INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 12, Issue 7, (2022) E-ISSN: 2222-6990

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

[1]Azarul Mokhtar, [1,2]Ahmad Fauzi Mohd Ayub, [2]Siti Salina Mustakim, [2]Rozita Radhiah Said

[1]Institute for Mathematical Research, Universiti Putra Malaysia, [2]Faculty of Educational Studies, Universiti Putra Malaysia

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v12-i7/14333 DOI:10.6007/IJARBSS/v12-i7/14333

Published Date: *08* July 2022

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 TIMMS provides a platform for directly comparing Malaysia's education performance with other countries. However, the country's performance in TIMMS 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.
Corrected Model	Procedural Knowledge	6185.941	2	3092.971	18.211	0
	Conceptual Knowledge	2014.324	2	1007.162	5.999	0.004
	Post Test	1714.198	2	857.099	14.921	0
Intercept	Procedural Knowledge	15439.997	1	15439.997	90.908	0
	Conceptual Knowledge	12984.401	1	12984.401	77.34	0
	Post Test	3682.761	1	3682.761	64.111	0
Pre-Test	Procedural Knowledge	105.923	1	105.923	0.624	0.433
	Conceptual Knowledge	64.989	1	64.989	0.387	0.536
	Post Test	1713.098	1	1713.098	29.822	.000
Module	Procedural Knowledge	6158.934	1	6158.934	36.263	0
	Conceptual Knowledge	2013.759	1	2013.759	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 Zulnaidi 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

References

Alghazo, Y. M., & Alghazo, R. (2017). Exploring Common Misconceptions and Errors about Fractions among College Students in Saudi Arabia. *International Education Studies*. https://doi.org/10.5539/ies.v10n4p133

Ally, M. (2005). Using learning theories to design instruction for mobile learning devices. *Engineering Education*, 5–8.

Angateeah, K. S. (2017). An investigation of students' difficulties in solving non-routine word problems at lower secondary. *International Journal of Learning and Teaching*, *3*(1), 46–50. https://doi.org/10.18178/ijlt.3.1.46-50

Bahagian Pembangunan Kurikulum. (2014). *Elemen KBAT Dalam Pedagogi*. Kementerian Pendidikan Malaysia.

Bahagian Pembangunan Kurikulum. (2018). *Dokumen Standard Kurikulum dan Pentaksiran Matematik Tahun 4 (semakan 2017)*. Kementerian Pendidikan Malaysia.

Booth, J. L., Newton, K. J., & Twiss-Garrity, L. K. (2014). The impact of fraction magnitude knowledge on algebra performance and learning. *Journal of Experimental Child Psychology*. https://doi.org/10.1016/j.jecp.2013.09.001

Boonen, A. J. H., de Koning, B. B., Jolles, J., & Van Der Schoot, M. (2016). Word problem-solving in contemporary math education: A plea for reading comprehension skills training. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2016.00191

Cahyono, A., Slamet, I., & Usodo, B. (2019). Mnemonic on the logarithm of the form of creativity from 21st-century skills. *Journal of Physics: Conference Series - The 6th Seminar Nasional Pendidikan Matematika Universitas Ahmad Dahlan*, *1188*(1). https://doi.org/10.1088/1742-6596/1188/1/012097

Campbell, D. T., & Stanley, J. C. (2015). *Experimental and quasi-experimental designs for research*. Houghton Mifflin Company.

Clarke, D., Roche, A., & Mitchell, A. (2011). One-To-One student interviews provide powerful insights and CLEAR focus for the teaching of fractions in the middle years in C.Doug, R., Anne & M., Annie (Eds). *Fractions: Teaching for Understanding,* 23–41. Australian Association of Mathematics Teachers

Chen, Y. H. (2012). Cognitive diagnosis of mathematics performance between rural and urban students in Taiwan. *Assessment in Education: Principles, Policy, and Practice*, *19*(2), 193–209. https://doi.org/10.1080/0969594X.2011.560562

Chindang, D. A., & Maat, S. M. B. (2017). Aplikasi analisis kesilapan Newman dalam penyelesaian masalah matematik berayat murid tahun 4. (Paper Presentation). *Simposium Pendidikan DiPeribadikan: Perspektif Risalah An-Nur (SPRiN2017).*, Akademi Kepimpinan Pendidikan Tinggi, Negeri Sembi. http://conference.ukm.my/sprin/index.php/sprin/sprin/schedConf/presentations

Conderman, G. (2019). Mnemonics for the middle grades. *The Clearing House: A Journal of Educational Strategies, Issues, and Ideas*, *92*(3), 71–77. https://doi.org/10.1080/00098655.2019.1579695

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*

(3rd ed.). SAGE Publications.

Fan, S. P., & Idris, N. (2008). Perwakilan pecahan sekolah rendah: Isu dan prospek. *Jurnal Masalah Pendidikan*, *31*(1), 41–57.

Fasih, P., Izadpanah, S., & Shahnavaz, A. (2018). The effects of mnemonic vocabulary instruction on content vocabulary learning of students. *Journal of Language and Education*, *4*(1), 42–62. https://doi.org/10.17323/2411-7390-2018-4-1-42-62

Fraenkel, J. R., Wallen, N. E., & Hyun, H. (2019). How to Design and Evaluate Research in Education. In *McGraw-Hill Higher Education*. McGraw-Hill.

Freeman-Green, S. M., O'Brien, C., Wood, C. L., & Hitt, S. B. (2015). Effects of the SOLVE Strategy on the Mathematical Problem Solving Skills of Secondary Students with Learning Disabilities. *Learning Disabilities Research & Practice*, *30*(2), 76–90. https://doi.org/10.1111/ldrp.12054

Guido, R. M. D. (2014). Evaluation of a modular teaching approach in materials science and engineering. *American Journal of Educational Research*, *2*(11), 1126–1130. https://doi.org/10.12691/education-2-11-20

Ha, C. S., & Rosli, R. (2017). Penggunaan kaedah cubes dalam penyelesaian masalah matematik berayat tahun 6. (Paper Presentation). *Simposium Pendidikan Diperibadikan: Perspektif Risale-I-Nur 2017*, Akademi Kepimpinan Pendidikan Tinggi, Negeri Sembi. http://conference.ukm.my/sprin/index.php/sprin/schedConf/presentations

Iskenderoglu, T. A. (2017). The problems posed and models employed by primary school teachers in subtraction with fractions. *Educational Research and Reviews*, *12*(5), 239–250. https://doi.org/110.5897/ERR2016.3089

Javed, M., Eng, L. S., & Mohamed, A. R. (2015). Developing reading comprehension modules to facilitate reading comprehension among Malaysian secondary school ESL students. *International Journal of Instruction*, *8*(2), 139–154. https://doi.org/10.12973/iji.2015.8211a

Kassim, N. (2019). *Pembangunan dan pengujian keberkesanan modul pengajaran pecahan dengan penyebatian kemahiran berfikir aras tinggi ke atas pengetahuan konseptual dan pengetahuan prosedural pecahan*. (Tesis PhD yang tidak diterbitkan), Universiti Kebangsaan Malaysia.

Kementerian Pendidikan Malaysia. (2013). *Pelan pembangunan pendidikan 2013-2025 (Pendidikan prasekolah hingga lepas menengah)*.

Kementerian Pendidikan Malaysia. (2020). *Laporan Kebangsaan TIMSS 2019*. Bahagian Perancangan Dan Penyelidikan Dasar Pendidikan Kementerian Pendidikan Malaysia.

Krulik, S., & Rudnik, J. A. (1989). *Problem-solving: A handbook for senior high school teachers*. Allyn & Bacon.

Lee, B. N., & Hassan, N. A. (2019). The use of the mnemonic and mathematical mnemonic methods in improving historical understanding. *International Journal of Educational and Pedagogical Sciences*, *13*(2), 93–97.

Locke, S. K. (2016). *The effects of the RIDE strategy on teaching word problem-solving skills to students with learning disabilities*. (Unpublished Ph.D. Thesis). Rowan University.

McCormick, R. (1997). Conceptual and Procedural Knowledge. *International Journal of Technology and Design Education*, *7*(1–2), 141–159. https://doi.org/10.1023/A:1008819912213

Md, M. R. (2019). 21st Century Skill "Problem Solving": Defining the Concept. *Asian Journal of Interdisciplinary Research*, *2*(1), 64–74. https://doi.org/10.34256/ajir1917

Ndalichako, J. L., & Ndalichako, J. L. (2013). Analysis of pupils' difficulties in solving fractions-

related questions: The case of primary school-leaving examination in Tanzania. *Creative Education*, *4*(9), 69–73. https://doi.org/10.4236/ce.2013.49b014

Ibrahim, N. (2019). *Development of higher-order thinking using a module based on a cognitive apprenticeship model for Year Five students on the topic of measurement and geometry*. (Unpublished PhD. Dissertation), Universiti Putra Malaysia.

Polya, G. (1957). How to solve it: a new aspect of mathematical method second edition. In *The Mathematical Gazette* (Vol. 30). http://www.jstor.org/stable/3609122?origin=crossref

Radovic, T., & Manzey, D. (2019). The impact of a mnemonic acronym on learning and performing a procedural task and its resilience toward interruptions. *Frontiers in Psychology*, *10*(November), 2522. https://doi.org/10.3389/fpsyg.2019.02522

Radzali, R., Meerah, T. S. M., & Zakaria, E. (2010). Hubungan antara kepercayaan matematik, metakognisi dan perwakilan masalah dengan kejayaan penyelesaian masalah matematik (The relationship between mathematical beliefs, metacognition and problem representation with mathematical problem solving performance. *Jurnal Pendidikan Malaysia*, *35*(2), 1–7.

Rittle-Johnson, B., & Koedinger, K. R. (2005). Designing knowledge scaffolds to support mathematical problem-solving. *Cognition and Instruction*, *23*(3), 313–349. https://doi.org/10.1207/s1532690xci2303_1

Rittle-Johnson, B., Siegler, R. S., & Alibali, M. W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology*, *93*(2), 346–362. https://doi.org/10.1037/0022-0663.93.2.346

Rodrigues, J., Dyson, N. I., Hansen, N., & Jordan, N. C. (2016). Preparing for algebra by building fraction sense. *TEACHING Exceptional Children*, *49*(2), 134–141. https://doi.org/10.1177/0040059916674326

Sahendra, A., Budiarto, M. T., & Fuad, Y. (2018). Students' representation in mathematical word problem-solving: exploring students' self-efficacy. *Journal of Physics: Conference Series*, *947*(012059), 1–6. https://doi.org/10.1088/1742-6596/947/1/012059

Hudin, S. S., Saad, N. S., & Dollah, M. U. (2015). Penggunaan modul pengajaran dan pembelajaran matematik nombor dan operasi kssr tahun 3 bagi tajuk darab dalam pengajaran dan pembelajaran matematik tahun 3. *Jurnal Pendidikan Sains & Matematik Malaysia*, *5*(1), 44–56.

Nahdi, S. D., & Jatisunda, G. M. (2020). Conceptual understanding and procedural knowledge: A case study on learning mathematics of fractional material in elementary school. *Journal of Physics: Conference Series*, *1477*(4), 1–5. https://doi.org/10.1088/1742-6596/1477/4/042037

Shiung, C. J. (2017). *Kesan pengajaran menggunakan modul konkrit, gambar, abstrak (KGA) terhadap pencapaian dan pengekalan pencapaian murid tahun empat sjkc dalam pecahan*. (Tesis PhD yang tidak diterbitkan). Universiti Sains Malaysia.

Siegler, R. S., Thompson, C. A., & Schneider, M. (2011). An integrated theory of whole number and fractions development. *Cognitive Psychology*, *62*(4), 273–296. https://doi.org/10.1016/j.cogpsych.2011.03.001

Tahir, S. (2006). *Pemahaman konsep pecahan dalam kalangan tiga kelompok pelajar secara keratan lintang*. (Tesis Phd yang tidak diterbitkan). Univeristi Teknologi Malaysia.

Tajudin, N. A., Puteh, M., Adnan, M., Faizal, M., & Lee, N. (2015). Persepsi dan amalan pengajaran guru matematik dalam penyelesaian masalah algebra. *Jurnal Pendidikan Sains & Matematik Malaysia*, *5*(2), 12–22.

Teng, T. S., & Zakaria, E. (2018). Analisis jenis kesilapan murid dalam operasi penambahan dan penolakan pecahan. (Kertas Kerja yang dibentangkan). *Seminar Kebangsaan Majlis Dekan Pendidikan Universiti Awam*, Fakulti Pengajian Kontemporari Islam, UniSZA.

Zawawi, T. Z., Mustapha, R., & Habib, A. R. (2009). Pengetahuan pedagogi isi kandungan guru matematik bagi tajuk pecahan: Kajian kes di sekolah rendah. *Jurnal Pendidikan Malaysia | Malaysian Journal of Education*, *34*(1), 131–153.

Thambi, N., & Eu, L. K. (2013). Effect of students' achievement in fractions using GeoGebra. *SAINSAB*, *16*, 97–106.

Watanabe, T. (2002). Learning from Japanese lesson study. *Educational Leadership*, *59*(6), 36–39.

Wilkins, J. L. M., & Norton, A. (2018). Learning progression toward a measurement concept of fractions. *International Journal of STEM Education*, *5*(27), 1–11. https://doi.org/10.1186/s40594-018-0119-2

Zainudin, I. (2017). *Pembangunan modul pembelajaran seni reka grafik berasaskan teknologi dan gaya pembelajaran pelajar bermasalah pendengaran*. (Unpublished PhD Thesis), Universiti Malaya.

Zientek, L. R., Younes, R., Nimon, K., Cage Mittag, K., & Taylor, S. (2013). Fractions as a foundation for algebra within a sample of prospective teachers. *Research in the Schools*, *20*(1), 76–95.

Zulnaidi, H., & Zamri, S. N. A. S. (2017). The effectiveness of the GeoGebra software: The intermediary role of procedural knowledge on students' conceptual knowledge and their achievement in mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(6), 2155–2180. https://doi.org/10.12973/eurasia.2017.01219a