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Remediating High School Students' Lack of Fraction Sense Using Representation Construction Approach

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Jamuel T. Mujeres[1], ORCID No. 0009-0006-8924-9508
Leorence C. Tandog[2], PhD, ORCID No. 0000-0003-2755-070X

[1]MST-Mathematics, Graduate School, University of Southern Mindanao, Kabacan, Philippines
[2]Vice President for Academic Affairs, University of Southern Mindanao, Kabacan, Philippines

Abstract

This study aimed to design and produce activity sheets based on the representation construction approach to remediate Grade 10 students' lack of fraction sense with minimal teacher guidance and to evaluate their impact on students' performance. The activity sheets were developed using the frameworks outlined by Tytler et al. (2013) and McIntosh et al. (1992) and assessed through students' performance on Trends in International Mathematics and Science Studies (TIMSS) questions. A quasi-experimental research design with a pre-test and post-test control group design was used. Sixty-eight students from Matalam National High School-Linao with math grades below 85 were selected, with 30 selected to the experimental group through simple random sampling and the other 38 to the control group. T-test results on the pre-test showed no significant difference ($t = 0.81$, $p = 0.42$), confirming the comparability of the groups. There was a significant improvement in the experimental group's posttest results ($t = 17.1$, $p < .001$), indicating the effectiveness of the activity sheets. The mean gain scores also showed a significant difference ($p < .001$), suggesting that the representation construction approach had a significantly greater effect on improving students' fraction sense. Based on the findings, it was recommended that mathematics teachers consider using activity sheets grounded in the representation construction approach to help students improve their understanding of fractions.

Keywords: activity sheets, fraction sense, high school students, Representation Construction Approach, remediation

INTRODUCTION

Fraction sense is an essential aspect of mathematical understanding, serving as a foundation for more complex mathematical concepts and problem-solving skills. Students with a strong understanding of fractions are more likely to succeed in algebra and calculus (Bailey et al., 2014). Fractions are important in education because they serve as a foundation for more advanced mathematical concepts (National Mathematics Advisory Panel, 2008, as cited in Siegler et al., 2013).

However, several studies on the teaching and learning of fraction sense revealed that students worldwide struggle with learning about fractions. Gabriel et al. (2013) acknowledge that fractions have been used for centuries in both everyday situations and mathematics, but students often find them difficult to understand and master.

With the above-stated problems, it was found that manipulatives help students relate mathematics to other subject areas, strengthen their understanding of various academic subjects, and connect learning to real life (Lee & Chen, 2010, as cited in Gaetano, 2014). The use of various representations can also make these concepts easier to understand. Representations serve as important tools that improve reasoning, enhance communication in mathematics, and convey mathematical thinking (Barbosa & Vale, 2021). According to Skolverket (2022), as cited by Tossavainen and Helenius (2024), different forms of representation include concrete materials, diagrams, and symbol, and understanding of the relationship among fractions, decimals and percentages is essential in learning mathematics.

Moreover, Tytler et al. (2023) claimed that the representation construction approach helps students identify what to focus on, what data to collect, how to collect it, and how to develop an understanding of various ways of representing a problem. Many researches also have the same findings with the representation construction approach. These studies show that this approach helps in achieving learning outcomes in mathematics and science, encouraging students to make their own representations (Tytler et al., 2023).

In the representation construction approach, challenges in generative representations help in the contextualization of main concepts and guide students in refining their knowledge. Xu et al. (2021) stated that this procedure helps students know the importance of representations and conventions and use them correctly to improve learning.

Therefore, the present study seeks to remediate high school students' lack of fraction sense through activity sheets based on the representation construction approach. This approach uses different models, figures, symbols, and written language (Murniasih et al., 2018, as cited by Murniasih et al., 2020), and can be used as a tool to help and challenge students to create representations that may further develop their fraction sense. Through enhancing this skill, the study aims to contribute to improved mathematical understanding and student achievement in the Philippines, thereby advancing the quality of teaching and learning mathematics.

Objectives of the Study. This research aimed to design and produce activity sheets based on the representation construction approach to remediate high school students' lack of fraction sense with minimal teacher guidance and evaluate the effect of this implementation on students' performance. The activity sheets were designed based on the representation construction approach outlined by Tytler et al. (2013) and the framework for number sense outlined by McIntosh et al. (1992).

The effectiveness of the representation construction approach activity sheets was evaluated based on students' performance in answering TIMSS questions. Specifically, it sought to determine:

1. the performance of grade 10 students in the strand of fraction sense;
2. if there is a significant difference between the pre-test scores of grade 10 students in the control and experimental group;
3. if there is a significant difference between the post test scores of grade 10 students in the control and experimental group;
4. if there is a significant difference between pre-test and posttest of the control and experimental group;
5. if there is a significant difference between the gain scores of the control and experimental group.

LITERATURE REVIEW

Number Sense. Number sense is widely known as the ability to understand quantities, numbers, operations, and how they relate to one another. Wilson et al. (2009) cited by Maghfirah and Mahmudi (2018), explained that number sense enables students to make quick and flexible decisions in math, perform mental computations, and the capability to evaluate the calculations reasonably. Similarly, Reynvoet et al. (2016, as cited by Ghazali et al., 2021), defined number sense as the innate ability to represent quantities using both non-symbolic and symbolic forms.

Number sense is considered to be a fundamental component of mathematical thinking. Maghfirah and Mahmudi (2018) described it as the capacity to use numbers and operations flexibly when making mathematical decisions.

Meanwhile, Hornigold (2017) emphasized that number sense is the ability to work with numbers in a flexible and intuitive way, enabling students to understand the meaning behind numbers, enhances their mental math skills, and allows them to relate math to real-life situations and make comparisons.

Furthermore, McIntosh et al. (1992) developed a framework that organizes number sense into three main components: understanding and skill with numbers, understanding and skill with operations, and applying knowledge of numbers and operations in computational contexts. From these components, six strands of number sense emerged: number concepts, multiple representations, effect of operations, equivalent expressions, efficient computation strategies, and measurement benchmarks. They further emphasized that number sense continues to grow beyond school and is more than just a list of skill.

Collectively, number sense is an essential and constantly developing component of mathematical reasoning. It involves understanding quantities, numbers, and operations, presenting them in various ways, and using them adaptably to solve problems. In both classroom and real-life contexts, students with strong number sense are able to reason mathematically, carry out mental calculations, estimate, compare quantities, identify trends, and make sound mathematical decisions.

Fraction Sense. According to Fennell and Karp (2017), Way (2011), and Woodward (1998, as cited in Murniasih et al., 2020), when applied to fractions, number sense is referred to as fraction sense. It consists of understanding fraction concepts, determining relationships between fractions, evaluating several representations of fractions, and developing flexible skills when utilizing fractions

One important aspect of fraction sense understands the size and magnitude of fractions. Van de Walle et al. (2019) cited the study of (Clarke & Roche, 2009) emphasized that fraction sense entails using benchmark values like 0, ½, and 1 to estimate and compare fractions, as well as acquiring an intuitive grasp of the relative sizes of fractions.

Likewise, Teoh et al. (2020) explained that fraction sense, much like number sense, includes using various techniques based on an individual's capacity to formulate and extend their understanding of fraction. It is important to develop fraction sense because sense-making and reasoning play an important role in enhancing conceptual understanding and mathematical knowledge.

Furthermore, Hull et al. (2011, as cited in Singh et al., 2021) stressed the need to acquire fraction sense since reasoning and sense-making are crucial for improving students' conceptual understanding and mathematical knowledge.

In addition, Lee and Boyadzhiev (2020) and Lamon (2012), as cited by Makhubele 2021), stated that the final essential idea in understanding rational numbers is recognizing the equivalence of fractions and decimals. They explained that equal part-whole fractions share the same number, length, or area, meaning that different fractions can represent the same value. Fraction sense develops when a person consistently demonstrates an understanding of fraction concepts, representations, comparisons, and operations.

Importance of Fraction Sense. Learning fractions plays a vital role for students to improve number sense and mathematical understanding. It enables them to recognize which properties apply to all real numbers and which properties hold true only for whole numbers but not for real numbers as a whole (Bailey et al., 2014).

Similarly, Roesslein and Codding (2019) and Hughes (2019), as cited by Teoh et al. (2020) emphasized that a strong understanding of fractions is necessary for secondary school students because fractions are important in mathematics not only because they help develop number sense but also because they provide the foundation for more advanced math. Likewise, Purnomo et al. (2014, as cited in Murniasih et al., 2020) explained that fraction sense serves as a foundation for understanding key mathematical concepts such as measurement, geometry, algebra, and data analysis.

Furthermore, Teoh et al. (2020) highlighted that students develop conceptual knowledge through examples and reasoning, which enables them to use various approaches to solve mathematical problems. For this reason, it is crucial to introduce fractions early to help students become capable in mathematics.

Students Lack of Fraction Sense. Learning fraction requires a strong grasp of numerals since it entails identifying the connection between fraction, decimals, and percentages, as well as developing computational skills required to apply these ideas in various mathematical context (Ekenstam, 1977, as cited by Singh et al., 2021).

However, when students lack this understanding, students tend to rely on memorization instead of truly understanding the concepts behind fractions. As a result, students tend to forget what they have learned about fractions when faced with new or unfamiliar problems (Way, 2013, as cited by Kor et al., 2019; Woodward, 1998, as cited by Kor et al., 2019). This highlights the importance of teaching approaches that help students in understanding the meaning rather than focusing only on rote memorization.

Fraction Sense Development. Mukwambo et al. (2018) stated that fraction sense enhances when students demonstrate their ability to understand fraction concepts, compare different representations, and carry out fraction operations. In achieving this level, Makhubele (2021) emphasized that studying fraction shouldn't be limited to memorizing the rules, as this could result in misconceptions and computation errors. Instead, instruction should assist students in understanding the significance of fractions and the relationships between ideas. This suggests that students need to understand the concept behind them before they calculate fraction effectively.

This conceptual foundation begins with understanding equal portions and unit fractions before students can compare fractions and gain a better understanding (McCoy, et al. 2016 cited by Teoh et al, 2020). Van de Walle et al. (2019) further emphasized the importance of partitioning, equivalence, estimation, and linking visual representation with fraction operations.

Clarke et al. (2008), Cramer and Whitney (2010), as cited by Van de Wall et al. (2019) recommended instructional strategies for developing fraction sense. They emphasized concentrating on the meaning of fractions rather than memorizing procedures, and identifying fractions as numbers through representations, such as number line. They also highlighted how crucial it is to assist students in comprehending fraction equivalency through both concrete and symbolic representations and promoting the usage of benchmark fractions and estimation in order to foster flexible reasoning around fractions.

Similarly, Tossavainen and Helenius (2024) cited the studies of Skolverket (2022a), Pantziara and Philippou (2011), Lee and Lee (2023), and Jakobsen et al. (2014), highlighted that diagrams, symbols, and the connections between fractions, decimals, and percentages are crucial for developing a strong understanding of fractions. These studies further suggested that while transitioning between representations can enhance conceptual learning, many student teachers continue to struggle with selecting appropriate representations and interpreting fraction solutions that differ from their own. Around the same time, as the studies mentioned earlier, Barbieri et al. (2019) using a number line-focused approach combined with research-informed instructional strategies supports struggling learners in achieving lasting improvements in their conceptual understanding of fractions.

Furthermore, to develop fraction sense, Teoh et al. (2020) revealed four strategies: comparing fractions to benchmark value like 0, 1/2, and 1; understanding denominator effect; applying unit fractions; and applying fraction concept with operations by using benchmark fraction and understanding denominator effects. These strategies are crucial for developing fraction sense.

These studies indicate that conceptual and representation-based instruction is necessary to improve fraction sense. Several representations, benchmark fractions, estimation, equivalence, and the relationships between fraction concept and operation place a strong emphasis on assisting students in comprehending the meaning of fraction.

Challenges in Developing Fraction Sense. Teaching and learning fractions remain challenging despite advances in instructional understanding. Research synthesized by Namkung and Fuchs (2019), drawing from DeWolf and Vosniadou (2015), Schneider and Siegler (2010), and others, highlights that difficulties with fraction occur not only among students but also among adults and professionals. National data further confirm these difficulties: only 21% of fourth-grade students can explain why one unit fraction is larger than another, and only 41% of eighth-graders can correctly order fractions (Van de Walle et al., 2019, citing Kloosterman et al., 2004; Sowder et al., 2004). More recent NAEP results show that only 32% of fourth-graders can determine whether fractions are greater than, less than, or equal to 1, underscoring the persistence of these learning gaps (Namkung & Fuchs, 2019).

Fractions difficulties affect not only school learners but also pre-service teachers. Siegler and Forgues (2015) found that some pre-service teachers understand fraction magnitude, but they struggle with multiplication and division of fractions, performing similarly to middle school students. Lemonidis and Pilianidis (2020) further emphasized that fractions are among the most difficult mathematical concepts, partly because teachers themselves face challenges in teaching them effectively. Much of this difficulty is attributed to an overreliance on the part-whole interpretation, which limits students' ability to develop deeper conceptual understanding necessary for algebra, ratios, and proportional reasoning (Wilkins & Norton, 2018). Consequently, students often acquire only procedural or instrumental knowledge.
Strong conceptual foundations are necessary for a deeper comprehension of fractions. Trivena et al. (2017) noted that many student errors come from a lack of understanding, affecting their ability to grasp advanced topics. Foundational knowledge, including units and unitizing, partitioning, and equivalence, is essential (Barnett-Clarke et al., 2010; Mulwa, 2015, as cited in Makhubele, 2021). Idris (2018, as cited in Makhubele, 2021) stressed that mastering fundamental concepts supports higher-order thinking, yet gaps persist due to informal interpretations of mathematical ideas.

These studies point out that insufficient conceptual understanding is the primary source of ongoing fraction difficulties. They emphasize the need for instruction that promotes conceptual depth alongside procedural skill.

Representation Construction Approach (RCA). Representation construction approach encourages students to create and construct representations that involve mathematical discourse rather than relying solely on text-based definitions. This method incorporates various modes of learning, including textual, visual, gestural, and embodied approaches (Tytler et al., 2023). In support of this approach, Research by English (2012), Lehrer and Schauble (2006), Mulligan (2015), and Oslington et al. (2020), as cited in Tytler et al. (2023), supports pedagogies where the teacher's role is to guide students in inventing, critiquing, and revising representations to explain phenomena in mathematics.

Through this process, students who receive support from teacher take an active role in problem-solving. They figure out what aspects of a phenomenon matter, decide what data to collect and why, and make judgments about which choices and conclusions make sense. As a result, students engage in disciplinary inquiry and model-based reasoning, enabling them to develop confidence in working with and discussing knowledge-building practices in the field Tytler et al. (2023).

Barbosa and Vale (2021) highlighted that by making connections between ideas more meaningful, visual models and multiple representations help students understand complex and difficult mathematical concept. They also emphasized how students' overall mathematical thinking is strengthened by visual representations, which facilitate reasoning, communication, problem solving, and comprehension of mathematical data.

In relation to this, the representation construction approach makes clear how essential it is to involve students in the creation and use of representations as a way to investigate mathematical concepts. Hubber et al. (2017) outlined the principles behind the representation construction approach, as described by Tytler et al. (2003):

1. Structure of representational challenges in which students create representations to actively explore mathematical ideas and make claims about phenomena.

2. Carefully evaluating representations: The teacher has several roles, including facilitating students to promoting student self-assessment as a collaborative classroom process.

3. Effective learning: Provide meaningful contexts and tasks that engage students, allowing them to make choices and encouraging their active involvement.

4. Assessment by using representations: Both formative and summative assessments should give students the chance to create and interpret representations.

Through this process, students are encouraged to justify their opinions, assess information and develop their deeper abilities, which support the growth of critical thinking.

Theoretical Framework. This study aims to design and produce learning activity sheets that help students develop their number sense, specifically in fractions, with minimal assistance from the teacher. The creation of this material is grounded in two key frameworks: the Representation construction approach outlined by Tytler et al. (2013) and the framework for number sense proposed by McIntosh et al. (1992).

The representation construction approach encourages students to create and construct representations that involve mathematical discourse rather than relying only on text-based definitions (Tytler et al., 2013). The activity sheets, which are based on these ideas, give students the opportunity to actively create their mathematical understanding by having them draw, model, explain, and compare representations of fractions.

This method is supported by McIntosh et al. (1992)'s number sense framework, which identifies the fundamental components of number sense, including understanding and skill with numbers, understanding and skill with operations, and applying knowledge of numbers and operations in computational contexts. These components are represented in the activity sheets through activities that develop the six strands of number sense, such as number concepts, multiple representations, effect of operations, equivalent expressions, efficient computation strategies, and measurement benchmarks.

When combined, these frameworks have a direct impact on how the learning activity sheets are designed. The number sense framework determines what fraction sense concepts and skills are developed through the activities, whereas the representation construction approach determines how students learn by actively creating and discussing representations. By integrating both frameworks, the intervention offers significant learning opportunities that foster the development of fraction sense, flexible reasoning, and conceptual understanding.

METHODS

Research Design. This study utilized a quasi-experimental research design, using pre-test and post-test control group. Pretest and posttest were administered to the two groups, but only the experimental group received the treatment.

Population and Sampling. Matalam National High School-Linao served as the study's research locale. The school is one of North Cotabato division's public secondary schools and is located in the rural neighborhood of Linao, Matalam, North Cotabato.

The participants were grade 10 students from Matalam National High School-Linao. The researcher submitted a request to the grade 10 Mathematics teacher for a list of the students who had an average grade of less than 85 in mathematics for the third quarter. The list comprised a total of 68 students, wherein 30 students were selected through a simple random sampling to be part of the experimental group, while the remaining 38 students to be part of the control group.

Research Instrument. Two sets of instruments were utilized in this investigation:

1. Consists of the pretest/posttest which was given to the respondents before and after an intervention.

2. Consists of researcher-created representation construction approach activity sheets that were used in remedial activities of the respondents.

The researcher used a 22-item questionnaire adopted from TIMSS and administered the same set of questions for both the pretest and posttest. The researcher-designed and developed representation construction approach activity sheets were provided to the students daily and were collected after one hour. These activity sheets were developed to help students develop a stronger conceptual understanding and a better sense of fractions. The materials were intended to encourage students to generate and construct their own representations of fractions rather than rely on text-based definitions.

Data Gathering Procedure. The data gathering procedure for this study followed a structured process to maintain consistency and uphold ethical standards. After the development of the learning activity sheets, a letter was submitted to the schools district supervisor requesting permission to undertake the study in the chosen school. Once approval was granted by the supervisor, the researcher sought endorsement from the school principal. The purpose of the study and its procedures were also presented to the principal, and their cooperation was also requested during the data gathering.

Considering that the participants were minors, assent forms were given to them, containing an age-appropriate explanation of why their involvement was needed in the study. The form contained the objectives of the study, the rights of students, an assurance of confidentiality, and voluntary participation. The students' parents were also requested to sign an informed consent form to confirm their approval of their child's participation in this study.

After the informed consents were obtained, the researcher immediately administered the pretest to the participants on March 13, 2025. Following this, the data were collected and recorded.

Subsequent to the pretest administration, the intervention was implemented and conducted daily from March 14, 2025 to April 11, 2025, with a total of 20 sessions of one hour each for the experimental group. Students were provided with activity sheets during each session, focusing on a specific topic. These topics consisted of partitioning and representing fractions, comparing and ordering fractions, adding and subtracting like and unlike fractions, as well as multiplying and dividing fractions. Students in the experimental group were encouraged to raise questions whenever they faced difficulty or misconceptions while working on the activity sheets. After each session, the researcher collected both the completed and incomplete activity sheets from the students.

After the 20-day intervention, both groups were given a posttest. The posttest was given to assess any changes in the students' fraction sense. The researcher was able to evaluate any changes in the students' fraction sense and the effectiveness of the intervention through the relation of the posttest findings with the baseline data. This comparison also revealed areas in which students had improved their fraction sense and areas in which they needed further intervention.

Data Analysis. Different statistical tools were utilized in examining the data in this study. In all sample data, the normality test was run to see if they are normally distributed. The Shapiro-Wilk test was used to determine if the data are either normally distributed or not. If found normal, parametric tests are used and non-parametric when normality is not found. A t-test was also used to compare the pretest results of the experimental and control groups. This was done to determine if the scores were statistically different. The same process was utilized for the posttest scores of the experimental and control groups. The magnitude of improvement was also evaluated by calculating the effect size (Cohen's d). The guide for interpreting the value obtained is shown in Table 1 below.

Table 1
General guidelines for interpreting cohen's d test

Cohen's d	Interpretation
0.01-0.19	Very small effect
0.2-0.49	Small effect
0.5-0.79	Medium effect
0.80-1.19	Large effect
1.20-1.99	Very large effect
2+	Huge effect

Additionally, the performance of students was analyzed using descriptive measures such as the mean and standard deviation.

Ethical Consideration. To ensure the participants' safety and fairness, the researcher carefully considered the ethical aspects of the study. Before the students participated in the study, the researcher explained the research to students and their parents, including the purpose of the study, where it would take place, how long it would last, and what they would ask to do. The researcher also assured them that the data would be used only for research purposes, their personal information would remain confidential, and they could withdraw from the study at any time. All the students and their parents signed an assent form and were informed of their participation to make sure that they were aware of the necessary information about their participation.

RESULTS

The findings are organized according to the objectives of the study, namely: the performance of grade 10 students in the strand of fraction sense; if there is a significant difference between the pre-test scores of grade 10 students in the control and experimental group; if there is a significant difference between the post test scores of grade 10 students in the control and experimental group; if there is a significant difference between pre-test and posttest of the control and experimental group; if there is a significant difference between the gain scores of the control and experimental group.

Performance of grade 10 students in the strand of fraction sense. The pre- and posttest results of the 68 grade 10 students from Matalam National High School–Linao, all of whom had a mathematics grade average of 85 or below in the third quarter, are shown in Table 2 for problems involving visual representation, problems involving symbolic representation and problems involving operations on fractions.

Table 2
Pre and posttests performance of Grade 10 students on the aspects of fraction sense

Aspects	Pretest mean score (Number of correct responses)	Posttest mean score (Number of correct responses)
Visual representation	17.9	36.4
Symbolic representation	16.7	30
Fraction operation	14.6	17.6

Based on the table, it is clear that Grade 10 students have significant gaps in their understanding of fractions in all aspects of fractions (visual representation, symbolic representation, operations of fraction) with average scores of 17.9, 16.7, and 14.6 respectively.

The findings indicate that students still struggle when the fractions are not common, but they can handle basic tasks. This shows that their knowledge is often shallow or memorized rather than meaningful and flexible. Without a stronger understanding, these students may continue to have difficulty with more advanced math topics that depend on solid fraction sense.

The pre-test scores of controls and experimental group. The pretest results show that the control group had a mean score of 5.18 (23.60%), while the experimental group had a mean of 5.57 (25.32%). This small difference of 0.39 points was found to be statistically insignificant based on an independent samples t-test (t=0.81, p=0.42), indicating that there is no significant difference between the two groups in terms of their prior knowledge of fractions. Based on the mean scores, most of the students in the study still have poor knowledge of fractions that they should have already mastered at the elementary level. Additionally, the Shapiro-Wilk test confirmed that the scores for both groups followed a normal distribution. These results suggest that the random assignment of students to the control and experimental groups was successful and that the groups are comparable in their understanding of fraction sense and operations.

The posttest scores of control and experimental group. The posttest results show a significant difference between the performances of the two groups. The experimental group, which received remediation using the representation construction approach, obtained a much higher mean score of 14.2 compared to the control group's mean score of 5.66.

Table 3
Comparison of pretest performance between the control group (n=38) and the experimental group (n=30)

	Control	Experimental	Total
Below 7	22	22	44
7-12	16	8	24
13-17	0	0	0
18-22	0	0	0
Total	**38**	**30**	**68**
Mean	5.18	5.57	
Standard Deviation	2.22	1.48	
t-Value	0.81		
p-value	0.42		

An independent samples t-test confirmed this difference was statistically significant, with a t-value of 17.1, and a p-value less than .001. This indicates strong evidence to conclude that the experimental group significantly outperformed the control group in the posttest, demonstrating the effectiveness of the representation construction approach in improving students' fraction sense.

The pretest and posttest mean scores of the control group. Table 3 and 4 show the pretest and posttest scores of the students in the control group. Most of the students obtained low score in the pretest, and many of them remained in the same low score range on the posttest. A total of 22 students had pretest scores below 7. Out of these, 20 students remained in the same range in the posttest, and only two (2) students moved up to the 7–12 range. These two students improved by only two points, with their scores going from 5 and 6 in the pretest to 7 in the posttest. Meanwhile, 16 students scored between 7 –12 in the pretest. Half of them (8 students) stayed in the same range, while the other half dropped to the below 7 range on the posttest. There were no students who scored 13 or above on the posttest, and none of the students started with a score higher than 12 in the pretest. This means that the control group showed little to no improvement. In fact, some students performed worse in the posttest.

Table 4
Comparison of posttest performance between the control group (n=38) and the experimental group (n=30)

	Control		Experimental	Total
Below 7	28		0	28
7-12	10		6	16
13-17	0		21	21
18-22	0		3	
Total	**38**		**30**	**68**
Mean	5.66		14.2	
Standard Deviation t-Value	1.49	17.1**	2.58	
p-value		<.001		

*** highly significant at 1% level*

The pretest and posttest results were examined using related sample t-test, with the findings outlined in Table 5. Before conducting the t-test, the Shapiro-Wilk test was administered to test if the scores are normal. The pretest had a p-value of .16 and a W-value of 0.96, while the posttest had a p-value of .07 and a W-value of 0.95. Since both p-values are greater than 0.05, the results showed that both the pretest and posttest scores are normally distributed, meeting the assumption required for the t-test.

The results show that the pretest had an average score of 5.18 with a standard deviation of 2.22, while the posttest had an average score of 5.66 with a standard deviation of 1.49. The mean difference between the two scores is only 0.49. An independent t-test was conducted, resulting in a t-value of 1.09 with 74 degrees of freedom and a p-value of .28. Since the p-value exceeds the 0.05 level of significance, this indicates that there is no statistically substantial difference between the pretest and posttest scores. In other words, there was not enough evidence to prove a substantial change in performance between the two tests.

Table 5
Crosstabulation of the pretest and posttest scores of the control group

Groups	Pretest Score	Posttest Score				
		Below 7	7-12	13-17	18-22	Total
Control	Below 7	20	2			22
	7-12	8	8			16
	13-17					
	18-22					
	Total	28	10			38
Mean	5.18			5.66		
Standard Deviation	2.22			1.49		
t-value			1.09			
p-value			0.28			

The pretest and posttest mean scores of the experimental group. The experimental group had a low pretest mean score of 5.57, but this improved substantially following the researcher's intervention, as evidenced by the posttest mean score of 14.2 shown in Table 6. The mean difference of 8.57 reflects a considerable increase from pre-test to posttest. The Shapiro-Wilk test was used to check if the scores were normal. The pretest has a p=.16, W=0.95, while the posttest has a p=.07, W=0.94. Results have shown that both scores are normally distributed. The results were further analyze using a t-test for related samples, and the test is summarized in Table 6. The p value is less than .001 tells that there is enough evidence to conclude that there was a significant difference between the pre-test and posttest scores of the experimental groups.

The data shows a clear positive trend in student performance after using the representation construction approach activity sheets. Students moved from lower pretest score ranges to higher posttest ranges, indicating improved understanding and retention of concepts. Two students who improved from the lowest range (below 7) to the highest range (18–22) demonstrated their willingness to deepen their understanding by actively asking questions and seeking help from the researcher whenever misconceptions arose in the activity sheets. The students' involvement successfully helped them in understanding fractions.

Table 6
Crosstabulation of the pretest and posttest scores of the experimental group

Groups	Pretest Score	Posttest Score				
		Below 7	7-12	13-17	18-22	Total
	Below 7	0	6	14	2	22
	7-12			7	1	8
Experimental	13-17					
	18-22					
	Total	0	6	21	3	30
Mean	5.57			14.2		
Standard Deviation	1.48			2.58		
t-value			16.4**			
p-value			<.001			

*** highly significant at 1% level*

Moreover, another student who began in the 7-12 range reached the highest range after actively participating in the intervention.

Meanwhile, most students who stayed in the same score range still improved their scores by 2 to 3 points, indicating progress even though they did not move to a higher range.

The mean gain scores of the control and experimental group. To further investigate and have a better comparison of the two groups and eventually draw a conclusion on the effectiveness of the activity sheets using representation construction approach, the mean gain scores of the control group and experimental group were compared. The main gain score of the control group is extensively lower than the experimental group, as shown in Table 7, by 8.13 points. The Shapiro-Wilk test was administered to test the normality of the gain scores of both control and experimental group. The gain score of the control group has a p- value of .68, W= 0.98 while p = .15, W= 0.95 for the experimental group. The results showed that both gain scores were normally distributed. To compare the two groups', mean gain scores, an independent samples t-test was performed. The p-value was less than .001, indicating strong statistical evidence of a substantial difference in the mean gain scores between the two groups. This suggests that the experimental group has improved more than the control group after the conduct of activity sheets that make use representation construction approach. The intervention implemented by the researcher to remediate students' fraction sense had a positive effect.

Table 7
Comparative gain scores of the control and experimental group

Group	Mean	Standard deviation	Mean difference	t	df	p- value
Control	*0.5*	*3.11*	*8.13*	*11.3***	*66*	*<.001*
Experimental	*8.63*	*2.75*				

*** highly significant at 1% level*

Effect size of gain scores of controls and experimental Group. The extent of the effect of the activity sheets (Table 8) was determined from the gain scores of the participants using Cohen's d test. The Cohen's d value obtained was 2.75 which signifies the 'the huge effect' based on the standard set by Cohen. Thus, the activity sheets using the representation construction approach had a highly positive effect on the development of students' fraction sense.

Table 8
Effect size of gain scores of control and experimental Group

Parameter	Cohen's d	Interpretation
Gain Score	2.75	Huge effect

DISCUSSION

The pretest results showed that grade 10 students had difficulties in all three aspects of fraction sense, namely: visual representation, symbolic representation and fraction operation. Among these components, students performed lowest in fraction operation, indicating that the use of fraction concepts in computational task might be difficult for them. This may be because their conception of fractions is still limited to counting parts rather than understanding fractions as ratios. Such limited understanding may have hindered their ability to interpret and manipulate fractions across different representations and operations. These findings indicate the need for instructional approaches that support students in developing a deeper understanding of fractions.

Following the implementation of the representation construction approach, students' posttest scores increased across all aspects of fraction, suggesting that the approach was effective in enhancing students' fraction sense. The findings are consistent with the study of Dayame (2019), which found that students' conceptualization of fractions improved when they received instructional intervention using manipulatives and visual models. The researcher concluded that providing students with relevant instructional interventions and visual models helped improved their comprehension of fraction concepts and enhanced their academic achievement. Similarly, the representation construction approach involves students in constructing, interpreting representations, enabling them to develop a more meaningful understanding of fractions.

The greatest improvements were observed in visual representation, probably because the activities emphasized conceptual understanding rather than procedural computation. By using visual models, students were able to compare, connect, and develop fraction sense as they can recognized the function of fractions. The findings are supported by Barbosa and Vale (2021), who stated that visual tools enhance students' understanding of fractions and improve problem-solving skills. Similarly, Dyson et al. (2018) reported that the use of number lines and fraction bars helped students developed a stronger understanding of fraction magnitude and equivalence by making abstract concepts more concrete. Similar to these findings, the representation construction approach used in the present study provided students with an opportunity to make connections between visual and symbolic representations, enabling them to develop a deeper understanding of fractions rather than relying solely on memorization, which may have contributed to the improvement in their fraction sense.

However, despite these gains, problems involving fraction operations that require procedural knowledge and multi-step reasoning showed minimal improvement. These operation questions consistently recorded the lowest scores and smallest improvements, suggesting that understanding the concept alone was not enough for students to perform difficult calculations with confidence.

Similar findings were reported by Teoh et al. (2020), who reported that students also scored lowest in the area of fraction operation. Likewise, Dyson et al. (2018) noted that although students may comprehend fraction size, they often struggle to use this information when executing fraction arithmetic. The limited improvement implies that although the representation construction approach is successful in developing students' conceptual understanding, procedural proficiency may not always follow. Therefore, students need to be supported with direct teaching and more practice to help them become confident in performing fraction operation.

Conclusion. The findings suggest that there is sufficient statistical evidence to prove that the use of activity sheets anchored in the representation construction approach was effective in improving the fraction sense of students. The approach was specifically beneficial for students who actively raised questions and sought guidance from the researcher. Thus, these students demonstrated the greatest improvement in their score. On the other hand, students who showed minimal interaction in the intervention process did not improve as much as of those who are fully engaged in the activities.

Going back to the items, higher improvement was observed in items that consisted of comparing and representing fractions using visual models and number lines. Students developed a deeper understanding of fractions, as what was shown in these items. Although some improved, they still lacked an understanding of fraction operations like addition, subtraction, multiplication, and division. These findings suggest that some students still struggle with applying what they learned in performing operations with fractions, despite the effectiveness of the approach in certain aspects.

Recommendation. Based on the findings of the study, the recommendations formulated are the following: It is recommended that students will actively use visual models and hands-on activities when learning fractions because the result showed that the representation construction approach helps improve fraction sense. Thus, it is suggested that these strategies will be used for better learning and retention. Teachers are prompted to encourage learners to develop their own representations and to foster a conducive learning environment where students are free to ask questions. The use of representation construction approach is also encouraged as it helps students relate ideas and develop thorough understanding of fraction concepts. Teachers also need to pay attention to students who may need extra supervision and support so that they will be motivated to learn. As for the school leaders, they are encouraged to provide activity sheets even during vacant time or short free periods.

These sheets, especially if anchored on the representation construction approach, will serve as tools for students to practice and better understand fractions. It is also a good idea if teachers or staffs are available to supervise students during these sessions. Future researchers in the same field could try using the representation construction approach in other math topics, such as decimals, ratios, or percentages. They may also test this method in different setting and grade levels to determine whether it benefits other groups of students. Furthermore, strategies to support students who are less engaged and frequently absent during interventions might also be a good subject of investigation. In this way, the approach will be proven effective in different situations and respondents.

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