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# MASTERING FRACTIONS AND INNOVATING WITH THE STATION ROTATION MODEL IN BLENDED LEARNING

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**ABSTRACT**

This study explores the effectiveness of the Station Rotation Model (SRM) in adding and subtracting fractions. A mixed-method design was conducted through convenience sampling of 31 students from Year 9. They were given pre-and post-tests consisting of ten questions for collecting quantitative data. Students' online questionnaires consisting of five-point Likert scales, two open-ended questions, and structured interviews with six selected students were further analysed to collect qualitative data. A non-parametric test was adopted to compare the results of the achievement tests. Wilcoxon's signed rank test findings showed a significant difference (p=0.024) and a large effect size (rb=0.558) between the achievement test scores. This indicates that the SRM positively impacts students' performance in adding and subtracting fractions. Three major themes emerged from the questionnaires and interviews about students' perception of using SRM: Manipulatives make learning fun, enjoyment of working in a group, and challenges in implementing the SRM. Overall, students positively viewed their experiences with the SRM as an approach to teaching and learning. The study offers insights into SRM's impact on student learning, aiding educators amd researchers assess its future application, especially in mathematics education.



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## 1. INTRODUCTION

Nowadays, Blended Learning (BL) approaches are widely embedded in educational systems worldwide to provide students with meaningful instructional activities that suit their learning needs (Gobbo et al., 2022; Han & Wang, 2021). Due to the changes brought by the Industrial Revolution, BL has emerged as one of the potential education developments and reforms (Lastariwati et al., 2021). The popularity of BL has risen due to the advancement of the internet (Bhardwaj et al., 2022). It enables teachers and students to utilise technology to foster a modern learning environment.

Teaching and learning can be conducted face-to-face or in a dual setting, asynchronously or synchronously (Chaeruman et al., 2018). Virtual and BL are categorised as digital learning, which acts as an umbrella for any terms that utilise educational technology. Virtual learning is conducted online without traditional classroom settings (Leite et al., 2022). This learning model benefits students by allowing them to access and study the content lesson at their preferred time and place, thus creating a comfortable learning environment (Mishra et al., 2020). BL, on the other hand, is a mixture of virtual and face-to-face learning (Anthony Jnr, 2022; Bower et al., 2015). It helps teachers design appropriate learning activities that meet the requirements of students in their classrooms while also boosting and extending the overall efficacy of the teachers (Ololube, 2011). It is intended that through BL, students will have some degree of control over the time, location, path, and pace of their learning. Several studies revealed that BL has improved student engagement (Halverson & Graham, 2019; Sahni, 2019) and significantly incorporates the values of self-regulated learning among students (Laer & Elen, 2017).

BL is a combination of both synchronous and asynchronous learning. Synchronous learning occurs when teachers and students use the same platform at an agreed time (Timonen & Ruokamo, 2021). It is further distinguished into synchronous physical and virtual learning (Khan, 2005). It is known as synchronous physical learning when teaching and learning occur at the same time and location, such as in the classroom (Moorhouse & Wong, 2022). Meanwhile, synchronous virtual learning is where teaching and learning happen simultaneously, but teachers and students are at different places (Moorhouse et al., 2021). Asynchronous learning is not constrained by a set timetable, thus allowing students to learn flexibly (Shahabadi & Uplane, 2015).

Staker and Horn (2013) defined BL as combining traditional and modern learning approaches by instilling several forms of e-learning supported by teachers and advanced technologies. It is also known as hybrid learning, in which the teachers will design different learning approaches for their students (Greener, 2021). The importance of media and internet-based resources in BL systems was also highlighted by Palioura and Dimoulas (2022). It improves student satisfaction by enabling them to learn independently (Faradillah & Hadi, 2020). BL also combines the principles of peer teaching and prioritises student-centred learning (Osguthorpe & Graham, 2003). Learning online helps to enhance students' retention by allowing more time to access information (Fox & Mackeogh, 2003).

There are four BL methods: rotation, flex, self-blend, and enriched-virtual (Staker & Horn, 2013). Each model has its characteristics and learning approaches to achieve an optimal learning environment. When choosing a suitable learning model for a digital classroom, teachers must consider students' learning styles and use learning outcomes to gauge the model's efficacy (Kintu et al., 2017).

The Station Rotation Model (SRM) will be the primary focus of this study. Teachers in Brunei Darussalam are fully supported and provided with learning materials to deploy BL successfully in their classrooms. One of the Ministry of Education's initiatives to improve students' numeracy levels is the implementation of the Teaching for Mathematics Mastery Framework through the Literacy and Numeracy Coaching Programme (LNCP, 2017). It focuses on students' enjoyment of learning mathematics, confidence in solving mathematics problems and applying their knowledge to a new context. As part of the Brunei Teachers' Standards – Teacher's Performance Appraisal framework, teachers should be able to design various student activities to motivate, engage the students, and support their conceptual understanding (Ministry of Education, 2015). Teachers must also create appropriate collaborative learning tasks that allow students to contribute and work with one another.

Therefore, the execution of the SRM in this present study intends to offer guidance for teachers who desire to use it in their digital classroom settings.

The model involves students rotating between online, collaborative, and teacher-guided stations (Ogude & Chukweggu, 2019). Each station has designated learning activities for students to turn to the adjacent station on a set schedule (Walne, 2012). In addition, the rotation model involves students rotating between online learning and face-to-face learning interaction. It is further classified into four sub-categories: station rotation, lab rotation, flipped classroom, and individual rotation. One of the rotation's learning activities must include using technology. Teachers use a designated time for students to complete the tasks before rotating to subsequent learning activities (Wang et al., 2021). The rotation concept has been around for a while, but what makes this approach unique is how online learning is integrated.

The teaching and learning in the flex model are done entirely online. Students will be responsible for learning the course content independently, most notably at their flexible time and place. Teachers will assess and record students' work, identify outliers on students' assessments, and provide additional support and guidance to students in need. According to Yang et al. (2016), the flex model requires students to have a sense of self-directed study. Teachers will have a small group or one-to-one tutoring to combat students' difficulties in learning the subject matter.

The modality where students need to participate in online classes with the assistance of an online teacher is called a self-blend. It allows students to foster an understanding of the course content taught in their school. According to Hrastinski (2019), students must be highly motivated and responsible for this hybrid learning approach to be efficient. The self-blend model is the right approach for students who want to enrol in additional classes. Unlike the self-blend model, the enhanced virtual model includes a whole school experience. It is a teaching strategy where students must participate in face-to-face instruction with the teacher but can then complete their learning tasks at their own pace outside school. In this learning approach, numerous online hybrid programmes are created to complement students' face-to-face learning in the classroom (Hrastinski, 2019).

The learning approach in the SRM is conducted wholly in a school environment. It differs from other rotation models because it only involves classroom rotation (Truitt & Ku, 2018). Ogude and Chukweggu (2019) described the SRM as a strategy that requires teachers to set up numerous stations so students can rotate around the station. Teachers can adjust the learning modalities of the SRM according to students' needs. The number of stations formed is not restricted to three stations only, but teachers are free to decide according to the total number of students they have to meet the needs of individual classrooms. Once teachers have agreed on the total number of stations, they must group the students and assign them to their respective stations. Students will rotate from one station to another, at least one with an online learning component. The other two stations can be used for teacher-led teaching and collaborative activities (Walne, 2012).

The effectiveness of SRM has been extensively reported, and many have yielded positive impacts on students' performance at any school level (Ayob et al., 2020). One of the favourable outcomes of the SRM is students' academic achievement. The use of SRM has shown a positive outcome in students' performance among secondary school students in learning science (Hamida et al., 2021). The model was applied to mathematics classrooms among secondary students in other studies (see Akinoso et al., 2020; Mendoza & Lapinid, 2021). It was discovered that the SRM had improved students' overall scores significantly. Similar research was led by Belazi and Ganapathy (2021); the SRM was integrated among secondary school students, and results showed that students improved their writing performance.

Nugraha (2020), in her study, revealed that the use of the SRM positively impacted students' critical thinking. The study was conducted among primary school students to compare the effectiveness of conventional and BL. It is believed that SRM can foster an environment where learning is active, independent, and problem-solving. Results also exhibited that the SRM can enhance students' creative thinking (Nida et al., 2020). The SRM was selected due to its flexibility in allowing students to experience direct, cooperative, and online learning. In learning mathematics, students must have mathematical thinking skills to gather and evaluate information into a new form of understanding (Lince, 2016).

The integration of the SRM has fostered students' confidence and motivation in learning (Ocak, 2010). Learning stations were proven to execute immediate satisfaction and excitement among students to learn the subject (Nugraha, 2020). Students who underwent the SRM reported feeling happy and less likely to get bored during class (Fitri & Zahari, 2019). The method can also reduce anxiety among students as it affects students' motivation, confidence, and excitement (Ozkan & Koseler, 2009). A study by Belazi and Ganapathy (2023) in a school in Libya revealed that using SRM resulted in positive educational effects. The students also expressed needing more time to complete each learning activity in the SRM. Nevertheless, BL has been proven to enhance student engagement, conceptual understanding, and knowledge outcomes.

Several studies discovered that when used in unification with technology, the SRM allowed students to learn independently at their preferred time and pace (Mahalli et al., 2019). The syntax of the BL model requires students to have complete responsibility for their learning compared to the conventional way of teaching (Manjanai & Shahrill, 2017; Wahyuni et al., 2019). George-Walker and Keeffe (2010) pointed out students' views of BL, which they agreed helped them to possess self-directed learning and self-efficacy in interacting with other members. The integration of virtual SRM has proven to improve students' participation and interaction in online learning (Skolastika, 2020). Thus, the SRM can help teachers accommodate various students' learning abilities in a single classroom.

Garrison and Kanuka (2004) discovered that implementing the SRM in a classroom is flourishing as it is also considered a low-risk strategy, especially in the current era of technological advancements. Technology can build students' creativity and enhance their self-determination to learn (Szymkowiak et al., 2021). It also improved their skills in acquiring information, presentation, and visualisation (Ali et al., 2015; Ali et al., 2022). The strategy transformed students into digital literate as technology can stimulate students' freedom in learning (Nugraha, 2020). When exposed to computer technology, students are seen to be more interactive and engaging, positively correlating with skill acquisition and knowledge gain (Hidayat & Aripin, 2023; Huda et al., 2017).

With the development of advanced technology and internet accessibility, being physically present in the classroom is not the only learning option, especially when the world is hit by a pandemic such as COVID-19 (Hidayat et al., 2023; Matzavela & Alepis, 2021; Rohaeti et al., 2023). Teachers need to comprehend a new learning model that complements the current digitalised era as an alternative to the conventional way of teaching (Gobbo et al., 2022). However, a lack of literature on the SRM might allow teachers to implement this approach in their classrooms (Truitt & Ku, 2018). Teachers may need more guidance to incorporate the approach into their teaching and learning. Often, this leads to frustration, discouraging teachers from exploring the model.

Fractions have been taught since primary school, and their difficulty level is subsequently elevated as students progress to secondary school (Abbas et al., 2022; Abbas et al., 2020; Finti et al., 2016; Japar et al., 2022; Low et al., 2020; Simpol et al., 2017). Several studies revealed that students often needed help understanding the conceptual procedures of adding and subtracting fractions, especially with unlike denominators

(Wulandari & Amir, 2022). In Brunei, the teachers often used physical manipulative or 'hands-on' experience to teach the four operations of fractions (Abbas et al., 2022; Abbas et al., 2020; Finti et al., 2016). Physical manipulative is one of the teaching aids where teachers use objects or items such as tangrams to accelerate students' understanding of learning fractions (Parungao, 2021). In a study by Kul et al. (2018), using physical manipulative positively impacts students' academic performance. However, studies found that teachers seldom adopt this strategy since it is challenging to execute pedagogically and practically in classrooms (Mendiburo & Hasselbring, 2014). Physical manipulatives are sometimes difficult for teachers to use as they consume valuable instructional time among teachers. Teachers might spend additional time monitoring every student; some items could be lost.

Visual manipulatives provide students with a meaningful understanding of mathematical concepts. Visual learning can pique students' curiosity and increase their interest in education (Cooper et al., 2018). The 'Butterfly Method' is an example of visual manipulative in adding and subtracting fractions. It requires students to circle the denominators and numerators diagonally and multiply the denominators horizontally. According to previous local studies, it has proven effective in improving students' overall performance (Laidin & Tengah, 2021; Low et al., 2020). The significance of a virtual manipulative is analogous to that of physical or visual representatives. The distinguishing feature of virtual manipulative is that it instils technology in understanding and solving problems (Bouck & Long, 2023; Ismail et al., 2023; Siswono et al., 2024). One of the learning activities in the SRM can be modified to game-based learning. The teachers can give students simulation games to enhance their understanding of fractions. Studies showed that game-based learning could stimulate students' interest in education and improve participation, confidence, and performance (Bayeck, 2020; Pg Abu Bakar et al., 2023; Qian & Clark, 2016; Salim et al., 2023).

This study investigates the effectiveness of SRM among Year 9 students. While earlier studies have explored the impact of implementing the SRM among primary school students in Western societies, they have not explicitly addressed its influence on secondary school settings, especially in mathematics learning. Consequently, one of the learning activities designed in the SRM includes utilising the 'Butterfly Method' to add and subtract fractions as the visual manipulative approach. Virtual manipulatives are also embedded in the teaching and learning to develop students' understanding of calculating fractions. For instance, the use of technological tools for students to access and watch an online video or play an online educational game. There is an expanding body of research on the visual aspects of BL. Thus, this study may guide future researchers, especially educators, on effectively adopting the SRM in a digital classroom.

## 2. METHOD

### 2.1. Research method

The study explores the effectiveness of SRM in learning addition and subtraction of fractions among Year 9 students. A mixed-method design was adopted to determine its effectiveness using quantitative and qualitative data collection approaches. The study employs a sequential explanatory data collection derived from numeric and text data (Creswell et al., 2003). The first research question, "How does the SRM impact students' performance in learning addition and subtraction of fractions?" is sought using the quantitative approach, and the second research question, "What are students' perceptions of using the SRM in the learning of addition and subtraction of fractions?" for the qualitative approach.

## 2.2. Participants

The study was conducted in one of Brunei Darussalam's government secondary schools, approximately 50 kilometres from the capital city, Bandar Seri Begawan—a convenience sampling selected 31 Year 9 students as participants for the study. Two single-gender classes were chosen, namely, Class A and Class B. Both groups came from various academic backgrounds, with abilities ranging from medium to high—Class A comprised 14 students who catered to higher-ability students. Meanwhile, Class B catered for medium to high-ability students consisting of 17. All students enrolled in the General Certificate of Education Ordinary Level Mathematics (GCE 'O' Level Mathematics). The participants were between the ages of 14 and 15. The rationale for choosing two classes in this study is due to the need for a larger sample. Larger sample sizes are favourable for researchers to yield more valuable data and reflect the population accurately (VanVoorhis & Morgan, 2007). Most studies found that one of the constraints to conducting their research was having a limited sample size (Hartney et al., 2022). Providing lesson intervention is possible since fractions are also taught at the selected grade level.

The study follows the ethical guidelines imposed by the University. Approvals were sought from the relevant departments. Participation is voluntary, and each student was given a random code to conceal their identity for ethics purposes. No other teachers were involved in this study as the researcher, the first author, was the mathematics teacher for Classes A and B. This is to ensure the study's integrity and eliminate the influence of the teaching factor.

## 2.3. Research instruments

The SRM serves as the independent study variable, while the achievement test scores and students' views of the SRM serve as its dependent variables. Four instruments were used to gather the data for the study and were employed in sequence. Firstly, a pre-test was administered to students, followed by a post-test. The scores from both achievement tests were compiled and analysed to find the outliers. Secondly, an online questionnaire was distributed to all students participating in the learning activity. Lastly, six selected students underwent a structured interview to determine their perception of using the SRM in adding and subtracting fractions.

The achievement test, which included a pre-test and a post-test, was used to evaluate the student's academic performance. The tests were administered before and after the lesson intervention. The pre-test, lesson intervention, and post-test were conducted on three days. According to Tomal (2010), achievement tests could be a helpful and effective method of evaluating students. The students spent 30 minutes answering ten questions about operations on fractions. Each question is worth one point, and the final score is 10. The pre-test and post-test have similar structures regarding their questioning style and difficulty level; only the sequence of the questions will be different. The achievement tests aim to evaluate whether students' performance improved after employing the SRM.

The achievement test questions were modified from the GCE 'O' Level Mathematics past year examination paper to ascertain the data instrument's validity. Additionally, the views of two mathematics teachers in the sampled school were gathered for face validity purposes to revise the achievement tests. Further amendments were made based on the feedback. The questions were also analysed for reliability in Jeffrey's Amazing Statistics Programme (JASP) (JASP Team, 2023). It was found that Cronbach's Alpha is 0.508, indicating moderate reliability (Tavakol & Dennick, 2011). The questions posed in the achievement tests are given in Table 1.

**Table 1**. Pre-test and post-test questions

| Item no. | Questions | Description |
|---|---|---|
| 1 | $\frac{1}{4}+\frac{1}{2}$ | Addition of fractions with numerator 1. |
| 2 | $\frac{3}{4}-\frac{1}{3}$ | Subtraction of proper fractions. |
| 3 | $\frac{3}{7}+\frac{1}{2}$ | Addition of proper fractions. |
| 4 | $\frac{1}{5}+\frac{2}{4}$ | Addition of proper fractions resulted in a mixed number. |
| 5 | $\frac{3}{4}-\frac{4}{6}$ | Subtraction of proper fractions resulted in a mixed number. |
| 6 | $5-\frac{5}{3}$ | Subtraction of a whole number and an improper fraction. |
| 7 | $1\frac{4}{3}-2$ | Subtraction of a mixed number and a whole number. |
| 8 | $2\frac{1}{2}+\frac{3}{5}$ | Addition of a mixed number and a proper fraction. |
| 9 | $1\frac{2}{5}+2\frac{1}{3}$ | Addition of two mixed numbers. |
| 10 | $\frac{1}{2}+\frac{2}{3}-\frac{3}{4}$ | Addition and subtraction involve three fractions. |

The present study used the Qualtrics application to create an online questionnaire and collect student responses. All participating students must complete the seven questions in the online survey. The questionnaire allows students to use the internet to develop ideas and organise thoughts. It is an effective technique for gathering data since it allows the researchers to acquire information from participants easily (Zboun & Farrah, 2021). It also allows students to express their true feelings about SRM without being constrained by peer pressure and their reluctance to speak in front of adults (Almahasees et al., 2021). A continuous, five-point Likert scale enabled students to indicate whether they strongly disagreed, disagreed, neutral, agreed, or strongly agreed. The scale also includes two structured questions to investigate students' attitudes toward the SRM. The five-point Likert scale is a universal way of collecting data and generates better distribution (Willits et al., 2016). The questionnaire was adopted from Truitt and Ku (2018) and modified accordingly. Two mathematics teachers in the sampled school and the supervisor (second author) validated and approved the survey. The resulting Cronbach's Alpha showed a desirable reliability of 0.796.

The quantitative data obtained from achievement tests were analysed, and the outliers were selected for an interview. The students underwent a structured interview for qualitative data collection and analysis. Purposive sampling determines whether a group of students meets the interview requirements according to the three categories: 1) Students who improved their overall marks, 2) Students who displayed a drop in their overall marks, and 3) Students who did not have any changes in their overall marks. For each class, three students were chosen for the categories mentioned, and one was chosen for each. Therefore, six participants were selected for the interview. Purposive sampling allows us to gain better insights and more precise research results by focusing on a small sample group (Suri, 2011).

Structured interviews were conducted with six selected students according to the abovementioned categories. In contrast to a questionnaire, an interview allows a researcher to observe students' behaviour while they respond, and this type of interaction yields more insightful and detailed information (Tomal, 2010). As previously mentioned, the student's achievement test scores were compared. Outliers were selected from those who fit the earlier criteria so they could be interviewed. Each student was asked similar questions throughout the one-to-one interview, making it easier to establish a thematic structure. The same three individuals (two mathematics teachers and the supervisor) further validated the interview questions. To ensure the reliability of the interview questions, the items must correspond to the study's second research question.

### 2.4. Data collection

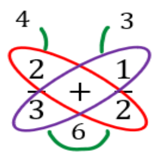
This section elaborates on the research procedures and how the data is being collected. Upon approval to carry out the research, participants were given a brief explanation of its aims, objectives, and ethical standards. Due to the involvement of two classes, data was gathered according to their designated timetables; nonetheless, the study's contents remained the same. The data from both groups were later combined and further analysed. Pre-lesson, actual lesson, and post-lesson intervention are the three stages of the study's implementation.

***Pre-lesson intervention***

**Lesson 1**. The first data collection phase was administering the pre-tests on the addition and subtraction of fractions to students. The students had 30 minutes to answer ten questions. Each question is worth one point, and the maximum score is 10. After the pre-test, the teacher arranged the students' seating to create a conducive environment for BL.

**Lesson 2**. Before the intervention lesson, the teacher spent a two-period class teaching the instructional concepts of adding and subtracting fractions by the butterfly method. The students will use this method during the intervention lesson. It allows the students to understand and recall what is being taught clearly. The butterfly method is an alternative way to visually add and subtract fractions. Figure 1 illustrates how the butterfly method works (Miller & Obara, 2017). Below are the steps in applying the butterfly method:

1) Diagonally draw two loops across the numerator and denominator of the first and second fractions.
2) Complete the drawing by adding the antenna and bottom of the loops.
3) Multiply the denominators and write the answer at the bottom of the loops.
4) Multiply the numbers of the first loop and record the answer on the corresponding antenna. Repeat the same step for the second loop.
5) Add or subtract the numbers on the antenna and simplify the fraction.




$$\frac{4+3}{6} = \frac{7}{6} = 1\frac{1}{6}$$

**Figure 1**. The procedural butterfly method

***Actual lesson intervention***

**Lesson 3**. In this lesson, students were exposed to the SRM learning activities. The students were randomly assigned into four groups and allocated to each station with different learning activities. Each station is named after plants: Aralia, Bamboo, Cactus, and Dahlia. Students followed the set timetable before moving on to the next station. A digital timer was projected on a screen to indicate the beginning of the first 12 minutes. The teacher also spent a few minutes explaining students' tasks and learning activities before starting the activity.

The Aralia station is an online learning platform where students watch a video of the lesson to be learned from Edpuzzle and then play a game called Educaplay based on what they have seen and understood. One laptop was provided, and the teacher pre-loaded the video and activity links for students to use independently. The Bamboo station is an independent learning station in which the students were required to answer the questions from past year's examinations with varying degrees of difficulty.

Meanwhile, the Cactus station deals with collaborative activities. Students play the non-digital activity called the 'Tarsia puzzle,' which is related to the addition and subtraction of fractions. Students who complete the puzzle are also given a 'Fraction Maze' task. The Dahlia station is a teacher-led station where the students can discuss and ask questions regarding the material taught to enhance their understanding. Each group rotates clockwise every 12 minutes until they return to their original station. The learning activities designed in the Aralia station are based on virtual manipulatives. The Bamboo and Dahlia stations allowed students to use the visual manipulative approach: the butterfly method. In the Cactus station, students were given physical manipulatives to solve questions about adding and subtracting fractions. Figure 2 illustrates the classroom arrangement for SRM.

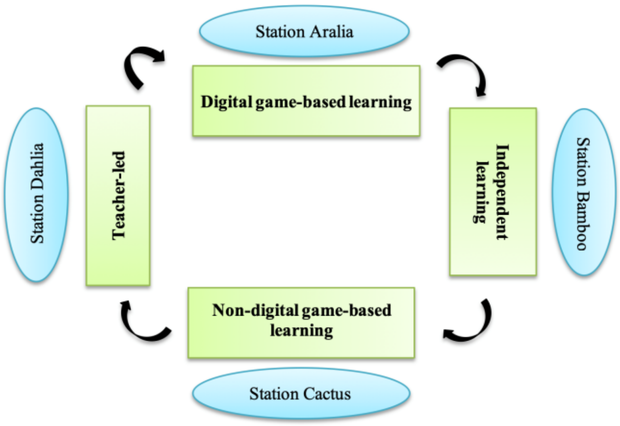



**Figure 2**. Classroom arrangement for SRM

It is worth mentioning that the teacher's role in the SRM differs from that in the traditional classroom; the teacher is no longer the centre of attention. Instead, it focuses on the student-centred learning concept, where students are the core knowledge (Govindaraj & Silverajah, 2017). Finally, feedback and misconceptions on the topic learned were addressed at the end of the activity to allow students to manage and improve their learning difficulties.

***Post-lesson intervention***

**Lesson 4**. After the intervention lesson, students were given a post-test and an online questionnaire.

**Lesson 5**. Comparisons of the pre-test and post-test results were conducted. The results allowed the teacher to select six students under the abovementioned categories for an interview. The one-to-one interview was recorded for transcription and conducted in an empty, quiet classroom. Lastly, all the data collected throughout the study were finalised.

### 2.5. Data analysis

In responding to the first research question, the JASP software was utilised to evaluate student performance. The JASP was selected because the study implemented the same group of participants to compare the achievement scores (Okagbue et al., 2021). Hence, a paired sample t-test was adopted where the mean scores of achievement tests were compared as they were given at different times (Delucchi, 2014). The paired sample t-test also reveals whether there is a mean significant difference between the achievement tests (Gerald, 2018). Before that, a parametric test was conducted to check whether the main assumptions of the paired sample t-test were fully satisfied. Otherwise, a non-parametric test that compares the median scores will be utilised to determine the intervention's effectiveness on students' performance (Kaur & Kumar, 2015). Meanwhile, for the second research question, the students' responses from online questionnaires and transcription of interviews were analysed thematically to support the qualitative data further. Discovering the patterns and differences among the respondents' experiences can help explore the study's data (McGrath et al., 2019).

## 3. RESULT AND DISCUSSION

### 3.1. The SRM impact on student's performance on fraction addition and subtraction

***Results and analysis of the pre-test***

Table 2 shows the descriptive statistics of the pre-test scores for Class A and B and the overall participants. Both classes used the same pre-test structure. Class A participated with 14 students, and the mean score of the pre-test was 8.79 (SD=1.53). The minimum and maximum scores obtained are 6 and 10, respectively. Meanwhile, Class B was attained by 17 students with a mean score of 7.88 (SD=2.32), which is slightly lower than Class A. Class B's minimum and maximum scores are 1 and 10, respectively. Overall, the mean score for both classes is 8.29 (SD=2.02), with a minimum score of 1 and a maximum score of 10.

**Table 2**. Descriptive statistics of pre-test scores

| Class | N | Scores | | | | Standard deviation |
|---|---|---|---|---|---|---|
| | | Mean | Median | Minimum | Maximum | |
| Class A | 14 | 8.79 | 9 | 5 | 10 | 1.53 |
| Class B | 17 | 7.88 | 8 | 1 | 10 | 2.32 |
| Overall | 31 | 8.29 | 9 | 1 | 10 | 2.02 |

Analysis of the students' overall pre-test scores revealed that of the 31 students, only one got the lowest mark of 1, and 10 students obtained a total of 10. The result indicates that most students (N=30) obtained a total score of above 5. None of the students scored 0 and between 2 and 4 during the pre-test. Figure 3 displays the frequency of students who obtained correct and incorrect responses for each pre-test item. The majority of the students (N=29) managed to score on Items 1, 3, and 5.

On the other hand, Item 7 is the least item students could score (N=10). The result shows that a high number of students managed to get a correct answer for Items 1 to 5. This is because the items involved adding and subtracting proper fractions. However, none of the students applied the butterfly method to calculate the fractions. The correct response for these items was solved mainly by finding the equivalent fraction, as depicted in Figures 4 and 5.

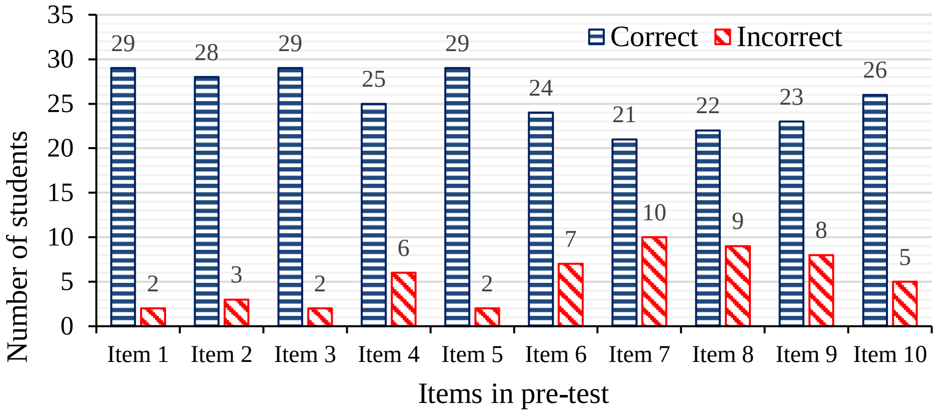



**Figure 3**. Number of correct and incorrect responses for each pre-test item

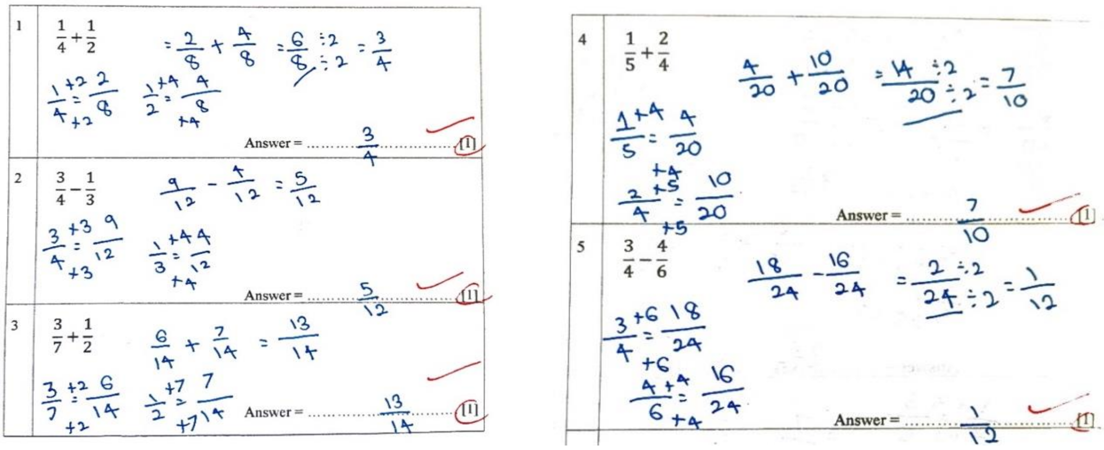


**Figure 4**. Samples of correct responses from student S11 for Items 1 to 5

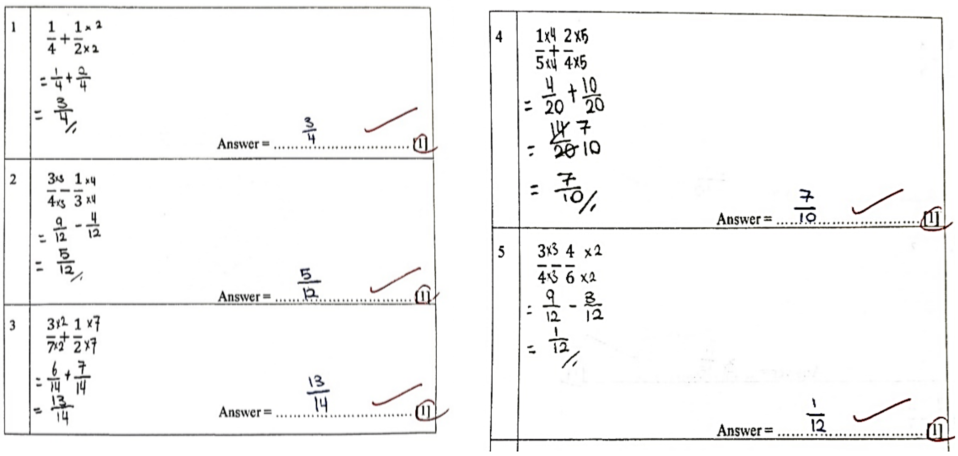


**Figure 5**. Samples of correct responses from student S10 for Items 1 to 5

The difficulty of the items increased between Items 6 and 7 as the students needed to add and subtract fractions involving mixed numbers and whole numbers. Figures 6 and 7 show the samples of students' incorrect responses for Items 6 and 7. It can be seen that students were not able to express the whole number into a fraction.

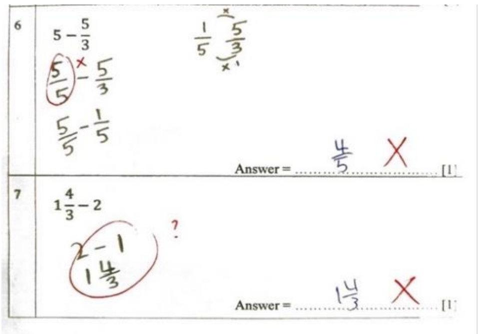


**Figure 6.** Samples of incorrect responses from student S27

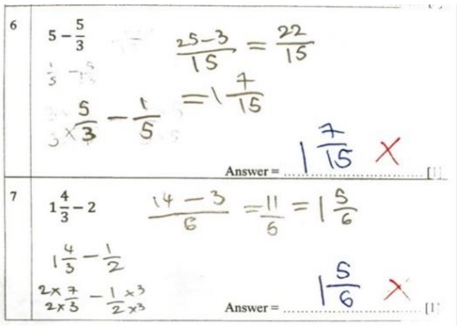


**Figure 7.** Samples of incorrect responses from student S29

Items 8 and 9 involved adding mixed numbers and proper fractions. Meanwhile, Item 10 required the students to add and subtract, which involved three fractions. The common mistake made by students was a miscalculation that resulted in wrong answers. Figures 8 and 9 show that students followed the correct procedures but incorrectly added or multiplied the numbers.

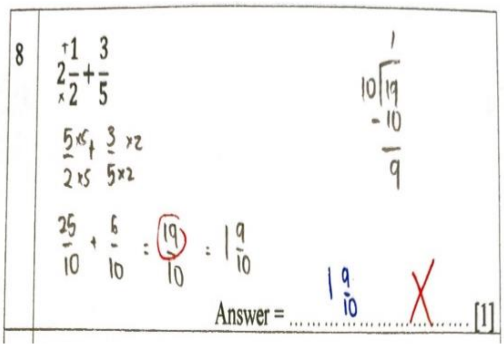


**Figure 8.** Sample of incorrect responses from student S2 for Item 8

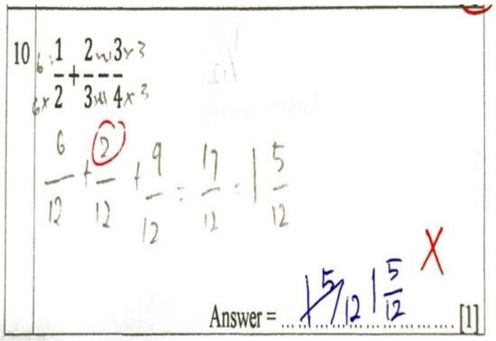


**Figure 9.** Sample of incorrect responses from student S25 for Item 10

Another misconception the researcher encountered was knowing how to express improper fractions into mixed numbers. Students used inaccurate procedures to place a digit into a mixed number (see Figure 10). Figure 11 also shows that the particular student had not mastered fractions' essential addition and subtraction. This implies that a proper intervention in adding and subtracting fractions is needed.

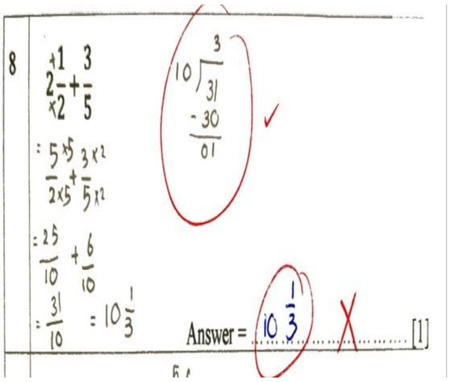


**Figure 10.** Sample of incorrect responses from student S28 for Item 8

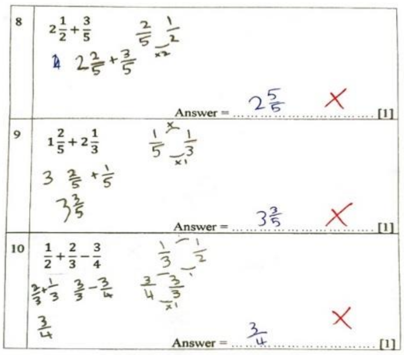


**Figure 11.** Sample of incorrect responses from student S27 for Items 8, 9 and 10

***Results and analysis of the post-test***

During the post-test, students were given the same structured questions as the pre-test, but the order of questions was rearranged. After the intervention, Class A obtained a mean score of 9.29 (SD=0.73) with minimum and maximum scores of 8 and 10, respectively (see Table 3). Meanwhile, Class B has a mean of 9 (SD=1.17), with the lowest score of 7 and the highest score of 10. From this result, the overall mean is 9.13 (SD=0.99), with minimum and maximum scores of 7 and 10, respectively.

**Table 3**. Descriptive statistic of post-test scores

| Class | N | Scores | | | | Standard deviation |
|---|---|---|---|---|---|---|
| | | Mean | Median | Minimum | Maximum | |
| Class A | 14 | 9.29 | 9 | 8 | 10 | 0.73 |
| Class B | 17 | 9.00 | 8 | 7 | 10 | 1.17 |
| Overall | 31 | 9.13 | 9 | 7 | 10 | 0.99 |

Analysis of the student's overall post-test scores revealed that all students scored above the passing mark of 5. Based on Figure 12, only eight students got the wrong answers for Item 8, where they were required to add two mixed numbers. Fewer than five students gave incorrect responses for each item corresponding with Items 1, 4, 5, 6, 9, and 10. Overall, the number of students who scored each item correctly is improving compared to the scores obtained during the pre-test.

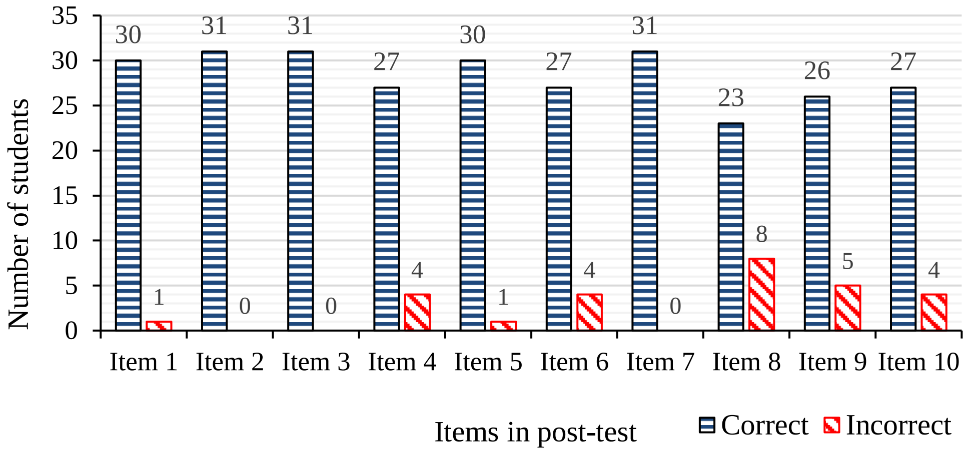



**Figure 12**. Number of correct and incorrect responses for each post-test item

After the intervention, most students (N=25) applied the butterfly method to fractions. Only six students preferred to use their method, that is, by finding the equivalent fractions to calculate the fractions. Examples of students' work who applied the butterfly approach are shown in Figure 13.

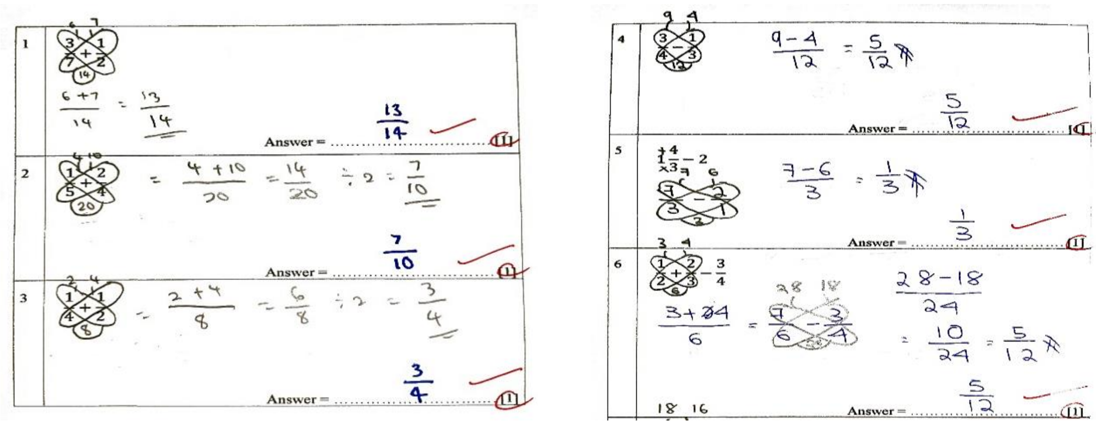


**Figure 13**. Samples of students' work who used the butterfly method

According to the data in Figure 12, Item 8 had the highest number of incorrect answers from students (N=8). After analysis, it was found that students miscalculated the numbers, which resulted in wrong answers. Also, one student was seen copying the wrong number in their calculation. These are depicted in Figure 14.

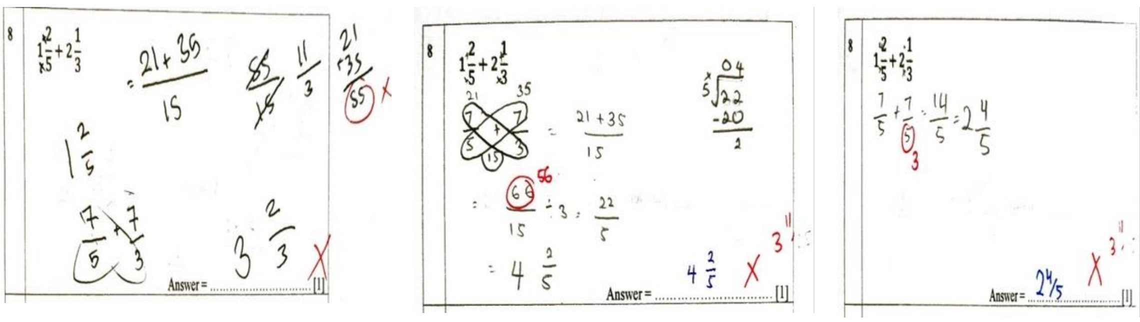


**Figure 14**. Samples of incorrect responses from students S12, S21 and S25 for item 8

Another frequent student error was converting an improper fraction into a mixed number. Nonetheless, only four students indeed converted the fractions using the incorrect procedures. Students appeared to be following the proper procedures by employing the division approach. They should have arranged the digits correctly when finalising their result as a mixed number (see Figure 15).

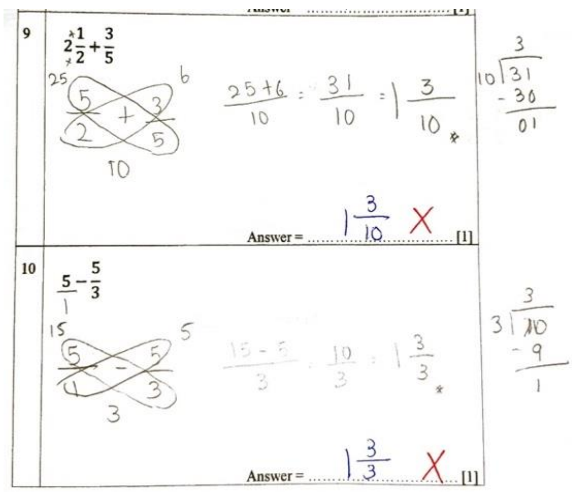


**Figure 15**. Sample of incorrect response from student S23 for items 9 and 10

### *Overall results and analysis of achievement tests*

The overall achievement results in Table 4 showed that the mean score improved from 8.29 to 9.13. The lowest mark recorded was one during the pre-test, which increased to 7 after the intervention. The standard deviation fell from 2.02 to 0.99. This demonstrates that the scores obtained during the post-test are spread out around the mean score of 9.13, indicating a better performance than the pre-test results.

**Table 4**. Descriptive statistics of pre-test and post-test scores

| | N | Scores | | | | Standard deviation |
|---|---|---|---|---|---|---|
| | | **Mean** | **Median** | **Minimum** | **Maximum** | |
| Pre-test | 31 | 8.29 | 9 | 1 | 10 | 2.02 |
| Post-test | 31 | 9.13 | 9 | 7 | 10 | 0.99 |

Figure 16 illustrates the total scores obtained by the overall students. The results revealed an increase in performance, with 14 students scoring a full mark during the post-test. The post-test results also showed that all students scored above the marginal mark. This proved that utilising the manipulatives in the SRM positively impacts student performance in adding and subtracting fractions.

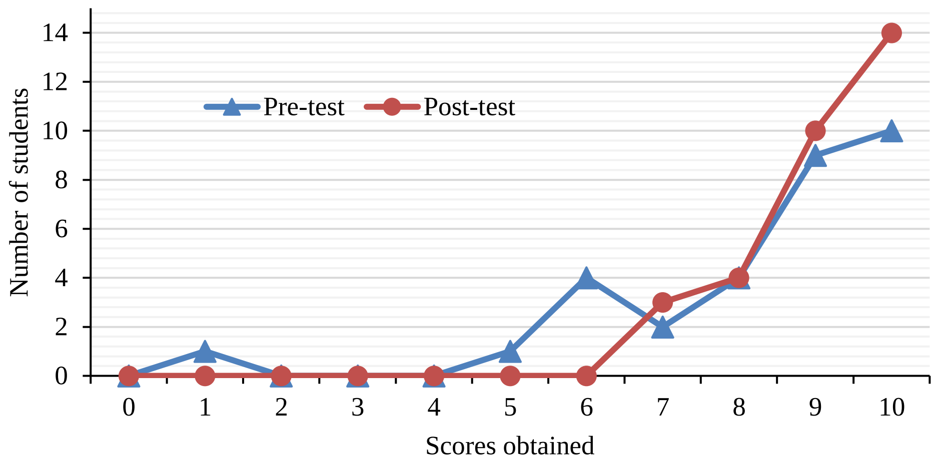



**Figure 16**. Students' scores comparison during the pre-test and post-test

### *Checking the assumptions of parametric test*

A parametric test was conducted to determine the effectiveness of the intervention on students' performance. Before conducting the statistical test, the main assumptions of the paired sample t-test must be satisfied (see Table 5).

**Table 5**. Four underlying assumptions of parametric test

| No. | Assumptions |
|---|---|
| 1 | The dependent variables should be continuous |
| 2 | The independent variable consists of two related groups |
| 3 | The differences in the dependent variable between the two groups should be approximately normally distributed |
| 4 | There are no outliers in the differences between the two groups |

The students were given a pre-test and post-test with a total score of ten, where each question had one mark. The intervention was also administered in two related groups, which the researcher combined to analyse the scores obtained further. Hence, the first and second assumptions are fully satisfied.

To check the normality of the differences in the dependent variable, the Shapiro-Wilk test was computed by using JASP. The data is considered normal if the significant value of the test is greater than 0.05 (Orcan, 2020). The result revealed that the significant value of the Shapiro-Wilk test is 0.02, indicating a deviation from normality (see Table 6).

**Table 6**. Test of normality (Shapiro-Wilk)

| Change in dependent variables | Shapiro-Wilk, W | Significant value, p |
|---|---|---|
| Post-test – Pre-test | 0.92 | 0.02 |

Furthermore, the skewness and kurtosis values should be close to zero to distribute the data normally (Orcan, 2020). Table 7 summarises the data's calculated outcomes of skewness and kurtosis values. The skewness and kurtosis of both the pre-test and post-test are negative, which indicates that the data is distributed more on the right (see Figure 17). Therefore, it violates the conditions for the data to be normally distributed.

**Table 7**. Test of normality (Skewness and Kurtosis)

| Achievement test | Skewness | Kurtosis |
|---|---|---|
| Pre-test | -1.83 | -0.93 |
| Post-test | 4.37 | -0.11 |

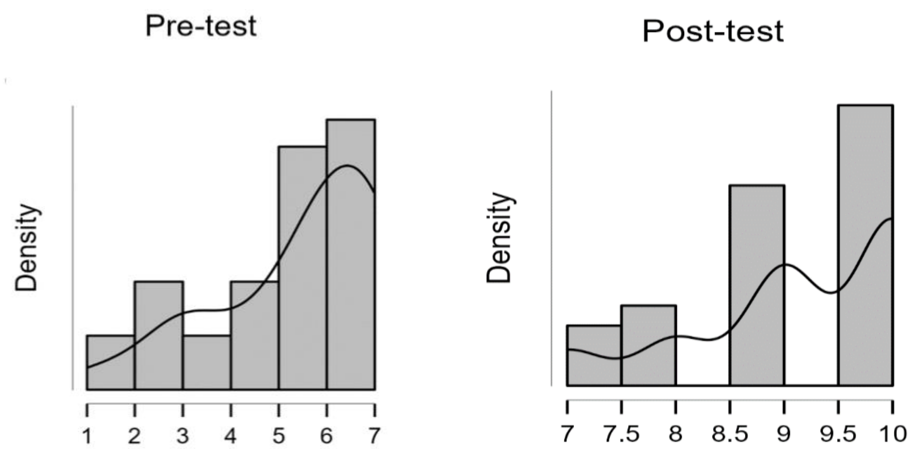



**Figure 17**. Distribution plot of the pre-test and post-test

The resulting boxplots in the pre-test and post-test datasets exhibited one and three outliers, respectively (see Figure 18). The results suggest a deviation from normality. Henceforth, the assumptions still need to be fully satisfied due to the dataset's normality and the presence of outliers. This signified that the study would adopt a non-parametric test, namely Wilcoxon's signed rank test, to compare the achievement test results further.

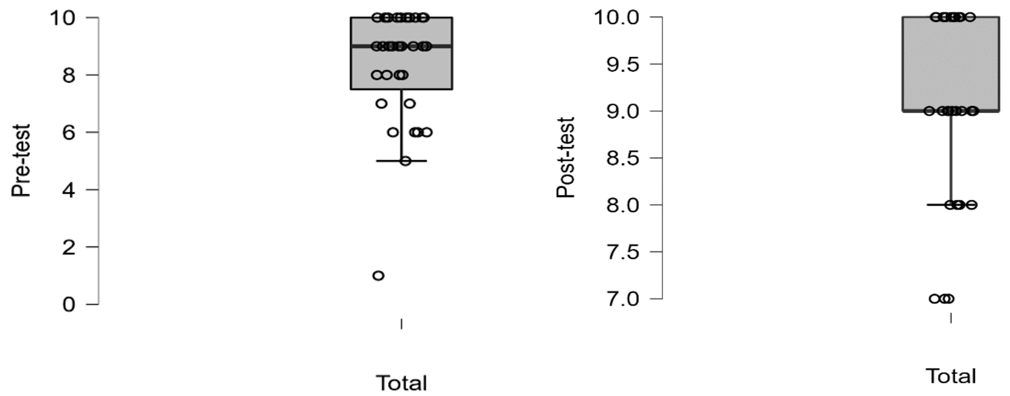



**Figure 18**. Boxplots of the pre-test and post-test

***Non-parametric paired sample t-test***

Wilcoxon's signed rank test was run on JASP between the two related variables. The two hypotheses of this study are as follows:

Null hypothesis (H0) : No significant difference will exist between the pre-test and post-test results.

Alternative hypothesis (H1) : A significant difference exists between the pre-test and post-test results.

The results in Table 8 revealed that the Wilcoxon W-statistic is highly significant (p=0.02), which is less than 0.05. Moreover, according to Table 9, the rank-biserial correlation suggests that the effect size is large (rb=0.56). The Hodges-Lehmann estimate is used to measure the median difference between the two variables, and it gave a value of 1, which means the medians between the pre-test and post-test are the same. Although the medians are reported to be equal (Mdn=9), the results were still significant, considering that the p-value is less than 0.05 with a larger effect size. Therefore, the study rejected the null hypothesis and accepted the alternative hypothesis. This implies that the SRM used in the intervention significantly enhanced students' performance in learning addition and subtraction of fractions through manipulative.

**Table 8**. Wilcoxon signed-rank test

| **Measure 1** | **Measure 2** | **W** | **p** | **Hodges-Lehmann estimate** | **Rank-biserial correlation** |
|---|---|---|---|---|---|
| Post-test | Pre-test | 51 | 0.02 | 1.00 | 0.56 |

**Table 9**. Effect size indicator for t-tests

| **Effect size** | **Trivial** | **Small** | **Medium** | **Large** |
|---|---|---|---|---|
| Rank-biserial correlation ($r_b$) | <0.1 | 0.1 | 0.3 | 0.4 |

## 3.2. Students' perceptions of using the SRM for fraction addition and subtraction

***Results and analysis of online questionnaires***

The online questionnaire was administered to all participants in the study. The researcher included five questions on a five-point Likert scale and two open-ended questions to investigate students' attitudes toward the SRM. Table 10 summarises the percentages and means for each item in the Likert scale.

**Table 10**. Percentages and mean of students' responses from the online questionnaire

| Question | Strongly disagree, 1 | Disagree, 2 | Neutral, 3 | Agree, 4 | Strongly agree, 5 | Mean |
|---|---|---|---|---|---|---|
| 1. I understand how station rotation activity works | 0% | 0% | 0% | 16.1% | 83.9% | 4.81 |
| 2. The station rotation activity boosts my motivation and confidence in learning fractions | 0% | 0% | 6.5% | 51.6% | 41.9% | 4.34 |
| 3. I enjoyed working in groups and collaborating with my friends | 0% | 0% | 9.7% | 22.6% | 67.7% | 4.56 |
| 4. I want the station rotation activity to be implemented in lessons more often | 0% | 0% | 3.2% | 32.3% | 64.5% | 4.59 |
| 5. The questions on fractions were challenging | 3.2% | 25.8% | 38.7% | 22.6% | 9.7% | 3.10 |

Item 1 deals with students' understanding of the procedure of the SRM in the classroom. All the students agreed that they understood how the SRM works, with 16.1% agreeing and 83.9% strongly agreeing. Item 2 concerns the students' perception of whether the SRM boosts their motivation and confidence in learning fractions. Most students agreed and strongly agreed with 51.6% and 41.9%, respectively. Only 6.5% of the students felt it was neutral for the SRM to boost their motivation and confidence in learning fractions.

Meanwhile, Item 3 seeks students' perception of their enjoyment in working as a group and collaborating with their peers. The percentage of students who strongly agreed with the statement is much higher than those who agreed, totalling 67.7% and 22.6%, respectively. However, only 9.68% of the students were neutral about using SRM in collaborating with their peers. Item 4 investigates the students' preferences for the regularity of SRM implementation in the classroom. 96.8% of the students agreed that the SRM should be practised frequently, and only 3.2% is on the neutral side.

The researcher also asked the students to assess whether the fraction questions were challenging in Item 5. The results showed that the students' responses were distributed from strongly disagree to strongly agree. The results showed that 32.3% of the students agreed that the questions were challenging. The figure somehow outweighed the percentage of students who felt the questions were neither easy nor challenging. On the other hand, 29.0% of the students think the questions were not thought-provoking.

The results also revealed that the means between Items 1 and 4 are approximately on a scale of 4. This indicates that students possessed a positive attitude towards implementing the SRM and tackling the operation of fractions. The mean of Item 5 is approximately on a scale of 3, meaning the questions given to the students were neither easy nor challenging.

Item 6 asked the students which part of the learning activities they liked the most. All of the students gave various responses. Among the top responses were that the digital game-based station was fun, the puzzle and fraction maze were fun, and working as a group was fun. Therefore, three major themes were developed, as discussed below.

***Theme 1: Manipulatives make learning fun***

***Technology makes learning fun***. Students' most anticipated response was that they could use the technology in the digital game-based station. Twelve students found it enjoyable to learn with technology such as laptops. One student also showed excitement about playing the online quiz and how it helps them to enhance their mental calculation by saying, "I liked the activity where you did the online quiz on a laptop because it was really fun and trained my mind to calculate even faster". Another student shared, "I like the digital learning activities because it was fun, and the frog was funny".

***Puzzles and mazes make learning fun***. Aside from the digital game-based station, 11 students commented on the non-digital game-based station, where they found working with the Tarsia puzzle and the fraction maze enjoyable. The questions given were challenging, and they helped the students to concentrate better. Examples of students' responses include "I really like the station which has the puzzles and maze. I like it because we are completing two tasks at once", "The maze because it is fun and challenging", and "The maze station because it is very fun and I can concentrate and understand more".

***Theme 2: Enjoyment of working in a group***

Another developed theme was collaboration and working with their peers. Eight responses from students expressed how much they enjoyed working with their friends in all the stations. One student stated that he or she preferred to work in a group than working alone, saying, "I like the part where each group rotated stations and working together with friends because it is easier than working alone". The learning also allowed students to discuss things with their friends and interested them in learning. For instance, students stated, "I like that we could work in groups, so we can ask our teammates if we have any problems," and "I like participating in group activities because it makes me more energised and interested in learning together".

***Theme 3: Challenges in implementing the SRM***

Meanwhile, in Item 7, students were asked which part of the learning activities they liked the least. The results showed that sixteen students did not have anything to dislike; for example, two students stated, "There was nothing that I disliked. Everything was good and done without a flaw" and "I do not dislike any part because I think this method of learning is great". However, two other top student responses voiced that the independent station was challenging and did not have enough time to complete all the learning activities.

***Challenging***. Nine students pointed out that the independent or Bamboo station is the least favourable part of the learning activities. The main reason was that the students were not allowed to use calculators, which made the task challenging. Some students stated, "The activity that I disliked was the independent activity because some questions were difficult, but I could not ask my friends for help" and "The independent activity because it is an individual work". This suggests that the absence of group work made it harder for them to tackle the questions.

***Inadequate time***. Other students voiced the time constraint of the whole station rotation activity. They felt that the time needed to be increased for them to complete the tasks given in each station, especially in the independent and non-digital game-based stations. One student said, "The time limit, I do not like rushing". Another student said, "My friends and I did not have enough time for the maze, but overall, it was fun".

***Results and analysis of students' structured interview***

The structured interview was conducted on six selected students based on the earlier criteria: From Class A – S12, S11 and S13; and from Class B – S27, S15 and S18. The interview was done individually with the students in an allocated time and place. The audio-recorded interviews were then transcribed to establish the thematic structure. Each student was asked four questions regarding their perceptions of using the SRM. When students were asked what aspect of the station rotation activity was the best or that they found interesting, the top responses received were the opportunity to use the technology, work with their peers and have fun playing puzzles and mazes. Three major themes are identified and discussed.

***Theme 1: Manipulatives make learning fun***

***Technology***. Most students mentioned how enjoyable participating in the digital game-based or Aralia station was. This station involves technology, allowing students to watch a video and simultaneously participate in an online quiz. Also, students were enthused about the online game they were eager to play as this learning activity is rarely used in other subjects. Some excerpts from the students' interviews were S12: "The digital game based because it is more interactive and it has more like resources."; S18: "The Aralia station for me because it involves computers which are rarely used in every subject."; and S27: "I think the best one is the digital game-based one because it was straightforward and fun to learn."

***They were having fun playing puzzles and mazes***. Students also repeatedly mentioned that they enjoyed playing puzzles and mazes in the non-digital game-based or Cactus station. Students gave various reasons why they favoured the Cactus station. For example, one student stated that it was fun to participate in the activity as it was his first time doing it. Although the learning activity was challenging, one student claimed it became enjoyable as it engaged their minds while solving the puzzles and maze. This can be proven in the excerpts of students' interviews, S11: "I think it is the non-digital game-based station because it got to play the Tarsia puzzle."; S13: "I think my favourite one is the Cactus station, the non-digital game based because it involves solving fractions but at the same time it solves puzzles. It was fun." Furthermore, "The puzzle because it was my first time playing it."

***Theme 2: Enjoyment of working in a group***

Another emerging theme is the students' excitement to work in a group. The main reason the students eagerly participated in the learning activity was that they got the opportunity to collaborate with their peers. This indicates that students work well and actively participate in a class activity involving group work. The extracts of students' interviews about working with their peers, S15: "The activity that I found the best is the video watching and the Educaplay because it was fun to hear the instruction and the quiz again, is also very fun to play with my friends." Moreover, S18: "The best one is the Cactus station because it is very challenging, and it was really fun to work with my teammates."

***Theme 3: Challenges in implementing the SRM***

The students were asked their opinions on which aspect of the station rotation activity they found the least enjoyable. The results showed that two themes can be developed from the interview transcription: the difficulty level of the questions and the inadequate time to complete the task.

***Question difficulty level***. Students stated that the independent or the Bamboo station was their least favourite part of the learning activity. As calculators were restricted at this station, it was challenging for students to calculate the fractions. This supports the assertion made by one of the students that the fractions utilised at this station were hard to comprehend. Students took a long time to simplify the fraction without a calculator. Hence, to allow them to complete the task within the allotted time, she adjusted the rule of this station where the remaining teams could use a calculator. Some excerpts from the students, S11: "The independent learning because some of the questions were challenging and hard. Even with a calculator, it is hard because of the fractions." Furthermore, S15: "The independent learning activity because we must do it independently. All of the fractions are difficult for me. We did not use a calculator at that time, so it is a bit difficult."

***Inadequate time***. Each station in the SRM was allocated 12 minutes before rotating to the subsequent station. Students voiced out about needing more time to complete the task in every station due to several factors, such as pressure on the time limits and lack of instruction in one of the stations. Samples of the excerpts, S12: "The non-digital game based because it is harder than the other stations and there is no guidance like in the digital station. Also, there is not enough time." Moreover, S13: "Digital game-based station because I got pressured due to the time limit." As the interview concluded, the students were also asked for suggestions on improving the lessons. Four students responded that everything was still the same or improved, and they agreed that the lesson was already better. One student suggested including a video demonstration of how the SRM works before engaging in the learning activity. Another student requested the researcher to incorporate technologically oriented tasks in one of the stations.

### 3.3. Discussion

The comparison of the overall mean achieved during the pre-test and post-test showed an improvement from 8.29 to 9.13. The minimum pre-test score was 1, and the figure increased to 7 during the post-test. Meanwhile, the maximum score obtained during the pre-test and post-test was 10. The line graph of the post-test shows an increasing pattern compared to the pre-test's line graph. This indicates that more students achieved higher scores during the post-test. In addition, the post-test results showed that all students scored above the marginal score of 5.

A non-parametric test, the Wilcoxon signed-rank test, was then conducted to determine the significant difference in the achievement tests' scores. The results revealed a significant difference between the pre-test and post-test with a p-value of less than 0.05 ($p=0.02$). The median is reported to be similar (Mdn=9). However, the results are still significant as the effect size is large ($rb=0.56$). Therefore, this implies that the SRM used in the intervention significantly enhanced students' performance in learning addition and subtraction of fractions through manipulatives.

Our study suggests that the SRM has improved students' academic performance among secondary school students, consistent with the study conducted by Hamida et al. (2021). In addition, implementing SRM also significantly improved the students' overall mathematics scores, similar to the results obtained in the studies by Akinoso et al. (2020) and Mendoza and Lapinid (2021). The proposed learning method may benefit from the use of manipulatives in adding and subtracting fractions without adversely impacting the students' overall performance and their understanding of learning fractions (Laidin & Tengah, 2021; Low et al., 2020; Parungao, 2021).

Based on the qualitative analysis of the students' online questionnaire and interviews, it can be concluded that the students showed a positive attitude towards using SRM in learning addition and subtraction of fractions. Three major themes emerged after analysing both qualitative instruments. The first theme is that manipulatives make learning fun. The learning activities designed in each station varied from physical, virtual and visual manipulatives. The variation of instructional activities helped to improve students' participation and interaction in their learning, which aligns with the study conducted by Skolastika (2020). The study's findings supported Nugraha (2020), who stated that the learning approach could achieve immediate student satisfaction and excitement. The second theme is the enjoyment of working in a group. Students showed their excitement, and they engaged more when doing group work. Similar findings were found in a previous study conducted by Govindaraj and Silverajah (2017), where they indicated that the SRM allows the students to do peer teaching and prioritises student-centred learning. The third theme is the challenges in implementing the SRM. In this theme, the students expressed that the tasks given in the SRM were challenging and that the time allotted for each station needs to be increased. The study by Belazi and Ganapathy (2023) revealed a similar finding about students' perceptions of the SRM. The students expressed that the timing of the class was not long enough to complete the whole activity in the SRM. The differentiated tasks designed in each station were found to be challenging, especially in the independent station. Nevertheless, if the tasks are designed appropriately, students can experience an active learning environment and enhance their critical thinking (Nida et al., 2020). As Lince (2016) mentioned in his study, to enhance students' creative thinking, teachers need to design learning activities that allow students to have the capacity of mathematical thinking skills to evaluate information in a new form of understanding

This study has three main limitations. Firstly, it was limited to two classes from Year 9 in one secondary school; therefore, the findings of this study cannot be generalised to populations who did not partake in this research. Secondly, due to poor internet connectivity, accessing the internet while conducting the SRM in the classroom is too much work. This is because one of the SRM activities utilised a technological tool that required students to watch an online video and play a simulation game. An internet connection was required for students to access the abovementioned learning activities. Thirdly, all study participants were medium-to-high-ability science stream students enrolled in the GCE 'O' Level Mathematics. Because of this, most students scored slightly higher on the pre-test. They probably discovered that fraction addition and subtraction were simple. The study's limitation is that it did not represent the performance of other students, such as those who took the International General Certificate of Secondary Education (IGCSE) Ordinary Level Mathematics.

This study explored comprehensive mathematics learning, especially fractions, by implementing SRM. However, further and in-depth studies may be needed to confirm its effectiveness to larger samples from different academic levels, such as students taking IGCSE Mathematics or lower secondary students or other subjects. It is also suggested that future researchers join any professional development or training conducted by relevant authorities to enhance their knowledge and skills in using the SRM effectively. The training will aid future research to create and design appropriate learning modalities for their students. It is also recommended that the study be extended to the whole year. The present study was conducted in fewer than three months, so it is challenging to conclude students' true feelings about SRM. Extending the duration of the intervention will allow future research to see the actual perceptions of students towards the use of the SRM.

## 4. CONCLUSION

The study investigated the effectiveness of the SRM among Year 9 students in the learning of addition and subtraction of fractions. It was found that the intervention effectively improved students' achievement test scores. This is proven through an increase in overall mean scores during the pre-test and post-test. Also, the number of students who obtained correct responses during the post-test significantly improved after implementing the intervention activity. The non-parametric paired sample t-test revealed a positive significant difference and a large effect size between the achievement test scores. This shows that implementing SRM effectively improves students' performance in mathematics. The study also revealed that the students demonstrated positive attitudes towards using the SRM as a BL approach in the classroom. The effectiveness of the SRM is mainly credited with its technology and collaborative view of learning, which develops students' excitement to learn. Hence, teachers can embed the SRM in their teaching and learning as an alternative to the conventional way of teaching. This also allows teachers to adopt the SRM as a BL approach and transform the classroom into a digital setting.

This study provides insights for educators and researchers on the impact of the SRM on students' learning. The research enables readers to assess how this approach may be used in future learning, primarily in mathematics. The first pedagogical implication obtained from the study is that the SRM can be a means for teachers to enhance students' understanding in various subject areas and not only limited to mathematics-related topics. Teachers are free to explore and design multiple interdisciplinary learning modalities and integrate them into the station rotation activity that best suits the learning style of their students. The second implication is that teachers who intend to employ the SRM in the classroom should be patient, as it takes time for teachers and students to adapt to a new learning strategy. It is highly recommended that teachers spend time designing the learning activities for each station and regularly practice implementing them with the students. This way, teachers can reflect, and adjustments could be made for the following lessons. The students might become familiar with and comfortable with how SRM works in the long term. Thirdly, teachers and students should possess technological literacy as the learning activities involve using technological tools. For the SRM to reach its full potential, teachers should assess students' technological skills to design appropriate learning opportunities. It is worth mentioning that teachers' careful planning and diligent effort are required for the SRM to be integrated successfully into the classroom. Over time, the implementation of the SRM will eventually evolve the classroom into one filled with students' enthusiasm and eagerness to learn.

## ACKNOWLEDGEMENTS

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