International Electronic Journal of Mathematics Education
2025, 20(1), em0806
e-ISSN: 1306-3030
https://www.iejme.com

MODESTUM

Research Article **OPEN ACCESS**

Innovative teaching strategy of using the "Transcard" model in conceptualizing fraction and decimal for primary mathematics education

Nur Aini Khoo Ahmad Fuad Khoo [1], Heng Wen Qi [1], Sharifah Osman [1*]

[1] Department of Innovative Science and Mathematics Education, Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Johor, MALAYSIA
***Corresponding Author:** sharifah.o@utm.my**

Citation: Ahmad Fuad Khoo, N. A. K., Qi, H. W., & Osman, S. (2025). Innovative teaching strategy of using the "Transcard" model in conceptualizing fraction and decimal for primary mathematics education. *International Electronic Journal of Mathematics Education, 20*(1), em0806. https://doi.org/10.29333/iejme/15735

ARTICLE INFO

Received: 11 Jun. 2024

Accepted: 29 Nov. 2024

ABSTRACT

Students are indeed weak when it comes to understanding fractions and decimals. In line with the national curriculum, whole numbers and fractions are taught first before students start to learn decimals. By the time the students approach decimals, they should have acquired sufficient knowledge of whole numbers but limited knowledge of fractions. Unfortunately, many students face difficulty learning the subsequent concept due to the misinformation or misconception that happened during previous years' learning. The main objective of this study is to investigate the effectiveness of the innovative teaching strategy using the "Transcard" model in learning fractions and decimals and the perceptions of students towards this model. This study employed a mixed-methods research design, which comprises both quantitative and qualitative data analysis. 30 primary school students from the Chinese primary school in Johor Bahru were selected through convenience sampling. There were two instruments used to investigate student achievement in learning fractions and decimals after applying the "Transcard" model during the pre- and post-test. A semi-structured interview was conducted to explore the students' perceptions upon applying the method. Data were analyzed using statistical package for social science version 25. The result of the paired sample t-test indicates that the students perform better after the application of the "Transcard" model in learning fractions and decimals. Findings from the interviews revealed that the application of the "Transcard" model has increased the level of understanding and spiked students' motivation in learning fractions and decimals. This study may offer an alternative way for primary school teachers to teach fractions and decimals, as using the "Transcard" model provides an engaging and purposeful experience throughout the learning process.

Keywords: "Transcard" model, primary mathematics education, fractions and decimals, innovative teaching strategies, mixed-methods research

INTRODUCTION

Mathematics is the best medium to develop the potential of an individual, his intellectual capacity and human resources, as the essence within mathematics prompts the student to think logically and in a systematic way (Devlin, 2021). Thus, developing the mathematics curriculum also takes into consideration the elements that bestow individuals' personal development in line with the needs of developing the country. This is to make certain that we can compete globally and fulfil the importunity of human resources in this modern era that is accordant with the need to be provided with sufficient mathematical skills and knowledge. In Malaysia, mathematics is one of the core subjects that is compulsory for all students who partake in the national education system (Li & Schoenfeld, 2019). Each student is obliged to undergo a minimum amount of basic education that spans over eleven years, namely primary education (6 years) and secondary schools (5 years). The Ministry of Education Malaysia reinstated that school mathematics aims to develop and equip students with sufficient mathematical knowledge and skills which will come in handy to solve their daily life problems in addition to achieving a higher level and become a future pillar that stands for the nation. The mathematics advisory panel (NMAP, 2008) put forward fractions are indeed one of the main mathematics topics and considered important for students (Shin & Bryant, 2015) and the same goes for the decimal numeral. It is important to understand fractions, decimals procedural and conceptual knowledge in primary school before the student faces more advanced mathematical concepts such as algebra in secondary school (Jordan et al., 2013; Ying et al., 2020). It will also come in handy in daily life activities such as finance and cooking (Jordan et al., 2013). If students can master it early, students should be able to discover the solution

that is related to fractions and decimals (NMAP, 2008). However, it has also been mentioned that fractions are one of the areas that are extremely difficult for many students (Singh et al., 2021).

Secondary school standard curriculum stated that mathematically *fikrah* means individuals who can be creative and innovative with mathematical thinking and are able in using mathematical skills and knowledge to solve daily life problems efficiently and conceptualizes the right idea, based on the their values and attitudes in order to assist them to possess the knowledge needed to face the problems or provocations in their daily life, in accordance to the robust development of science and technology (Aliyu et al., 2021; Kurikulum, 2012).

Therefore, the common problems like converting fractions to decimals or otherwise that student face in fraction and decimal must be solved in order to develop an individual who is "mathematically fikrah". According to the standard of the curriculum and assessment standard document, mathematically fikrah refers to the quality of students to be developed through the national mathematics education system. The "Transcard" model can help students understand the concept of fractions and decimals by just using imagination and abstract thinking. Using concrete objects such as fractions bars or decimals blocks to associate with numeric values can help children to understand and comprehend better (Bakar et al., 2020; Booth & Newton, 2012). Even though fractions and decimals in mathematics bear different concepts, both concepts can be made easier to understand when they use the "Transcard" model. In early childhood stage, children formed their concepts of numbers by revolving around natural digits (Can, 2020). Counting using fingers emphasizes and focuses on the fact that numbers possess qualities such as discreteness and total enclosure. This notion is further cemented in their minds when young learners learn basic operations such as addition, subtraction and multiplication between digits (Sarama & Clements, 2009). Comprehension towards mature numbers misleads young learners to believe that the larger the digits shown, the bigger value they hold. A common misbelief amongst students is believing that adding zeros to the left-side of any digit makes it larger (Alkhateeb, 2019). However, when they first encounter rational numbers (fractions and decimals), the new information learned does not fit easily into their current conception (Ni & Zhou, 2005).

In most of the school curriculum, whole numbers and fractions will be taught first before students begin to learn decimals (Tian & Siegler, 2018). By the time the students learn decimals, they should have acquired much knowledge of whole numbers yet limited knowledge of fractions (Lamon, 2007). Thus, the student will face difficulty when learning the next concept due to the misconception in previous years. As mathematics is a part of science, each lesson must be learned step by step to accommodate another new concept. If the students are having difficulty or unaware of misconception in learning the previous concept, it may affect their future in learning mathematics and they will face similar problems when another new concept pops up (NCTM, 2009). Henceforth, it may impede the students' learning progress.

Recently, many researchers have examined how students compare rational number values, such as fractions and decimals using number comparison tasks (Ching et al., 2024; González-Forte et al., 2020; Rosenberg-Lee et al., 2023). Research found that student observed fractions and decimals based on particular aspects such as the length of decimal number and separate numerator and denominator, for example, students thought that the longer the decimal length, the bigger the value. Another common misconception among students is, they compare fractions by separating the value of numerator and denominator without regarding the true method (should be compared with the same denominator) (Alkhateeb, 2019). According to Jabal and Rosjanuardi (2019), the majority of students also struggle when converting fractions to decimals. The typical mistake that occurs is that students will write the denominator on the right side of the decimal point and the numerator on the left. The difficulty of understanding is not only limited to fraction. According to findings by Hurst and Cordes (2018), fourth- and fifth-grade children exhibited a correct response rate of only 77% in solving decimal addition problems. These problems involved decimals with one or two digits positioned to the right of the decimal point.

It suggests that proficiency in comprehending decimals is contingent upon a foundational grasp of fractions (Jabal & Rosjanuardi, 2019). The challenge lies in the fact that students typically encounter whole numbers more frequently and at an earlier stage than other types of numbers. Consequently, there is a risk of conceptualizing fractions and decimals solely in terms of their whole-number counterparts (Deringöl, 2019), impeding a deeper understanding. Moreover, Hurst and Cordes (2018) emphasizes that proficiency in arithmetic involving fractions and decimals necessitates a thorough comprehension of these numerical entities themselves. Indeed, difficulties in fraction and decimal arithmetic often stem from a fundamental deficiency in understanding the constituent fractions and decimals.

A comprehensive grasp of fractions and decimals holds significant importance (Rosenberg-Lee et al., 2023). It is a fact that fractions and decimals are not only textbook materials, but also of great importance in real life (Fitri & Tantri, 2023). Fractions and decimals are also widespread in physics, chemistry, biology, engineering, sociology, economics, psychology, and many other fields. Knowledge in fractions and decimals is central to many common jobs such as nurse and pharmacist, for example calculate the dosage. Furthermore, to understand basic statistical and probability information reported in social media and home finance reports, fraction and decimal arithmetic are really handy.

In the field of arithmetic, it is imperative to identify and address misconceptions once they have been recognized, as outdated concepts and erroneous knowledge can profoundly impact learning outcomes (Lin, 2022) Failure to acknowledge misconceptions in mathematics can present a significant threat, particularly if students perceive these misconceptions as unimportant to their learning journey (Rashid, 2024). So, if the misconception is left untreated, how will the students be able to deal with the challenges in the 21st century? Therefore, this research is important to make sure the lack of understanding fraction and decimal by students could be tackled to ensure they are able to face the challenges in their future.

Much research have been done to support the conceptual and procedural knowledge of fractions and decimals (Pant, 2019), such as the concrete-representational-abstract (CRA) that is effective in the teaching of fractions (Flores et al., 2020).

Contradicting, while using the concrete tool in teaching and learning process, the teacher will face some problems such as student keep playing the tools rather than using it for mathematical purposes (Shin & Bryant, 2015).

According to Flores et al. (2019), visual manipulatives are also more transportable and potentially engaging for the student. In recent years, many kits and tools were innovated to teach fraction, decimal and percentage whereas all of the tools are visualization-based learning such as "indigenized domino activity" (Alboroto, 2021). Even though so many tools are created to help students in learning fractions and decimals, most of the tools did not assist students to understand the underlying concept of the conversion of fractions to decimal to percentage (Shin & Bryant, 2015).

Therefore, the "Transcard" model is introduced as a teaching model for teacher, a learning model for students and it is a teaching and learning tool by combining the visual manipulative and CRA instructions concept to help student anticipate and overcome the problems they might face while learning fractions and decimals. It also helps that teachers who have procedural knowledge rather than conceptual knowledge can easily explain the concept of fractions and decimals by using the "Transcard" model. But before the usage of this model, the teacher is required to explain the relationship between fractions and decimals elaborately to eliminate confusion among students. Now, with the help of the "Transcard" model, teacher can just simply show the "Transcard" to the students and they will directly know why ½ is equivalent to 0.5, without saying or explain much to student.

Objectives of the Study

1. To statistically compare students' achievement in fractions and decimals after using the "Transcard" model.
2. To explore students' perceptions after using the "Transcard" model.

Research Hypotheses

H_0. There is no significant difference in participants achievement in fractions and decimals after using the "Transcard" model.

H_a. There is a significant difference in participants achievement in fractions and decimals after using the "Transcard" model.

THE "TRANSCARD" MODEL

There are a few disadvantages derived from the traditional ways used to teach fractions and decimals (Schiller & Siegler, 2022). One of those disadvantages is that the students are forced to think abstractly about some fraction or decimal number (DeWolf et al., 2014). The students could not see how it really works and the logic behind changing fraction to decimal or vice versa. The virtual manipulative to learn fraction, decimal and percent are costly because, in order to use it, every student needs to have their own computers (Li et al., 2021). Besides that, traditional manipulative needs to be planned carefully and it takes a long time. The usage of traditional manipulative sometimes might be more difficult for the students to understand the underlying concepts and it might be boring (Lin et al., 2020).

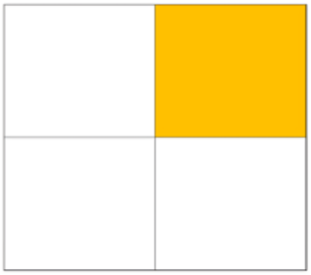
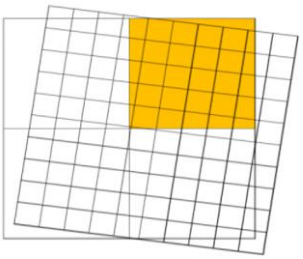
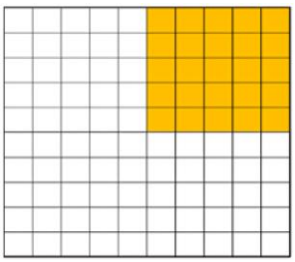
To examine the sophisticated concepts associated with fractions and decimals, Rittle-Johnson et al. (2001) introduced bar models and number lines as initial representation of fraction and decimals. On the other hand, Buckley and Waring (2013) also mentioned that using visual models and diagrams in teaching and learning is a well-established and time-honored way to support students' understanding.

According to Malaysia education mathematic year 4, 5, and 6 textbooks, the topic of fraction and decimal are mostly presented by using a variety of images. For example, pie chart is used to represent the pizza, and a square picture represents a cake. In addition, the bar model also can be found in the mathematic textbook in helping students to understand better. This means that the Ministry of Education Malaysia also supports the stance of using images in learning fraction and decimal for primary school students.

The "Transcard" model is designed according to the images that represent both fraction and decimal. In school, fraction and decimal are teach in different topics in different ways. It causes the students' inability to really understand the concept of equivalent fraction and decimal, for example, ½ is equal or same with 0.5. When we let the student look at a fraction number, for example 3/4, they cannot think of its decimal value–0.75. With this model, the student can clearly and quickly understand the equivalent fraction and decimal. The reasoning behind this is the "Transcard" model consists of two main components, fraction transparency card and decimal transparency card. The student only needs to place the decimal transparency card above the fraction transparency card, then they can have an overview of the answers within those cards. Besides that, the student also can use this model for other purposes namely addition, subtraction and multiplication fraction.

The "Transcard" ideology comes from the concrete and visual manipulative. It is the combination of concrete tool and visualization based learning. With the use of these tools, it helps students to easily understand the concept underlying fractions and decimals. **Table 1** shows the way of using the "Transcard".

Table 1. Using the "Transcard" model in converting fraction to decimal

Step	Description	Image
1	Draw the card to represent $\frac{1}{4}$	$\frac{1}{4} = ?$ 
2	Just place the transparency over the card to see the answer	
3	The answer is 0.25	

METHODOLOGY

Research Design

This research employed a mixed-method research which comprises of both quantitative and qualitative data analysis. This research benefits from using the mixed-method approach due to the need to analyze the data in numerical value and also the need to obtain data where numerical values cannot reach and explain. Creswell and Plano Clark (2017) describe mixed methods research as an approach in which researchers integrate elements from both qualitative and quantitative methodologies to achieve a comprehensive understanding of the research topic.

This research was comprised of 30 year 5 primary school respondents from a Chinese national-type school. The respondents have an intermediate proficiency level in mathematics. This research was conducted over the course of four weeks. The same respondents were given the approach of using the "Transcard" model learning method. The same teacher and respondents participated in the remedial activities. A pre- and post-test were also given to investigate if there is any improvement in their achievement before and after the introduction of such an approach. Semi-structured interviews were also conducted after the execution of plans to gain a broader view of the students regarding the use of the model.

The quantitative data was analyzed using the SPSS 25.0 software to calculate their mean and standard deviation to answer research question 1 of the research questions. A paired sample t-test was used due to the research involving only one group of respondents. paired sample t-test was also used to analyze if there is a significant difference between pre- and post-test scores. As for qualitative data, the data was analyzed by using thematic analysis taken from the interview with the respondents after the intervention. The keywords were then put into categories.

Instrument

Equivalent fractions and decimals tests

The researcher will conduct pre-tests before introducing the intervention and post-test after the intervention. The questions will be checked by some specialist mathematics teachers beforehand to make sure the questions do not deviate from the main concept and also to prove the reliability and validity of the test. All participants will partake in the test to identify students' level of performance before and after the intervention in changing fractions to decimals. The topics of equivalent fractions and decimals are chosen to put the "Transcard" model into application. Questions for pre and post-test will be different, but the level of difficulty remains the same. The questions are standardized. All respondents are asked exactly the same questions in the same order.

Table 2. Method of data collection

Research questions	Methods of data collection
Research question 1: Is there any significant difference students' achievement in fractions and decimals after using the "Transcard" model?	Pre- and post-test [paired sample t-test]
Research question 2: What are students' perceptions after using the "Transcard" model?	Interview [thematic analysis]

Table 3. Paired samples statistics

		Mean	N	Standard deviation	Standard error mean
Pair 1	Pre-test	41.0000	30	18.26057	3.33391
	Post-test	78.0000	30	13.99507	2.55514

Table 4. Paired samples test

	Paired differences					t	df	Sig. (2 tailed)
	Mean	Standard deviation	Standard error mean	95% confidence interval of the difference				
				Lower	Upper			
Pre-/post-test	-37.000	15.346	2.801	-42.730	-31.269	-13.20	29	.000

Interview

The second instrument was a semi-structured interview. Conradie (2012) states that interviewing is a useful strategy for examining the construction and negotiation of meaning in a natural setting. For this study, the interview session consisted of five questions related to the perceptions of the students. Three participants were randomly selected for the interview. The interview was conducted face-to-face and using questions that were prepared earlier. The interview was recorded using an audio recorder with the permission of the interviewees.

Methods of Data Collection

The data collection was done using quantitative approaches to gain a broader understanding of the different approaches. For quantitative approaches, the quantitative data was collected through interview and the pre- and post-test scores. The respondents were given a briefing on the objectives and aims of the intervention before the pre-test to enable them to understand what the intervention was aimed at. **Table 2** shows the method of data collection for each research question:

To collect data for the first research question, a pre- and post-test were conducted to determine their score. A pre-test was given before the intervention. Students were given 15 minutes to finish the entire test paper. After the 2 weeks intervention with six times appointments by teaching the students using the "Transcard" model, the students went through the post-test. The test was marked by three teachers with the first teacher (using red pen) been the primary marker while the second (using blue pen) and third teacher (using black pen) served to review and justify the marks given. The second and third markers were senior teachers with more than eight years of teaching experience in the mathematics field. This was to enhance the reliability and validity of the marks given. Again, the final scores for each individual were recorded into SPSS for comparison with the pre-test scores. To collect data for all three research questions, interviews were done right after the pre- and post-test to harvest and garner the students' perception while applying the "Transcard" model.

RESULTS

To determine if the difference is statistically significant, a paired-sample t-test was used**.** The analysis of data, as shown in **Table 3** and **Table 4**, indicates that there was a significant value between the pre- and post-test scores as the students improved by a large margin after using the "Transcard" model. There was a significant difference in the scores for pre-test scores (mean [M] = 41, standard deviation [SD] = 18.26) and post test scores (M = 78, SD=13.99); t [29] = -13.20, p = 0.000. The Sig. (p) value is 0.000 which is less than alpha 0.05 and thus shows that there is a significant effect after intervention using the "Transcard" model. These results suggested that the "Transcard" model has a more significant impact on students' acquisition of the fractions and decimals as compared to traditional instruction, based on the previous results. Furthermore, the mean difference between pre- and post test scores from the paired sample test shows a significant improvement (M = -37, SD= 15.35).

Table 5 shows codes that were deduced from the transcripts. Codes were searched and identified to answer the second research question. All codes were assembled to find suitable themes for the study.

Table 6 shows that five themes were generated from the transcript. This analysis provides insights into how different performance levels influence students' perceptions of and intentions to use the "Transcard" model. Students' perceptions after using the "Transcard" model are influenced by factors such as their performance levels, challenges with understanding and application, enjoyment and interest, perceived effectiveness, and intentions for future use. While some students may find the model challenging initially, others perceive it as a valuable and effective tool for learning fractions and decimals, indicating its potential to enhance mathematics education

Table 5. Participants' transcripts and codes

Participant	Transcript	Codes
Low performance level (excerpt 1)	Teacher: What do you think about the "Transcard" model? S24 : Very difficult. Teacher: How do you feel when you use the "Transcard" model? S24: Hmm … I don't know how to apply. Teacher: Why do you feel that way? S24: Because it has too many pictures that I need to combine and understand. Teacher: Do you think the "Transcard" model is able to help you? S24: Maybe yes, because it is fun when combined half shaded picture with a hundred grids picture. Teacher: Will you use this "Transcard" model in the future? Why? S24: If I understand how to apply, I will use it because it is interesting.	Difficulty understanding Challenging to apply Too many pictures Fun Will use in the future
Medium performance level (excerpt 2)	Teacher: What do you think about the "Transcard" model? S23: It is fun and interesting. Teacher: How do you feel when you use the "Transcard" model? S23: It is fun and easy to get the answers. Teacher: Why do you feel that way? S23: Because it is easy to understand and easy to apply. Teacher: Do you think the "Transcard" model is able to help you? S23: Yes, but some questions are hard to be applied with the same method. Can you teach me again? Teacher: Will you use this "Transcard" model in the future? Why? S23: Of course. It is easy to use.	Fun Interesting Easy to get answers Easy to understand Easy to apply Helpful Difficulties with certain questions. Easy to use
High performance level (excerpt 3)	Teacher: What do you think about the "Transcard" model? S9: It is very easy to apply. Teacher: How do you feel when you use the "Transcard" model? S9: I personally think it is very helpful . I understood better and it helps me to answer the questions. Teacher: Why do you feel that way? S9: Because the method is very unique, and it uses images. Teacher: Do you think the "Transcard" model is able to help you? S9: Yes, because it is easier to apply. So, I can remember how to use this method in future. Teacher: Will you use this "Transcard" model in the future? Why? S9: Yes. I already understood and it is easy to apply.	Easy to apply Helpful Aids in understanding Aids in answering questions Unique methods Using images Easy to apply Enjoyable to use Reasons for future use

Table 6. Themes based on the transcription codes

Themes	Codes
Perceived difficulty of the "Transcard" model	Difficulty understanding, too many pictures, challenging to apply, and difficulties with certain questions
Perceived enjoyment and interest	Fun, interesting, and enjoyable to use
Perceived ease of use and understanding	Easy to understand, easy to apply, easy to get answers, and easy to use
Perceived effectiveness of the "Transcard" model	Helpful, aids in understanding, and aids in answering questions
Intentions to use the "Transcard" model in the future	Will use in the future and reasons for future use

Analysis of Themes

Students' perceptions of the "Transcard" model vary depending on their performance levels. While some students find it difficult to understand and apply, others perceive it as enjoyable, easy to use, and effective.

Low performance level

Perceived difficulty of the "Transcard" model: The student finds the model very difficult to use due to the abundance of pictures that need to be combined and understood.

Perceived enjoyment and interest: Despite the difficulty, the student finds the model fun when certain elements are combined.

Perceived effectiveness of the "Transcard" model: The student believes the model may help if understood but expresses uncertainty about future use.

The student expresses willingness to use the model if understanding improves.

Medium performance level

Perceived enjoyment and interest: The student finds the model fun and interesting to use.

Perceived ease of use and understanding: The student finds the model easy to understand and apply to most questions.

Perceived effectiveness of the "Transcard" model: While generally helpful, the student notes some difficulties with certain questions.

Intentions to use the "Transcard" model in the future: The student expresses a clear intention to use the model in the future due to its ease of use.

High performance level

Perceived ease of use and understanding: The student finds the model very easy to apply to and personally helpful.

Perceived effectiveness of the "Transcard" model: The student attributes understanding and improved answering to the unique method using images.

Intentions to use the "Transcard" model in the future: The student confidently states intentions to use the model in the future due to clear understanding and ease of application.

DISCUSSION

Discussion on Significant Difference Students' Achievement in Fractions and Decimals After Using the "Transcard" Model

The findings for research question 1 were hinged on comparing the pre- and post-test results. The first research question investigates if there is any significant difference of students' achievement in fractions and decimals after using the "Transcard" model. Data were analyzed using SPSS 25.0 software. The paired-sample t-test results reveal a substantial increase in students' scores from the pre-test to the post-test after using the "Transcard" model. The mean score on the pre-test was 41, while the mean score on the post-test rose to 78. This substantial increase in scores demonstrates the effectiveness of the "Transcard" model in enhancing students' understanding and proficiency in fractions and decimals. The statistical analysis indicated that $p = 0.00$ (which is less than the alpha level of 0.05). Therefore, the null hypothesis is rejected. It showed there is a significant difference in participants' achievement before and after the implementation of the "Transcard" model. This suggests that the improvement in scores is not due to random chance but is indeed a result of the intervention using the "Transcard" model.

Moreover, the results suggest that the "Transcard" model could be more effective than traditional instructional methods that do not utilize such interventions for teaching fractions and decimals. These findings are consistent with those of Dewaard et al. (2014), who used programmed cards in their study and reported significant improvements in the experimental group compared to the control group The comparison between the intervention group using the "Transcard" model and a hypothetical control group receiving traditional instruction can be suggested for the future research to emphasize the superiority of the model in promoting learning outcomes. Also, while the results are promising, further research is warranted to explore the long-term effects of using the "Transcard" model on students' mathematical proficiency and retention. Additionally, investigating its effectiveness across different student populations and educational settings can provide valuable insights into its generalizability and applicability.

Discussion on Students' Perception After Using the "Transcard" Model

Research question 2 concerns participants' perception when they applied the "Transcard" model. Interviews were carried out with participants of three different performance levels in the post-test. Each conversation was transcribed, coded and categorized according to certain emerged themes as the data was analyzed using thematic analysis. Based on the data, it was reported that five themes were induced from the data through the analysis, namely perceived difficulty of the "Transcard" model, perceived enjoyment and interest, perceived ease of use and understanding, perceived effectiveness of the "Transcard" model and intentions to use the "Transcard" model in the future. The overall analysis of themes shows that students' perceptions and experiences with the "Transcard" model vary based on their performance levels. Lower-performing students struggle with understanding and applying the model, but still find some aspects enjoyable. This phenomenon is consistent with findings by Abdul Jabbar and Felicia (2015), who noted that complex gaming elements can promote engagement even when challenging, and Henritius et al. (2019), who discussed the coexistence of enjoyment and difficulty in educational settings. Medium-performing students generally find the model easy to understand and intend to use it in the future, despite encountering occasional challenges. This is supported by Kahu and Nelson (2018), who emphasized the role of perceived utility and confidence in the adoption of new learning methods. Higher-performing students perceive the model as highly effective, easy to use, and express clear intentions for future use aligning with findings from Stone and O'Shea (2019) on the importance of perceived effectiveness and ease of use in educational tools.

One notable contrast between the themes is the interplay between perceived difficulty and enjoyment. While students at all performance levels acknowledge the "Transcard" model's complexity, a spectrum of enjoyment is associated with its use. Lower-performing students express difficulties in understanding and applying the "Transcard" model, citing challenges such as the abundance of pictures and complexity. This indicates that certain students may require additional support or instruction to fully comprehend and utilize the model. Henritius et al. (2019) highlighted the need for additional support in similar contexts, emphasizing that effective instructional design can mitigate these challenges. Despite finding it difficult, some students still find elements of the model enjoyable, particularly when certain elements are combined or when the model is perceived as fun and interesting. This suggests that engagement and interest can exist alongside challenges, a notion supported by the work of Farrell and Brunton (2020), who found that self-efficacy and engagement are critical to overcoming initial challenges. Another key aspect is the relationship between perceived effectiveness and ease of use. Higher-performing students tend to perceive the model as both highly effective and easy to use, while lower-performing students struggle with both aspects. This highlights the importance of simplicity and clarity in educational tools for maximizing their effectiveness across different skill levels.

The intention to use the "Transcard" model in the future varies among students, influenced by their perceived ease of understanding and effectiveness. Kahu and Nelson (2018) highlighted that perceived utility and confidence play significant roles in shaping students' adoption of new learning methods. While some students express uncertainty or conditional intentions based

on improved understanding, others confidently assert their plans for future utilization. Each performance level offers unique insights into students' experiences with the "Transcard" model. Lower-performing students provide valuable feedback on areas of difficulty and potential barriers to adoption, while higher-performing students offer perspectives on the model's strengths and effectiveness. Integrating these diverse perspectives can inform the refinement and optimization of educational interventions to cater to a wide range of learners (Stone & O'Shea, 2019).

The themes generated from the transcripts highlight the importance of tailoring educational resources to meet the diverse needs and preferences of students across different performance levels. Understanding students' perceptions, challenges, and intentions regarding learning tools like the "Transcard" model can inform instructional strategies, curriculum design, and resource allocation to optimize learning outcomes for all students. Abdul Jabbar and Felicia (2015) and Farrell and Brunton (2020) both emphasize the necessity of designing educational interventions that are adaptable to varied learner needs. Overall, these themes shed light on the complex interplay between student perceptions, experiences, and intentions regarding educational tools, providing valuable insights for educators, curriculum developers, and policymakers striving to enhance learning experiences and outcomes (Henritius et al., 2019).

CONCLUSION

Earlier in this study, it was discussed that students usually had numerous misconceptions towards fractions and decimals which led to many other problems such as budding frustration and boredom. However, based on the findings from the test and interview conducted, all the findings indicate that students could eliminate their dislike towards fractions and decimals questions by using the "Transcard" model. The results showed that there was a significant difference in students' achievement after the implementation of the method. There were positive impacts not only on the results, but also on participants' attitude towards the questions. This method helped them to build their confidence as they were excited and courageous enough to try to answer all the questions given. Therefore, teachers need to put in extra effort in order for students to understand the concept of fractions and decimals although it may consume a lot of time to guide them in the beginning.

Certainly, the "Transcard" model can be a major help in learning for long-term mathematics success. It should be emphasized in education as it contributes to students' learning by bringing positive impacts to the students. It enhances students' understanding regarding fractions and decimals problems as it helps to make abstract concepts into a concrete one. Other than that, it can be applied to many different fractions and decimals operations. It can help the students to apply these concepts to a variety of challenging questions. Lastly, the method makes mathematics easier and more fun. In conclusion, the significant improvement in students' achievement in fractions and decimals following the intervention using the "Transcard" model emphasizes its effectiveness as an instructional tool. These findings offer compelling evidence for the adoption of innovative, hands-on approaches to mathematics education.

Author contributions: NAKAFK: visualization and writing–original draft; **HWQ:** conceptualization and investigation; **& SO:** supervision and writing–review and editing. All authors have agreed with the results and conclusions.

Funding: This study was partially supported by the Ministry of Higher Education under the Fundamental Research Grant Scheme (FRGS/1/2022/SSI07/UTM/02/3).

Ethical statement: The authors stated that this study did not require ethics committee approval. The study was conducted with official authorisation from the Education Policy Planning and Research Division (EPRD), Ministry of Education and this approval followed the proposal's endorsement by the university. The authors further stated that the highest ethical practices of scientific research were followed during the study.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Abdul Jabbar, A. I., & Felicia, P. (2015). Gameplay engagement and learning in game-based learning: A systematic review. *Review of Educational Research, 85*(4), 740-779. https://doi.org/10.3102/0034654315577210

Alboroto, S. M. P. (2021). Indigenized domino activity method: Its effectiveness on fraction preliminaries skills of Blaan pupils. *ASEAN Journal of Basic and Higher Education, 4*(1), 1-14.

Aliyu, J., Osman, S., Daud, M. F., & Kumar, J. A. (2021). Mathematics teachers' pedagogy through technology: A systematic literature review. *International Journal of Learning, Teaching and Educational Research, 20*(1), 323-341. https://doi.org/10.26803/ijlter.20.1.18

Alkhateeb, M. A. (2019). Common errors in fractions and the thinking strategies that accompany them. *International Journal of Instruction, 12*(2), 399-416. https://doi.org/10.29333/iji.2019.12226a

Bakar, K. A., Mohamed, S., Yunus, F., & Karim, A. A. (2020). Use of multiple representations in understanding addition: The case of pre-school children. *International Journal of Learning, Teaching and Educational Research, 19*(2), 292-304. https://doi.org/10.26803/ijlter.19.2.18

Booth, J. L., & Newton, K. J. (2012). Fractions: Could they really be the gatekeeper's doorman? *Contemporary Educational Psychology, 37*(4), 247-253. https://doi.org/10.1016/j.cedpsych.2012.07.001

Buckley, C., & Waring, M. J. (2013). Using diagrams to support the research process: Examples from grounded theory. *Qualitative Research, 13*(2), 148-172. https://doi.org/10.1177/1468794112472280

Can, D. (2020). Supporting learning trajectories for the development of number concept: Digital games. *Journal of Theoretical Educational Science, 13*(4), 663-684. https://doi.org/10.30831/akukeg.692165

Ching, B. H.-H., Li, X. Y., & Chen, T. T. (2024). Cross-notation knowledge of rational numbers predicts fraction arithmetic. *British Journal of Educational Psychology, 94*(3), 717-737. https://doi.org/10.1111/bjep.12674

Conradie, T. (2012). Co-constructing knowledge in news interviews: An application of Hardy and Palmer's (1998) discourse model. *Southern African Linguistics and Applied Language Studies, 30*(4), 497-509. https://doi.org/10.2989/16073614.2012.750823

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

Deringöl, Y. (2019). Misconceptions of primary school students about the subject of fractions. *International Journal of Evaluation and Research in Education, 8*(1), 29-38. https://doi.org/10.11591/ijere.v8i1.16290

Devlin, K. (2021). Teaching mathematics as a way of thinking–Not calculating. *Eesti Haridusteaduste Ajakiri. Estonian Journal of Education, 9*(1), 33-59. https://doi.org/10.12697/eha.2021.9.1.02b

Dewaard, R. J., Jagmin, N., Maisto, S. A., & Mcnamara, P. A. (2014). Effects of using programmed cards on learning in a museum environment. *The Journal of Educational Research, 67*(10), 457-460. https://doi.org/10.1080/00220671.1974.10884679

DeWolf, M., Grounds, M. A., Bassok, M., & Holyoak, K. J. (2014). Magnitude comparison with different types of rational numbers. *Journal of Experimental Psychology: Human Perception and Performance, 40*(1), 71-82. https://doi.org/10.1037/a0032916

Farrell, O., & Brunton, J. (2020). A balancing act: A window into online student engagement experiences. *International Journal of Educational Technology in Higher Education, 17*, Article 25. https://doi.org/10.1186/s41239-020-00199-x

Fitri, L. S., & Tantri, I. D. (2023). Analysis of error in solving fraction and decimals viewed from the Nolting theory in Madrasah Ibtidaiyah students. In *Proceedings of the Saizu International Conference on Transdisciplinary Religious Studies* (pp. 221-228). https://doi.org/10.24090/icontrees.2023.341

Flores, M. M., Hinton, V. M., & Meyer, J. M. (2020). Teaching fraction concepts using the concrete-representational-abstract sequence. *Remedial and Special Education, 41*(3), 165-175. https://doi.org/10.1177/0741932518795477

Flores, R., Inan, F. A., Han, S., & Koontz, E. (2019). Comparison of algorithmic and multiple-representation integrated instruction for teaching fractions, decimals, and percent. *Investigations in Mathematics Learning, 11*(4), 231-244. https://doi.org/10.1080/19477503.2018.1461050

González-Forte, J. M., Fernández, C., Van Hoof, J., & Van Dooren, W. (2020). Various ways to determine rational number size: An exploration across primary and secondary education. *European Journal of Psychology of Education, 35*(3), 549-565. https://doi.org/10.1007/s10212-019-00440-w

Henritius, E., Löfström, E., & Hannula, M. S. (2019). University students' emotions in virtual learning: A review of empirical research in the 21st century. *British Journal of Educational Technology, 50*(1), 80-100. https://doi.org/10.1111/bjet.12699

Hurst, M. A., & Cordes, S. (2018). Children's understanding of fraction and decimal symbols and the notation-specific relation to pre-algebra ability. *Journal of Experimental Child Psychology, 168*, 32-48. https://doi.org/10.1016/j.jecp.2017.12.003

Jabal, R. F., & Rosjanuardi, R. (2019). Identifying the secondary school students' misconceptions about number. *Journal of Physics: Conference Series, 1157*(4), Article 042052. https://doi.org/10.1088/1742-6596/1157/4/042052

Jordan, N. C., Hansen, N., Fuchs, L. S., Siegler, R. S., Gersten, R., & Micklos, D. (2013). Developmental predictors of fraction concepts and procedures. *Journal of Experimental Child Psychology, 116*(1), 45-58. https://doi.org/10.1016/j.jecp.2013.02.001

Kahu, E. R., & Nelson, K. (2018). Student engagement in the educational interface: Understanding the mechanisms of student success. *Higher Education Research & Development, 37*(1), 58-71. https://doi.org/10.1080/07294360.2017.1344197

Kurikulum, P. P. (2012). *Kurikulum standard sekolah menengah (KSSM)* [Secondary school standard curriculum (KSSM)]. Kementerian Pelajaran Malaysia.

Lamon, S. J. (2007). Rational numbers and proportional reasoning: Toward a theoretical framework for research. In F. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 629-668). Information Age Publishing.

Li, Y., & Schoenfeld, A. H. (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *International Journal of STEM Education, 6*, Article 44. https://doi.org/10.1186/s40594-019-0197-9

Li, Y., Ye, H., Ye, F., Liu, Y., Lv, L., Zhang, P., Xiao, Z., & Zhou, Y. (2021). The current situation and future prospects of simulators in dental education. *Journal of Medical Internet Research, 23*(4), Article e23635. https://doi.org/10.2196/23635

Lin, X. (2022). Difficulties in learning and teaching numbers: A literature review on the obstacles and misconceptions of learners and instructors. *Journal of Contemporary Educational Research, 6*(6), 111-118. https://doi.org/10.26689/jcer.v6i6.4073

Lin, Y., Zhou, Y., Wang, S., & Wijaya, T. T. (2020). Lesson design of geometric sequences based on the 6-question cognitive rheory. *Journal on Education, 2*(4), 313-322.

NCTM. (2009). *Focus in high school mathematics: Reasoning and sense making*. National Council of Teachers of Mathematics.

Ni, Y., & Zhou, Y.-D. (2005). Teaching and learning fraction and rational numbers: The origins and implications of whole number bias. *Educational Psychologist, 40*(1), 27-52. https://doi.org/10.1207/s15326985ep4001_3

NMAP. (2008). Foundations for success. The final report of the National Mathematics Advisory Panel. *National Mathematics Advisory Panel*. https://eric.ed.gov/?id=ED500486

Pant, V. (2019). Conceptual understanding and procedural knowledge of fractions: How to learn and how to teach. In M. Shelley, & S. A. Kiray (Eds.), *Education research highlights in mathematics, science and technology 2019* (pp. 17-35). ISRES Publishing.

Rashid, M. (2024). Addressing misconceptions in mathematics education: Understanding, implications, and solution. *Skyline University Colege*. https://www.skylineuniversity.ac.ae/knowledge-update/from-different-corners/addressing-misconceptions-in-mathematics-education-understanding-implications-and-solutions

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

Rosenberg-Lee, M., Varma, S., Cole, M. W., & Abreu-Mendoza, R. A. (2023). Competing numerical magnitude codes in decimal comparison: Whole number and rational number distance both impact performance. *Cognition, 241*, Article 105608. https://doi.org/10.1016/j.cognition.2023.105608

Sarama, J., & Clements, D. H. (2009). "Concrete" computer manipulatives in mathematics education. *Child Development Perspectives, 3*(3), 145-150. https://doi.org/10.1111/j.1750-8606.2009.00095.x

Schiller, L. K., & Siegler, R. S. (2022). Integrated knowledge of rational number notations predicts children's math achievement and understanding of numerical magnitudes. *PsyArXiv*. https://doi.org/10.31234/osf.io/42u3a

Shin, M., & Bryant, D. P. (2015). Fraction interventions for students struggling to learn mathematics: A research synthesis. *Remedial and Special Education, 36*(6), 374-387. https://doi.org/10.1177/0741932515572910

Singh, P., Hoon, T. S., Nasir, N. A. M., Han, C. T., Rasid, S. M., & Hoong, J. B. Z. (2021). Obstacles faced by students in making sense of fractions. *The European Journal of Social & Behavioural Sciences, 30*(1), 34-51. https://doi.org/10.15405/ejsbs.287

Stone, C., & O'Shea, S. (2019). Older, online and first: Recommendations for retention and success. *Australasian Journal of Educational Technology, 35*(1), 57-69. https://doi.org/10.14742/ajet.3913

Tian, J., & Siegler, R. S. (2018). Which type of rational numbers should students learn first? *Educational Psychology Review, 30*, 351-372. https://doi.org/10.1007/s10648-017-9417-3

Ying, C. L., Osman, S., Kurniati, D., Masykuri, E. S., Kumar, J. A., & Hanri, C. (2020). Difficulties that students face when learning algebraic problem-solving. *Universal Journal of Educational Research, 8*(11), 5405-5413. https://doi.org/10.13189/ujer.2020.081143