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The Effectiveness of The CLEAR Module in Improving Year Four Pupils' Procedural and Conceptual Knowledge of Fractions Titles in Urban School

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Abstract

Various heuristic approaches can be used as a solution to mathematical problems, and this study focuses on mnemonic techniques. Fraction is also a difficult topic for pupils to master. This module is known as "CLEAR" (Circle, Line, Evaluate, Answer, Recheck). Therefore, this research aims to determine the effectiveness of the CLEAR module on the students' cognitive aspects of students. This study adopted the quasi-experimental pre-post-test research design and was conducted in a school. The findings showed that a significant difference between the achievement scores of students who used the CLEAR module compared to students who used the conventional method in the post-test and post-delayed test. This study also found a significant difference in the students' mean scores for problem-solving skills; students who used the CLEAR module scored higher than students who used the conventional method in the post-test and post-delayed tests. In regard to their conceptual knowledge, there is also a significant difference between the students' mean scores in the post-test and post-delayed test. In this light, where students of the treatment group had better conceptual knowledge compared to students of the control group. Students who used the CLEAR module showed better conceptual knowledge than students who used the conventional methods. Furthermore, for procedural knowledge, students in the treatment group have shown better procedural knowledge compared to students in the control group in the post-delayed test. The findings on mathematical word problems show that the use of the CLEAR module can improve students' achievement in the topic of fractions. It indicates that the use of the CLEAR module is suitable for use by teachers to increase students' interest and achievement in mathematics, especially in the topic of fractions. This study contributes to a new teaching strategy, specifically the modular-based approach as a mathematics T&L practise in primary schools.

Keywords: Mathematical Word Problem, Experimental Design, Clear, Conventional, Problem Solving Skills

Introduction

The mastery of science and knowledge through education is essential in this era of globalization. Education is one of the main pillars of the country's development. In this light, a country's development could be affected if education-related matters are ignored. Realizing this importance, the Malaysian government has allocated a high annual expenditure as an investment to develop the country's education system, ensure continuous progress and produce first-class human capital. As an initiative to produce quality human capital, Malaysian education institutions have participated in several global assessments measuring students' cognitive skills over the past two decades. These assessments include the *Trends in International Mathematics and Science Study (TIMSS)* assessment. The Ministry of Education Malaysia (2013) stated that TIMSS provides a platform for directly comparing Malaysia's education performance with other countries. However, the country's performance in TIMSS 2019 had shown a four-point decrease compared to 2015. Malaysia scored 461 points in the assessment, far behind Singapore, which scored 616 (The Ministry of Education Malaysia, 2020).

The government has strived to improve Malaysia's education performance at the international level. As knowledge and skills are paramount for students' success in life, the Malaysian education system is going beyond imparting knowledge by focusing on cultivating problem-solving skills among students (Ha & Rosli, 2017). Problem-solving skills are an essential requirement in achieving the goals of the Mathematics curriculum (Chindang & Maat, 2017). Radzali et al (2010) explained that mathematics problem-solving is complex and challenging to learn. Moreover, according to Md (2019), it involves systematic observation and critical thinking to find appropriate solutions or methods to achieve the desired goal. This is in line with McCormick (1997), who asserted that solving mathematics problems require high-level thinking skills and procedural knowledge to determine how the solution strategy should be implemented in solving mathematics problems challenges pupils to apply Mathematical thinking in various situations (Sahendra et al., 2018). A study by Angateeah (2017) showed that high-achieving students often become careless when solving mathematical word problems or sentences, while low-achieving students are more prone to procedural mistakes and often lack understanding and fail to decipher the meaning of mathematical words and sentences. In this light, knowledge and experience of word problems help build confidence in completing a task. This is supported by Boonen et al. (2016), who showed that accurately solving mathematics word problems requires high cognitive ability and reading comprehension skills. Consequently, students' weakness in applying these strategies will cause them to lose focus, thus failing to understand the questions accurately and hinder them from solving mathematics word problems accurately. Fractions from the base of decimals, ratios, rates, and percentages. Hence, knowledge of particles is fundamental for mathematics skill development. Due to this importance, the topic of fractions is taught as early as Year 1 in all primary schools in Malaysia, and pupils are expected to master the knowledge and conceptual understanding of fractions to prepare them for learning subsequent titles such as decimal, percentage, and measurement. Idris (2008) mentioned that fractions have a unique property compared to whole numbers learned by pupils. Several past studies have shown the importance of pupils' mastery of fractions. A study by Ndalichako (2013); Siegler & Pyke (2013) specified that mastery of fractions is the main element in learning Mathematics.

Booth et al (2014); Zientek et al (2013); Rodrigues et al (2016) argued that mastering fractional headings will help pupils solve Algebra equations. This is because the topic of a fraction is

fundamental to understanding Algebra, Ratio, and Proportion (Wilkins & Norton, 2018). On the other hand, the topic of fractions is complex (Watanabe, 2002), and it is challenging to master (Tahir, 2006) and understand (Alghazo & Alghazo, 2017; Thambi & Eu, 2013). Consequently, students often deem this topic challenging (Fan & Idris, 2008). Such a scenario is attributed to teachers' lack of pedagogical knowledge, content knowledge, and practice on fractions (Iskenderoglu, 2017; Tan & Zakaria, 2018; Zainal et al., 2009).

In terms of learning, modules comprise a series of independent learning activities designed to help students achieve a well-defined objective (Guido, 2014). Zainudin (2017) defines a learning module as a module that functions as a diverse learning program that is beneficial, flexible, and uses instructional mediators to be used both individually and as a group. Under KSSR, Mathematics teachers are provided with a T&L module as a guide to generate teaching ideas during the Mathematics class. Its main objective is to ensure teachers understand the KSSR Mathematics learning objectives and outcomes. Hudin et al (2015) stated that the KSSR Year 3 Mathematics and Mathematical Operations Teaching and Learning Module positively affects pupils' mastery of mathematics operations, specifically, multiplication. The significant difference in pupils' achievements in the three tests proves that using modules is a good approach for teaching and learning multiplication. Another study by Shiung (2017) found that the use of concrete, photographic, and abstracts (KGA) modules significantly impacted the achievement of Year Four SJKC pupils in fractions.

Researchers in Mathematics education has put forward several mathematical problem-solving models. These include the POLYA (1957) model, Schoenfeld (1985) model, and Krulik & Rudnik (1989) model. The western-centric POLYA model is one of the main models recommended for teachers and pupils for teaching and solving Math problems (Bahagian Pembangunan Kurikulum, 2018). However, its use has yet to affect primary education in Malaysia significantly, as evidenced by previous studies (Tajudin et al., 2015). The analysis of the TIMSS report also showed that Malaysian students in Mathematics subjects have significantly deteriorated in 1999, 2011, and recently, in 2019 (Kementerian Pendidikan Malaysia, 2020).

The term 'mnemonic' originates from Mnemosyne, the ancient Greek goddess of memory (Fasih et al., 2018). Studies have found that the mnemonic technique effectively improves an individual's memory (Lee & Hassan, 2019). The helpful approach is a method that mentally assists individuals in remembering information such as names, numbers, formulas, new words, and historical dates (Fasih et al., 2018). Studies have also claimed that the mnemonic method can make it easier for pupils to easily remember formulas and terms in Mathematics (Cahyono et al., 2019). Subsequently, the mnemonic method has been used in teaching Mathematics to teach pupils with learning difficulties in mathematics in the classroom (Conderman, 2019). Several studies have demonstrated the use of the mnemonic method in Mathematical T&L, especially in solving mathematics questions. Ha, dan Rosli (2017) introduced CUBES (*Circle the numbers, Underline the question, Box the keywords, Evaluate, Solve and Check*) to help students analyze numbers, questions, and keywords before determining the mathematical operations needed to solve the problems. The findings showed that the CUBES method could systematically improve the students' skills in solving the math problem after the pupil understands the given question with the help of the given keyword sheet.

Cahyono et al (2019) demonstrated that T&L using mnemonic methods is an element of creativity in 21st-century skills. They added that this approach could provide better learning outcomes than conventional learning classes. Despite the new models introduced, the POLYA

model is still widely used in solving mathematics problems today (Kurikulum Bersepadu Sekolah Rendah, 2003). In this regard, mathematics problem-solving strategies and approaches should be reformed to improve students' achievement in Mathematics. There is a need to rebrand the teaching strategy and teaching aids in teaching Mathematics subjects to prepare students to face new educational challenges. This study presents the CLEAR module, which adopts the mnemonic method and is integrated with the POLYA model. This module was developed to assist students in solving mathematics problems in the form of Mathematics word problems.

Objective

This study was conducted to determine the effectiveness of the CLEAR module in improving year four pupils' procedural and conceptual knowledge of fractions titles in urban schools based on their post-test scores.

Hypothesis

Pupils' group (experimental or control) determines the post-test, delayed post-tests, procedural knowledge, and conceptual knowledge scores of Year Four pupils in urban and rural schools.

Research Methodology

The study used the *pre-post quasi-experimental research design*. The experimental method was selected as this study intends to test the effectiveness of the CLEAR module on pupils in urban and rural schools. Experimental studies were used when researchers wanted to determine the cause-and-effect relationship between non-dependent and dependent variables (Creswell & Clark, 2017). These quasi-experimental designs are based on unequal groups (Campbell & Stanley, 2015) and do not involve randomly selecting respondents (Fraenkel et al., 2019). The design was chosen given that pupils are in their respective classes and intact group during the study to prevent disruption from affecting the timetable and teachers. This experimental study was conducted during school hours.

Research Finding

The descriptive analyses were conducted to obtain post-test scores for both groups (see Table 1). Pupils who used the CLEAR module obtained an average score of 32.2 with a standard deviation of 10.296. Meanwhile, pupils who underwent the conventional T&L method (KONVEN group) scored an average of 31.9 (SP = 8.259). As for the procedural knowledge score, the mean score of the CLEAR module group is 53.4 (SP = 13.102), higher than the pupils in the KONVEN group (Min = 33.4, SP = 12.896). Furthermore, the scores for conceptual knowledge show that pupils of the CLEAR group (Min = 45.1, SP = 13.024) have a higher mean score than the KONVEN group (Min 33.7, SP = 12.775). Overall, students using the CLEAR module scored higher than those using the conventional T&L in the post-test, procedural and conceptual knowledge.

Table 1

The Mean and standard deviation scores for post-test, procedural knowledge, and conceptual knowledge

	Group	Mean	Standard Deviation	Number
Procedural Knowledge	KONVEN	33.4	12.896	33
	MODUL	53.4	13.102	28
Conceptual Knowledge	KONVEN	33.7	12.775	33
	MODUL	45.1	13.024	28
Post-Test	KONVEN	31.9	8.259	33
	MODUL	32.2	10.296	28

The Pillai's Trace multivariate test showed that the pupils in the CLEAR group showed significantly higher scores (3, 56)81.39, $p = .000 < .05$) on the post-test, procedural knowledge, and conceptual knowledge. Based on these results, the null hypothesis was rejected. In this regard, being in the CLEAR group influences the achievement score of Year 4 pupils in urban schools. Furthermore, the *Levene Test equality of Error Variances* identified whether the variance for the dependent variables across each category in the independent variable is similar. The analysis showed that all three dependent variables obtained insignificant results ($p > .05$), indicating the assumption of homogeneity for the variance is fulfilled. At the same time, the MANOVA analysis performed on post-test, procedural knowledge, and conceptual knowledge scores showed that there are significant differences between the two groups in their procedural knowledge scores [$F(1, 58) = 32.263$, $p = .000 < .05$] and conceptual knowledge [$F(1,58) = 11.995$, $p = .000 < .05$]. Nevertheless, there is no significant difference in the post-test score [$F(1,58) = 1.456$, $p = .233 > .05$]. The findings of this study showed that being in the experimental or control group influenced pupils' procedural and conceptual knowledge but not their post-test achievement.

Regarding the mean value of each dependent variable, using the CLEAR module has significantly helped pupils achieve higher scores in procedural and conceptual knowledge compared to those exposed to conventional methods. The experimental group contributed 38.6% to procedural knowledge and 17.1 % to conceptual understanding of urban pupils.

These findings suggest that the CLEAR module that uses mnemonic approaches could be used in classrooms as it helps improve pupils' procedural and conceptual knowledge, even though the results showed no significant differences in post-test scores. This study has found significant differences between the achievements of the CLEAR group and the KONVEN group, which showed that the CLEAR group's conceptual and procedural knowledge achievement scores are better than the KONVEN group.

Table 2

Between Subjects Effect Tests

Source	Dependent variable	Type III Sums of Square	Df	Mean Square	F	Sig.
				3092.97		
Corrected Model	Procedural Knowledge	6185.941	2	1	18.211	0
	Conceptual Knowledge	2014.324	2	2	5.999	0.004
	Post Test	1714.198	2	857.099	14.921	0
				15439.9		
Intercept	Procedural Knowledge	15439.997	1	97	90.908	0
	Conceptual Knowledge	12984.401	1	01	77.34	0
				12984.4		
	Post Test	3682.761	1	1	64.111	0
	Procedural Knowledge	105.923	1	105.923	0.624	0.433
Pre-Test	Conceptual Knowledge	64.989	1	64.989	0.387	0.536
	Post Test	1713.098	1	8	29.822	.000
				1713.09		
Module	Procedural Knowledge	6158.934	1	4	36.263	0
	Conceptual Knowledge	2013.759	1	9	11.995	0.001
	Post Test	83.612	1	83.612	1.456	0.233
Error	Procedural Knowledge	9850.813	58	169.842		
	Conceptual Knowledge	9737.413	58	167.886		
	Post Test	3331.737	58	57.444		
Total	Procedural Knowledge	126686	61			
	Conceptual Knowledge	104221	61			
	Post Test	67638	61			
Corrected Total	Procedural Knowledge	16036.754	60			
	Conceptual Knowledge	11751.738	60			
	Post Test	5045.934	60			

b R Squared = .386 (Adjusted R Squared = .365)

c R Squared = .171 (Adjusted R Squared = .143)

d R Squared = .340 (Adjusted R Squared = .317)

Discussion

The study's findings reflect that using the CLEAR module can help improve pupils' procedural and conceptual knowledge. Based on the rubrics, the conceptual understanding was evaluated based on pupils' answer scripts in the post-test and delayed post-tests. Both tests showed that urban and rural pupils improved their conceptual knowledge after using the CLEAR module. This result has proven that new teaching strategies are more effective than conventional teaching. Pupils also showed positive acceptance of mnemonic strategy because they are keen to use new and non-conventional learning strategies. The elements in the

CLEAR element have made it easier for pupils to understand the requirements of questions and helped them to answer the questions accurately. This can indirectly enhance their conceptual knowledge. Furthermore, this study's findings showed that using the CLEAR module could help weak students in urban and rural schools understand mathematics questions. Thus, the CLEAR module can build pupils' confidence and motivation to answer the mathematics questions.

Teachers' attitudes and cognitive ability can also affect pupils' conceptual knowledge. Teachers exposed to various Mathematics content and new pedagogy are more creative and have a higher mental level than teachers who still use the conventional teaching methods. Creative teachers can make pupils learn quickly and understand the concept of fractions more easily. In this sense, teaching aids such as the CLEAR module can help students solve mathematical word problems. This is in line with the study by Clarke et al (2011), which suggests teachers place greater emphasis on the various meanings of the current fraction of T&L to improve pupils' understanding of fractions.

As we all know, procedural knowledge is closely related to problem-solving. Pupils who can solve problems often have good procedural understanding. This can be seen by analyzing the problem-solving skills of urban and rural school pupils using the CLEAR module. The findings showed that pupils who used the CLEAR module were more skilled in problem-solving than students who used conventional teaching approaches. This is in line with the analysis of procedural knowledge for urban and rural school pupils, which found that pupils who use the CLEAR module showed higher procedural knowledge than pupils using conventional teaching approaches. This suggests that mnemonic methods can help improve the procedural knowledge of urban and rural school pupils. When pupils use the CLEAR technique, they can easily understand the question's requirements and systematically solve the word problems regarding fractions. This is in line with the study (Freeman-Green et al., 2015; Locke, 2016; Radovic & Manzey, 2019), which states that mnemonic strategies improve learning, influence mental representation, and help pupils solve mathematics word problems.

Moreover, procedural knowledge is also closely related to conceptual knowledge. Pupils with good conceptual knowledge will have good procedural knowledge. This is influenced by the teacher's teaching attitude and practice during the T&L process. Teachers with an excellent cognitive level can effectively communicate a concept and various problem-solving solutions to pupils, primarily when the teacher guides pupils to use the CLEAR technique in solving problems. At the same time, the teacher should explain the concept of fractions and shows various solutions. The effect can be seen in the pupils' performance in terms of their problem-solving skills. Pupils' effective problem-solving skills are due to their conceptual and procedural knowledge, as shown in the study's findings. It was found that the use of the CLEAR module has led to higher procedural knowledge than pupils exposed to the conventional methods. This is in line with Zulnaldi dan Zamri (2017), who found that pupils in the experimental group that used the GeoGebra application showed higher procedural knowledge than pupils in the control group. Similarly, Nahdi and Jatisunda (2020) stated that pupils with good conceptual knowledge would have good procedural knowledge and vice versa.

Learning through modules can help students improve their procedural knowledge. Topics in a good module should be well organized (Javed et al., 2015) and adequately planned (Ally, 2005). The use of the CLEAR module can impact the pupil's procedural knowledge, as this module was developed after the researchers obtained expert opinions. The CLEAR module focuses on one topic, fractions, and this module has two editions, one for the teacher and

one for the pupils. This is different than the MOE module, which teachers can only use. This study showed that students who used the CLEAR module had better procedural knowledge than students who used the conventional methods. This is in line with the study (Kassim, 2019; Ibrahim, 2019), which found that the use of modules had a significant impact on the procedural knowledge of pupils, of which the treatment group pupils had higher procedural knowledge compared to the control group pupils.

The finding implies that using the CLEAR module can increase pupils' procedural knowledge. T&L processes often involve modeling, production, and *scaffolding*. Hence, activities provided in the CLEAR module can help pupils strengthen their procedural knowledge. These findings are in line with a study by Rittle-Johnson & Alibali (2001), which stated the initial conceptual knowledge of the pupil is a determinant of the improvement of procedural knowledge. In contrast, the improvement of procedural knowledge will determine the conceptual improvement of the pupil.

In the meantime, although there are no significant differences in the post-test scores, there are significant differences in the conceptual and procedural knowledge of pupils in both groups who used different approaches to learning. The use of CLEAR in favor of conventional modules had impacted the pupils' conceptual and procedural knowledge. Furthermore, the module incorporated different teaching strategies and considered multiple intelligence among pupils. As a result, the pupils found it easier to accept a new approach to learning and vice versa.

Implications and Recommendations

This study helps teachers diversify the strategies and methods to teach fractions, particularly in solving mathematics word problems. The CLEAR module can increase the efficiency of teachers' T&L strategies. Moreover, using the CLEAR module can improve pupils' ability to solve word problems on the topic of fractions. The researcher also ensured that the content and structure of the CLEAR module were arranged in an orderly manner so that pupils could easily use this module and motivate them to learn fractions and solve word problems. The observation of pupils post-intervention found that pupils showed high motivation to learn. This is because the CLEAR strategy in the CLEAR module made it easier for them to solve the mathematics questions accurately.

Teachers are provided with the Math T&L module as a guide in conducting T&L sessions in the classroom. While the aspect of problem-solving skills is highly emphasized during the T&L session, the Curriculum Development Division (2014) did not supply any problem-focused fractions learning module as part of the Curriculum. Thus, the provision of the CLEAR module can help teachers diversify their teaching methods to improve primary school pupils' ability to solve word problems. Therefore, this study recommends that the conceptual framework, the environment, and CLEAR intervention module based on the POLYA model be integrated with mnemonic methods and structured to include:

- i) Subtopics and different topics in KSSR and KSSM Mathematics
- ii) Achievement tests, problem-solving skills, conceptual and procedural knowledge according to gender, and other capabilities.
- iii) Pupils' different cognitive and numerical abilities
- iv) Other research methodology

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