beings have the innate capabilities of solving problem and it includes the concept of computational thinking as it involves solving problems by progressively designing systems and frameworks for solution. Therefore, it can be said that problem solving skills exist naturally within most of us.

Referring back to Baroody and Coslick (1998), problem solving is defined as the individual’s ability to think critically, analytically and logically. However, over time there is a realisation that pupils find mathematical problem solving complicated and boring or dull and this can be related to a wide range of factors starting from the very basic of the Mathematics pedagogy in schools which do not emphasise on exploration of problems and structuring of problem solving frameworks but rather a teacher-centred outcome-centric lesson (Geist, 2010). Silver et al. (2005) also attribute the negative perceptions pupils have in mathematical problem solving to the teachers' shocking lack in mathematical knowledge which do not demonstrate innovativeness in teaching learners about the nature of problem solving. Therefore, it can be said that the controlled group did experience some increase in the post-test due to the fact that computational thinking for problem solving does exist naturally, however, it must be remembered that the current study is not introducing problem solving as a new skill but rather an effort to see if the use of Scratch could enhance those naturally available skills.

5.4.2 Effectiveness of using Scratch in Enhancing Word Problem Solving Achievement in Basic Arithmetic

The current study was formulated by understanding some issues within the target pupils when it comes to mathematical problem solving. The first problem being the reading skills of these pupils. The researcher noted earlier on that the children faced a difficulty, not in reading the word problems, but in understanding what the problem stated. Imam, Abas-Mastura, and Jamil (2013), through a study in the Philippines used 666 students from 18 private and public high schools aimed at discovering the relationship between reading skills and the abilities in problem solving in Mathematics. They found that the three main factors in understanding a problem in order to successfully solve it are understanding vocabulary in context, extraction of the gist or main ideas and the skills of inferring. Similarly Lamb (2010) and Walker et al. (2008) also found the correlation between reading skills and the success in solving problems in basic arithmetic. The use of the Scratch software simplifies the entire readability issue faced by learners by redefining how they view problems in Mathematics. The input of extracted information from the problems can be generated as multi-dimensional solutions which can enhance understanding of learners (Sáez-López, Román-González, & Vázquez-Cano, 2016). At the end of the day, the use of Scratch just allows pupils to solve problems better because it takes away the obstacle of understanding what the words mean. Understanding what words mean should not be the focus in solving mathematical problems but understanding the problem leads to successful problem solving.

Another area of discussion is the use of Scratch as a platform that emulates computational thinking processes of the brain that actually enhances the capacity of problem solving effectively. It was earlier stated that Malaysia has deteriorated significantly in the scores of Trends in International Mathematics and Science Study (TIMMS) and this has brought up various issues in the local educational context. The core issue highlighted here is the decline in the number sense area which has resulted in lack of problem-solving skills in Mathematics. A. Abdullah et al. (2017) noted that the decrease in content domains like number and fraction, algebra, geometry and data was caused by disappointing achievement in cognitive areas like knowing, applying and reasoning. This is where Scratch comes in as an enhancement tool that creates a platform that restructures how children know, apply and reason with the information they get from mathematical problems. The software employs the strategy which emulates solutions based on fundamental similarities in mathematical structure (Silver, 2013b). Silver (2013b) also stated that while children cannot immediately identify millions of similarities among a huge range of mathematical solutions and problems, the software can do it easily and categorise it in order to make problem solving easier for the children. In conclusion, the findings in this part has proven that the Scratch software for mathematical problem solving significantly aids in constructing how problems are processed and sequenced. It creates a systematic platform which processes and presents the data from a problem so that solutions can be formulated more effectively.

5.5 Implications of The Study

The implication of the current study to the entire teaching and learning community in Malaysia is immense but considering the sample used for the study, it is appropriate to say that it has impacted how mathematic teachers at the lower primary level, specifically year two pupils of a primary school in Bangsar, Kuala Lumpur, teach problem solving skills to those pupils.

5.5.1 Teaching and Learning of Problem Solving in Basic Arithmetic

First of all, the study has implied and further strengthened the relationship between computational thinking and the problem-solving skills required in solving word problems in basic arithmetic. The relationship between computational thinking and problem-solving skills has been drawn in the sense that the study has revealed that the Scratch software provides a more effective way of utilising the computational thinking to solve problems. As mentioned earlier, the computational thinking does exist naturally in every learner and it is a matter of putting it into presentation (Barr et al., 2011; Sáez-López et al., 2016). Zavala et al (2013) mentioned in their report that the use of the Scratch software allows pupils to create ways to identify the numerical sequences. Numerical sequences which in fact is a solution to various arithmetic problems is something that can be computed naturally by the human mind, given that the learner has been trained and has the gift of achieving such fast and accurate sequencing. However, the current study has proved that Scratch eliminates all that training and the probability of gifted abilities by providing learners with the ability to compute sequences in easier and fun ways. Therefore, the current study implies that teachers need to increase their understanding about computational thinking that is essential for mathematical problem-solving and at the same time identify teaching strategies that will introduce ways to demonstrate easier computation to young learners.

Drawing on the findings and propositions made by Yimer and Ellerton (2010), computational skills need to be introduced in basic word problem solving activities because the enhancement of problem-solving skills is progressive. It is not something that is acquired over a short frame of time. This study is crucial to Mathematics teachers in Bangsar to further understand that it cannot be done unless we admit that more time needs to give to pupils to explore the problems and discover solutions effectively. This is because problem solving in Mathematics requires back and forward referencing that is done continuously until the right solution is formulated (Yimer & Ellerton, 2010). Although the current study is focused on the use of Scratch to enhance solving of word problems in basic arithmetic, it has also caused a realisation that while Scratch is a mere tool that only aids pupils to visualise the problems, the greater significance is to understand that pupils need to be taught how to identify operations and solutions that are appropriate to a problem.

Traditional teachers have always perceived mathematical problems in schools as tasks that require the correct answer. As long as the answer is correct, then the problem is considered as solved. The findings in the current study has reflected that word problem solving among pupils, especially lower primary learners require a more comprehensive approach because pupils feel detached and demotivated when it is merely about finding the right answer. The fact is that the right answer is in no way related to the context or the nature of the problem. This happens because traditional methods have failed to help children to visualise the problem. The Scratch software helps pupils to visualise the problem using multiple features and interactive algorithms. The conceptualisation has increased their motivation to solve mathematical word problems and understand the nature of the problem posed to them. This is an important implication because it changes how teachers in Malaysia, specifically Mathematics teachers in Bangsar, Kuala Lumpur view the teaching of basic arithmetic in their respective classrooms. The focus should be in the process of conceptualising problems by providing them a platform to re-imagine the various variables of a problem. This cannot be done by mere numbers alone. It must be done by giving pupils a proper base or platform to understand the problem deeper and the base is called Scratch.

5.6 Recommendations for Further Study

The first most crucial weakness in the current study is in its research design which is quantitative and quasi experimental to be specific. The lack of random sampling and the absence of manipulation of independent variable in the design does call for questions over its internal validity. A recommendation for further study is to conduct a qualitative study that will further explore the attitudes of pupils towards using the software and how it affected their problem-solving skills. A qualitative study using interviews and observation is crucial to prove that Scratch does reduce anxiety among pupils. This is because quantitative data collected using survey methods can only project abstract elements like anxiety, motivation and enjoyment to a certain extent. Kozak, Bigné, and Andreu (2004) state that the quantitative survey lacks the linguistic accuracy that interviews provide in qualitative studies. This would be one good improvisation for future studies.

Earlier on the researcher has noted how the use of Polya's problem solving theory merely demonstrates a method of problem solving rather than the nature of general heuristics. This must be addressed in future research as the research to study problem solving skills in arithmetic must be based on frameworks that are related to the metacognitive skills of pupils. As elaborated earlier, the research found significant results of how Scratch helped learners develop computational skills. This must be focused by choosing a theoretical framework that is more pertinent to the metacognition involved in solving problems in Mathematics. Researches by Pennequin, Sorel, Nanty, and Fontaine (2010) and Lazakidou and Retalis (2010) provide a more solid base for a future research that can focus more on the metacognitive skills of pupils in using Scratch when solving mathematical problems.

5.7 Contribution of the Study

The study contributes to the pupils, if not all, the participants who took part in the study in the sense that it has given them the chance to use the Scratch software for their Mathematics lessons. The focus of the research in the problem-solving area of basic arithmetic has motivated the pupils to take part in multiple sessions where they actively utilise the software to solve problems. The findings of the study have proven that Scratch could enhance pupils' achievement in word problem solving in basic arithmetic. Pupils in experimental group could explore word problems visually and learn better with the technology tool.

The study also has brought very significant contributions to the researcher as a teacher, teachers in the selected schools and pupils. As a teacher, the researcher has managed to identify the importance of utilising the right kind of research methodology and framework to solve problems that are identified. Quantitative research has been proven as the best way to identify a problem that exists within the classroom and given the right framework and methodology, a teacher can pin-point a solution to the problem. In this case, pupils not being able to master word problem solving in basic arithmetic was the main problems. Embarking on a research has allowed the researcher to understand that a teacher is both an educator and a researcher, because day to day teaching requires a teacher to identify problems in teaching and coming up with solutions that are effective. Scratch for example, was identified as a solution to the problem, but the research has significantly educated the researcher how the software effects the learning of problem-solving skills and how it can used to its maximum capacity.

5.8 Conclusion of the Study

In this study, Scratch was used to enhance the word problem solving achievement in basic arithmetic among Year Two pupils. The pupils showed improvement in solving word problems where they were able to think and analyse a problem. Pupils with reading difficulty who failed to comprehend and encode a particular word problem could also solve the problems without much struggle because Scratch provides visual elements which promotes better understanding of the word problem.

In conclusion, the entire research has been a thorough journey which began with the discovery of the surface issue of how pupils in Malaysia have deteriorated in the TIMMS and PISA ratings mainly because we have failed to guide them towards mastering proper problem solving skills up to the discovery of Scratch as a software that enhances achievement among learners when it comes to solving mathematical word problems. It has also projected the basis behind using technology for learning, which is to enhance the skills that are capable by the human mind. In this case, the research has uncovered that computational skills that exist as innate skills in the average human mind only requires a platform that will allow pupils to visualise the problems and then compute the solutions more effectively. With reference to the current study, the use of Scratch has definitely enhanced the word problem solving achievement among the pupils.

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