Effect of Students’ Achievement in Fractions using GeoGebra

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Abstract

Studies had shown that students have poor understanding in the conceptualization of fractions. The purpose of this study was to investigate the effect of students achievement in fractions using GeoGebra. A quasi experiment research design was used to compare the achievement of two groups of Year Four primary school students. Results indicated that there was a significant difference between the mean scores of the control and experiment groups. This finding illustrated that the students in the experiment group performed better when using GeoGebra than the control group with the traditional learning method. This implications were useful in proposing an alternative way of teaching and learning fractions as well as assisting students in visualizing fractions using GeoGebra.

Keywords: fractions, GeoGebra, visualization, students achievement

1. Introduction

Mathematics is one of the subjects that is suitable to integrate technology during lessons. This is because the subject requires students to see how any changes in the variables could affect others. Providing students to visualize what they are learning could help them to understand mathematics better compared to just manipulating numbers to get the final answer; which only the bright students could master.

One of the topics that primary school students is unable to master is fraction. Traditional teaching approach using inconsistent teaching aids can confuse the students who are trying to develop the concepts of fraction. Besides, manipulating numbers approach is only suitable for the bright students and those who can memorize the steps to get the answers. There is even some occasion when students can give the correct answer although they don’t really understand the concept itself. When these students are tested with higher order thinking type of questions, they may face difficulties as they do not have sufficient conceptual knowledge of fraction.
1.2 Objectives of Research
The main objective of this study was to investigate the effect of pupils achievement in fractions using GeoGebra. This study also aims to understand how the visualization of fractions with GeoGebra was useful in instruction.

2. Review of related literature

2.1. Fraction
Fractions is one of the earliest topics introduced to students after learning the four basic arithmetic operations. It is an important for teachers to carefully guide the students to understand the concept of fractions. This is because all of their existing knowledge on mathematics only involve whole numbers and operations. Any incorrect teaching of fractions can affect their understanding of the topic.

Study by Chinnappan (2000) on pre-service teachers revealed that they concerned more on how those pre-service teachers would approach to teach fractions and less about difficulties the children or learner might face. This is because the respondents are in their early stage of teaching thus they haven’t really experience what the student might face (Chinnappan, 2000). Teacher should master on how to clarify each concept before they present it to the students during the lesson instead of focusing more on drilling instead of building the correct concept. Only then can the students move forward clearly and with the correct fractions concept. Newstead and Murray (1998) in Niekerk, Newstead, Murray, & Olivier (1999) stated that one of the factors that contribute to the poor understanding of fractions is the initial presentation of fractions to children - both the way and the sequence in which the content is presented to them. For example, the use of pre-partitioned manipulative and a restriction to halves and quarters only (Niekerk, Newstead, Murray, & Olivier, 1999).

2.2. Teaching Fractions in Malaysia
In the Malaysian primary school syllabus (KBSR), students are exposed to fractions in Year 3 (Centre, 2003). They learn the concepts of parts, meaning of half and quarter represented by concrete objects and manipulative materials. Students are learning this new concept, thus presenting them using concrete objects and manipulative materials are a good way of doing it. However, teachers should build bridge between using discrete objects and what fractions is really all about to avoid students’ misconception (Wu, 2011). For example, the statement of half of two students’ pocket money might not have the same amount, because it depends on how much pocket money they have (Nunes, Bryant, Hurry, & Pretzlik, 2006).

In Year 4, students write proper fractions with denominators up to 10. They also compare the value of two proper fractions with the same denominators as well as with the numerator of 1 and different denominators up to 10. Later, they express and write equivalent fractions for proper fractions and express equivalent fractions to its simplest form (Centre, 2006a).
Students start to manipulate two fractions by adding and subtracting fractions in Year 4. They will operate on two fractions with the same denominator up to 10 either with 1 as the numerator for both fractions or with different numerators. The final answer is supposed to be in the simplest form.

In Year 5, students are exposed to improper fractions with denominators up to 10 and comparing the value between two of them (Centre, 2006b). They then convert improper fractions to mixed numbers and vice versa. Addition and subtraction of fractions will also include mixed numbers either with the same or different denominators up to 10. Multiplication of fractions will begin by multiplying whole numbers with proper fractions.

Students learn to add and minus three mixed numbers in Year 6 (Centre, 2006c). Multiplication of fractions will involve mixed numbers and whole numbers. To complete fraction the syllabus in the Malaysian primary curriculum (KBSR), students learn to divide fractions with a whole number and with another fractions. They also learn to divide mixed numbers with a whole number and a fraction.

The Standard Curriculum for Primary Schools (KSSR) syllabus was introduced in 2011 where students were exposed to fractions as early as in Year 1 (Kurikulum, 2011a). KSSR covered Year 3 in KBSR syllabus by recognizing half and quarter using concrete objects, pictures and paper folding. Year 2 students recognize proper fractions and shade the fractions accordingly, with numerator is 1 (Kurikulum, 2011b). Fractions are to be compared afterwards. Students in Year 3 continue to operate on proper fraction with denominator up to 10 by expressing equivalent fractions and simplify the fractions (Kurikulum, 2012).

Typical teachers would just give simple tricks in learning fractions starting in Year 4 by providing steps in manipulating the values of the numerators and denominators. Students will then follow through on their own pace. Some succeed if they understand the first lesson or they need drilling activities before they can remember the way of obtaining the answer. This kind of teaching can jeopardize the students in the long run as they do not really understand what and why they are doing certain steps to get the answer. Worse still if the students have mental block out during examination and cannot remember the procedure to solve the problem.

2.3. Malaysian Education Blueprint 2013-2025
Eleven shifts have been recognized to transform the system, and the seventh shift is to leverage ICT to scale up quality learning across Malaysia. Among initiatives taken by the government are by providing internet access and virtual learning environments via 1BestariNet for all 10,000 schools by 2013, augmenting online content to share best practices starting with a video library in 2013 of Guru Cemerlang delivering lessons in Science, Mathematics, Bahasa Malaysia, and English language as well as maximising use of ICT for distance and self-paced learning to expand access to high-quality teaching regardless of location or student skill (Education, 2012).

Even before this blueprint being set-up, MOE has extensively allocated a huge sum of money into providing ICT facilities in schools. However, at ground level (in school) ICT usage is still at a questionable level. For example, a 2010 Ministry study found that
approximately 80% of teachers spend less than one hour a week using ICT, and only a third of students perceive their teachers to be using ICT regularly (Education, 2012). Critically, the 2012 UNESCO review found that ICT usage has not gone much further than the use of word-processing applications as an instructional tool. ICT has tremendous potential to accelerate the learning of a wide range of knowledge and thinking skills. However, this potential has not yet been achieved.

2.4. ICT in Mathematics
Numerous numbers of studies on integrating ICT in teaching and learning mathematics received various responses mostly from teachers. Some of them are for it, while some are against it. There are also those who will consider to use it given certain circumstances. This might be the case of experienced teachers who are already comfortable with their current way of teaching (Adedokun-Shittu & Shittu, 2011). Nevertheless, it doesn’t mean that they totally reject the idea of integrating ICT into teaching and learning as a whole, and mathematics particularly. Given enough training and authorities to select and decide what and how to use them in class would increase teachers’ perception towards integrating ICT in classroom.

Teachers’ response in Adedokun-Shittu & Shittu (2011) also stated that it is hard to integrate ICT as students would easily distracted with the technological functions rather than to focus on the knowledge content that teachers are trying to convey. Misha & Koehler (2008) have introduced TPACK framework and its knowledge components that are suitable to be adapted by teachers who wish to integrate ICT in their classroom. It laid out the important components that should be there in teaching and learning and the relationship between components (Mishra & Koehler, 2008). However, as students vary in terms of background, education achievement and class condition, it is the teacher who should have the final word on how to make ICT integration in the classroom a success. ICT facilities availability in school and its condition also affect the decision to integrate ICT in the classroom. This is because an appropriate usage level of computers in the instructional process can promote the construction of deeper levels of conceptual understanding of fractions (Chinnappan, 2000).

GeoGebra is as an open-source dynamic mathematics software that incorporates geometry, algebra and calculus into a single and open-source package (Hohenwarter, Jarvis, Lavicza, 2008). Statistical analysis on a study on college level students confirmed the fact that the use of the applets created with the help of GeoGebra and used in differential calculus teaching had a positive effect on the understanding and knowledge of the students (Dikovic, 2009). Another study on teachers’ perceptions showed that GeoGebra can and should be used as an alternative to promote the use of technology in the teaching and learning of mathematics (Zakaria & Lee, 2012).

2.5. Visualising fractions with GeoGebra
Preiner (2008) in Chrysanthou (2008) stated that technology is integrated into mathematics teaching and learning in two forms. First, there are virtual manipulatives which consist of specific interactive learning environments. In the virtual manipulatives settings students can
explore mathematical concepts without having special computer skills or knowledge about specific educational software packages. Secondly, there are mathematical software tools that are appropriate for educational purposes and can be used for a wide variety of mathematical content topics, thus allowing more flexibility and enabling both teachers and students to explore mathematical concepts (Chrysanthou, 2008).

GeoGebra falls into the second type of technology. It is a dynamic mathematics software for schools that can be used to learn geometry, algebra, statistics, and calculus from elementary school to university level (Hohenwarter & Hohenwarter, 2012). Its interface is being divided into three area, which are graphics, algebra and table area that are connected and fully dynamic. When student make a change in graphics, numbers in algebra and table will change dynamically. The same thing will also happen whenever input in algebra or table is being changed, their graphics and numbers in table or algebra will also change accordingly.

Although GeoGebra is not mainly used to teach fractions as one of the respondents in (Lu, 2008) stated that GeoGebra cannot really be used to teach fractions compared to geometry and others, there are evidences that it is being used for this matter (Johnson & Brophy; Lavicza, 2011). (Escuder & Furner, 2012) support them by stating that GeoGebra can be used in teaching continued fractions.

Thus, one of the ways to help students who still can’t get the concept of fraction through conventional chalk and talk way of teaching as well as new learners is by introducing learning fraction by visualizing it, and GeoGebra can be used to achieve that purpose. Integrating educational software into teaching and learning session is at par with what the Ministry of Education (MOE) aims to do as stated in its current policy, Malaysian Education Blueprint 2013-2025.

3. Methodology

3.1. Research Design and Sample

This study employed a quasi-experimental design. A pre test and post test was administered to both the groups. The experimental group underwent an intervention where they learnt fractions using GeoGebra for one week while the control group on the other hand learnt fractions using traditional chalk and talk method.

Two classes of Year Four female students aged nine to ten years old were selected for this study. Their academic achievement were comparable as they were appointed to each class by zigzagging after they were streamed according to the previous year’s final examination result. The first student with the highest accumulative mark went to C Class, second to B Class, third to B Class, fourth to C Class, fifth to C Class, sixth to B Class and so on. A total of 85 students were involved in this study with 43 students in Class C and 42 students in Class B. Permission were granted by the school administrator to use these students and computer laboratory where Class B students underwent learning fraction using GeoGebra. Class B was assigned as the experimental group while Class C was the control group. The researcher became the instructor of the both the groups.
Table 1. Composition of samples

<table>
<thead>
<tr>
<th>No of students</th>
<th>Group of students</th>
<th>Breakdown of No (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>Experimental</td>
<td>42</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>43</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>85</td>
<td></td>
</tr>
</tbody>
</table>

3.2. Procedure

The study took place on the week after these students had their first semester examination. The examination covered fraction until addition and subtraction of fraction. They haven’t learnt multiplication and division of fraction yet as it will only be covered in Year Five. Due to that, researcher has to teach them the concept of multiplication and division of fraction. Both the control group sat for an achievement test on fractions called the pre-test.

For the control group, it was then followed by teaching them how to get the answer in the traditional way. Because they have studied for examination, researcher only needed to refresh the concept of fraction from constructing to comparing fraction, as well as operation of addition and subtraction involving fraction.

The experimental group occupied the computer laboratory for the whole week. The first day was to let the students familiar with GeoGebra by playing around with features available in it after they refreshed the concept of fraction they have learnt. On the second day, in morning session, students started to be exposed on how fraction can be constructed in GeoGebra using rectangle representation. After recess, they underwent Instructional Activities of Constructing and Comparing Fraction. On the third day, students were guided to solve addition of fraction questions during morning session based on Addition of Fraction Instructional Activity. They were then continued to solve subtraction of fraction based on Subtraction of Fraction Instructional Activity after recess. The students learned to multiply and divide fraction using rectangle representation, and not the traditional way of manipulating numbers on the last day. They solved multiplication of fraction based on Multiplication of Fraction Instructional Activity in the morning, and solved division of fraction based on Division of Fraction Instructional Activity after recess. The students were told to record on what they did at the end of each session to show their understanding of the activities.

On the fifth day, students from both the control group and experimental group sat for the achievement test that is also known as the post test.

There’s a view in GeoGebra called Geometry Perspective. If it is used with grid being shown, it can act as template for fraction to be constructed in rectangle form. The width of rectangle is dependent on the value of first denominator, while its height is according to the second denominator. First numerator will determine the number of column(s) to be coloured in the first rectangle, while second numerator will determine the number of rows to be
coloured in second rectangle. Overall, all of the operations work according to this same flow, but multiplication of fractions will have quite a different method compared to the other operations.

After students managed to construct the rectangle, they could just see the answer directly for multiplication and division of fractions. For addition of fractions, they just have to add the units being coloured in both rectangles to get the numerator of the answer. As for subtraction of fractions, students are needed to subtract the number of units being coloured in the first rectangle to the number of units being coloured in the second rectangle to get the numerator. Denominators of the answer for all of the operations are dependent on the number of units in one whole rectangle.

3.3 Data Analysis

Inferential statistics was used to answer the objectives of this study. Achievement test scores were analyzed using Statistical Package for Social Science Version 18.0 (SPSS 18.0). The t-test was used to test for statistical significance difference between the pre-test and post-test of both the groups.

4. Results

The results of this study are discussed in the section below.

Table 2
Results of the independent t-test on the pre test of both groups

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (C)</td>
<td>42</td>
<td>3.78</td>
<td>3.13</td>
<td>12.31</td>
<td>.000</td>
</tr>
<tr>
<td>Experimental group (B)</td>
<td>43</td>
<td>4.76</td>
<td>2.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 showed that the control group obtained a mean score of 3.78 while the experiment group obtained a mean score of 4.76. This indicated that the experimental group achieved higher mean scores compared to control group. The mean score difference between the groups was 0.98 with a t-value of 12.31. However, the p-value was significant with a p-value of 0.0001 (p<0.05). This means that the difference in the mean score of both the groups was significant. In short, both the students in the control and experiment group were less similar in abilities before the treatment was administered.

Table 3
Results of the independent t-test on the post test of both groups

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group (C)</td>
<td>42</td>
<td>6.92</td>
<td>4.19</td>
<td>42.78</td>
<td>.000</td>
</tr>
<tr>
<td>Experimental group (B)</td>
<td>43</td>
<td>10.92</td>
<td>1.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To determine whether any significant differences exist between the post test mean score of both the control and experiment group, an independent sample t-test was done. Table 3 showed that the experimental group obtained a mean score of 10.92 while the control group obtained a mean score of 6.92. The mean score difference between the groups was 4.00 with a t-value of 42.78. However, the p-value was 0.0001 (p<.05) indicating the difference in the mean score of the two groups was significant. This finding illustrated that the students in the experiment group performed better using GeoGebra than the control group that uses the traditional learning method. The students in the experimental group performed better in the post test compared to the control group.

5. Discussion

According to the theory of constructivism, knowledge is not taught but is learned by the learner themselves through constructing new knowledge on the bases of old knowledge, under a certain setting, with the help of others such as teachers or study partners, and utilizing certain study resources. Students being the centre of teaching and learning process while teacher works as organizer, facilitator and motivator, utilizing setting, cooperation and dialogue to motivate students’ interests, activity and creativity (Liu, 2010).

Numerous researches have been made as early in 80’s to current years on challenges students face in understanding fractions (Bruce & Ross). They also collected reasons on why those things happen as well as various strategies proposed by researchers to help students to engage fractions better (see Bruce & Ross), not forgetting the ones with technology-assisted learning.

Findings from this study support previous studies to show that learning through technology does give positive impact in constructing students’ knowledge and understanding of fractions. Learning process underwent by experimental group also enable open communication between students and teacher, as well as among students themselves. By visualizing fractions in rectangles, it helps those who are visual-spatial type of learners better than rote learning process. At the same time, this strategy helps students to understand the meaning behind numerator and denominator signs, regardless of what type of leaner they are. Thus, it enables students to grasp basic concepts of arithmetic involving fractions properly so they will not face difficulties in the future.

Fractions can be regarded as one of the basic concepts that students must master in primary level just like they have to master all the rules in arithmetic. However, simple misleading methods taught by teachers or misconceptions develop by the students themselves will jeopardize their perception towards mathematics in later stages. Those who keep getting wrong answers without any alternative way to help them in understanding fractions properly would possibly diminish their interest towards mathematics. Thus, teachers should improvise as many alternatives as possible to cater to different type of students in their learning of the
basic concepts. This proposed way of learning arithmetic involving fractions can possibly be considered by teachers to guide students who are still struggling in understanding the basic.

6. Conclusion

In this study, the teaching and learning of fractions using GeoGebra has been effective. This was shown through the improved scored of the students in the experimental group. The findings highlighted that students in the experiment group performed better using GeoGebra than the control group that uses the traditional learning method. In addition, students in the experimental group performed better in the post test compared to the control group. The software also enhanced visualization and understanding of the fractions concept for both the teacher and the students.

References


