Investigating The Effectiveness of Manipulatives in Teaching Fractions Among Grade 6 Students/Tutees of Academika Learning Center

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Abstract — This research delves into the effectiveness of utilizing manipulatives in teaching fractions, particularly focusing on Grade 6 students at Academika Learning Center. Manipulative materials, known for their tangible representation of abstract concepts, have been widely used in mathematics education to enhance student comprehension and engagement. This study aims to investigate the impact of manipulatives on students' understanding of fractions, their motivation, and overall academic achievement. Drawing from previous research, which has shown positive outcomes of manipulative-based instruction, this study seeks to contribute further evidence by employing a quantitative research design, specifically utilizing a paired t-test to analyze pretest and post-test data. The study entails a two-week intervention phase where students engage with manipulative-based activities, followed by assessments to measure their comprehension of fraction concepts. Despite anticipated limitations such as a small sample size and a brief intervention period, the study expects to yield valuable insights for educators, curriculum designers, and policymakers in enhancing mathematics education outcomes through the strategic integration of manipulatives.

I. Introduction

Manipulative materials play an essential role in the pedagogical approach to mathematics, particularly in the teaching of abstract concepts like fractions. These materials offer students tactile and visual representations of mathematical concepts, facilitating deeper understanding and engagement in learning. Despite the widespread recognition of their benefits, there remains a gap in localized research regarding the effectiveness of manipulatives in teaching fractions, especially within the Grade 6 context at Academika Learning Center.

While international studies have shown positive outcomes associated with manipulative-based instruction in mathematics, it is crucial to investigate their effectiveness within our local educational context. This study aims to address this gap by examining how manipulatives impact Grade 6 students' comprehension of fraction concepts, their motivation, and overall academic achievement.

One of the significant challenges in teaching mathematics, particularly fractions, is the abstract nature of the concepts involved. Students often struggle to grasp these concepts solely

through symbolic representations. Manipulatives offer a tangible bridge between abstract mathematical ideas and concrete, real-world objects, making fractions more accessible and comprehensible for students.

Moreover, previous research has demonstrated the effectiveness of manipulative-based instruction in improving students' understanding of fractions and their motivation to learn mathematics. Studies by Horan (2018) and Alegre, et al. (2020) have shown that students who engage with manipulatives exhibit higher levels of conceptual understanding and engagement compared to those taught through traditional methods.

However, while these studies provide valuable insights into the benefits of manipulative-based instruction, there is still a need for localized research to understand how these findings translate to our specific educational context. By conducting this study at Academika Learning Center, we aim to fill this gap and provide evidence-based insights that are relevant to our local educators, students, and policymakers.

Furthermore, by employing a quantitative research design and utilizing a paired t-test to analyze pretest and post-test data, we seek to provide robust evidence of the effectiveness of manipulative-based instruction in teaching fractions. The study will involve a two-week intervention phase, during which students will engage in various manipulative-based activities designed to enhance their understanding of fraction concepts.

Despite the anticipated limitations, such as a small sample size and a brief intervention period, this study is expected to yield valuable insights that can inform pedagogical practices and curriculum development in our local educational context. By understanding how manipulatives impact students' comprehension of fraction concepts, educators can tailor their teaching strategies to better meet the diverse learning needs of students at Academika Learning Center.

Overall, this research seeks to contribute to the ongoing discourse on effective mathematics instruction by providing localized evidence of the benefits of manipulative-based instruction in teaching fractions. By bridging the gap between theory and practice, this study aims to empower educators with the knowledge and tools they need to enhance mathematics education outcomes for Grade 6 students at Academika Learning Center.

Statement of the Problem

The primary objective of this research is to assess the efficacy of employing manipulatives in the instruction of fractions within the Grade 6 students at Academika Learning Center. Additionally, the study aims to address the following questions:

1. How does the incorporation of manipulatives in teaching fractions affect students' overall comprehension of fraction concepts?

2. In what ways do manipulatives influence students' motivation and engagement in learning fractions?

3. To what extent do manipulatives contribute to increased achievement in fractions compared to traditional teaching approaches?

Significance of the Study

The researcher holds significant importance for various stakeholders, including educators, students, and educational policymakers. By investigating the effectiveness of manipulatives in teaching fractions among Grade 6 students at Academika Learning Center, this study seeks to contribute valuable insights to the field of mathematics education. The findings of this research can provide educators with evidence-based insights into the effectiveness of manipulatives in teaching fractions. This information can aid teachers in refining their instructional strategies to better cater to the diverse learning needs of students.

Policymakers in the field of education can benefit from the study's insights when making decisions about curriculum design and resource allocation. Understanding the impact of manipulatives on student learning outcomes can inform policy initiatives aimed at improving mathematics education.

The research intends to build upon prior studies by adopting a comprehensive approach, incorporating a larger sample size, and considering additional learning criteria. This contribution to the literature aims to advance the understanding of the nuanced effects of manipulatives on students' comprehension of conceptually challenging fraction concepts.

The study's outcomes may guide future research endeavors in the domain of mathematics education, specifically regarding the use of manipulatives. Researchers can draw upon the findings to explore related areas or conduct further investigations with refined methodologies.

Scope and Limitation of the Study

The study focuses specifically on Grade 6 students at Academika Learning Center, examining the effectiveness of manipulatives in teaching fractions within this particular educational setting.

The research is confined to Grade 6 students, considering their developmental stage and curriculum content related to fractions. The study is conducted exclusively at Academika Learning Center, providing insights into the effectiveness of manipulatives in the context of this specific educational institution. The research is centered on teaching and learning fraction concepts, including addition and subtraction, utilizing manipulatives as instructional tools. The study adopts a quantitative research design, specifically utilizing a paired t-test to analyze pretest and post-test data.

While the research aims to contribute valuable insights, it is important to acknowledge certain limitations that may impact the generalizability and applicability of the findings. The study involves a relatively small sample size of fifteen Grade 6 students from the Academika Learning Center. The findings may not be fully representative of broader student populations or other educational settings. The research is conducted within the confines of Academika Learning Center, and the findings may not be universally applicable to students in different geographical locations or educational systems. Due to the specific context and limited sample size, caution should be exercised when generalizing the findings to broader educational contexts.

Despite these limitations, the study aims to offer valuable insights into the effectiveness of manipulatives in teaching fractions within the specified scope. The outcomes may serve as a foundation for future research endeavors and contribute to the ongoing discourse on innovative instructional strategies in mathematics education.

Definition of Terms

Manipulatives - Physical or digital objects, such as blocks, shapes, spinners, and computer-based programs, are used as instructional tools in teaching mathematics to enhance the understanding of abstract concepts, particularly in the context of fractions.

Paired t-test - A quantitative research design employed to assess the relationship between independent (manipulative use) and dependent variables (pre-test and post-test scores) after an action, aiming to determine the impact of manipulatives on students' mathematical achievement.

Posttest - A subsequent assessment conducted after the two-week manipulative-based instruction, also consisting of 50 items, was designed to evaluate the impact of the intervention on students' comprehension of fraction-related content.

Pretest - An initial assessment administered before the manipulative-based intervention, comprising 50 items to evaluate the baseline understanding of fraction concepts among Grade 6 students.

II. Methodology

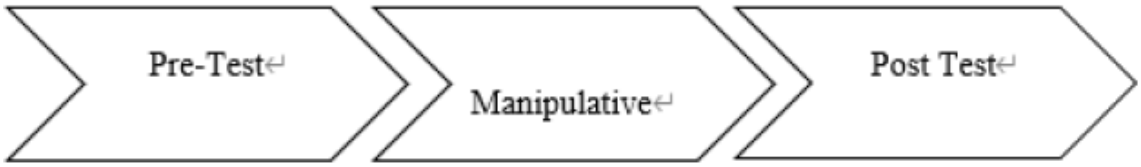
This chapter presents the research design, sampling design, data-gathering procedure, and data analysis.

Research Design

The study utilized a type of quantitative research, the paired t-test. The paired t-test design was used to find the relationship between independent and dependent variables after an action.

The dependent variable was a measure of the pre-test and post-test and the independent variable was manipulative in this study. The researcher's goal is to determine whether the manipulations cause changes in the students' mathematics achievement.

The process of the t-paired test is illustrated below:



Sampling Design

In this study, the researchers will use simple random sampling. The learning center has 29 Grade 6 students. Out of 29 students, fifteen students will be randomly selected. The researchers will use the wheel of names in selecting the participants. Each participant has an equal chance of being selected.

Research Instrument

In this study, a quantitative research approach is employed, and the primary research instrument utilized is a pretest and posttest designed to assess students' understanding of fraction concepts before and after the intervention involving manipulatives.

The pretest comprises 50 items designed to evaluate the baseline understanding of fraction concepts among Grade 6 students. Similar to the pretest, the posttest consists of 50 items assessing students' comprehension of fraction concepts, with a focus on the impact of manipulative-based instruction.

Various manipulative-based activities are incorporated into the instruction phase, including modeling manipulatives, interactive group exercises, independent tasks, and computer-based programs integrating manipulatives.

The wheel of names is used as a tool for simple random sampling, ensuring that each of the 29 Grade 6 students at Academika Learning Center has an equal chance of being selected for the study.

The paired t-test serves as the statistical tool for analyzing the data obtained from both the pretest and posttest. It measures the significance of the difference between the means of the two sets of data, providing insights into the growth achieved by the student group.

Data Gathering Procedure

The data-gathering procedure for the study will involve the utilization of a 50-item pretest and posttest. Initially, a group of 15 students will be given the pretest to establish a baseline. Subsequently, the students in the group will receive instruction on various concepts and understanding of fractions, including addition and subtraction, based on the results of the pretest. This instruction phase will span approximately two weeks.

During the two-week learning process, the students will engage in a variety of activities. They will observe manipulatives being modeled by the teachers, interact with each other using manipulatives, work independently with manipulatives, and participate in computer programs incorporating manipulatives. The two teachers present will take turns teaching each group separately, ensuring that teaching style will be a manageable factor in the study. Additionally, the students will be assigned homework from a workbook provided by the researchers.

Data Analysis

Following the two-week instruction period, a posttest identical to the pretest was administered. The data obtained from both the pretest and posttest were subjected to analysis using a paired t-test to measure the amount of growth achieved by the group.

Pre test Results	Post Test Results
12	40
20	45
24	42
18	39
20	39
16	40
17	43
18	44
19	48
20	39
21	45
24	45
13	44
15	41
17	38
18	39

Table 1.0 Pre Test and Post test results

Ho: There is no significant difference in learning outcomes between Grade 6 students who are taught fractions using manipulatives and those who are not.

(Ho: $\mu A = \mu B$)

Ha: Grade 6 students who are taught fractions using manipulatives show significantly better learning outcomes compared to those who are not.

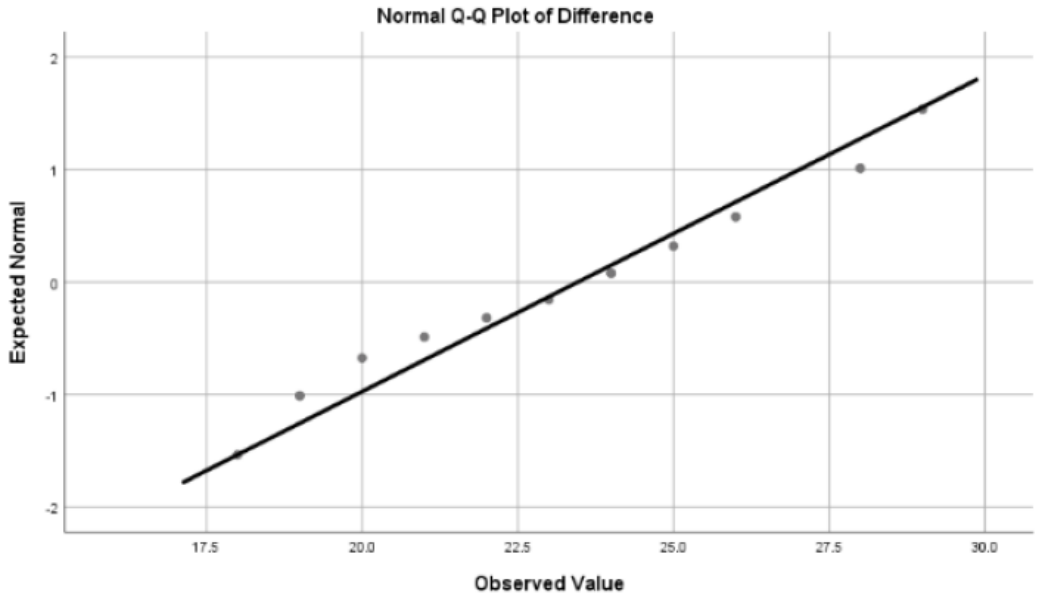
(Ha: $\mu A < \mu B$)

Let $\alpha = 0.05$; one-tailed; df = 14; ttab = 1.761.

Use t – test for dependent samples.

Compliance with the use of the Paired t – Test

1. The scores of the students (dependent variable) is of the ratio level of measurement.
2. The independent variable consists of two categorical /related groups (scores before and after using manipulatives).
3. There are no significant outliers in the differences between the two related groups.



4. The distribution of the differences in the dependent variable between the two related groups is approximately normally distributed.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference	.101	15	.200*	.950	15	.529

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The p-value 0.529 from the Shapiro-Wilk test of normality is greater than 0.05 which implies that it is acceptable to assume that the difference distribution is normal.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Difference	15	18.00	29.00	23.4667	3.56304	-.017	.580	-1.215	1.121
Valid N (listwise)	15								

Note:

Skewness Ratio:

$$\frac{1.215}{1.121} = 1.08 < 2$$

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest	18.27	15	3.474	.897
	PostTest	41.73	15	2.963	.765

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreTest & PostTest	15	.396	.144

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PreTest - PostTest	-23.467	3.563	.920	-25.440	-21.494	-25.508	14	.000

III. Results and Discussion

The forthcoming study aims to assess the prospective impact of manipulative-based instruction on the comprehension of fraction concepts among Grade 6 students at the Academika Learning Center.

The results from the pre-test (M= 18.27, SD=3.474) and post-test (M=41.73, SD= 2.963) scores before and after the use of manipulatives in learning fractions show an increase of scores.

This difference is significant because the null hypothesis is rejected, t(14)= -25.508, p (0.00)<5. The results obtained from the study serve as a significant indicator, highlighting the importance of using manipulatives in teaching fractions. It is evident that when educators incorporate manipulatives into their instruction, students are able to internalize fractional concepts more successfully, leading to significant growth in their understanding. These results also demonstrate the superiority of manipulative-based instruction over the traditional paper-and-pencil style of teaching when it comes to fractions.

IV. Conclusion

In summary, this study aimed to investigate the effectiveness of manipulative-based instruction in enhancing the comprehension of fraction concepts among Grade 6 students at Academika Learning Center. A pretest and posttest, along with a two-week intervention involving manipulatives, were employed to assess the impact on students' understanding of fractions. The anticipated results, based on previous research, suggest that manipulative-based activities contribute to improved academic performance, increased engagement, and a more tangible understanding of abstract mathematical concepts.

The analysis of the pretest and posttest scores, utilizing a paired t-test, is expected to reveal a statistically significant difference, affirming the positive influence of manipulative-based instruction. The rise in posttest mean scores indicates the potential of manipulatives to address challenges associated with teaching fractions, particularly in elementary education. While acknowledging the study's anticipated limitations, such as a small sample size and a brief intervention period, the results are expected to contribute valuable insights to the field of mathematics education.

In conclusion, the anticipated findings of this study suggest that manipulative-based instruction holds promise as an effective strategy for enhancing students' understanding of fractions. The recommendations aim to guide educators, curriculum designers, and policymakers in leveraging the potential of manipulatives to improve mathematics education outcomes.

REFERENCES

[1] Horan, E. (2018). How Much Guidance Do Students Need?. https://eric.ed.gov/?id=EJ1195245
[2] Alegre, F., et. al. (2020). Academic Achievement and Peer Tutoring in Mathematics: A Comparison Between Primary and Secondary Education https://journals.sagepub.com/doi/full/10.1177/2158244020929295