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The Effectiveness of Dorayaki Module on Achievement, Interest and Mathematics Understanding

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Abstract

The main objective of this study is to evaluate the effectiveness of Dorayaki Module on achievement, interest and mathematics understanding on fraction topic among Year Four pupils. The research design employed in this study is a mixed method. Two main phases in this study are Design and Development Research (DDR) and the qualitative approach. By the end of this study, Dorayaki Module has been developed. The results show that there is a significant difference in mean achievement scores in the post-test between the control (M=33.17, SD=10.969, N=60) and treatment group (M=50.33, SD=13.17, N=60), $p<0.002$. The interest of pupils towards Fraction topic is also high (M=4.1) after Dorayaki Module has been implemented. Besides, all the ten respondents achieved four out of eight layers of understanding after the intervention. In conclusion, the Dorayaki Module needs to be implemented among all pupils who are facing difficulty in problem solving for Fraction topic. This study brings implications to Ministry of Education Malaysia, teacher trainees, and Year Four mathematics teachers.

Keywords: Effectiveness, Fractions, Mathematics, Mixed Method, Module

Introduction

It is imperative to explore various strategies and develop effective interventions to support pupils with mathematics learning difficulties (Yoong et al., 2024). Teachers need to be creative and innovative to improve the mathematics skills among pupils who faced difficulties (Yoong & Ismail, 2021). There are several critical issues that have been found based on the literature review. First, pupils are less interested and face difficulties in visualizing the solution of fractions question. Pupils often make mistakes when changing the denominator of a Fraction and give the wrong answer at the end. Pupils fail to solve fraction questions because they do not have strong operational understanding (Faridah, 2018; Singga & Effandi, 2020). Pupils need help from teachers to understand the denominator conversion in solving fraction questions (Jannah & Prahmana, 2019).

Besides, pupils also forget to multiply the numerators. The principle of denominator conversion is often solved in various that lead to wrong answers (Aksoy & Yazlik, 2017). The

steps of denominator conversion in fraction addition and subtraction are often a problem for pupils (Mahrufah, 2019). This problem should be overcome so that pupils no longer make mistakes when solving fraction addition and subtraction. A module needs to be developed to assist pupils in learning addition and subtraction for fractions.

Hence, Dorayaki Module has been developed. The objectives of this study are to:

- evaluate the effectiveness of Dorayaki Module towards pupils' achievement for Year Four fraction;
- identify the effect of Dorayaki Module towards pupils' interest on fraction; and
- identify the effect of Dorayaki Module towards mathematics understanding for Year Four fraction.

Literature Review

The literature review to be discussed in this section included; (1) fractions; (2) interest; and (3) mathematics understanding.

Fraction is a number that has uniqueness if compared to whole number, where the uniqueness makes this fraction difficult to understand (Mohd Afifi, 2019). Fraction refers to one of the topics covered in Year Four Mathematics. This topic belongs to the field of learning fractions in the *KSSR Semakan* syllabus (Ministry of Education Malaysia, 2017). The are five learning standards in this topic namely; (1) converting improper fractions to mixed numbers and vice versa; (2) adding up to three numbers involving proper fractions, whole numbers and mixed numbers; (3) subtraction of fractions; (4) addition and subtraction operations involving whole numbers, proper fractions and mixed numbers; and (5) determine the value of proper fractions and mixed numbers from a quantity.

Interest can determine the improvement or setback of a student in Mathematics. A student's interest has a great influence on his achievement (Du et al., 2021; Oppermann et al., 2021). Students often not interested in, do not understand, fear and worry when learning mathematics because this subject is considered difficult (Li & Tsai, 2022). In this study, Year Four students' interest in the topic of fractions has been identified.

Skemp (1987) stated that "to understand something means to assimilate it into appropriate schema". This means that a person's understanding of something depends on their level of knowledge in a matter. Understanding depends on a person's prior knowledge, it will happen when explaining something means doing something to produce understanding. Eight layers of Pirie-Kieren Model of Mathematical Understanding are primitive knowledge, image making, image having, property noticing, formalizing, observing, structuring, and inventising (Yao, 2020).

Methodology

This section will discuss research design, experts profile, population and sampling, and instruments.

Research Design

The research design used in this study is mixed method. There are two main phases in the design of this study, namely Design and Development Research (DDR) and qualitative

approach. Design and Development Research contains three phases which are needs analysis phase, design and development phase, and evaluation phase (Yoong & Ahmad, 2020). Module Dorayaki has been designed and developed based on data from needs analysis survey. In addition, literature support has been used in designing the activities for Dorayaki Module. Plickers interactive games have also been designed in this module.

Besides, Piaget's Constructivism Theory, Polya's Model, ARCS Model, and Pirie-Kieren's Theory of Mathematics Understanding are the support theories and models. The elements in these theories and models play important role in designing the Dorayaki Module and the instrument. The Dorayaki Module has been validated by the content experts before it was implemented in the quasi-experiment. The achievement and interest of students towards fractions have been determined.

A qualitative approach was used to determine the students' mathematical understanding after the intervention of Dorayaki Module. Ten students were selected to carry out the Fraction Summative Test. The data of qualitative findings was obtained from three sources, namely voice-over transcript, Fraction Summative Test and interview transcript. Voice-over transcript obtained from participants who answered the problem-solving questions by voicing their thoughts. The data obtained was analyzed and summarized. Voice-over transcripts were obtained during the session of FST.

Sample and Respondents

There were 120 Year Four pupils being selected in the quasi-experiment. These pupils were selected by their Mathematics teachers and screened through a pre-test. The students who had mastered the Fractions topic were withdrawn from the study. Year Four pupils who face difficulties in learning Fractions were randomly divided into groups. According to Yoong et al. (2023), it is necessary to identify pupils who are facing difficulties in learning mathematics, otherwise they will continue to be left out.

Table 3 shows the number of schools and pupils who participated in the experimental study. All the pupils went through a post-test under three months intervention using Dorayaki Module. Sixty pupils in treatment group have answered the interest questionnaire.

Table 3

Number of Schools and Pupils in the Experimental Study

Groups	Number of Schools	Number of Pupils
Treatment	2	60
Control	2	60
Total	4	120

The qualitative phase involved ten pupils from treatment group. Purposive sampling was used to select these pupils. They were selected based on post-test grades. These pupils were required to answer the FST in pairs. Table 4 shows the background of participants in the qualitative phase. Mathematics understanding of these pupils were determined during this phase.

Table 4
Background of Participants in the Qualitative Phase

Pairs	Participants	Grade
1	Ali and Benjamin	A
2	Cindy and Dev	C
3	Eva and Floral	B and A
4	Gucci and Hana	C
5	Ina and Jenny	B

Instruments

Five instruments in this study are (1) pre-test and post-test; (3) interest questionnaire; (4) Fraction Summative Test; and (8) interview protocol. Face validity and content validity need to be evaluated by experts in the content and language (Yoong et al., 2023). All students in the quasi-experiment went through a pre-test before the intervention. The purpose of pre-test is to ensure the level of achievement and existing knowledge for both groups is equivalent before intervention takes place. On the other hand, post-test is a test given after the intervention process. The results of both tests were compared to determine whether there was an increase in the pupils' achievement among control and treatment groups. It is also used to evaluate the effectiveness of Dorayaki Module among Year Four pupils.

Interest questionnaire consists of 15 items. All the pupils in the treatment group completed the interest questionnaire after the intervention. The purpose of this survey is to test the pupils' interest in learning Fractions after using Dorayaki Module. The completed interest questionnaire was analyzed using the Cronbach Alpha to obtain interest coefficients value for the module.

Fraction Summative Test consists of five questions, namely (1) converting improper fractions to mixed numbers and vice versa; (2) adding up to three numbers involving proper fractions, whole numbers and mixed numbers; (3) subtraction of fractions; (4) addition and subtraction operations involving whole numbers, proper fractions and mixed numbers; and (5) determine the value of proper fractions and mixed numbers from a quantity. Ten pupils were selected from the treatment group to carry out this Fraction Summative Test.

The theory applied in the interview protocol was Theory of Mathematics Understanding (Pirie & Kieren, 1994). Pupils' understanding has been identified and analysed in pairs. Eight layers of relational understanding analysis used in this study are primitive knowledge, image making, image having, property noticing, formalizing, observing, structuring, and inventising. Table 5 shows the items in interview protocol.

Table 5
Items in Interview Protocol

No.	Types of Understanding	Item
1	Primitive Knowledge	-Do you understand the information given in the question? -What is requested in this question?
2	Image Making	-Why did you draw that diagram? -Why did you do that?
3	Image Having	-What are you thinking? -Can you explain what you understand about this question?
4	Property Noticing	-What are you thinking? -Can you explain what you understand about this question?
5	Formalizing	-Why do you use that formula? -How do you solve this problem?
6	Observing	-Explain how you solve it? -How did you get this solution step? - Why do you solve the question in this way?
7	Structuring	-How did you get the steps to solve this question? -Why do you think so? -Explain how you solved it?
8	Inventising	-Why do you use this procedure to solve the question? -How did you get this answer?

Findings

This section discussed about three research questions in the study. The findings are based on DDR and qualitative approaches. Three research questions to be answered are:

(1) Is Dorayaki Module effective in improving the achievement of Year Four Pupils?
(2) What is the pupils' level of interest on fraction after using Dorayaki Module?
(3) What is the pupils' level of mathematics understanding after using Dorayaki Module?

Effectiveness of Dorayaki Module

Table 6 shows the comparison between post test for control group and treatment group. All pupils in both groups went through the post then, with N=60 for control group, and N=60 for treatment group. In this output, the mean for treatment group was 50.33 with the standard deviation of 13.650 and standard error mean of 1.762. On the other hand, the mean for control group was 33.17 with the standard deviation of 10.969, and standard error mean of 1.416. The difference between mean of post test for both groups was 17.16.

Table 6
Comparison between Post Test for Control Group and Treatment Group

Groups	N	Mean	Standard Deviation	Standard Error Mean
Control Group	60	33.17	10.969	1.416
Treatment Group	60	50.33	13.650	1.762

Independent t-test was conducted with the post-test for control and treatment groups. The p-value for independent t-test was 0.002. Since this p-value was less than 0.05, nul hypothesis was rejected. The results showed that there is a significant difference between the control and treatment groups. In short, the post-test means for treatment group (M=50.33, SD=13.17, N=60) is significantly different from the post-test mean for control group (M=33.17, SD10.969, N=60), $p < 0.002$. Hence, Dorayaki Module is effective in improving the achievement of Year Four Pupils.

Interest on Fraction

Interest questionnaires were distributed to 60 pupils in the treatment group. The purpose of this survey is to identify the level of interest among pupils after using the Dorayaki Module. Based on this survey, the overall average mean for all items in this questionnaire achieved 4.1. Figure 2 shows the percentage for agreement scale in interest questionnaire. There are 26.8% of pupils answered very agree, 61.6% of pupils answered agree, 11.2% of pupils answered not sure, 0.5% answered disagree, and none of them (0.0%) answered very disagree. Hence, the pupils' level of interest on fraction after using Dorayaki Module is considered high.

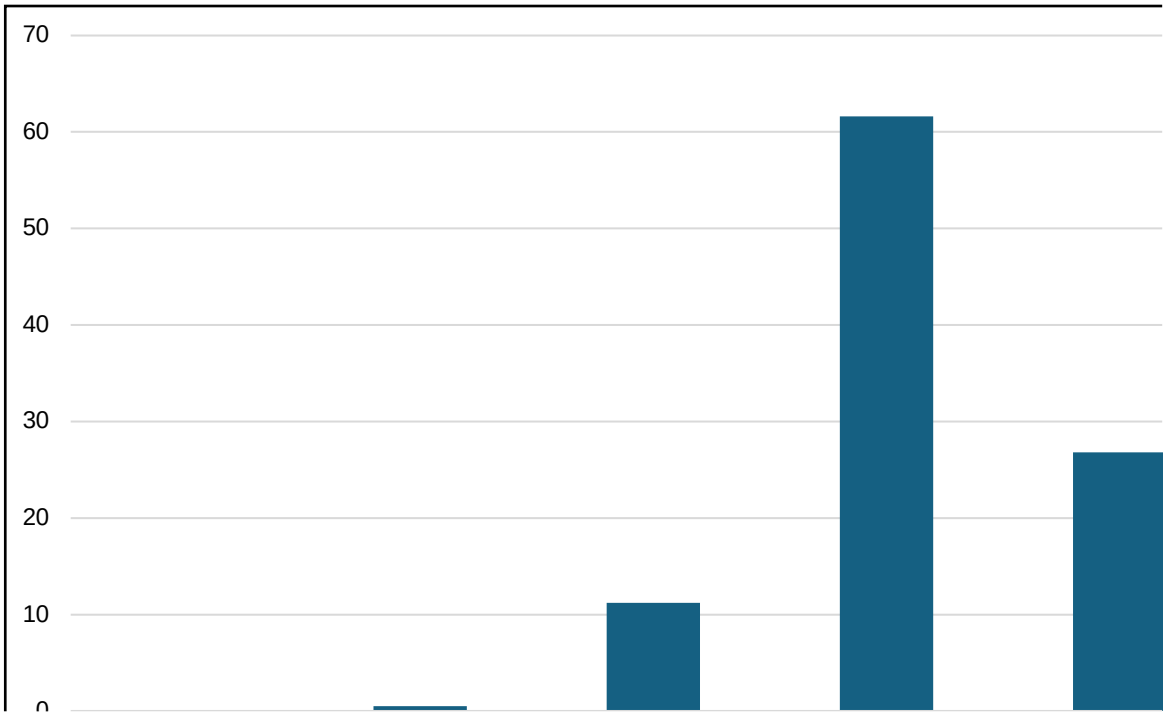

Figure 1. Percentage of Agreement Scale in Interest Questionnaire

Mathematics Understanding

The identified understanding of participants was analyzed and summarised by pairs. Relational understanding analysis was divided into eight layers, namely primitive knowledge, image making, image having, property noticing, formalizing, observing, structuring, and inventisings. Figure 2 shows the analysis of relational understanding across pairs. It has been summarized based on the relational understanding among each pair of pupils. Overall, all pupils were having relational understanding. Even though only the fourth pair of pupils achieved observing layer, three pairs of the pupils achieved the layer of formalizing. It is worth mentioning that all the pairs of pupils have achieved the layer of property noticing.

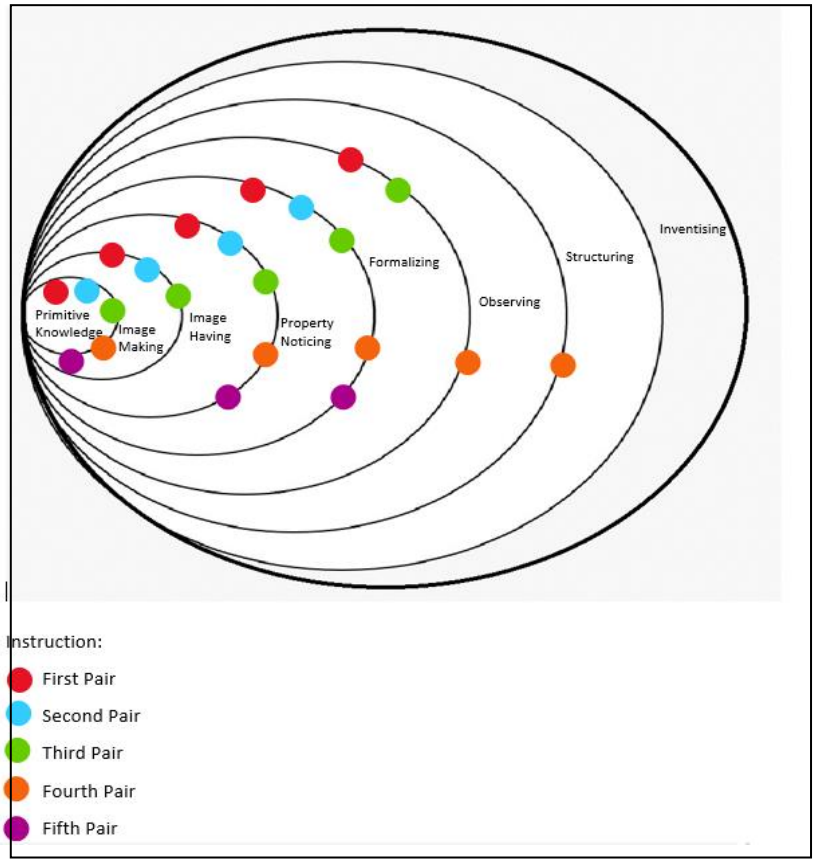

Figure 2. Analysis of Relational Understanding Across Pairs (Pirie & Kieren, 1994).

Conclusion

All the three research questions were answered. The effectiveness of Dorayaki Module was analysed by t-test. The findings showed that there is a significant difference between the mean of post-test for control and treatment groups ($p=0.002 < 0.05$). So, the Dorayaki Module is effective in improving the achievement of Year Four pupils in primary school.

Overall, the effectiveness of Dorayaki Module on pupils' interest towards fractions has been evaluated through a systematic and detailed analysis procedure. The findings showed that interest toward fractions among Year Four pupils is high after carrying out the three months intervention using Dorayaki Module.

For the qualitative approach, ten pupils were selected as the respondents to determine their Mathematics understanding. The findings showed that only one pair of pupils achieved layer

of observing. The first, third and fourth pairs of pupils achieved the layer of formalizing. Meanwhile, all the pupils achieved the layer of property noticing

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