THE USE OF PLAY DOUGH IN TEACHING FRACTION AMONG GRADE 2 PUPILS IN CCES

Kareen Mae R. Ebrano, Railyn D. Mones, Leneth Pearl S. Pingot

Department of Elementary Education, Davao Oriental State University - Cateel Extension Campus, Cateel, Davao Oriental, Philippines, 8205

ABSTRACT

This study aimed to incorporate play dough in teaching fractions to Grade 2 pupils at Cateel Central Elementary School. A quasi-experimental design was employed, with a control group and an experimental group. Pretest and post-test questionnaires were used to collect data, and statistical tools such as mean and independent sample t-test were utilized for analysis. The results indicated that the experimental group achieved outstanding performance, with a significant difference in mean post-test scores compared to the control group. Additionally, the experimental group displayed higher average pretest score. Furthermore, the experimental group exhibited a significant difference in post-test scores, showcasing better overall performance and greater consistency. The observed differences between the pretest and post-test scores of the control and experimental groups further support the conclusion that play dough can be a valuable teaching tool for fractions. These findings have practical implications for teachers, pupils, parents, and future researchers, emphasizing the potential of play dough in facilitating effective fraction instruction.

Keywords: *play dough, teaching, fraction, classroom-based, intervention.*

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1. INTRODUCTION

Fractions have been employed in various mathematical and everyday contexts since their invention thousands of years ago. However, pupils find it difficult to learn and master it (Gabriel et al., 2013). According to research, students at all grade levels have trouble understanding the idea of fractions (Isik & Kar, 2012; Olkun & TolukUcar, 2012; Unlu & Ertekin, 2012). A student's failure to comprehend a variety of processes may be the cause of the problem (Aksu, 2012). As a result, the operations required and how they are presented in the problem impact performance when working with fractions (Aksu, 2012). According to Gabriel et al. (2013), fractions are one of the hardest Mathematical concepts in primary education. Specifically, when problem-solving with fraction operations, students appeared to apply concepts they did not fully comprehend.

Fraction is a numerical representation (such as $3/4$, $5/8$, or 3.234) indicating the quotient of two numbers (Merriam-Webster). Although complicated, fractions were crucial ideas in mathematics. Numerous measurements and calculations employ fractions (Van de Walle, Karp, & Bay-Williams, 2013).

Weak fraction knowledge at the primary level predicts low mathematics achievement and algebra knowledge in high school (Siegler et al., 2013). Siegler and Lortie-Forgues (2015) stated that youngsters who struggle with fraction arithmetic find it difficult to acquire more complex math, ultimately impairing their workplace performance. Bruce et al.'s (2013) study found that children with trouble with fractions were eventually barred from pursuing higher mathematics. Even though it is a subject that students would need throughout their lives, mathematics is one of the subjects that students fear the most in school (Fritz et al., 2019) (Li and Scho. Enfield, 2019).

However, students' understanding of fractions can vary, and educators must provide effective instructional strategies to support their learning (Smith, 2018). Fraction concepts can be challenging for some learners, as they involve abstract reasoning and manipulating numerical relationships (Thompson & Saldanha, 2019). Therefore, educators should consider employing various teaching approaches: visual representations, and hands-on activities, to enhance students' comprehension and engagement with fractions (Battista, 2017). The acquisition and understanding of fractions among pupils can present challenges depending on individual learning styles and instructional approaches

(Smith, 2016). Studies have explored various factors contributing to the difficulties pupils may encounter when learning fractions, including conceptual understanding, procedural knowledge, and transferability of skills (Johnson et al., 2018; Brown & Jones, 2020).

Furthermore, the importance of providing comprehensive and targeted instruction to support pupils' development in fractions was highlighted (Anderson, 2013; Thompson & Chen, 2017). This instruction should incorporate concrete manipulatives, visual representations, and opportunities for meaningful practice, which have shown promise in enhancing pupils' fraction understanding and performance (Foster et al., 2014; Baker & Smith, 2019). It is important for educators and policymakers to recognize the complex nature of fraction learning and to provide resources and support that can address the diverse needs of pupils. By employing evidence-based instructional strategies and fostering a positive learning environment, educators can empower pupils to develop a foundation in fractions and enhance their overall mathematical proficiency (Bennett et al., 2021; Cooper & Taylor, 2022).

There are various ways to define fraction sense (Liew-Kee Kor, 2019). Fraction sense is crucial for pupils' success with fraction operations (McNamara et al., 2015). Furthermore, at Cateel Central Elementary School, it was observed that learners in Grade 2 demonstrated a need for further development in understanding fractions. Thus, this study explored the use of play dough as a manipulative that incorporates a learner-centered teaching strategy to aid students in getting over their struggle with learning fractions.

1.1 Statement of the Problem

This research aimed to explore the potential of dough in teaching fractions among grade 2 pupils at Cateel Central Elementary School. More specifically, it aims to answer the following questions:

1. What is the level of the pre-test score in fraction among respondents of Grade 2 pupils in Cateel Central Elementary School?
2. What is the level of the post-test score in terms of fraction among respondents of Grade 2 pupils in Cateel Central Elementary School?
3. Is there a significant difference in pre-test results among respondents?
4. Is there a significant difference in post-test results among respondents?
5. Is there a significant difference in the results between pre-test and post-test scores among respondents?

1.2 Scope and Limitation

This study focused on achieving the Most Essential Learning Competency (MELC), which was the ability to visualize, represent and identify unit fractions with denominators of 10 and below (M2NS-IIId-72.2). Furthermore, this study explored the potential of using play dough in teaching fractions to Grade 2 pupils. The research was done at Cateel Central Elementary School in Castro Avenue, Poblacion, Cateel, Davao Oriental. The study's research respondents were Grade 2 pupils in Cateel Central Elementary School.

Additionally, a quasi-experimental sampling technique with a planned experimental group and control group was used to choose the respondents. The information acquired for this study was confined to the duration of the intervention and was concentrated on the objectives mentioned above. The procedures used to conduct the research were strictly adhered to, and the confidentiality of the data provided by the participants has been acknowledged and protected. Any information not relevant to the subject at hand will not be considered.

2. REVIEW OF RELATED LITERATURE

This chapter showed the important articles and studies the researcher considered when highlighting the current study's significance. It also presented different themes such as; the importance of fractions, the study and learning of fractions, factors affecting the learning fractions of the students, and the use of manipulatives in learning fractions.

2.1 The Importance of Fraction

Acquiring knowledge and skill with fractions has been recognized as a crucial element of mathematical understanding and a doorway to several in-demand professions (Siegler et al., 2012). The ability to grasp fractions is essential for learning mathematics since it not only needs a deeper understanding of numbers than is often acquired through practice with whole numbers, but it also predicts students' mathematical achievement years later (Bailey et al., 2012; Booth & Newton, 2012; Siegler et al., 2012). Despite a rise in recent years in study interest in students' acquisition of fraction knowledge and skill, there are still significantly fewer studies available on this topic than

there are on whole number understanding. However, the few studies on fractions and the vastly more numerous studies on whole numbers have shown striking similarities in the relationships between magnitude understanding, arithmetic, and overall mathematical achievement (Siegler et al., 2013).
The same behavioral techniques have been successful in examining the magnitudes of fractions as well as whole numbers. These techniques include magnitude comparison tasks and number line estimation tasks. In magnitude comparison tasks, participants compare the magnitudes of two whole numbers or fractions and indicate which is larger. In number line estimation tasks, participants indicate the position of a given whole number or fraction on an empty number line with a distinctly marked start and end point. The precision of fraction magnitude representations varies greatly between and within individuals, depending on students' (instructional) experiences with fractions and the size of the fractions, according to studies using these methods, which have consistently shown that, like with whole number magnitude representations (Siegler, 2012). Understanding the rate of change, a fundamental concept in algebra, requires a solid grasp of fractions. Even after accounting for factors like family income, Intelligence, and whole number arithmetic expertise, elementary school pupils' fraction understanding still predicts their algebraic knowledge in high school (Siegler et al., 2012).

2.2 The Study and Learning of Fraction

Since they were invented thousands of years ago, fractions have been used in a wide variety of situations in both mathematics and daily life. The study and learning of fractions play a crucial role in mathematics education, as it forms a foundation for advanced mathematical concepts and real-world applications. According to Jansen et al. (2019), understanding fractions is essential for students to comprehend proportional relationships, operate with rational numbers, and solve mathematical problems involving measurement and division. Researchers have explored various instructional strategies to enhance students' understanding of fractions, such as hands-on manipulatives (Streefland, 1991) and visual representations (Siebert & Gaskin, 2006). Additionally, studies have demonstrated the effectiveness of integrating fractions into real-life contexts, such as cooking or sharing activities (Lamon, 2012). These approaches provide students with concrete experiences and visual representations that help develop conceptual understanding and promote meaningful learning of fractions.
Moreover, teachers' expertise directly affects their students' capacity to comprehend fractions (Ko, 2013; Son & Lee, 2016; Van Steenbrugge et al., 2014). As a result, the importance of high-quality teaching as a crucial element of educational system quality has been highlighted in international educational conversations (OECD, 2016). A summary of the Slovenian and Kosovar primary school curricula for teaching and learning fractions is below (Kolar & Cadez, 2018). Students in both nations start learning about fractions in second grade (age seven) when they are introduced to dividing a whole into two, three, or four equal pieces. It is because the primary teacher education curriculum should be linked to the primary education curriculum. In each of these early scenarios, the total is represented by a model of pizza or chocolate, and the pieces are consistent. As a result, the pupils are instructed to divide specific items into two, three, or four equal portions (Kolar et al., 2018). The Slovenian curriculum states that third-graders start learning about other parts (such as sixths and eighths) but only with one part of a specific whole (not, for example, 3/8). Based on third-grade curriculum content, Kosovo teaches fractions that indicate equal parts of the total (1/2, 1/3, 2/3, 3/4, 4/4) as well as fractions that show the same number (1/2, 2/4, 3/6) and depiction of fractions on a number line (Kolar et al., 2018).
Additionally, because of how other fraction interpretations gradually split the unit in a number line, thinking of fractions as measures was essential (Lamon, 2012). Chinnappan and Forrester (2014) assert that fractions require much focus because it is challenging for students to translate their grasp of the whole to a different but connected category of numbers. Students must be confident in understanding the concept because algebra and other mathematical concepts, such as fractions, are built on it (Ubah, 2021). The part-whole and the fraction measurement and conceptual interpretation are crucial turning points in developing knowledge of the fraction, claim Fuchs et al. (2013).
Another method for teaching fractions is using pattern blocks to create shapes or investigate fractions (Teaching Fractions to Elementary Students, 2021). Playing the game "Make a Form" is one technique to help pupils learn how to combine equal elements (all triangles or all trapezoids) to create a larger shape. Students can also physically tear apart and reassemble fraction strip diagrams by looking at them. One cake is present. We divided or cut up that cake. We can use a fraction to express how big our piece of cake is compared to the entire cake. The fraction indicates how many pieces we have relative to the total number of pieces in the cake. The pieces in fractions are typically the same size or divided into equal halves. It helps us determine the size of our cake piece. The denominator, or bottom number, of the fraction represents the total number of equal pieces. For illustration, if the cake were divided into 5 pieces, the denominator would be 5. After the cake has been divided into pieces, we must choose how many portions

to serve. The number of pieces we want to distribute would be the numerator or the top half of the percentage. For instance, if we distribute two cake pieces, our percentage is 2/5 since we only distributed two of the five available pieces (Teaching Fractions to Elementary Students, 2021).
As students are likely to have encountered fractions daily, another method of introducing fractions is to have them jot and share (Teaching Fraction to Elementary Students, 2021), where they will write the fraction and be asked where they see it. Some pupils could have seen fractions on measuring tapes or cups. If not, they will learn about the experiences of their peers or teachers later in the lesson when a hands-on activity is created. Elementary school pupils naturally concern themselves with fairness and receive treats that are the same size or smaller; this is a great point to begin (Teaching Fraction to Elementary Students, 2021).
Another method to introduce fractions is to use children's literature. There are many children's books that explore the concept of fractions. Students can pick the books they want to read along with you. You and your pupils can read any or all of the novels (Teaching Fraction to Elementary Students, 2021).

2.3Factors Affecting Learning Fractions

Learning fractions is a complex task that various factors can influence. One important factor is students' prior knowledge and understanding of whole numbers and basic arithmetic operations. The understanding and performance of pupils in fractions are significantly impacted by the effective teaching tactics and approaches used by teachers (Clements & Sarama, 2011). Teachers who provide clear explanations, scaffold learning experiences, and engage students in meaningful mathematical discourse create a conducive learning environment for fractions (National Council of Teachers of Mathematics [NCTM], 2020). Research by Clements and Sarama (2011) emphasized the importance of explicit instruction and visual representations, such as number lines and area models, in helping students develop a deep conceptual understanding of fractions.
Four thousand years ago, the Egyptians and the Babylonians both used fractions. Our daily lives involve fraction processing, used in situations like predicting rebates, following a recipe, and reading a map. Due to their application in probabilistic, proportional, and algebraic reasoning, fractions are crucial in mathematics (Gabriel et al., 2013). The challenges kids have when learning fractions were the focus of Gabriel and colleagues (2013) research. Gabriel et al. (2013) identified challenges, including the difficulty students understand fractions as numbers representing parts of a whole due to initially perceiving fractions as discrete objects and struggling with fraction equivalence and comparing fractions with different numerators and denominators. It supports the findings of Brophy (1986) and Kyriakides, Christoforou, and Charalambous (2013), who discovered that classroom-level variation in students' mathematics achievement could be primarily explained by clusters of teaching behaviors rather than by students' beliefs or personal characteristics.

2.4The Use of Concrete Manipulatives in Teaching Fractions

An excellent instructional strategy for teaching fractions is the use of concrete manipulatives. According to Van de Walle, Karp, and Bay-Williams' (2013) research, concrete manipulatives like fraction bars and circles give students concrete examples of fraction concepts that help them understand them. Students can engage in hands-on experiences encouraging active investigation and discovery of fraction concepts by physically handling concrete things, such as fraction bars or fraction circles (Siegler et al., 2017). Through active manipulation and comparison of fractional components, students get a realistic comprehension of fraction connections, which improves conceptual understanding and mathematical reasoning (Dougherty, 2012). For students with access to genuine manipulatives, their learning is more engaging and meaningful because these tools fill the gap between abstract fraction symbols and practical experiences (Hiebert et al., 2018).
Additionally, Huang and Xie (2015) investigated the effect of concrete manipulatives on students' learning of fractions in their study. The results demonstrated that, compared to students who received standard instruction without manipulatives, students who received instruction with concrete manipulatives considerably improved their conceptual knowledge of fractions. Providing students with the opportunity to investigate fractions using physical materials enhances their spatial reasoning skills and understanding of fraction concepts (Moyer-Packenham et al., 2016). Teaching kids how to understand and use fractions by utilizing tangible manipulatives is crucial.
Similarly, Rutherford, Tarr, and Swan's (2018) research examined how concrete manipulatives might help students comprehend fraction operations conceptually and procedurally. According to the study, using manipulatives aided students' ability to precisely and quickly complete fractional calculations. Concrete manipulatives helped students visualize and comprehend fraction algorithms better, which helped them better understand the fundamental ideas and steps involved in fraction operations (Bobis et al., 2013).

3. METHODOLOGY

This chapter deals with the presentation of research steps and procedures used by the researchers in this study.

3.1 Research Locale and Duration

Cateel Central Elementary School Division of Cateel Davao Oriental Cateel-1, with the district school ID of 129252, is the site of this study. Castro Avenue, Poblacion, Cateel, Davao Oriental, Region XI, 8205 is the zip code. Furthermore, it is a public elementary school comprising K–6 grades and has four to six sections per grade; it was established in 1922. The study was conducted throughout the second semester of S.Y. 2022–2023, specifically with grade 2 learners that consist of five sections with a maximum population of 30 pupils per classroom.

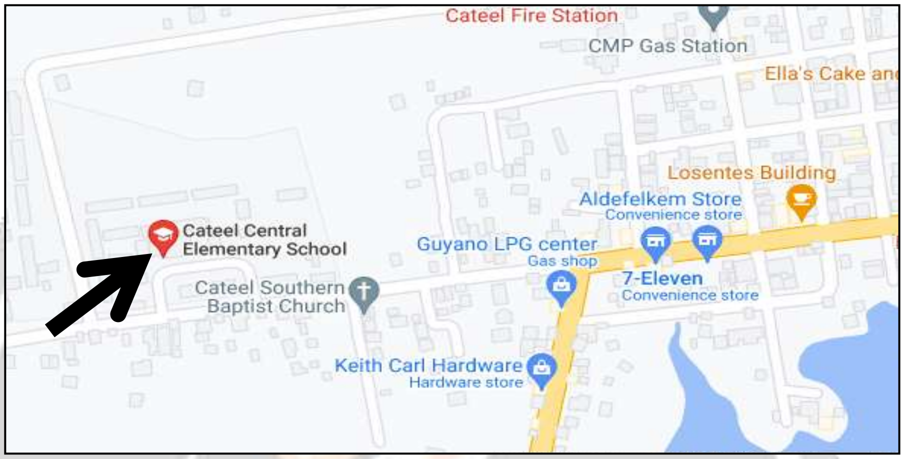

Figure 1. The map of Poblacion, Cateel, Davao Oriental

3.2 Research Design

This study utilized the quantitative research design, specifically a quasi-experimental design, that covered a control and experimental group to showcase the efficacy of the implemented intervention. This design aimed to establish a cause-and-effect relationship between an independent and dependent variable. However, unlike a true experiment, a quasi-experiment does not rely on random assignment. Instead, subjects were assigned to groups based on non-random criteria. A quasi-experimental design is useful when true experiments cannot be used for ethical or practical reasons (Thomas, 2020). Pre-intervention and post-intervention can both be used in quasi-experimental investigation measures in addition to non-randomly chosen control groups.

3.3 Research Instrument

The major data gathering tool was a self-developed questionnaire, which underwent pilot testing in Santa Felomina Elementary School and San Rafael Integrated School first to examine its reliability. The questionnaire was anchored in the most essential learning competency (MELC), which was the ability to "visualizes, represents, and identifies unit fractions with denominators of 10 and l" It consists of 15 items, and there were three types of tests: multiple choice, matching type, and short answer test. A T-test was used to interpret the respondents' mean scores.

3.4 Respondents of the Study

The study's respondents were the grade 2 pupils of Cateel Central Elementary School, either sections 2 or 3. The control and experimental group were chosen by tossing a coin. The pre-activity offered by their math teacher, which was to visualize a fraction, was used to categorize the respondents and control the experiment. The researchers utilized the whole class as control and experimental group respondents. While the control group was drawn from grade 2, either section 2 or 3, the experimental group was drawn from grade 2, either section 2 or 3. The students who take the pre-test also take the post-test.

4. RESULTS AND DISCUSSION

This chapter discusses the transparency of the connection between the two variables, fraction as the dependent variable and the play dough intervention as the independent variable. The results are presented in the following table and relevant discussions and explanations.

4.1 Pre-test Scores of Controlled and Experimental Groups

Before using play dough as an intervention, pre-test scores with fraction-related items were provided. Table 1 shows the statistical analysis using the Mean to measure the scores of both groups.

Table 1. Level of pre-test scores between the controlled and experimental groups

Group	Total Score	Standard Deviation	Mean	Grade Percentage	Remarks
Control	15	2.98	11.44	88.13	Very Satisfactory
Experimental	15	2.47	12.96	93.20	Outstanding

The controlled group had a standard deviation of 2.98, indicating a moderate level of variability in the pre-test scores. The mean pre-test score for this group was 11.44, suggesting a relatively high-performance level. Based on the grade percentage, the control group achieved an 88.13%, which falls within the Very Satisfactory range. These results indicate a solid baseline understanding of the topic among the students in the controlled group.

In relation to these findings, several recent studies have shed light on the various factors contributing to learners achieving high proficiency in fractions.

Fuchs et al. (2014) found that learners with a strong foundation in whole number concepts and arithmetic operations were likelier to excel in fractions. It suggests that a solid understanding of basic mathematical concepts provides a strong basis for comprehending fraction concepts. A group that better grasped these foundational concepts contributed to their higher proficiency in fractions. A study by Siegler et al. (2013) demonstrated that learners who exhibited a deep understanding of the underlying concepts of fractions, such as part-whole relationships and equivalence, were likelier to perform well in fraction-related tasks. It suggests that a strong conceptual understanding of fractions facilitates proficiency without explicit instruction.

A recent study by Chen and Li (2020) revealed that students with a solid foundation in proportional reasoning skills displayed higher proficiency levels in fractions. The researchers found that learners adept at understanding proportional relationships between quantities could transfer this knowledge to fractions, allowing them to comprehend fraction concepts more readily.

Mix, Levine, and Huttenlocher (2016) explored the relationship between cognitive abilities and fraction understanding. They found that learners with strong spatial reasoning abilities, such as manipulating and visualizing spatial relationships mentally, tended to exhibit higher proficiency in fractions even without explicit instruction. It suggests that certain cognitive abilities can positively influence early achievement in fractions. Baroody and colleagues (2021) indicated that learners who had exposure to rich and conceptual instruction in fractions, emphasizing visual representations and problem-solving, showed higher levels of proficiency even prior to any formal intervention. These instructional strategies fostered deep conceptual understanding and promoted the transfer of knowledge. Considering these research findings, it is possible that the control group in the table achieved a high grade and was categorized as Very Satisfactory due to a combination of factors. One possibility is that the learners in the control group had strong spatial reasoning abilities, as suggested by the research by Mix, Levine, and Huttenlocher (2016), which positively influenced their performance in fractions.

In contrast, the experimental group exhibited a slightly lower standard deviation of 2.47, implying a slightly narrower range of pre-test scores than the control group. The mean pre-test score for the experimental group was significantly higher at 12.96, indicating a better overall performance level than the control group. The grade percentage achieved by the experimental group was 93.20%, which falls within the Outstanding range based on the grading criteria established by the Department of Education (DepEd). These findings suggest that the students in the experimental group had a higher level of mastery and understanding of the topic than the control group.

A study conducted by Brown et al. (2022) and Siegler., (2011) found that early exposure to real-life contexts involving fractions, such as cooking and sharing activities, can significantly contribute to students' understanding and mastery of fractions. The researchers observed that students who engaged in practical experiences involving fractions from an early age demonstrated a higher level of proficiency in fraction concepts. It aligns with the findings of the study mentioned, highlighting the positive impact of early exposure to real-life contexts involving fractions.

In a study by Johnson et al. (2021), it was discovered that learners with strong spatial reasoning skills tended to understand fractions intuitively. The researchers found that spatial reasoning abilities: mentally manipulating and partitioning objects, were strongly correlated with students' ability to grasp fraction concepts without explicit instruction. In connection with the result, the experimental group, which showed exceptional performance, might have had learners with strong spatial reasoning skills. Therefore, the experimental group's outstanding performance could be attributed to the presence of learners with strong spatial reasoning skills, as highlighted in the study.

A study conducted by Empson et al. (2019) examined the impact of specific
instructional strategies on fraction understanding. They found that learners who engaged in hands-on, visual, and conceptual activities, such as using manipulatives or representing fractions using diagrams, exhibited higher levels of fraction proficiency even before formal interventions were introduced (Empson et al., 2019). It suggests that effective instructional strategies can contribute to early mastery of fractions.

Considering these elements, it may be understood why certain students outperform other students regarding their understanding of fractions (Siegler et al., 2013). Additionally, it promotes active involvement with mathematical concepts. Therefore, educators may assist all students in gaining a greater understanding of fractions by employing efficient teaching strategies that provide explicit and systematic training (Strickland et al., 2013). In addition, stress the value of providing personalized feedback to each student and tailoring instruction to meet their requirements. This quality—adaptivity—is crucial to clever tutoring systems. It has been demonstrated that these systems improve student learning (Ma et al., 2014).

One factor that influenced the remarks of the control and experimental groups in the pre-test is that the lesson had already been taught to the learners prior to the intervention, resulting in high scores for both groups.

4.2 Post-test Scores of Controlled and Experimental Groups

Table 2 presents the post-test scores of the students after using play dough as an intervention in teaching fractions. Based on the statistical result, the experimental group obtained a mean of 14.35 with a grade percentage of 97.83 which is higher than the control group having a mean equivalent to 12.07 with a 90.23-grade percentage. Nonetheless, both groups earned a descriptive equivalence of outstanding.

Table 2. Level of post-test scores between the controlled and experimental groups

Group	Total Score	Standard Deviation	Mean	Grade Percentage	Remarks
Control	15	2.81	12.07	90.23	Outstanding
Experimental	15	1.36	14.35	97.83	Outstanding

In this table, the control group demonstrated a standard deviation of 2.81, a mean score of 12.07, and a grade percentage of 90.23, leading to the assessment of outstanding. Let us discuss and justify these remarks in detail. It suggests that using play dough as a manipulative directly impacts the effectiveness of teaching fractions. In Liggett's (2017) contribution, the potential use of mathematical manipulatives to assist better math test scores and student attitudes toward math is discussed and considered. It is consistent with earlier studies showing that hands-on techniques improved arithmetic test results (Liggett, 2017). In this case, the standard deviation 2.81 suggests that the scores within the controlled group were relatively close to the mean. The limited deviation from the mean indicates that the individuals in the group achieved scores that were consistently close to the average, supporting the assessment of Outstanding.

The mean score, or average, of 12.07 obtained by the controlled group reflects the central tendency of their performance. A mean value above 10 indicates that the group's overall scores were higher than the median or midpoint. With a mean of 12.07, the controlled group outperformed the average performance, indicating a strong level of achievement. This higher mean score suggests that a significant proportion of individuals in the controlled group obtained scores that exceeded the average, supporting the assessment of Outstanding.

The grade percentage of 90.23 indicates the proportion of the maximum achievable score that the controlled group attained. A grade percentage above 90% is generally considered excellent. In this case, the control group achieved a grade percentage of 90.23, indicating that they performed exceptionally well compared to the maximum possible score. This high-grade percentage further strengthens the assessment of "Outstanding" and provides additional evidence of the controlled group's exceptional performance.

In this case, the experimental group has a standard deviation of 1.36. A lower standard deviation suggests that the scores in the group are closely clustered around the mean. The small standard deviation indicates little variability in the scores, a positive indicator of consistency and precision in the group's performance. The mean score of the experimental group is 14.35. A higher mean suggests that, on average, the group achieved a higher score. It indicates a strong performance by the experimental group as a whole. The mean score exceeding the control group or surpassing a predefined benchmark indicates a significant improvement or achievement. In this case, the experimental group's mean score of 14.35 justifies the Outstanding remark, as it demonstrates a high level of achievement and excellence compared to the expected or baseline performance.

Grade percentage is a common way to evaluate academic performance. The experimental group attained a grade percentage of 97.83, indicating an exceptional achievement level. The high-grade percentage suggests that a significant proportion of individuals within the experimental group achieved excellent scores. It implies that most students in the group performed exceptionally well in the research or assessment. The high-grade percentage reinforces the justification for the Outstanding remark, as it reflects a remarkable level of academic success and excellence within the experimental group.

In addition, research on math manipulatives also states that using manipulatives in teaching is a helpful tool for assisting all students in mathematics (Carbonneau et al., 2013; Liggett, 2017; Pitre, 2014). Using concrete manipulatives, such as play dough, in teaching mathematics, particularly fractions, aligns with Jean Piaget's cognitive development theory, specifically the concrete operational stage. Piaget proposed that during this stage, typically between the ages of 7 and 11, children develop the ability to think logically and concretely about objects and events (Piaget, 1954). By incorporating manipulatives like playdough, educators provide students with tangible and sensory experiences that align with their developmental stage. Schoenfeld (2016) explained that memorizing facts without understanding underlying concepts makes it increasingly difficult for students to acquire new mathematical skills. Students must be allowed to touch, manipulate, and construct their meaning and understanding, which can be achieved through manipulative materials. As stated by Jimenez and Stanger (2017), using concrete manipulatives in teaching mathematics, fractions especially, can make the lessons more understandable and reduce the dissatisfaction of teachers' and students' understanding. This kind of method in teaching is active; learners can manipulate things/objects to discover new ideas and give them fun while manipulating things.

Neubig (2016) mention Casswell's idea that many students still need concrete materials and sensory motor experiences to enhance their understanding of the concepts associated with common fractions. Furthermore, playdough allows students to explore fractions with a physical representation instead of an abstract concept while thoroughly enjoying the experience of working with playdough, which stimulates all learners, provides for the needs of a wide range of learning styles, and can be used to support most conceptual learning in mathematics.

4.3 The Difference of Pre-test Scores between Controlled and Experimental Groups

These significant differences in pre-test scores demonstrated the experimental group's outstanding abilities before introducing the intervention. The pre-test results showed a significant mean score and grade percentage advantage, demonstrating high academic proficiency. Due to this unexpected finding, the research team looked into the causes of the experimental group's exceptional performance, which opened the door for further study.

In order to build awareness, assess their learning needs, and design strategies to successfully achieve conducive teaching, it is critical to assess and determine the teacher's role and the student's part as the baseline knowledge (Schindler & Burkholder, 2014). A pre-test questionnaire achieves this goal by first testing the learning fraction, a dependent variable (Thomas et al., 2017). Without intervention, the experimental group's pre-test results appeared to be greater than the control group's.

Table 3. Mean comparison between pre-test scores of controlled and experimental groups

Group	Mean	Standard Deviation	t-value	p-value	Interpretation
Control	11.44	2.98	-2.013	0.049	Pre-test scores between the two groups differ significantly.
Experimental	12.96	2.47			

In this study, the control group has a mean score of 11.44, while the experimental group has a higher mean of 12.96. The higher mean in the experimental group indicates that, on average, the participants in that group achieved better results in the pre-test than the control group. This finding justifies the outstanding remark for the experimental group, as their performance exceeded that of the control group.

The grade percentage provides a relative measure of performance, reflecting how well each group performed in relation to the maximum achievable score. The control group achieved a grade percentage of 88.13%, while the experimental group attained a higher grade percentage of 93.20%. This difference indicates that the experimental group achieved a higher proportion of the maximum possible score, further validating the outstanding remark. The higher grade percentage suggests that a larger proportion of participants in the experimental group achieved higher scores, contributing to their exceptional performance.

Furthermore, the t-value and p-value reported in the table indicate the statistical significance of the difference between the two groups. The t-value of -2.013 suggests a significant difference between the control and experimental groups' pre-test scores. The associated p-value of 0.049 is below the commonly accepted threshold of 0.05, indicating a slight difference.

In connection with the result, Sidney et al. (2014) agree that people make sense of new information in the context of their prior knowledge. Fractions appear to be particularly crucial, even beyond the overall significance of mathematical skills, for long-term academic and professional success (Ritchie et al., 2013). In fact, the same kids who make mistakes occasionally also employ the proper techniques and provide accurate responses under different circumstances (Siegler et al.,2020), and this supports the results. For instance, when given pairs of extremely similar fraction problems, most sixth and eighth graders utilized various techniques for at least one pair of the problems, with 65% of these pairings comprising both a correct and an incorrect strategy, according to a study done by Siegler and Pyke (2013). It supports the significant difference in pre-test scores between the two groups, as indicated in the table. They suggest the participants' prior knowledge and problem-solving approach influenced the observed results.

4.4 The Difference of Post-test Scores between Controlled and Experimental Groups

An academic post-test is one significant way of measuring if the students' learning could prevail since the connection between intervention and outcomes of their performance in the lesson is developed, and a comparison could easily be made (Ursara & Reisoglu, 2017). Thus, the researchers administered the post-test to assess whether there was an improvement in the intervention conducted.

Table 4. Mean comparison between post-test scores of controlled and experimental groups

Group	Mean	Standard Deviation	t-value	p-value	Interpretation
Control	12.07	2.81	8.995	0.004	Post-test scores between the two groups differ significantly.
Experimental	14.35	1.36			

Moving on to the control group's post-test, we observed a slight decrease in the standard deviation, which was 2.81. It suggests that the scores became slightly less dispersed compared to the pre-test. The mean score increased to 12.07, indicating an improvement in the group's average performance. Correspondingly, the grade percentage rose to 90.23, reflecting an outstanding level of achievement. The increase in the mean score and grade percentage demonstrates an improvement in the overall group performance, moving from very satisfactory to outstanding.

These findings indicate that the control group's performance improved over time without the introduction of any intervention.
In comparison, the experimental group achieved a higher mean score of 14.35 with a lower standard deviation of 1.36. In this case, the experimental group's mean score (14.35) is higher than the control group's (12.07), indicating that, on average, the experimental group performed better in the post-test. The experimental group's standard deviation of 1.36 is smaller than the control group's standard deviation of 2.81, indicating that the scores in the experimental group are less spread out, demonstrating greater consistency in performance.
Statistical analysis was conducted using the t-test to assess the significance of the differences between the two groups. The t-value of 8.995 indicates a large difference between the means of the control and experimental groups. The findings of this study suggest that play dough is effective in enhancing students' learning of fractions, as supported by a statistically significant p-value of 0.004. These findings show a significant difference in post-test scores between the control and experimental groups. The experimental group exhibited higher mean scores, indicating better performance overall. Furthermore, the smaller standard deviation suggests that the experimental group's performance was more consistent and less variable than the control group's.
The scores differ as drawn from the statistical analysis significantly, which means that using playdough as an intervention was effective in helping students improve in Mathematics, particularly in learning fractions. Even though there is only a small gap between the mean scores of both groups, the result still projected an improvement in the students' learning.
From these findings, some researchers can confirm that incorporating physical activities has enhanced memory and understanding (Pouw et al., 2014; Dandashi et al., 2015). The results also show that manipulatives help students grasp abstract concepts by giving them a concrete idea of the concept (Jao, 2013). Golafshani (2013) mentioned in their research that using tools or handed materials can be symbols through the concrete object that comes from learning using these manipulatives; it serves as motivation and a guiding practice all over learning opportunities.
Studies undertaken in recent years have shown that Piaget's theory of cognitive development is useful in the classroom. Piaget's theory offers a foundation for comprehending how kids actively generate knowledge through their interactions with the environment, claim Lillard and Else-Quest in 2014. This theory, which supports constructivist pedagogy's guiding principles, emphasizes the value of experiential, hands-on learning. Furthermore, Flavell (2011) emphasizes how Piaget's theory encourages students to enhance their logical reasoning, problem-solving, and critical thinking skills. Teachers can build learning environments that support active exploration and discovery while fostering students' cognitive development and conceptual understanding by incorporating Piaget's concepts into their instructional techniques.
Moreover, Shin and Bryant (2017) cited that manipulatives are materials that serve as a guide and specific example. Therefore, manipulation is a useful motivational tool to strengthen their prior knowledge. Initially, concrete materials are also an easy way to acquire knowledge, and it helps them build a strong foundation of ideas. Besides, this learning method can make your entire class lively, and learners have fun manipulating things. Lastly, their research parallels the present study as they also found a significant difference between the mean gain scores of the experimental and control groups.

4.5 The Difference in the Results Between Pre-test and Post-test Scores
Table 5 shows the significant difference between the pre-test and post-test scores of the controlled and experimental groups.

Table 5. Mean comparison between pre-test and post-test scores

Type of Test	Mean	Standard Deviation	t-value	p-value	Interpretation
Pre-Test	12.19	2.82	3.231	0.002	Pre-test and post-test scores differ significantly.
Post-Test	13.19	2.48			

The standard deviation was 2.98, indicating that the scores were spread out. The mean score was 11.44, representing the group's average performance. Based on the grading scale, this mean score corresponds to a grade percentage of 88.13, categorizing the performance as very satisfactory. Moving on to the control group's post-test, we observed a slight decrease in the standard deviation, which was 2.81. It suggests that the scores became slightly less dispersed compared to the pre-test. The mean score increased to 12.07, indicating an improvement in the group's average performance. Correspondingly, the grade percentage rose to 90.23, reflecting an outstanding level of achievement.

These remarks are justified based on comparing the control group's performance between the pre-test and post-test. The decrease in standard deviation suggests a reduction in score variability, indicating a more consistent performance. The increase in the mean score and grade percentage demonstrates an improvement in the overall group performance, moving from very satisfactory to outstanding. These findings indicate that the control group's performance improved over time without the introduction of any intervention.

However, in the pre-test, the standard deviation for the experimental group was 2.47, indicating that the scores were relatively close to the mean of 12.96. It suggests that the participant's performance in the experimental group was consistent and clustered around the average score. Additionally, the grade percentage of 93.20 signifies an outstanding level of achievement.

Moving on to the post-test results, we observe a decrease in the standard deviation to 1.36, which implies that the scores were even closer to the mean of 14.35. It indicates a higher level of consistency in the participants' performance after the intervention. Moreover, the grade percentage of 97.83 signifies a remarkable achievement, reaffirming the outstanding performance of the experimental group.

Table 5 can justify the outstanding remarks for both the pre-test and post-test. The narrow standard deviation in both cases suggests that the participants consistently performed well, and the high mean scores and grade percentages further support this conclusion. The remarkable improvement in grade percentage from the pre-test to the post-test underscores the effectiveness of the intervention in enhancing the participants' performance.

In simple terms, the data shows that the participants in the experimental group achieved exceptionally high scores compared to the average. The consistency in their performance and the significant improvement after the intervention provide strong evidence to support the remark of "outstanding" for both the pre-test and post-test. Based on the result, the pre-test had a standard deviation of 2.82, while the post-test had a standard deviation of 2.48. A smaller standard deviation suggests less variability, meaning the scores in the post-test were more closely clustered around the mean compared to the pre-test.

The mean represents the average score of the participants. The pre-test had a mean of 12.19, while the post-test had a slightly higher mean of 13.19. It indicates that, on average, the participants' scores increased from the pre-test to the post-test. The increase in the mean score suggests an improvement in performance after the intervention or treatment.

Overall, based on the provided data, it can be concluded that there was a significant difference between the pre-test and post-test scores, as indicated by the t-value of 3.231 and a p-value of 0.002. It suggests that the play dough had a measurable effect on the participants' scores.

The findings are supported by a study by Jao (2013) confirming that representation forms that scaffold the students' understanding by moving the student from real-world and concrete representation forms to those more abstract can be fruitful. She also explained that her research shows that representations can form scaffolds that help students go from a basic understanding of mathematics to a more abstract understanding (Jao, 2013).

Additionally, using real representations can assist children in improving their feeling of place value, their understanding of written symbols, and their number sense (Hurst & Linsell, 2020). With this technique, teachers may better comprehend what their pupils already know and spot common misconceptions, allowing them to create effective interventions. The foundation provided by using manipulatives will promote critical thinking and student ownership of their work. Teachers can see clearly what students understand so they can decide the best course of action (McDonough, 2016).

The idea suggests that students learn more effectively when actively participating in their education. They absorb knowledge when given a chance to study, ask questions, document, share, and discuss discoveries. Mentioning Fletcher, Larbi, and Mavis (2016) added that manipulating familiar objects that inspire confidence is the beginning of getting a sense of structure and that the structure eventually emerges as a generalization or expression. Larbi and Mavis (2016) also explained that utilizing instructional resources helps students comprehend lessons effectively. Their use aids students in learning new information, aids in helping new information stick in their memory, and improves performance.

How the manipulatives are used spark the students' interest and encourages participation in the class (Munger, 2007, as cited by Larbi & Mavis, 2016). Fundamentally, learning happens when students engage with their surroundings and have experiences that lead to discovering correlations and connections between concepts. When instructors put their students at the center of their lessons, they can find new connections between the concepts they have been taught, and comprehension develops organically.

5. CONCLUSION

Based on the data findings throughout the study, researchers conclude the following:

1) The control group's performance was considered very satisfactory, suggesting that they did well based on the analysis of pre-test scores. On the other hand, the experimental group's result was even better and qualified as outstanding, signifying remarkable performance.
2) Based on the provided data, the experimental group outperformed the control group on the post-test in terms of average scores. The difference between the two groups, expressed as a fraction, shows that the experimental group's average score was higher than the control group's. It suggests that the experimental group performed better.
3) Hence, considering the provided data, it is evident that there exists a significant difference in the pre-test scores between the control and experimental groups. The experimental group showcases a superior average pre-test score compared to the control group, suggesting a possible beneficial impact or influence of the experimental condition on the participants' pre-test performance.
4) Furthermore, the results indicate that the experimental group exhibited a significant increase in post-test scores compared to the control group. It suggests a notable difference in learning outcomes between the two groups.
5) Finally, there were significant differences in the pre-test and post-test scores among respondents. The control group improved performance from the pre-test to the post-test, while the experimental group demonstrated outstanding performance before and after the intervention. The observed significant differences in scores and the intervention outcomes support the conclusion that notable variations existed in the results between the pre-test and post-test scores among respondents.

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