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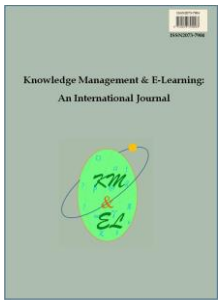

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Abstract: Several reports have suggested that students have difficulties in understanding the concepts of fraction, particularly on fraction equivalence and addition of fractions that involved unlike denominators. It is envisaged that the implementation of Virtual Manipulative using iPad would enhance students' conceptual understanding. The purpose of this study is to examine the effectiveness of Virtual Manipulative with the use of iPads in teaching equivalence and addition of fractions. The target groups were two Year 7 classes in one of the secondary schools in Brunei, one class comprising high-achieving students, while the other consist of low-achieving students. An action research design that included quantitative and qualitative data analyses was conducted. The findings revealed that the implementation of Virtual Manipulative using iPad has significant effect on students' performance in-group activities, and it has significant effect for students with low abilities. The study also revealed that students' motivation to learn fractions increased as they found the use of iPads to be fun and interesting. However, the results also revealed that the use of iPads as a teaching tool appeared to be challenging for teachers.

Keywords: Virtual manipulative; iPad; Secondary education; Fractions; Motivation

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1. Introduction

In general, the proper understanding of mathematical concepts has always been an issue of struggle for secondary school students, which always leads to misconceptions on mathematical concepts (Sarwadi & Shahrill, 2014), and alas, a majority of students in Brunei secondary schools are no exception to this perplexing concern. According to Yusof and Malone (2003), one of such mathematical concepts whereby students often have difficulties in comprehending is the concept of fractions. Yusof and Malone (2003) further stated that the issue of understanding fractions is further heightened when a fraction concept involves 'unlike dominators' whereby students' struggle persists even in calculating basic operations such as fraction equivalence and addition of fractions.

With the advancement of technology, mathematics teachers need to enhance their pedagogies from teaching using 'Chalk and Talk' to a more students' centred approach (Matussin, Abdullah, & Shahrill, 2015). Contributing to the students' struggle in comprehending the concept of fractions is the customary reality in which students are taught by means of procedural understanding when learning fractions instead of focusing on a students' centred approach of conceptual understanding in teaching Mathematics (Suh, 2005). Thus, the method of using a manipulative is an example of a students' centred approach whereby it promptly instils conceptual understanding of any mathematical concept in the students' comprehension. The most common usage of manipulative used by Mathematics teachers to teach students on Mathematical concepts is by the method of utilising physical manipulatives.

With the recent advances in computer technology, Mathematics teachers can now implement Virtual Manipulative (refer to Moyer-Packenham & Suh, 2012) in their teaching by using modern technology such as iPads. Furthermore, researchers suggest that the increase usage of Virtual Manipulative will improve students' attitude towards their own learning, motivation and their academic achievement (Suh, Moyer, & Heo, 2005; Moyer-Packenham & Suh, 2012). Further supporting the mentioned researches, it has been as well suggested that students enjoy learning and understanding mathematical concepts using Virtual Manipulative as it is more entertaining than the traditional 'Chalk and Teach' approach previously utilised by common Mathematics teachers (Spencer, 2013).

It is suggested that a majority of students who have difficulties in understanding mathematical concepts would show low motivation and interest towards learning Mathematics (Yusof & Malone, 2003). This lack of interest in learning Mathematics is reflected in their tests and examinations based on their previous academic records

whereby most of the students have low-test scores, and have difficulties in completing their class work and homework. A Mathematical concept which most students still find difficult to understand and master is the concept of fraction especially when it involves fraction equivalence and addition of fractions. Through discussion with senior colleagues and mentors, it was understood that there had been efforts made by Mathematics teachers to utilise physical manipulative to provide students with 'hands-on' experience to reinforce their understanding of fractions. Yet, more often than not, most of the physical manipulatives used are categorised as a traditional approach of using procedural understanding of fractions. It becomes apparent that there was a need to research on the effect of Virtual Manipulative in a mathematics classroom by using iPads that would increase students' understanding of the concept of fractions.

2. Literature review

2.1. Fractions and the learning issues

According to Drake (2011), fractions can be defined as numbers found between whole numbers. However, Mills (2011) definition of fraction as "a whole divided into equal parts" is much clearer. The main issues of learning fractions are not in terms of defining fractions but are more inclined towards the issue of understanding the main concepts relating to fractions, and how to perform operations on them. The results from Drake (2011) revealed that nine learning problems concerning fractions which most students have difficulties to understand are: interpreting numerals to each other; fractions behave differently from whole numbers; relating fraction to the partitioned whole; comparing fractions with mixed numbers; understanding equivalence; understanding multiplication of fractions and relating fractions with decimals. This argument raised an important question: How will students learn and understand concepts of fractions so that they can perform operations such as addition, subtraction, multiplication and divisions?

Suh (2005) suggested that there is a need to facilitate a connection between procedural understanding and conceptual understanding of fractions in order to maximise students' understanding of fractions. Other researchers supported Suh's claims that in order to learn fractions, the use of manipulative such as using appropriate visual or interactive models can enhance students' conceptual understanding (Drake, 2011; Mills, 2011; Suh, Moyer, & Heo, 2005).

2.2. Integration of iPads in teaching and learning

The iPad is a type of tablet that is designed for portability and it is designed with a touch LCD screen onto which data can be inputted with either fingertips or stylus (Apple Inc., 2016). In terms of its integration in schools, several researchers agreed that iPad is a suitable educational tool for teachers and students to maximise their teaching and learning respectively. Soule (2013) claimed that iPads provide immediate feedback, which is very useful for teachers, and there is a huge selection of educational applications for learning and teaching. Other researchers claimed that the usage of iPad allowed teachers to introduce and implement a wide range of teaching strategies in the classroom (Attard & Curry, 2012; Spencer, 2013). These authors concluded that the usage of iPad increases students' engagement, confidence and motivation in the classroom due to the nature of iPad applications that promote interactivity, challenges and fun. However, most of the studies have been carried out mainly on the effective use of iPads in primary

schools (McKenna, 2012; Spencer, 2013). Thus, other literature points out that further research needs to be done in secondary schools to assess students' understanding of Mathematical concepts (Williamson-Leadley & Ingram, 2013). Nevertheless, the results from the research done in primary schools should not be ignored. A recent study of using iPads in two primary classrooms in California revealed that the usage of iPad is suitable for concept development and critical thinking activities and it enhanced the students' learning and achievement (McKenna, 2012). Similarly, Spencer (2013) has found that in relation to Mathematics, the usage of iPad can also improve students' numeracy learning.

2.3. Using Virtual Manipulative

Virtual Manipulative is "an interactive Web-based visual representation of a dynamic object that presents opportunities for constructing Mathematical knowledge" (Moyer, Bolyard & Spikell, 2002, p. 373). As opposed to physical manipulative where teachers provide students with objects such as blocks to teach students to understand fraction concepts, Virtual Manipulative offers something beyond what physical manipulative can do. Teachers always struggle when implementing physical manipulative effectively as they need to monitor every student, and at times the manipulative pieces or blocks might be lost or broken (Mendiburo, Hasselbring, & Biswas, 2014).

Technology such as iPad has the ability to provide visual representations of mathematical concepts that are just as meaningful as physical manipulative (Moyer-Packenham & Suh, 2012; Mendiburo, Hasselbring, & Biswas, 2014). There are various benefits of using Virtual Manipulative when teaching and learning. A result of a study carried out to compare the effectiveness of instructions of physical manipulative and virtual fraction manipulative in four Year 5 Mathematics classes by Mendiburo, Hasselbring, and Biswas (2014), for example, has shown that the instructions that included virtual fraction manipulative was as effective as instructions that included physical manipulative but the instruction using Virtual Manipulative was significantly more time efficient.

Other studies revealed other positive results of using Virtual Manipulative. For instance, students were able to express a conceptual understanding of Mathematical concepts such as fractions and they were more engaged in the classroom (Moyer-Packenham & Suh, 2012; Reimer & Moyer, 2005; Suh, Moyer, & Heo, 2005). However, Reimer and Moyer (2005) strongly emphasised and argued that the mere use of any single form of manipulative does not guarantee that students will understand concepts and procedures. Therefore, teachers need to use a variety of teaching pedagogies, which include the use of various forms of manipulative to teach concepts and the usage of technology such as the Internet and iPads to be used as teaching and learning tools. This relates to an important question: "What are the challenges faced by teachers in implementing the use of Virtual Manipulative with the use of iPad and other forms of technology for teaching and learning?"

2.4. The issues and challenges

Despite the potential benefits mentioned earlier, the implementation and the usage of Virtual Manipulative and iPads in teaching and learning Mathematics also have drawbacks or challenges. One of the challenges of using Virtual Manipulative with iPad comes from its implementation. Teachers were not confident in using iPad into their pedagogy (Spencer, 2013) and many of them were not aware of the capabilities of Virtual Manipulative and did not use them in Mathematics lessons (Suh, Moyer, & Heo, 2005).

Attard and Curry (2012) suggested the need for teachers to have professional development, such as trainings and workshops on the usage of iPad. Furthermore, teachers need to keep abreast of the latest development in technology, particularly on any developments of educational applications which can be used for teaching and learning provided that they are given time to locate appropriate applications for the right level of students (Spencer, 2013; McKenna, 2012).

Another challenge in the usage of iPad in teaching and learning is its cost of availability and maintenance. To provide iPads for every student in one classroom seems to be possible, but it can be quite expensive. It is very important to understand that not all students can afford to own iPads. Furthermore, according to McKenna (2012) in order to gain access to the educational applications in iPad Apple Store, money is required to purchase those applications to be downloaded. Moreover, there is also the cost of maintenance (Williamson-Leadley & Ingram, 2013) that is another important issue that cannot be overlooked.

Lastly, the usage of iPads can be a distraction for students in the classroom. The increase in students' engagement by using iPads in the classroom can be at times distracting because they tend to lose concentration in learning as they were too excited to play other non-educational apps while the teacher is teaching (McKenna, 2012). Therefore, Spencer (2013) suggested the need for students' behaviours in using iPads to be monitored by the teacher. He further stated that prior planning on the effective usage of iPads need to be done by the teacher so that every student in the classroom has the chance to learn by using iPads (Spencer 2013).

The review of past literature has concentrated largely on the problems faced by students in learning fractions particularly on equivalent fractions and addition of fractions. It also highlighted the importance and benefits of using iPad as a teaching and learning resource in general. By comparing the previous studies cited and the research questions given earlier, there are still few gaps found in the literature. For instance, there was lack of research conducted on the use of Virtual Manipulative in teaching and learning fractions specifically using iPad and its effectiveness. Another issue or perhaps, a question that has not been discussed in the literature is who benefited from learning fractions using Virtual Manipulatives – all students or, students with high ability or students with lower ability? Hence, this study attempted to investigate these concerns as they pose a gap in literature. In particular, this study aimed to contribute to the body of knowledge about Virtual Manipulatives studies in the learning and teaching fractions and Mathematics in general.

3. Methodology

The purpose of this study is to examine the effectiveness of Virtual Manipulative with the use of iPads in teaching equivalence and addition of fractions. In this study, an action classroom-based research is used to analyse the effects of Virtual Manipulative towards students' conceptual understanding of fractions. Through the use of Virtual Manipulative using iPads, it is envisaged that there will be an increase of students' interest in learning Mathematics, encouraging them to engage and participate in the classroom activities, which will possibly lead to a better academic achievement in Mathematics.

3.1. Research design

The research design is a mixed method, which began with an action research using an experiment, and followed by classroom observations. It is based on a methodology that meets three criteria: (i) random assignment, (ii) experimental control, and (iii) using appropriate measures (Odle & Mayer, 2009). The purpose of using a mixed method experimental research design was to find out the effects of using Virtual Manipulative with the use of iPads in teaching and learning equivalent fractions and addition of fractions, and to determine whether the use of iPads improves students' understanding of fractions. Furthermore, this study was based on classroom action research design conducted by a teacher in the classroom. The purpose of using classroom action research was to improve teaching practices as highlighted by Johnson (2003) that "action research as the potential to change education; to keep our teaching practices evolving" (p. 29).

3.2. Participant sample

The sample in this study consisted of Year 7 students in one of the secondary schools in Brunei. The action research took place within a classroom setting and all students in the classes participated. Table 1 shows the distribution of the number of students who participated in this study. There were a total number of 43 students comprising two Year 7 classes *viz.* a high achieving class (Class A), and an average performing class (Class B). Due to limited number of iPads provided by the school, only two Year 7 classes were chosen in the study.

Table 1
Number of sample students in each class

	Class	No. of Males	No. of Females	Total no. of Students
	A	11	12	23
	B	8	12	20
Total	2	19	24	43

3.3. Instrumentation and data sources

Data was collected using the following methods.

***Pre-test and Post-test*:** The pre-test and post-test were designed by the researchers to assess students' understanding of equivalent fractions and addition of fractions, and at the same time to analyse students' misconceptions of fractions. Both tests were identical to each other (see Appendix A).

Attitude Survey: A closed questionnaire was used as a secondary form of data designed by the researchers to analyse the students' attitudes and perceptions on the use of Virtual Manipulative using iPad in the classroom (see Appendix B). Students would provide their opinions about Virtual Manipulative on a Likert Scale. They were given choices to either select a happy face to show that they agree to a statement which represents a positive response, a straight face to show that their uncertainty to a statement which represents a neutral response, and lastly a sad face to show they disagree with a statement which represents a negative response. The Likert Scale was used because it is a simple form of a questionnaire based on Year 7 students' level of thinking and that is why it should be made simple.

Lesson Artefacts: Lesson artefacts consisted of the collection of video-recordings from all the lessons in which this study was conducted and the recordings or screenshots of students' group work activities using iPad and without iPad (see Fig. 1). The purposes of the video-recordings were first, to identify and analyse students' attitude when using iPad and to explore the challenges encountered by the teacher when teaching using iPad; and second, to analyse the mistakes made by students when they were given group work activities using iPad and without using iPad.

3.4. Procedures

The entire study was conducted over a three-week block of school placement during regular school hours, conducted during regular scheduled mathematics classes (normal lessons of two periods of a total of 60 minutes). Before the intervention took place, the teacher gave the students from the two classes a pre-test on fraction equivalence and addition of fractions for 15 minutes. Then, on the first day of the intervention, students were divided into groups of two or three based on the results of the pre-test. Students who achieved high marks were grouped with students with lower marks so that the high ability students can help those with lower ability. Since there were only ten iPads available, the students were grouped so that a group shared an iPad. Each group would be assigned a numbered iPad to allow the students to save their group work solutions during each lesson activity. It is also important to note that all the lessons were video recorded.

The lesson began with an introduction to the Mathematics topic of the day, followed by an introduction to the iPad application 'Virtual Manipulative'. ABCya.com developed this application and it is available to for download from the Apple Store for free (ABCya.com, 2012). This application, Virtual Manipulative became the main tool for teaching fractions during the intervention period. A projector screen was used to display the application so that the teacher could show examples of Virtual Manipulative on the big screen. The lesson proceeded with the teacher reviewing the instructions with the students, followed by a demonstration on how to use the Virtual Manipulative. Then, the students started working with their group members on two activities. The first activity required students working in a group using the Virtual Manipulative on the iPad. For this activity, the answers using iPad were screenshot and saved for future analysis. The second activity was done individually and did not require the use of the iPad. During the last day of the intervention, the students were given the post-tests and attitude survey to respond.

One of the limitations of this research was the limited number of iPads, where students had to share the iPads, so individual assessment was often limited. This limitation was overcome by making the students do the activities in groups. Another limitation of the research was the difficulty in identifying the appropriate applications for the right level of students' ability. Furthermore, some of the applications were not free to be downloaded to iPads.

3.5. Research questions

Based on the purpose of the study, this research sought to address the following research questions:

1. Does the use of Virtual Manipulative help to improve or increase students' performance in fractions?
2. How do students perform when using Virtual Manipulative in learning fractions?

3. What are students' attitude regarding the use of Virtual Manipulatives on iPads in a Mathematics Lesson?
4. What are the challenges in implementing the use of iPads in a Mathematics Lesson?

4. Results and discussions

4.1. Pre-test and post-test

The first research question was to assess if the use of Virtual Manipulative helps to improve or increase students' performance in fractions? To test whether there would be some improvement in students' performance in learning fractions using Virtual Manipulative, students' scores on pre-test and post-test of both classes were analysed and compared using a paired sample t-test at the .05 significance level. These results are shown in the Table 2 below.

Table 2
The comparison of pre-test and post-test using a paired t-test (N=43)

	Pre-Test	Post-Test	t	P-value (Sig. 2-tailed value)
Mean	12.35	17.21	-8.145	0.000
Standard Deviation	3.677	2.455		

$p < .05$

The two-tailed paired samples t-test revealed that there was an improvement between the scores on post-test (M=17.21, SD=2.455) and the scores on pre-test (M=12.35, SD=3.677), $t(42) = -8.145$, $p \leq .05$. From Table 2, it is concluded that the average score on post-test (M=17.21) was greater than the average score on pre-test (M=12.35). The improvement in the students' scores suggested that there was a positive effect of the use of Virtual Manipulative in the learning and understanding of fractions concepts i.e. addition and equivalence of fractions.

Table 3
Pre and post-test scores for different achievement groups or classes

Achievement Groups			Pre-Test	Post-Test	Mean difference
High Ability (High Achieving Class)	Class A (n = 23)	M	14.17	17.43	3.26
		SD	2.758	2.150	
Mixed Ability (Average Performing Class)	Class B (n = 20)	M	10.25	16.95	6.70
		SD	3.522	2.800	

By comparing the performance of the two different achievement groups before and after the intervention using Virtual Manipulatives, Table 3 showed that the average performing class improved more as compared to the high achieving class in their post-tests. The difference in the mean scores of the pre-test and the post-test (mean difference = 6.70) is much higher and improved in the average performing class compared to the

difference of the mean scores of the high achieving class (mean difference = 3.26). This improvement in the mean scores strongly suggests there was a positive effect of the use of Virtual Manipulative in the learning and understanding fraction concepts especially for the average performing class.

Further inspection on the data was to assess any changes in individual students' pre- and post-test scores; and to compare if the scores increase, decrease or remained unchanged. The results of the analysis are shown in Table 4.

Table 4
Individual scores in pre-test and post-test (N=43)

Difference in Individual Scores in Pre-test and Post-test	No. of Students
Improvement	38 (88%)
No changes	3 (7%)
Underachieve	2 (5%)

The data from individual students' scores in Table 4 indicated that in both classes, 38 out of 43 students improved their scores between the pre-test and post-test. A majority of the students from both classes (Class A and Class B) improved their scores on their post-test after using the virtual fraction manipulative. These results indicated that the Virtual Manipulative helped 38 out of 43 students (88%) in improving their performance in learning fractions, while 3 students showed no change (7%) and 2 students' scores decreased (5%). These results also indicated that students with low and average ability performed better when using Virtual Manipulative compared to students with high ability. It may be explained that the reason for the increased change was due to the fact that these students learned at their own pace, and they may be highly motivated. It can also be assumed that the low ability students were focused more on understanding fraction concepts, while the high ability students who more focused on using procedural approach in doing the worksheet.

Generally, 37 out of 38 students whose scores improved, showed gains at least two points, and as many as eleven points between the pre-test and post-test. One of the three students whose score remained unchanged had extremely high score on the pre-test, hence obtaining the same high score on the post-test.

4.2. Students' performance when using Virtual Manipulative using iPad

This section addressed the second research question *viz.* how do students perform when using Virtual Manipulative in learning fractions? In order to answer this research question, data from the video recordings and saved worksheets on iPads were analysed qualitatively to assess students' engagement in the lesson, and their understanding of fractions as well as to identify any challenges which persist at the time when iPads were used in the lessons.

The aim was to analyse how students could learn using Virtual Manipulative and enhanced their conceptual understanding of equivalent fractions and addition of fractions in groups, and then individually applied the conceptual and procedural method of understanding on equivalent fractions and addition of fractions.

During the group activity, each group was given two main topics on equivalent fractions and addition of fractions using an iPad application. The main aim of this activity was to maximize the use of conceptual understanding of equivalent fractions and addition of fractions as mentioned earlier. Each group had the opportunity to discuss and work out the answers together from the worksheets using Virtual Manipulative with the use of iPads.

Equivalent fraction: For this activity, each group used a Virtual Manipulative application using the iPad on equivalent fractions. The teacher displayed one fraction strip e.g. 1/2 and each group was to discuss and work out the equivalent fraction of 1/2 by dragging the possible fraction strips below the fraction strip that represented 1/2. This would allow students in the groups to visualize and identify more than one equivalent fraction. Based on class observations and analyses from the screenshots of students' activity (see Fig. 1), all groups were able to answer correctly all the 5 questions on equivalent fractions using Virtual Manipulative.

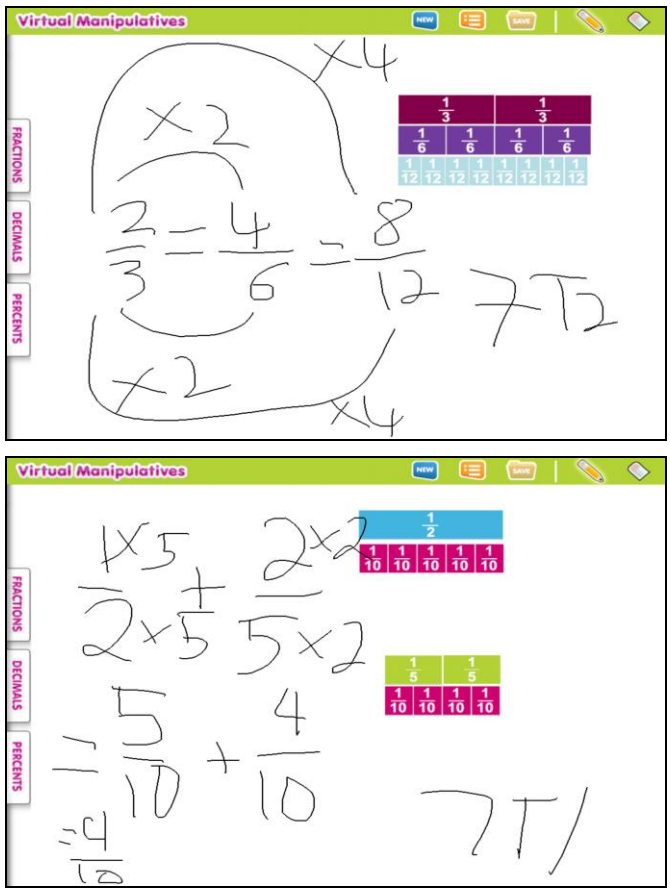

Fig. 1. Examples of students' activity using Virtual Manipulative application

In the individual activity, each student was given a worksheet consisting of four questions (see Appendix D) on equivalent fractions. The students were not allowed to use an iPad to answer the questions. Based on our analyses, 23.8% of students answered all questions correctly, 42.9% of students scored 15 out of 16, and only 9.5% of students

scored 13 out of 16, while 14.3% of students scored 12 out of 16, and lastly 4.8 % of students scored 10 out of 16.

From the above analyses, we concluded that although students were not allowed to use the Virtual Manipulative in the iPad to answer the worksheets, it was important to highlight that all of the students obtained the correct answers in their worksheets, which could indicate that these students might gain a conceptual understanding of equivalent fraction learned when using Virtual Manipulative from their group activity. However, there was not enough evidence to support this claim. Nevertheless, this analysis also revealed that students with lower scores mostly made mistakes in Question 3 and Question 4 (see Appendix C), which tested attainment of conceptual understanding. The results showed that based on their answers, these students did not know how to interpret the fraction tiles into equivalent fractions, while others considered filling the missing numerators as 'sequence' instead, and not in terms of equivalent fractions. This finding indicated that there were still a few students who had difficulties in applying the conceptual understanding of equivalent fraction when doing the individual worksheet when students did not use the Virtual Manipulatives in iPads.

Table 5
Frequency of correct or wrong answers from group activity on addition of fractions using iPad (n=20, Class B)

Question No.		Correct Answer n (%)	Wrong Answer n (%)
1.	$\frac{3}{10}+\frac{2}{10}$	20 (100%)	0
2.	$\frac{2}{5}+\frac{1}{2}$	19 (95%)	1 (5%)
3.	$3\frac{2}{8}+2\frac{4}{8}$	18 (90%)	2 (10%)
4.	$2\frac{1}{4}+1\frac{1}{6}$	16 (80%)	4 (20%)

Addition of fractions: For this group activity, each group used a Virtual Manipulative application in iPad for addition of fractions with unlike denominators. The class consisted of 20 students from mixed ability class and students from high performing class. There were four questions altogether (see Table 5 and Appendix E) in the group activity. Each question was displayed on the projector and the groups were asked to solve each question using Virtual Manipulative by moving virtual fraction strips on the iPad. By doing so, students could visualize a bigger picture of how to work out on the addition of fractions with unlike denominators.

Table 5 showed the following findings: First, all the students in all groups (100%) answered the first question correctly using Virtual Manipulative. Second, one group (5%) failed to answer correctly the second question using Virtual Manipulative. Third, two groups (10%) did not get the correct answer to Question 3. Lastly, four groups (20%) found that it was difficult to use Virtual Manipulative to solve Question 4, which involved the addition of two mixed numbers with unlike denominators. Further inspection of the data, it was shown that out of these four groups, only one group

correctly solved Question 4 using Virtual Manipulative despite their careless mistake, whereas the other three groups did not know how to use Virtual Manipulative correctly in order to solve Question 4.

Table 6
Frequency of correct or wrong answers from individual activity on addition of fractions without using iPad (n=43)

Question No.		Correct Answer n (%)	Wrong Answer n (%)
1(a)	$\frac{4}{9}+\frac{7}{9}$	43 (100%)	0
1(b)	$\frac{3}{8}+\frac{1}{3}$	37 (86%)	6 (14%)
2(a)	$3\frac{5}{7}+6\frac{1}{7}$	42 (98%)	1 (2%)
2(b)	$7\frac{2}{4}+4\frac{2}{5}$	34 (79%)	9 (21%)
2(c)	$5\frac{2}{5}+\frac{4}{15}$	25 (58%)	18 (42%)

For the individual student activity, each student was given a worksheet consisting of 5 questions on the addition of fractions (refer to Table 6 and Appendix F) without using Virtual Manipulatives in iPad. In general, for both classes A and B, most students were able to answer most of the questions correctly without using Virtual Manipulatives in iPad but there were careless mistakes made using procedural approach.

Table 6 shows that all 43 students (100%) were able to answer Question 1(a) correctly, as the question is quite straightforward and easy. However, a few students were unable to answer Question 1(b) that involves 'unlike' denominators. Although 37 students (86%) were able to answer Question 1(b) correctly, there were still 6 students (14%) who made careless mistakes in calculation and relied heavily on using procedural approach such as using Least Common Multiple (L.C.M.) to make the denominators equal.

Question 2a, 2b and 2c involved the addition of mixed numbers. Only one student (2%) did not answer Question 2a correctly whereas 42 students (98%) answered the question correctly as these questions involved equal denominators. However, only 34 (79%) out of 43 students able to answer Question 2b, and only 25 students (58%) were able to answer Question 2c. The mistakes made in these questions may be attributed to students' carelessness in calculation, and their dependence on using the procedural approach.

Based on the overall analyses from the group activity (using Virtual Manipulatives in iPad) and individual activity (without using Virtual Manipulatives in iPad), it was concluded that 35 students (81%) benefited from using the Virtual Manipulative when doing the worksheet with the use of iPad. The remaining number of students did not gain the benefit of using Virtual Manipulative. Perhaps, these students were too dependent on using procedural approaches as they worked out the exercises individually since they were accustomed to applying procedural approach in primary

schools, which led to a tendency of making careless mistakes resulting from students' oversimplified or overcomplicated workings (Fuentes, Bloom, & Peace, 2014).

4.3. Student attitude surveys and questionnaire

This section addressed the third research question i.e. what are students' attitudes towards the use of *Virtual Manipulative using* iPad in a Mathematics Lesson. To elucidate answers to this questions, the attitude surveys were analysed quantitatively. Students' responses were calculated in the frequencies and percentages of positive, neutral and negative response.

From the student attitudes survey, students were asked to evaluate their own experiences when using iPad for the learning of fractions, and also to evaluate their experiences using the Virtual Manipulative application. A summary of student responses to the survey to the questions is presented in Table 7.

Table 7
Frequency of responses in students' attitude survey (N=43)

Question	Positive Response f (%)	Neutral Response f (%)	Negative Response f (%)
Did you like using the iPad to work on Fractions?	37 (86%)	6 (14%)	0
Did the "Virtual Manipulatives" application on the iPad help you understand Equivalent Fractions and Addition of Fractions?	35 (81%)	8 (19%)	0
Do you think the "Virtual Manipulatives" application was easy to use?	32 (74%)	11 (26%)	0

The majority of the students' responses on all the questions about their experiences with the use of iPad and the Virtual Manipulative application were positive. Table 7 shows the highest percentage for all the questions were positive responses, a small percentage was neutral responses and none of the students gave negative responses. The highest positive responses to the survey showed that first, students (86%) liked using iPad to work with fractions; second, the Virtual Manipulatives application helped them to understand equivalent and addition of fraction (81%); and lastly, the Virtual application was easy to use (74%). This reason for these findings (highest positive responses and zero negative response) may be due to fact that it was their first experience in learning using iPad, making them excited and motivated to use the iPads. This result supported the claims made by Spencer (2013) and Attard and Curry (2012), which stated that students enjoy learning and understanding mathematical concepts using Virtual Manipulative as it was more entertaining, as well as it improved their motivation and confidence.

4.4. Video recordings of classroom observations

The last research question was: What are the challenges in implementing the use of iPads in a Mathematics Lesson? In order to answer this research question, the video recordings were analysed. During the classroom observations, four lessons on using iPad and Virtual

Manipulative were recorded using a video-recorder. From the video recordings, we able to observed students doing their work and identify any challenges when implementing iPads in teaching and learning of fractions. Based on the analyses of the video recordings from the beginning until the end of the lessons, four main themes or challenges were identified regarding the implementation of iPads in teaching and learning which might affect the lessons. These challenges were identified as (i) preparation issue, (ii) the issue of giving instructions, (iii) the issue of management of the class and discipline and lastly, (iv) technical issue. Below were some of the examples of the challenging issues that occurred during the lesson observations from the video recordings:

Preparation Issue: Based on the lesson observations from the video recording, it was revealed that the teacher spent more time preparing and setting up the iPad just to get it to work with the overhead projector. There was one particular incident where the projector did not work at all, and the teacher had to seek help from her colleague.

***Issue with Instructions*:** The video recordings of the lessons showed that the teacher had a difficult time teaching students on how to use the iPads and the application because most of students had no previous experience in using an iPad. Thus, the teacher had to spend time to teach the students on how to use the iPad, show them how to open and use the Virtual Manipulative application before they started the lessons on equivalence and additions of fractions.

Class Management: From the video recordings of the lessons, it was evident that there was class management issue. It was difficult for the teacher to monitor all the students especially when the teacher was explaining in front of the class. Some of the students were too excited using the iPads while others were not paying attention to the teacher, as they were distracted playing with other applications in the iPad such as the camera application.

Technical Issue: When the group activity using iPad was carried out, there were a few groups of students who complained that they were having troubles with their iPads. Some of the groups complained that as they were making the screenshots to save their work, the iPad screen turned black and froze. Other groups told the teacher that their iPads were running out of battery.

5. Conclusions

This action research study was aimed to investigate the effectiveness of Virtual Manipulative with the use of iPads in teaching and learning fraction concepts of equivalence and additions. Based on the pre-test and post-test results, the students' performance improved when Virtual Manipulative using iPad was introduced and applied. This supports the research study by Moyer-Packenham and Suh (2012) that by using Virtual Manipulative, students gained conceptual understanding of fraction concepts, which resulted in improvement in their performance. Another conclusion that can be drawn from the current study was that students with low ability performed much better compared to students with high ability. Therefore, the research cycle needs to be repeated to explore and confirm this finding. However, the extent to which students' performance have improved using Virtual Manipulative and the extent to which students have gained conceptual understanding using Virtual Manipulative are still debatable because from the findings, there were still a few students who did not know how to apply Virtual Manipulative in their group and individual activities. Furthermore, the students could not relate conceptual understanding (when using Virtual Manipulative) with

procedural understanding when they were given individual worksheets that they have been practicing for a few years at primary level. This was evident in the findings whereby students were still relying on using procedural approaches to solve the questions on the addition of fractions. Reimer and Moyer (2005) argued that the mere use of any single form of manipulative does not guarantee that students will understand concepts and procedures.

Based on the survey on students' attitude, the perception of students using Virtual Manipulative was positive. Students liked using iPad as their learning tools. Although there was no negative response, a majority of the students agreed that they understood the concept of fraction when Virtual Manipulative was used in their learning. This was particularly due to the fact that students enjoyed using iPad, especially for those who had never used an iPad before. Hence, there was no doubt that students' motivation in learning was enhanced when using iPad. This result required further investigation on the extent at which the students had understood on fraction concepts using Virtual Manipulative.

From the lesson observations using the video recordings, the implementation of iPad for teaching and learning could be quite challenging especially for teachers. It can be concluded that teachers need to be aware of the potential barriers or challenges of using technology such as iPad so that these challenges can be avoided or reduced in order to maximize students' learning. However, it can also be concluded that the effectiveness in implementing iPads in teaching and learning can also be related to teachers' competency with technology. More problems will arise if the teachers are not technologically competent in using technology such as iPads.

The findings of this study implied that Virtual Manipulative with the use of iPad was effective in enhancing students' performance in terms of conceptual understanding. The use of Virtual Manipulative could improve students' understanding of fraction concepts especially when group activity was involved. Hence, this finding implies that teachers need to carry out more group activities when using technology such as iPad in order to maximise students' learning. However, it also implies that teachers should not rely excessively in using Virtual Manipulative, as students need to know both conceptual and procedural approaches. Furthermore, the use of iPad in general can also improve students' motivation and confidence in learning fraction concepts or any other mathematical concepts. However, it would be better if teachers allow students to use iPads as their learning tool so they will be motivated and interested to learn. However, for teachers who would want to use iPad or any technological devices in the classroom would need to overcome the challenges and problems encountered during the process of implementation. Teachers need to be aware of such challenges and overcome any problems for the successful implementation of iPad that would maximise students' learning.

Teachers need to be competent in using the Virtual Manipulative application before they use the application in the classroom. It is recommended that such application needs to be evaluated for its suitability for Year 7 use. Last but not least, it is recommended that teachers should provide ample guidance when using this application by giving clear instruction to students. This can be achieved through collaboration among teachers through trainings or workshops on the use of iPad or any technological devices to be used for teaching and learning.

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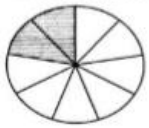
Appendix A. The pre-test and post-test

Name: _____
Class: _____ Date: _____

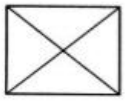
YEAR 7 FRACTION UNIT TEST

1) What is the fraction of the shaded area?

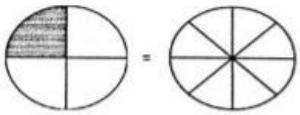


= _____

2) Shade $\frac{3}{4}$ of the square.

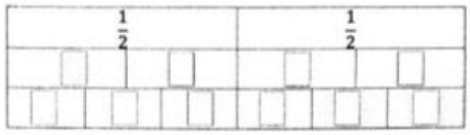


3) Shade the second circle to show that the fractions are equivalent and fill in the missing numerator.



$\frac{1}{4}$ is equivalent to $\frac{\quad}{8}$

4) Use the fraction tiles to help you find the equivalent fractions of $\frac{1}{2}$.
Put the correct fraction into the empty box in each of the tiles.



From your answers above, fill in the missing numerators below.

$\frac{1}{2} = \frac{\square}{4} = \frac{\square}{6}$

5) Find the sum of the following fractions. Write your answer in the simplest form. Show your workings in the spaces provided.

a) $\frac{4}{14} + \frac{3}{14} =$

b) $\frac{2}{3} + \frac{1}{8} =$

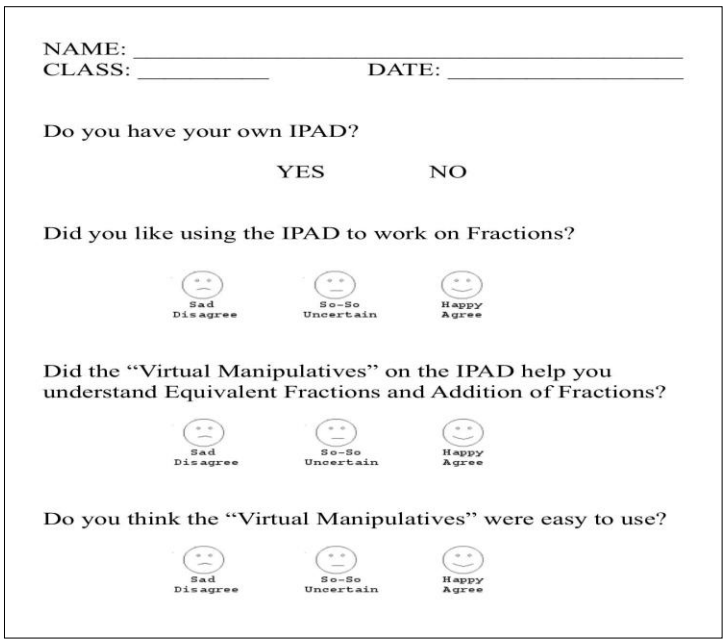
6) Find the sum of the following fractions. Write your answer in the simplest form. Show your workings in the spaces provided.

a) $3\frac{1}{8} + 5\frac{3}{8} =$

b) $4\frac{1}{3} + 3\frac{2}{5} =$

TOTAL MARKS:

Appendix B. Survey questionnaire using Likert scale



NAME: _____
CLASS: _____ DATE: _____

Do you have your own IPAD?

YES NO

Did you like using the IPAD to work on Fractions?

Sad Disagree So-So Uncertain Happy Agree

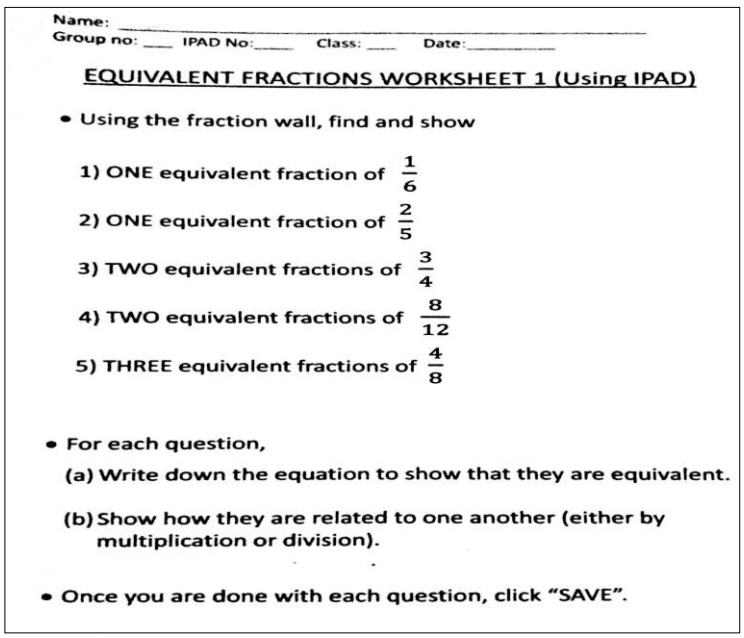
Did the "Virtual Manipulatives" on the IPAD help you understand Equivalent Fractions and Addition of Fractions?

Sad Disagree So-So Uncertain Happy Agree

Do you think the "Virtual Manipulatives" were easy to use?

Sad Disagree So-So Uncertain Happy Agree

Appendix C. Worksheet on equivalent fraction by using iPad (Group Activity)



Name: _____
Group no: ___ IPAD No:____ Class: ___ Date:_____

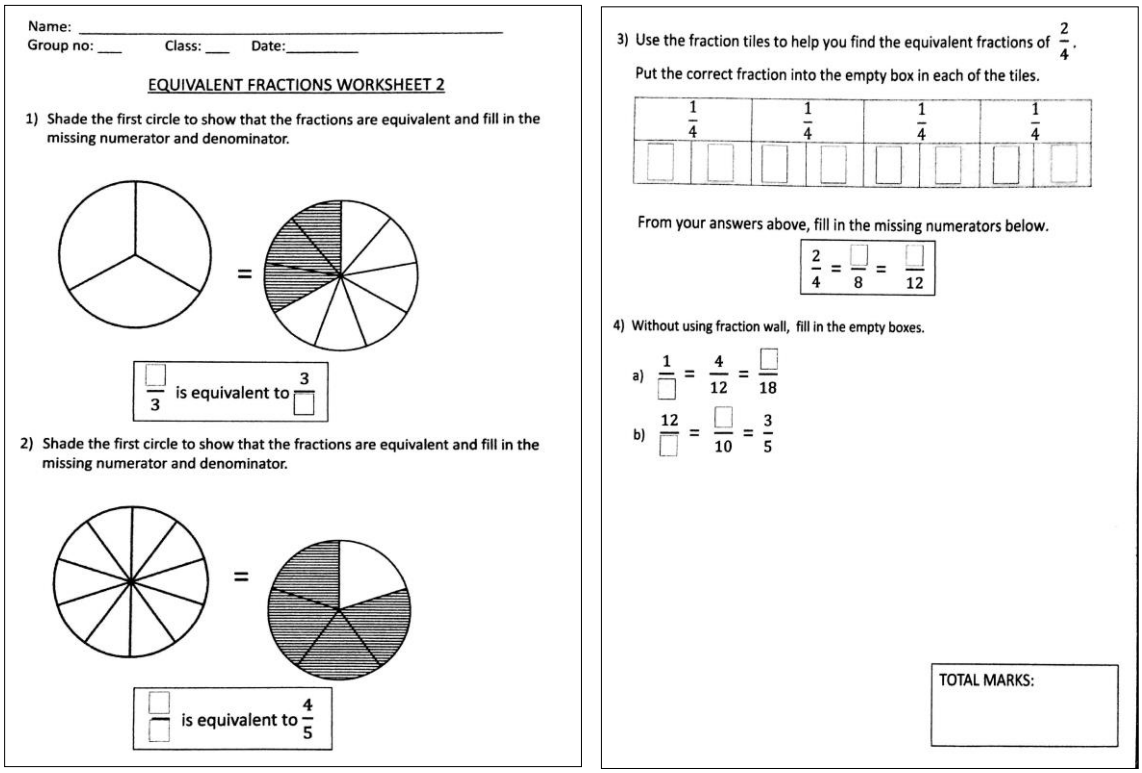
EQUIVALENT FRACTIONS WORKSHEET 1 (Using IPAD)

- Using the fraction wall, find and show

1) ONE equivalent fraction of $\frac{1}{6}$
2) ONE equivalent fraction of $\frac{2}{5}$
3) TWO equivalent fractions of $\frac{3}{4}$
4) TWO equivalent fractions of $\frac{8}{12}$
5) THREE equivalent fractions of $\frac{4}{8}$

- For each question,
  (a) Write down the equation to show that they are equivalent.
  (b) Show how they are related to one another (either by multiplication or division).
- Once you are done with each question, click "SAVE".

Appendix D. Worksheet on equivalent fractions without using iPad (Individual Activity)



Name: _____
Group no: ___ Class: ___ Date:_____

EQUIVALENT FRACTIONS WORKSHEET 2

1) Shade the first circle to show that the fractions are equivalent and fill in the missing numerator and denominator.

$\frac{\square}{3}$ is equivalent to $\frac{3}{\square}$

2) Shade the first circle to show that the fractions are equivalent and fill in the missing numerator and denominator.

$\frac{\square}{\square}$ is equivalent to $\frac{4}{5}$

3) Use the fraction tiles to help you find the equivalent fractions of $\frac{2}{4}$.

Put the correct fraction into the empty box in each of the tiles.

$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
$\square$ $\square$	$\square$ $\square$	$\square$ $\square$	$\square$ $\square$

From your answers above, fill in the missing numerators below.

$\frac{2}{4} = \frac{\square}{8} = \frac{\square}{12}$

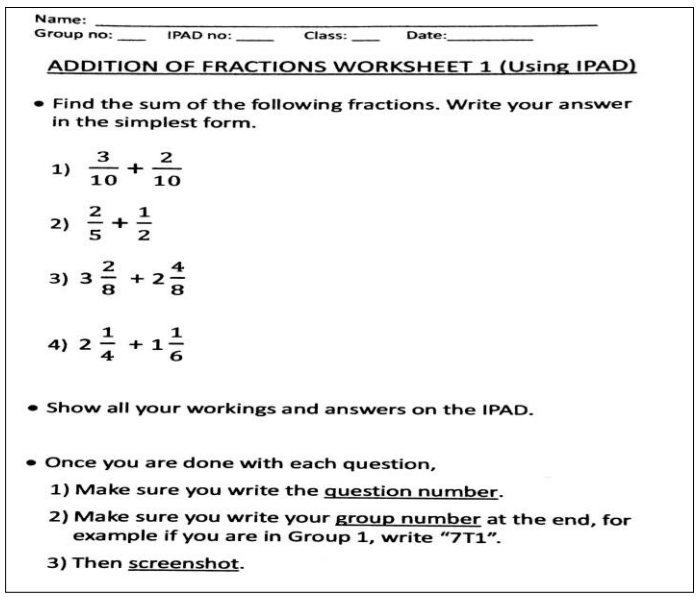
4) Without using fraction wall, fill in the empty boxes.

a) $\frac{1}{\square} = \frac{4}{12} = \frac{\square}{18}$

b) $\frac{12}{\square} = \frac{\square}{10} = \frac{3}{5}$

TOTAL MARKS:

Appendix E. Worksheet on addition of fractions by using iPad (Group Activity)



Name: _____
Group no: ___ IPAD no: ____ Class: ___ Date:_____

ADDITION OF FRACTIONS WORKSHEET 1 (Using IPAD)

- Find the sum of the following fractions. Write your answer in the simplest form.

1) $\frac{3}{10} + \frac{2}{10}$

2) $\frac{2}{5} + \frac{1}{2}$

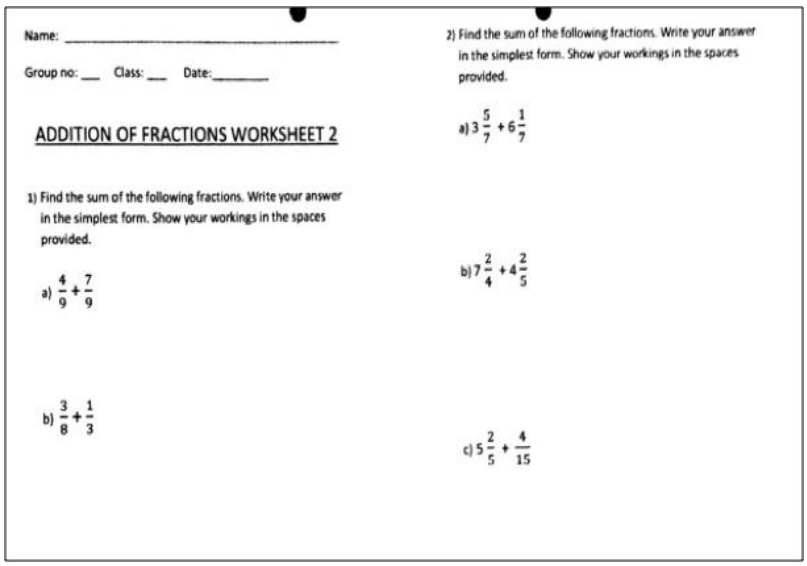
3) $3\frac{2}{8} + 2\frac{4}{8}$

4) $2\frac{1}{4} + 1\frac{1}{6}$

- Show all your workings and answers on the IPAD.

- Once you are done with each question,
  1) Make sure you write the question number.
  2) Make sure you write your group number at the end, for example if you are in Group 1, write "7T1".
  3) Then screenshot.

Appendix F. Worksheet on addition of fractions without using iPad (Individual Activity)



Name: _____

Group no: ___ Class: ___ Date:_____

ADDITION OF FRACTIONS WORKSHEET 2

1) Find the sum of the following fractions. Write your answer in the simplest form. Show your workings in the spaces provided.

a) $\frac{4}{9} + \frac{7}{9}$

b) $\frac{3}{8} + \frac{1}{3}$

2) Find the sum of the following fractions. Write your answer in the simplest form. Show your workings in the spaces provided.

a) $3\frac{5}{7} + 6\frac{1}{7}$

b) $7\frac{2}{4} + 4\frac{2}{5}$

c) $5\frac{2}{5} + \frac{4}{15}$